A Guide on Exploitation of Agricultural Residues in Turkey

ANNEX XIV: Guide
A GUIDE on
EXPLOITATION OF AGRICULTURAL RESIDUES IN TURKEY

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<table>
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INTRODUCTION

This guide is a finding of the project results of entitled "Exploitation of Agricultural Waste in Turkey" by EU Life Third Countries conducted by The University of Cukurova, TUBITAK-MRC, EXERGIA and EMC’s according to WP8's sub task.

One of the main aims of this guide is to increased the usage of the agricultural waste, and makes the results that have been obtained from project mainly in domestic and foreign investors become widespread. The guide has been prepared that including all of the topics in the project as give below:

- Agricultural biomass potential of Turkey
- The Administrative and institutional framework
- Biomass energy policy, law and regulation
- Environmental regulation and limitation
- Identification and assessment of potential policy and market instruments
- Identification of barriers to agricultural waste exploitation and possible Scenarios
- Incentives
- Case studies for utilisation of biomass energy
- Evaluation of investments
- Technology review and assessment
- Building linkages with local actors

It is also expected this study could be a useful guide for domestic and foreign investor and all stakeholders.

1. AGRICULTURAL BIOMASS POTENTIAL OF TURKEY

1.1. Biomass and Bioenergy

Bioenergy is the energy contained in "Biomass". Biomass means any plant-derived organic matter available on a renewable basis. The capture of solar energy as fixed carbon via photosynthesis is the key initial step in biomass production:

\[ \text{CO}_2 + \text{H}_2\text{O} + \text{light} + \text{chlorophyll} + \text{(CH}_2\text{O}) + \text{O}_2 \]

Burning biomass returns the CO2 that was absorbed as the plants grew back to the atmosphere. There is "no net release of CO2" if the cycle of growth and harvest is sustained. Biomass energy systems can be based on a wide range of feedstocks. They use many different conversion
technologies to produce solid, liquid and gaseous fuels. These can then be used to provide heat, electricity and fuels to power vehicles; using burners, boilers, generators, internal combustion engines, turbines or fuel cells.

Power can be generated by:

- Co-firing a small portion of biomass on existing power plants;
- Burning biomass in conventional steam boilers;
- Biomass gasification; and
- Anaerobic digestion.

The same power plants that produce power can also yield useful steam and heat in combined heat and power (CHP). Biomass can be used in fireplaces and kilns to heat homes and at a bigger scale for “district heating”. Unlike other renewable energy sources, biomass can be converted directly into liquid fuels for transport. The two most common biofuels are ethanol and biodiesel.

Biomass includes the biodegradable fraction of products, waste and residues from agriculture (including vegetal and animal substances), forestry and related industries, as well as the biodegradable fraction of industrial and municipal waste. The main biomass sources in use for energy production are: forest residues, agricultural residues, pulp and paper operation residues, animal waste, landfill gas and energy crops. Many of the techniques employed for exploiting biomass have been used for a number of years (e.g. stokers for combustion) while others are only just being tested and demonstrated (e.g. gasification).

Others appear to have good potential for becoming conceivable future techniques, although they have not yet been fully tested (e.g. ethanol from lignocellulose). The techniques of greatest current interest are:

- Direct combustion in boilers
- Advanced thermal conversion of biomass into a secondary fuel by thermal gasification or pyrolysis, followed by use of the fuel in an engine, turbine or fuel cell.
- Biological conversion into methane by anaerobic bacterial digestion
- Thermochemical or biochemical conversion of organic material into hydrogen, methanol, ethanol or diesel fuel.

Biomass fuels are sustainable. The green plants from which biomass fuels are derived fix carbon dioxide as they grow, so their use does not add to the levels of atmospheric carbon. In addition, using refuse as a fuel avoids polluting landfill disposal. Biomass can pay a dual role in greenhouse gas mitigation, both as an energy source to substitute fossil fuels (bioenergy) and as a carbon sink. For example, biomass already contributes 5% of the European Union's (EU) energy
supply, and 65% of the total renewable energy production; predominately for heat and power applications. In the long term, the contribution of biomass in the EU energy supply may increase to 20%, depending on the policies adopted by the EU in relation to agriculture, sustainability, a secure energy supply and Kyoto obligations. Renewable Energy Systems (RES) mainly produce electricity. However, only 20% of current EU energy supply is in the form of electricity - the remaining 80% is in the form of fuels for heating and transport. Biomass is the only RES which produces solid or liquid fuels which could be used as, or transformed into, fuels for heating (in buildings and industry) and transport. In addition, biofuels are one of the few options for a net CO₂-free system for transport applications.

Agricultural and forest residues, as well as purpose-grown energy crops, are among Turkey's major potential energy resources. Use of home-grown resources can significantly reduce Turkey's need to import oil and other fossil fuels and at the same time increase a secure energy supply. The use of biomass contributes to reducing emissions that contribute to climate change, in accordance with the Kyoto Agreement. Fuels derived from biomass contain less sulphur. Properly designed systems using biomass can also reduce other atmospheric pollutants, and thus improve local air quality. Using residues will also improve the local environment, while at the same time planting energy crops on land not required for food production can generate jobs, improve rural economies and help maintain agriculture and forestry.

Because biomass energy systems can be based on a wide range of feedstock and use many different conversion technologies to produce solid liquid and gaseous fuels, the spectrum of their future applications is large. In addition to the current applications, in the future, biomass could play an increasing role throughout combined heat and power (CHP) and transport applications.

Biomass could be a basic element of the world's future renewable energy system. For example, in the long term, biomass has the potential to produce 20% of the EU's energy supply. To realise the potential offered by increased biomass use, Turkey needs to optimise the use of the agricultural and forest residues, to introduce energy crops and to adopt cost-effective, environmentally friendly processes, which are attractive to investors and acceptable to planning authorities and the general public.

The principal objective for future biomass research should be to develop cost-effective integrated approaches from biomass collection to fuel production and use, which take sustainable biomass procurement and market opportunities into account. Sustainable biomass should be taken into account in any future development. Research should also include an investigation into the socio-economic and environmental impacts of biomass energy.

If biomass is to play a strong role in the energy market this will require an adequate infrastructure in order to assure a steady supply. At present, significant residues are available for emerging biomass energy schemes. However, as they are insufficient, an investment is needed to
encourage biomass production. Financiers and planners need to know where best to direct investment and how to respond to, and overcome, objections. The public need to be aware of and accept the benefits of energy from biomass schemes. There are still technology challenges to achieve the mass commercialisation of bioenergy in some sectors; e.g. co-firing, CHP and transport. Moreover, researchers and developers have to recognise the key issues to be addressed so that systems with improved conversion efficiencies and better economics can reach the market place.

1.2. Agricultural Biomass Potential of Turkey

Historically, the agricultural sector has been Turkey’s largest employer and a major contributor to the country’s GDP, exports and industrial growth. As the country develops agriculture declines in importance, however it still accounts for a relatively larger share of total output and employment than in many other countries. Indicatively, the export of agricultural commodities (excluding agro-industry) for 1995 has been 2.3 billion USD, 10.7% of total Turkish exports. Agriculture accounted for 16.4% of the country’s GDP for the same year.

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 burnt in open-air fires or disposed of to decay. Either case, they give rise to significant environmental impacts while at the same time useful resources are wasted in the expense of imported fuels.

The present project has been designed to address this need, in other words strengthen the capacity of the Turkish administration to deal with the sustainable exploitation of agricultural waste. The main driver will be the development of a strategy to coordinate actions towards the alleviation of existing barriers, be they administrative, legislative or technological. Other significant dimensions of the project are the comprehensive mapping of the exploitable potential in Turkey, the training and support of trainers in order to build the necessary capacity at regional level, the setup of a supporting framework for investors and a rich dissemination campaign targeting a wide range of stakeholders.

The potential benefits of the project are significant since the exploitation of agricultural waste is actually a win-win case. The major benefits are environmental and relate to the reduction of GHG emissions (since crops are considered CO2 neutral), conservation of natural resources, and avoidance of fossil fuel consumption. They are complemented by economic benefits (reduction of imported fuel consumption), regional development and investment increase.

Although some scopes may exist for developing energy plantations, experience elsewhere indicates that close attention must be paid to issues of sustainability; management, cost and the contribution to Turkey’s long-term energy requirements would be modest. Nevertheless, taking biomass potential in aggregate, it appears that Turkey could increase its renewable usage significantly in addition to the current extensive exploitation of hydropower resources using larger hydropower plants.
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Turkey is an energy importing country. More than about 60% of energy consumption in the country is met by imports and the share of imports continues to grow each year. Therefore, it is critical to supply its energy demand by using domestic non-renewable resources (such as lignite, hard coal, oil and natural gas) and renewable resources. Renewable energy resources (solar, hydroelectric, biomass, wind, ocean and geothermal energy) are inexhaustible and offer many environmental benefits over conventional energy sources. Each type of renewable energy also has its own special advantages that make it uniquely suited to certain applications. Almost none of them release gaseous or liquid pollutants during operation. In their technological development, the renewable ranges from technologies that are well established and mature to those that need further research and development. The other important factor of renewable resources is to create new employment opportunities.

Turkey’s geographic location has several advantages for extensive use of most of the renewable energy sources. It is on the humid and warm climatic belt which includes most of Europe, the near east and western Asia. A typical Mediterranean climate is predominant at most of its coastal areas, whereas the climate at the interior part between the mountains that are a part of the Alpine Himalayan mountain belt is dry with typical steppe vegetation.

Biomass energy includes agricultural residues, municipal wastes, fuel wood, animal wastes and other fuel derived from biological sources. The estimate is based on the recoverable energy potential from main agricultural residues, livestock farming wastes, forestry and wood processing residues and municipal wastes as given in the literature. The total recoverable bioenergy potential is estimated to be about 16.92 Mtoe. The biomass energy production for the year 2001 is 6.98 Mtoe [9]. Comprising mostly wood and dung for heating and cooking, it is mainly used in rural areas.

The agricultural total land of Turkey is about 26.350 million ha, from which: 38.4% sown area, 44.1% forest, 10.4% fallow land, 7.1% cultivated with fruit and vegetable areas. Cereals, oily seeds and tuber crops are among the most widespread in Turkey. Cereals are extensively grown in the central, eastern and southern parts of Turkey, whereas sunflower is prevalent in the region of Thrace (N-W Turkey). Cotton with maize are the dominant crops in the south (the SE Anatolian regions), and the west (the Aegean region). Tubers are widely produced in the Marmara (potatoes) and Central Anatolian (potatoes and sugar beet) regions. The highest estimated amounts of residues are of wheat and barley followed by maize and cotton. The total annual amount of agricultural residues in the country is about 50-65 Mtons.

Agricultural residues have been considered in three categories:

1. Annual crop residues that remain in the field after the crops are harvested. The main annual crops in Turkey are cereals, maize, cotton, rice, tobacco, sunflower, groundnuts, soybeans,

2. Perennial residues in Turkey that remain in the field after pruning of trees, shells, kernels etc.
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3. Agro-industrial residues such as; cotton-ginning, seed oil industries, olive oil industries, rice industries, corn industries, wine and kernel factories.

Residues left over the field after agricultural production. Cereal straw is used for various purposes such as animal feeding and animal bedding. Mainly residues from the production of industrial agricultural products are left over the field. The species are cotton stalk, corn stalk, sunflower stalk, straw and tobacco stalk etc. The main types of agro-industrial residues that can be used for energy production in Turkey are the residues from the cotton ginning factories, seed oil industries, and olive oil and olive kernel factories.

Total annual field crops production and residues in Turkey was represented in Table 1.1. Total calorific value is 228 PJ. The major crops that take place in the ratio of total calorific value are maize 33.4%, wheat 27.6%, and cotton 18.1%. Table 1.2 shows the total annual fruit production and residue in Turkey. Total calorific value is 75 PJ. The major crops that take place in the ratio of total calorific value are hazelnut 55.8%, and olive 25.9%.

Table 1.1. Total field crops production and residues in Turkey

<table>
<thead>
<tr>
<th>Crops</th>
<th>Residues</th>
<th>Production (tons)</th>
<th>Area (ha)</th>
<th>Yield (kg/ha)</th>
<th>Total Residues (tons)</th>
<th>Available Residues (tons)</th>
<th>Availability (%)</th>
<th>Calorific Value (MJ/kg)</th>
<th>Total Calorific Value (GJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wheat Straw</td>
<td>22,439,042</td>
<td>9,424,785</td>
<td>2,381</td>
<td>291,707,550</td>
<td>23,429,907</td>
<td>3,514,486</td>
<td>15</td>
<td>17.9</td>
<td>629,093,000</td>
</tr>
<tr>
<td>Barley Straw</td>
<td>8,327,457</td>
<td>37,329,922</td>
<td>2,231</td>
<td>9,992,948</td>
<td>8,963,012</td>
<td>1,344,452</td>
<td>15</td>
<td>17.5</td>
<td>235,279,008</td>
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<td>Rye Straw</td>
<td>253,243</td>
<td>145,907</td>
<td>1,736</td>
<td>405,188</td>
<td>358,040</td>
<td>53,706</td>
<td>15</td>
<td>17.5</td>
<td>939,855</td>
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<td>Oats Straw</td>
<td>322,830</td>
<td>150,459</td>
<td>2,146</td>
<td>419,678</td>
<td>321,236</td>
<td>48,185</td>
<td>15</td>
<td>17.4</td>
<td>838,425</td>
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<td>Maize Stalks</td>
<td>2,209,601</td>
<td>565,109</td>
<td>3,910</td>
<td>5,911,902</td>
<td>4,970,259</td>
<td>2,982,155</td>
<td>60</td>
<td>18.5</td>
<td>551,698,73</td>
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<td>596,592</td>
<td>1,907,307</td>
<td>1</td>
<td>18.4</td>
<td>210,566,67</td>
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<td>Millet Stalks</td>
<td>7,283</td>
<td>3,605</td>
<td>2,020</td>
<td>10,196</td>
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<tr>
<td>Rice Straw</td>
<td>331,563</td>
<td>59,879</td>
<td>5,537</td>
<td>582,555</td>
<td>209,532</td>
<td>125,719</td>
<td>60</td>
<td>16.7</td>
<td>2,099,510</td>
</tr>
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<td>Husk</td>
<td></td>
<td></td>
<td></td>
<td>88,527</td>
<td>77,747</td>
<td>62,198</td>
<td>80</td>
<td>12.9</td>
<td>807,327</td>
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<td>Tobacco Stalks</td>
<td>181,382</td>
<td>222,691</td>
<td>814</td>
<td>362,763</td>
<td>410,778</td>
<td>246,467</td>
<td>60</td>
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<td>Cotton Stalks</td>
<td>2,292,988</td>
<td>680,177</td>
<td>3,371</td>
<td>6,317,181</td>
<td>2,520,281</td>
<td>1,512,169</td>
<td>60</td>
<td>18.2</td>
<td>27,521,470</td>
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<td>Ginning residue</td>
<td>481,527</td>
<td>732,220</td>
<td>585,776</td>
<td>80</td>
<td>15.6</td>
<td>9,167,391</td>
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<td>Sunflower Stalks</td>
<td>836,260</td>
<td>545,963</td>
<td>1,532</td>
<td>2,341,554</td>
<td>2,259,121</td>
<td>1,355,472</td>
<td>60</td>
<td>14.2</td>
<td>192,747,09</td>
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<td>Groundnuts Straw</td>
<td>55,241</td>
<td>25,167</td>
<td>2,195</td>
<td>127,054</td>
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<tr>
<td>Shell</td>
<td>27,621</td>
<td>28,638</td>
<td>22,910</td>
<td>80</td>
<td>20.7</td>
<td>475,155</td>
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<tr>
<td>Soybeans Straw</td>
<td>28,795</td>
<td>15,064</td>
<td>1,912</td>
<td>60,468</td>
<td>21,872</td>
<td>13,123</td>
<td>60</td>
<td>19.4</td>
<td>254,595</td>
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Table 1.2. Total fruit production and residues in Turkey

<table>
<thead>
<tr>
<th>Crops</th>
<th>Residues</th>
<th>Production (tons)</th>
<th>Number of trees</th>
<th>Total Residues (tons)</th>
<th>Available Residues (tons)</th>
<th>Availability (%)</th>
<th>Calorific Value (MJ/kg)</th>
<th>Total Calorific Value (GJ)</th>
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<tr>
<td></td>
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</tr>
<tr>
<td>Apricots</td>
<td>Shells</td>
<td>467,903</td>
<td>11,288,357</td>
<td>1,328,846</td>
<td>86,964</td>
<td>69,571</td>
<td>80</td>
<td>19.3</td>
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<tr>
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<td>Tree</td>
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<td></td>
<td>39,916</td>
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<tr>
<td>Sour cherries</td>
<td>Shells</td>
<td>114,466</td>
<td>4,446,680</td>
<td>137,359</td>
<td>21,400</td>
<td>17,120</td>
<td>80</td>
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<tr>
<td>Olive</td>
<td>Cake</td>
<td>1,496,630</td>
<td>90,208,994</td>
<td>673,484</td>
<td>829,816</td>
<td>746,834</td>
<td>90</td>
<td>20.69</td>
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<td>Tree</td>
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<td>441,254</td>
<td>220,627</td>
<td>50</td>
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<td>Pistachios</td>
<td>Shells</td>
<td>42,926</td>
<td>29,600,005</td>
<td>14,007</td>
<td>4,202</td>
<td>30</td>
<td>19.26</td>
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<td>Walnuts</td>
<td>Shells</td>
<td>115,698</td>
<td>3,737,868</td>
<td>173,546</td>
<td>75,792</td>
<td>60,633</td>
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<td>50,480</td>
<td>25,240</td>
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<td>Tree</td>
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<td>13,076</td>
<td>28,500</td>
<td>22,800</td>
<td>80</td>
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<tr>
<td>Hazelnuts</td>
<td>Shells</td>
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<td>286,697,887</td>
<td>698,499</td>
<td>566,437</td>
<td>453,150</td>
<td>80</td>
<td>19.3</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td></td>
<td></td>
<td>2,177,986</td>
<td>1,742,389</td>
<td>1,423,594</td>
<td>80</td>
<td>19</td>
</tr>
<tr>
<td>Lemons</td>
<td>Peel</td>
<td>475,159</td>
<td>5,529,038</td>
<td>236,852</td>
<td>88,465</td>
<td>70,772</td>
<td>80</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Oranges</td>
<td>Peel</td>
<td>1,180,851</td>
<td>11,884,275</td>
<td>3,424,439</td>
<td>237,686</td>
<td>190,148</td>
<td>80</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mandarin</td>
<td>Peel</td>
<td>592,884</td>
<td>8,619,163</td>
<td>918,970</td>
<td>103,430</td>
<td>82,744</td>
<td>80</td>
<td>17.6</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Grapefruits</td>
<td>Peel</td>
<td>126,285</td>
<td>894,293</td>
<td>14,309</td>
<td>11,447</td>
<td>80</td>
<td>17.6</td>
<td>201,466</td>
</tr>
<tr>
<td></td>
<td>Tree</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 1.3 illustrates the number of animals, waste quantity and calorific values of animal wastes in Turkey. The number of cows, sheep and poultry in Turkey per year is approximately 13, 30 and 265 million, respectively. With these amounts, the capacities of waste quantities are 128, 25 and 8 million tons per year. Considering dry manure ratio (as percentage) for cows, sheep and poultry to be 12.7, 25 and 25%, respectively, the amounts of total dry manure were determined as 16.2, 6.1 and 1.9 tons per year. Total amount of available dry manure was determined by taking the availability of the manures on the site as 65, 13 and 99% respectively. Thus, the total available dry manure was determined by multiplying total dry manure with availability. Ratio of dry manure to biogas is 200 m³ per tons for cow, sheep and poultry manure. And, calorific values are 22.7 MJ/m³. Therefore, the total calorific values for cow, sheep and poultry wastes in Turkey were found to be approximately 47.8, 3.6 and 8.7 million GJ/year, respectively.

Table 1.3. Total number of animals, amount of animal wastes and calorific values of the wastes for Turkey

<table>
<thead>
<tr>
<th>Animal Waste</th>
<th>Animal Number</th>
<th>Waste Quantity (tons/year)</th>
<th>Total Dry Manure (tons/year)</th>
<th>Availability (%)</th>
<th>Available Dry Manure (tons/year)</th>
<th>Available Biogas (m³/year)</th>
<th>Calorific Value (MJ/m³)</th>
<th>Total Calorific Value (GJ/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cow</td>
<td>12,838,285</td>
<td>127,645,932</td>
<td>16,211,033</td>
<td>65</td>
<td>10,537,172</td>
<td>2,107,434,345</td>
<td>22.7</td>
<td>47,838,760</td>
</tr>
<tr>
<td>Sheep</td>
<td>29,903,590</td>
<td>24,558,323</td>
<td>6,139,581</td>
<td>13</td>
<td>798,146</td>
<td>159,629,101</td>
<td>22.7</td>
<td>3,623,581</td>
</tr>
<tr>
<td>Poultry</td>
<td>264,784,050</td>
<td>7,731,694</td>
<td>1,932,924</td>
<td>99</td>
<td>1,913,594</td>
<td>382,718,866</td>
<td>22.7</td>
<td>8,687,718</td>
</tr>
</tbody>
</table>
1.3. Regional Distribution of Agricultural Biomass Potential in Turkey

Turkey consists of seven regions. These are Mediterranean Region, Aegean Region, Marmara Region, Central Anatolian Region, Eastern Anatolian Region, South-eastern Anatolian Region, and Black Sea Region.

**Mediterranean Region:** The total calorific value of field crops residues is around 57 PJ in this region. The major crops that take place in the ratio of total calorific value are maize 63.9%, cotton 19.5%, and wheat 12.5%. The total calorific value of fruit production residue is 8 PJ in Mediterranean Region. The major crops that take place in the ratio of total calorific value are citrus 61% and olive 30.8%. The number of cows, sheep and poultry in this region per year is approximately 0.89, 1.86 and 29.3 million, respectively. With these amounts, the capacities of waste quantities are 8.85, 1.52 and 0.86 million tons per year. Therefore, the total calorific values for cow, sheep and poultry wastes in Mediterranean Region were determined to be approximately 3.32, 0.23 and 0.96 million GJ/year, respectively.

**Aegean Region:** The total calorific value of field crops residues is around 24.2 PJ in this region. The major crops that take place in the ratio of total calorific value are cotton 29.2%, wheat 25.4% and maize 20.4%. The total calorific value of fruit production residue is 15.3 PJ in this region. The major crops that take place in the ratio of total calorific value are olive 86.5% and citrus 7.6%. The number of cows, sheep and poultry in this region per year is approximately 1.27, 2.9 and 28.9 million, respectively. With these amounts, the capacities of waste quantities are 12.6, 2.38 and 0.84 million tons per year. Therefore, the total calorific values for cow, sheep and poultry wastes in Aegean Region were determined to be approximately 4.736, 0.35 and 0.95 million GJ/year, respectively.

**Marmara Region:** The total calorific value of field crops residues is around 41 PJ in this region. The major crops that take place in the ratio of total calorific value are maize 36.7%, sunflower 36.5% and wheat 18.2%. The total calorific value of fruit production residue is 9.5 PJ in this region. The major crops that take place in the ratio of total calorific value are hazelnut 65.9% and olive 28.5%. The number of cows, sheep and poultry in this region per year is approximately 1.07, 2.21, and 57.7 million, respectively. The data as seen in the table shows that the total calorific values for cow, sheep and poultry wastes in Marmara Region were approximately 4.01, 0.27 and 1.89 million GJ/year, respectively.

**Central Anatolian Region:** The total calorific value of field crops residues is around 31.3 PJ in this region. The major crops that take place in the ratio of total calorific value are wheat 58.5%, barley 32.1% and sunflower 5.2%. The total calorific value of fruit production residue is 1 PJ in this region. The major crops that take place in the ratio of total calorific value are apricots 47.7% and walnut 20.6%. The number of cows, sheep and poultry in this region per year is approximately 1.8, 6.4 and 37.4 million, respectively. The total calorific values for cow, sheep and poultry wastes in Central Anatolia Region were approximately 6.85, 0.77 and 1.228 million GJ/year, respectively.

**Eastern Anatolian Region:** The total calorific value of field crops residues is around 8.2 PJ in this region. The major crops that take place in the ratio of total calorific value are wheat 68.6%,
barley 24.8% and tobacco 2.1%. The total calorific value of fruit production residue is 0.94 PJ in this region. The major crops that take place in the ratio of total calorific value are apricots 61.3% and walnut 28%. The number of cows, sheep and poultry in this region per year is approximately 2.47, 10.29 and 14.02 million, respectively. The total calorific values for cow, sheep and poultry wastes in Eastern Anatolia Region were approximately 9.21, 1.25 and 0.46 million GJ/year, respectively.

**South-eastern Anatolian Region:** The total calorific value of field crops residues of is around 37.1 PJ in this region. The major crops that take place in the ratio of total calorific value are cotton 49.5%, wheat 28.3% and barley 13.3%. The total calorific value of fruit production residue is 4 PJ in this region. The major crops that take place in the ratio of total calorific value are pistachios 72.9% and olive 22.3%. The number of cows, sheep and poultry in this region per year is approximately 0.66, 3.98 and 5.22 million, respectively. The total calorific values for cow, sheep and poultry wastes in South-eastern Anatolia Region were approximately 2.47, 0.48 and 0.17 million GJ/year, respectively.

**Black Sea Region:** The total calorific value of field crops residues of is around 29.6 PJ in this region. The major crops that take place in the ratio of total calorific value are maize 56.9%, wheat 26.5% and barley 7%. The total calorific value of fruit production residue is 36.1 PJ in this region. The major crops that take place in the ratio of total calorific value are hazelnuts 98.3% and walnuts 1.2%. The number of cows, sheep and poultry in this region per year is approximately 4.62, 2.24 and 92.03 million, respectively. The total calorific values for cow, sheep and poultry wastes in Black Sea Anatolia Region were approximately 17.22, 0.27 and 3.02 million GJ/year, respectively.

### 2. STUDY OF THE ADMINISTRATIVE AND INSTITUTIONAL FRAMEWORK

Administrative and Institutional Framework was considered for the three relevant governmental areas: Agriculture, Environment, and Energy. Relevant institutions in each area are identified below.

#### 2.1. Agricultural Policy Institutions

The Ministry of Agriculture and Rural Affairs is the main body for the formation and implementation of agricultural policy. The Ministry of Agriculture and Rural Affairs addresses activities such as irrigation, land improvement, village road construction, forest road construction, provision of drinking water, and afforestation.

#### 2.2 Environmental Policy Institutions

The Ministry of Environment and Forestry is the main body for the formation and implementation of environmental policy. The Ministry of Environment and Forestry addresses activities related to environmental protection and prevention/remediation of contamination. This includes defining and implementing environmental policy; monitoring air emission sources; taking
2.3 Energy Policy Institutions

The Ministry of Energy and Natural Resources is the main body for the formation and implementation of energy policy in general and renewable energy in particular. The Electric Power Resources Survey and Development Administration (EIEI) carry out investigations and surveys to identify the energy potential of water, wind, and solar energy resources. If large hydropower generation potential is located and considered for realization in the renewable energy group, the Directorate General of State Hydraulic Works (DSI) is the main implementing organization.

The main state organizations having responsibility for planning the energy policy in Turkey are given in Table 2.1.

Table 2.1. Main state organizations having responsibility for planning Turkish energy policy

<table>
<thead>
<tr>
<th>Organization Name</th>
<th>Under the Responsibility of:</th>
</tr>
</thead>
<tbody>
<tr>
<td>DPT, State Planning Organization</td>
<td>Prime Minister</td>
</tr>
<tr>
<td>TUBITAK, Scientific and Technical Research Council of Turkey</td>
<td>Prime Minister</td>
</tr>
<tr>
<td>Research, Planning and Co-ordination Board</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>Directorate General for Energy Affairs</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>Directorate General of Mining Affairs</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>Directorate General of Petroleum Affairs</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TEUAS, Turkish Electricity Generation Company</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TEIAS, Turkish Electricity Transmission Company</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TEDAS, Turkish Electricity Distribution Company</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TETTAS, Turkish Electricity Trading and Contractor Company</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>DSI, Directorate General of State Hydraulic Works</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TPAO, Turkish Petroleum Company</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>EIEI, Electric Power Resources Survey and Development Administration</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>BOTAS, Turkish Pipeline Corporation</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>TKI, Turkish Coal Enterprises</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
<tr>
<td>Turkish Hard Coal Enterprises (TTK)</td>
<td>Ministry of Energy and Natural Resources</td>
</tr>
</tbody>
</table>

The above directorate generals are operating under the Energy and Natural Resource Minister and his Undersecretary. Therefore, the main body responsible for energy policy is the Ministry of Energy and Natural Resources. All groups receive directives from Ministry and implement the policy accordingly. As indicated above, there is a separate Department of Energy Directorate General, which...
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reports to the Minister and his Undersecretary. The Energy and Natural Resource Minister reports their works to the Prime Minister.

There are also some non-Ministerial agencies with responsibilities for various aspects of energy policy (Table 2.2).

Table 2.2. Non-Ministerial agencies with responsibilities for various aspects of energy policy

<table>
<thead>
<tr>
<th>Regulation or Policy Category</th>
<th>Involved Organization(s)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy policy and/or regulation</td>
<td>Energy Market Regulatory Authority</td>
</tr>
<tr>
<td>Nuclear power</td>
<td>Turkish Atomic Energy Authority (state organization)</td>
</tr>
<tr>
<td>Energy efficiency</td>
<td>TUBITAK MRC Energy Institute (state organization)</td>
</tr>
<tr>
<td></td>
<td>Various Universities (presenting reports, organizing meetings and courses)</td>
</tr>
<tr>
<td>Energy standards</td>
<td>TSE, Turkish Standardization Institute</td>
</tr>
<tr>
<td></td>
<td>IEC, International Electro technical Commission</td>
</tr>
<tr>
<td>- R&amp;D</td>
<td>Energy Systems &amp; Environmental Research Institute / Marmara Research Centre</td>
</tr>
<tr>
<td>Renewable energy</td>
<td>Clean Energy Foundation</td>
</tr>
<tr>
<td></td>
<td>Turkish Wind Energy Association</td>
</tr>
<tr>
<td></td>
<td>International Solar Energy Society Turkish Section</td>
</tr>
<tr>
<td></td>
<td>Geo-thermal Energy Association</td>
</tr>
</tbody>
</table>

3. BIOMASS ENERGY POLICY, LAW and REGULATION

3.1 Energy Policies and Objectives

There are three type of investment and operation model in Turkey. These are: build-own-operate (BOO), build-operate-transfer (BOT), and build-operate (BO). Legislation was adopted in February 2001 to allow competition in the electricity market and adapt Turkey’s legislation for European Union (EU) membership. This legislation is called the Free Market Law of Electricity. A new Gas Market Law was adopted in May 2001 for the same purposes.

➢ The main objectives of Turkey’s current energy policy, including renewable energy considerations are [1]:

- To meet demand using domestic energy resources as the highest priority. In the medium and long term, this is to occur through a mix of public, private, and foreign capital.
- To develop existing sources while accelerating the penetration of new and renewable sources.
- To diversify energy sources and to avoid dependence on energy imports from a single source or country.
- To encourage private-sector investment and to accelerate capacity construction and privatization in the power industry. Preparations are to be made for the introduction of nuclear power.
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- To improve the reliability of electricity supply through upgrades in the power transmission and distribution grid.
- To improve energy efficiency in end-use and transformation, e.g. through reduction of losses in energy production, transmission, and consumption.
- To protect the environment and public health.

To make use of Turkey’s geopolitical location to establish the country as a pivotal transit area for international oil and gas trade (“Eurasia energy corridor”).

3.2 Law and Regulations in Turkey

Existing Turkish law and regulation with relevance to the use of renewable energy source is legislation and a law. Both of them have been developed for the electricity sector. The regulation is the Electricity Market Licensing Regulation, which has incentives to encourage the use of renewable energy sources. The law is on the Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy.

The Electricity Market Licensing Regulation: The regulation has some incentives is to increase the usage of renewable energy sources.

The Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy

In both regulations, biomass (i.e. the energy resource category relevant to agricultural waste exploitation) is included in the definition of renewable energy resource. No legislation currently exists for biomass alone.

3.2.1 The Electricity Market Licensing Regulation

The objective of this Regulation is to set forth the principles and procedures regarding the licenses to be granted to the legal entities who shall be acting in a competitive environment, governed by private law, in a financially sound, stable and transparent electricity market to be formed as stipulated by the Electricity Market Law no: 4628, with the purpose of delivering sufficient, good quality, uninterrupted, low cost and environmentally friendly provision of electricity to consumers.

This Regulation covers the provisions to be included in the licenses to be obtained by legal entities who are or will be engaged in generation, transmission, distribution, wholesale, retail and retail services, import, and export activities in the electricity market, and the principles and procedures applicable to the granting, modification, renewal, termination and cancellation of licenses and the rights and obligations of the licensees.

A license is an authorization document that a legal entity should be granted by the Authority in order to operate in the market. All legal entities shall obtain separate licenses for each activity they are engaged in, and for each facility where the same activity is conducted. Legal entities willing to engage in generation business under the same name in different facilities can only be granted one type of license among generation, Autoproducer or Autoproducer group licenses.
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Types of Licenses

The following licenses can be obtained from the Authority based on fields of activity (Article 6): Generation license, Autoproducer license, Autoproducer group license, Transmission license, Distribution license, Wholesale license, Retail license.

Effectiveness of Licenses, License Fees

License Applications

All legal entities subject to private law and applying for a license in order to operate in the market, are required to have been established as joint stock or limited liability companies in accordance with the provisions of the Turkish Commercial Code no. 6762 (Article 7).

In cases where in the applications for generation, autoproducer and autoproducer group licenses, the establishment of a generation facility to generate electricity from domestic natural resources such as; lignite, hard coal, bituminous schist, asphaltite, geothermal, wind, waves, tide and solar energy is desired, the applicants shall document that; For lignite, hard coal, asphaltite, bituminous schist and geothermal resources: The applicants shall demonstrate that they have signed the fuel supply agreement regarding the energy resource to be used or have acquired the right of use for the energy resource or other real rights (real property rights) or that such rights have been guaranteed by the authorized real persons or legal entities.

The license applications shall be concluded within sixty days following the commencement of the review and evaluation process. If deemed necessary, that period may be extended for a maximum of 180 days and the time extension shall be notified to the related applicant (Article 10).

The results of the review and evaluation process conducted by the Authority shall be submitted to the Board and the license application shall be concluded with a Board decision. In cases where the license applications are rejected with a Board decision, the grounds for that rejection shall also be notified in writing to the related legal entities within five working days following the Board decision.

The legal entities that are deemed eligible for obtaining a license as a result of the review and evaluation process, shall be notified in writing that in order to be granted the related licenses, they must, within ninety days following the Board decision;

a) Amend their main charters as required,

b) Submit to the Authority the document proving that they have paid the remaining amount of the licensing fee in the account of the Authority.

The legal entities fulfilling the requirements indicated in this Article shall be granted the related license by a Board decision. The commercial title of the legal entity and the type and term of the license shall be published in the Official Gazette and publicized in the website of the Authority.

Effectiveness of Licenses

The licenses shall become effective as of the dates indicated on each license and the rights and obligations of the licensees within the scope of their licenses shall be effective as of that date (Article 11).
License fees
The Board shall determine the licensing fees, annual license fees, license renewal fees, license modification fees and license duplication fees which shall be applicable for the following year and shall be deposited in the account of the Authority by the legal entities operating in the market by the end of August of every year and announces such fees in the Official Gazette and on the website of the Authority (Article 12).

The licensing fee shall be determined according to the field or size of the activity as a fixed price, annual license fees shall be determined relatively according to the amount of electricity generated, transmitted, distributed, sold in wholesale or retail and according to the fields of activity. Such fees shall be paid in line with the provisions of this Regulation.

The license renewal fees, license modification fees and license duplication fees shall be paid in cash.

The legal entities applying for licenses for construction of facilities based on domestic natural resources and renewable energy resources shall only pay one percent of the total licensing fee. The generation facilities based on renewable and domestic energy resources shall not pay annual license fees for the first eight years following the facility completion date inserted in their respective licenses. The provisions of this paragraph shall not be applicable for generation facilities based on domestic natural resources and renewable resources that are operating or will operate within the scope of existing contracts and autoproducer and autoproducer group contracts signed by the Ministry after the effective date of the Law in line with the provisions of item (a);(3) of provisional article 3 of the Law.

Renewal of Licenses
Upon the request of the licensees, the licenses may be extended each time for forty nine years at most, after the completion of the license term in effect with due regard to the minimum limits set forth in the Law (Article 14).

The written applications for license renewals shall be filed with the Authority a year at the earliest and nine months at the latest before the completion of the license term in effect.

Expiration of Licenses
The licenses shall automatically expire if the license holder is declared bankrupt or at the end of their terms unless extended. The cancellation of licenses upon the request of the license holders shall be subject to Board decision (Article 15).

Cancellation of Licenses
The licenses may be cancelled within the framework of the provisions of Article 11 of the Law (Article 16).

The distribution licenses and the main charters of the distribution licensees shall include the provision that in cases where it becomes mandatory to revoke a distribution license:

a) In order to ensure that the licensed facilities be partially or wholly assigned for use of other legal entities, a Board decision taken before the cancellation of the license may temporarily change the members of the executive board of the licensee by replacing them partially or completely,
b) If the facilities within the distribution area operated by the distribution licensee are owned by the related distribution licensee, the facilities owned by the distribution licensee shall be transferred at the price determined in the tender to be held on behalf of the related licensee by the Authority within one hundred and twenty days within the framework of the legislation.

Excluding the general force majeure defined in this Regulation and the specific force majeure defined in the related licenses; in case there is a delay that exceeds half of the period between the facility completion date and the license grant date inserted in generation, autoproducer group licenses and autoproducer licenses based on renewable and domestic resources, or upon the evaluation of progress reports submitted to the Board if it is evident that the facility completion date cannot be met even the half of the completion period is considered the license shall be cancelled. In case the license provisions envisage the completion of different units at different dates, this provision shall be enforced separately for each unit of generation facilities based on renewable energy resources.

**Market activities to be performed under Generation Licenses**

The generation licensees may engage in the activities of construction and commissioning of generation facilities, electricity generation, and sale of the generated electricity and/or capacity to customers (Article 17).

The generation companies may enter into affiliate relationships with distribution companies without having control over them.

The total share of any private sector generation company, together with its affiliates, in the market may not exceed twenty percent of the total installed capacity of Turkey for the previous year, as published by TEIAS.

The legal entities engaged in generation activity at facilities based on renewable energy resources may purchase electricity from private sector wholesale companies on the condition not to exceed the annual average generation amounts indicated in their licenses in a calendar year.

**Terms of Generation Licenses**

The generation licenses can be issued for a maximum of forty-nine years and a minimum of ten years, at a time.

**Market activities that may be performed under Retail Licenses**

The retail licensees may engage in the sale of electricity and/or capacity to consumers in the market. The retail licensees may also be engaged in import of electricity and/or capacity at the distribution level provided that their licenses contain the relevant provisions (Article 30).

The retail licensees shall be engaged in retail and retail services without any limitation of regions. The distribution companies holding retail licenses shall only be entitled to sell electricity and/or capacity to eligible consumers located within the authorized area of another distribution region, provided that their retail licenses include related provisions.
The retail licensees may not be engaged in any other market activity other than those indicated herein. The activities that may be performed by retail licensees without requiring further Board approval shall be indicated in their licenses.

Applicable for sales to non-eligible consumers; if the price of electricity generated at generation facilities based on renewable energy resources is equal to or lower than the sales price of TETAŞ and if there is no cheaper alternative, the retail licensees shall be obliged purchase such energy for the purposes of re-sale to the non-eligible consumers.

System access and system use rights

TEIAS and/or distribution licensees shall assign priority for system connection of generation facilities based on domestic natural resources and renewable resources.

3.2.2 Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy

There exist a law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy date 10.5.2005 and No: 5346

The purpose of this Law is to expand the utilization of renewable energy resources for generating electrical energy, to benefit from these resources in secure, economic and qualified manner, to increase the diversification of energy resources, to reduce greenhouse gas emissions, to assess waste products, to protect the environment and to develop the related manufacturing sector for realizing these objectives.

The Law encompasses the procedures and principles for conservation of the renewable energy resource areas, certification of the energy generated from these resources and utilization of these resources.

The terms used in this Law are defined as follows;

**Renewable energy resources:** Non-fossil energy resources such as hydraulic, wind, solar, geothermal, biomass, biogas, wave, current and tidal energy,

**Renewable energy resources in the scope of this Law:** The electrical energy generation resources suitable for wind, solar, geothermal, biomass, biogas, wave, current and tidal energy resources together with hydraulic generation plants either canal or run of river type or with a reservoir area of less than fifteen square kilometres,

**Biomass:** The fuels in solid, liquid or gaseous phase obtained from organic wastes and from the agricultural and forestry products including the waste products of agricultural harvesting and oil extraction from plants as well as from the by products formed after their processing,

**Turkish average wholesale electricity price:** The average of the wholesale prices of electricity calculated by EMRA and applied in the country annually.

Identification, conservation and utilization of the resource areas

**Renewable Energy Resource Certificate**

The legal entity holding generation license shall be granted by EMRA with a “Renewable Energy Resource Certificate” (RES Certificate) for the purpose of identification and monitoring of the
resource type in purchasing and sale of the electrical energy generated from renewable energy resources in the domestic and international markets (Article 5).

Principles of Implementation

The legal entities holding licenses to generate and transact electricity from the renewable energy resources in the scope of this Law are subject to the principles of implementation specified hereunder (Article 6):

a) The electrical energy generated from the renewable energy resources in the scope of this Law shall be purchased by the legal entities holding retail sale license on the basis of bilateral agreements to be concluded in pursuance with the provisions of paragraphs (b), (c) and (d) of this article.

b) Within the framework of prepared projection by the Ministry, the relevant information on amount of RES certified electrical energy, which shall utilize the implementations in the scope of this Law, shall be issued by EMRA annually. Each legal entity holding retail sale license shall be entitled to purchase RES certified electrical energy in an amount declared by EMRA considering the proportion of the energy amount he has sold within the previous calendar year to the total electrical energy amount which all legal entities holding retail sale license offered for sale in Turkey.

In case the total electrical energy amount with RES certificate is sufficient, the legal entities holding retail sale license shall be entitled to purchase RES certified electrical energy not lower than eight per cent of the electrical energy they have sold in the previous calendar year.

c) Until the end of 2011, the applicable price for the electrical energy to be purchased in pursuance with this Law within each calendar year shall be the Turkish average wholesale electricity price in the previous year determined by EMRA. The Council of Ministers is entitled to raise this price up to 20% at the beginning of each year.

d) As of the end of 2011, this pricing methodology shall not be applicable for the RES certified electrical energy generation plants which are under operation for more than seven years. The retail sale companies shall purchase the RES certified electrical energy, which they are obliged to purchase on the basis of the provisions of this Law, primarily from those plants which have not yet completed a business period of seven years, in accordance with the pricing methodology laid down in part (c) of this article, and in case the purchased amount of electrical energy is less than the ratio specified in part (b) of this article, they shall buy the remaining amount, until reaching the ratio referred hereof, through bilateral agreements at the price formed in the market without exceeding the Turkish average wholesale electricity price.

Investment Period Implementations

The real persons and legal entities establishing an isolated electricity generation plant and grid supported electricity generation plant by utilizing hydraulic resources with a maximum installed capacity of 1000 kW for meeting solely their own demands, shall not be claimed to pay the amounts of service for the projects, of which final designing, planning, master planning, preliminary surveying and first auditing were prepared by either DSİ or EIİ (Article 7).
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Within the framework of this Law:

a) Investments on energy generation facilities;
b) Procurement of domestically manufactured electromechanical systems;
c) Investments on research and development and manufacturing in the scope of the electricity generation systems by utilizing solar cells and concentrated collectors;
d) Investments on research and development facilities for generation of electrical energy or fuels by utilizing biomass resources;

can benefit from the incentives determined by the Council of Ministers.

Implementations related to Acquisition of Land

In case of utilization of all sorts of property which is under the possession of Forestry or Treasury or under the sovereignty of the State for the purpose of generating electrical energy from the renewable energy resources in the scope of this Law, these territories are permitted on the basis of its sale price, rented, given right of access or usage permission by Ministry of Environment and Forestry or Ministry of Finance. Fifty percent deduction shall be implemented for permission, rent, and right of access and usage permission in the investment period. ORKOY and forestation special allowance revenue shall not be charged in forested land (Article 8).

Coordination of the Implementations

The Ministry shall provide coordination in implementation, steering, monitoring and assessment of the fundamental principles and obligations specified in this Law, and in planning the measures to be undertaken (Article 9).

Sanctions

The legal entities holding retail sale license that breach the provisions of Article 6 of this Law shall be charged administrative fine of 250 billion TL by EMRA and shall be warned to eliminate the violation in sixty days (Article 10).

In case the activities that necessitate imposing a fine are not corrected or repeated, the amount of fine is doubled every time. If the same action is not taken in a two year period that necessitates imposing the same administrative fine, the preceding fines are not taken into account. But the increased fine that will be imposed if the action is taken more than once in two year period cannot be more than ten percent of the legal entity’s gross income in the balance sheet. If the fine reaches to this level, EMRA may cancel the license.

- The legal entity that take place among the existing contracts, as defined by Electricity Market Law numbered 4628 and in the scope of the build - operate - transfer model, which is not in operation and which will generate electricity from renewable energy resources under this Law shall utilize the applications in this Law, provided that they should waive their rights arisen from existing contracts. EPDK shall grant generation licenses to such projects (Provisional Article 1).

- Public distribution companies holding a retail sale license shall be exempt from the purchase obligations under article 6 of this Law, up to 01.01.2007, except for the Ministry's and EMRA's existing regulations and applications. However, they shall contract electricity sales agreements with
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legal entities holding a RES–certified generation license, for purchase obligations, to be effective from 01.01.2007 (Provisional Article 2).

– The projection stated in article 6 of this law shall be published by the Ministry within three months after effectiveness of this Law. However, such projection shall cover those projects, whose generation licenses have been granted by EMRA before effectiveness of this Law and those projects, among those existing contracted ones as defined in provisional article 1, whose licenses would be awarded under this law (Provisional Article 3).

4. ENVIRONMENTAL REGULATION AND LIMITATION

In Turkey including agricultural waste emissions all industrial originated air pollution limits are determined by the regulation “Industrial Originated Air pollution Control Regulations” dated 2/11/1986 and numbered 19269.

4.1 Industrial Air Quality Control Regulation

The purpose of this regulation is to bring under control the emissions in the form of soot, smoke, dust, gases, steam and aerosols diffused into the atmosphere as a result of activities of any kind; to protect human beings and their environment from the hazards arising from pollution of the air as a receptor medium; to eliminate the adverse environmental effects of air pollution which cause important harm to the public and to neighbourly relations and to ensure that such effects are not created.

The provisions of this regulation embrace; the preliminary permission, permission, conditional and partial permissions to construct and operate of plants, to prevent the emission diffusion and the air pollution in the effect area of the facility, scrutiny and determination, production, use, storage, and transportation of industrial plants fuel, raw materials and products.

According to “Industrial Originated Air pollution Control Regulations” agricultural wastes are the products that obtained from defined in classification of biomass originated fuels that a vegetal substance itself, complete or partly used as fuel, to gain contained energy, obtained from agriculture or forestry. These products are vegetal wastes originated agriculture or forestry, obtained from food process industry, raw paper pulp, and its vegetable waste, vegetal waste, which obtained from bottle cork waste, wooden waste, wooden protective material treated or organic compound comprises, related to coating process, salty (with halogen) and this kind of waste comprises especially except from construction and destruction based wood.

The duty of perfection and pursuit of the regulation has been given to Ministry of Environment and Forestry and to the office of the provincial governor of the region.

According to the provisions of this regulation, to establish and operate of the facility the preliminary permission of emission (at the stage of planning), and emission permission (at the stage of operation) are needed to be taken. The permissions are given by The Ministry of Environment and Forestry for the facilities that biomass used as fuels (olive oil cake, sunflower, cottonseed etc.) if burning thermal power is bigger than 50 MW, and by the office of the provincial governor of the
region, under the condition of to be taken appropriate point of view by the province of local environment committee for the facilities that biomass used as fuels (olive oil cake, sunflower, cotton seed etc.) if burning thermal power is bigger than 500 kW, and smaller than 50 MW.

**The principles of establish and operate of the facilities that need to obeyed**

Basic obligations of persons who establish and operate the facility subject to get a permission and the following principles shall be realized during the construction and operation:

a) The harmful effects of the facility on the public and on the environment must be reduced in keeping with the technological level and must not create any hazards,

b) The technical conditions laid down in this regulation must be complied with,

c) The emission standards stated in this regulation must not be exceeded,

d) Air quality of the facility effect area, limits values, must not be exceeded, given by “Industrial Originated Air pollution Control Regulations”.

e) Emissions and environmental air quality must be measured by the plant operator in accordance with the methods stated in this regulation, (kg/h m²)

f) For available facilities, if mass flow rates in Article 40, Table 4.1 are exceeded, the persons who operates the facility in the effect area, in the frame of Article 40 provisions, for the aim of measuring air pollution level and evaluating air pollution contribution values of the facility, to calculate of air pollution contribution values with using a distribution model, which agreed by international laws and regulations,

g) The facilities that will be newly established must determine their chimney gas emissions (as kg/h and mg/ Nm³) and emitting emissions mass flow rate (kg/h-m²) into the atmosphere from out of chimney,

h) For new facilities if mass flow rates in Article 40, Table 4.1 are exceeded, the persons who operates the facility in the effect area, for the aim of evaluate the level of pollutant values, to calculate of air pollution contribution values with using a distribution model, if there is a suspicion of reaching the important level of the air pollution in the facility area, the air quality must be measured in accordance with this regulation.

i) The waste materials and discharges issuing from the plants must be re-cycled, or, if this is not economically or technically feasible, they must be appropriately purified or disposed.

j) In the facility area, if air pollutants exceed the limits of air quality that has been determined amount under “Industrial Originated Air pollution Control Regulations” the persons who operates the facility must comply with action plans that has been prepared by office of the provincial governor of the region.

**Preliminary Permission of Emission**

The following principles shall be adhered to with regard to Preliminary Emission Permits:

a) For the facilities in which the scope of Environmental Effect Evaluation (EEE) regulations according to EEE, has been taken an affirmative decree or a not required decree, is to substitute for the preliminary permission of emission. If of EEE an affirmative decree or a not required decree is
cancelled that means the preliminary permission of emission also is cancelled. The facilities don’t take place in the scope of EEE but in Annex 1 A and being on the lists to be dependent on the preliminary permission of emission.

b) The preliminary permission of emission is given at the stage of facility planning.

c) Preliminary permission may be granted by the authorized official if sufficient information is not available to assess the effects of the proposed plant on the environment, and if such preliminary permission is reasonably justified.

d) To take Preliminary Permission to the plants which take place in Annex 1 List A and B, should apply to governorship with a petition and also the documents that stated in Preliminary Permission Form.

1) Preliminary permission file and documents are examined by the governorship. If the file is found incomplete and insufficient the time will be given to the applicant to complete. After completing the file if the plant takes place in Annex 1 List A and B, governorship will evaluate and conclude the process within 20 work days. If the plant takes place in Annex 1 List A, the file is sent to the ministry by the governorship and the ministry is concluded the process within 40 work days. The stated period begins with after file reaches the ministry. The time which is given to complete the deficiencies is not included to the period.

g) If the plants, which is given the Preliminary permission, within one year following the producing starts, Preliminary permission shall be automatically invalidated if an application for permission is not made.

How to obtain permission

The following principles shall be adhered to with regard to make an application for Emission Permits: (“Industrial Originated Air pollution Control Regulations”)

a) To take Emission Permission to the plants which take place in Annex 1 List A and B, should apply to governorship with a petition and also the documents that stated in Emission Permission Form.

b) Emission permission file and documents are examined by the governorship within 20 work days. If the documents submitted are incomplete and insufficient, the authorized official may grant the applicant a certain period of time in which to secure further documents.

Objections made during the process of obtaining permission for the building and operating of a plant shall not be considered unless they have been submitted at the stage of securing partial or preliminary permission in the process of Environmental Effect Evaluation (EEE). However in the process of the establishing the plant or after that in the plant area, according to the measurements, unknown in the beginning in the condition of environmental pollution from the plant to the environment appears, objections are considered and emission permission is not given.

The governor offices and the agencies defined as authorized officials within the framework of this regulation, as well as the provincial health directorates and the municipalities, which perform the secretarial function, are in no way responsible for approving a purification project or proposing
methods. Objections must be submitted in writing to the authorized official within this period. Any objections submitted after this period shall not be considered unless they involve violations of personal rights.

c) If the plant takes place in Annex 1 List A and B, is examined in the scope of the regulation provisions by the committee, which is constituted by the governorship. The prepared technical report is attached to the emission preliminary permission file. If the governorship requires the necessity of the technical personnel for the committee can be ask from the institutions/organizations and municipality.

Giving the Emission Permission Certificate

- After giving the Emission permission, the permission is documented with the emission permission certificate and is given to the person who operates the plant (Article 11). The contents of the emission permission certificate and required matters are determined by the authorized department or office concerned.

Obligation of the Confirmation ("Industrial Originated Air pollution Control Regulations" Article 15)

For authorities of the plant who are given the emission permit take place in Annex 3 List A and B every two years, for the plant that takes place in Annex 1 List B every three years must report the suggested permission data whether exceeded or not and the improvement of the plant. The report is prepared measuring the emissions and considering the conditions to take a sample should comply with standards such as ISO, EPA, DIN and etc. and methods of the measurements which determined by the ministry or agreed by the international committee. One copy of the report should be secured in the plant, one copy of it should submit to the governorship which the plant takes place, and it is evaluated by the governorship. For the plants which take place in Annex 1 List A, emission measurement report should be sent to the ministry with the governorship's point of view. Besides, authorities of the plant are obligated to submit in their report the improvement in the plant.

Emission standards for industrial plants subject to permission

Emission limits for industrial plants subject to permission (Article 39)

For industrial plants subject to permission in Annex 1 List A and B, in Article 43, If there is no obligation for limitation of Emission limits, emission limits that is given in Article 39 and in Article 42 the principles are obligatory. In industrial plants using combustion facilities for the purpose of heating are not subject to get emission permission but their measurements must be in the emission limits.

In Facilities

a) Soot

1) The grade of soot in the waste gases at solid fuel-fired plants must be 3 or the less than that on the Bacharach Scale.

b) Emissions in the form of dust
Section Four
Calculation of Contribution to Air Pollution and Measurement of Air Quality of the Plants. (“Article-40”)

In the effect area of the plant has been built or is to be built, contribution values to air pollution, and measurement of air quality calculation and calculation methods can be carried out using with a distribution model of “Industrial Originated Air pollution Control Regulations” the as follows:

The mass flow rate given emissions from the stack or out of the stack of plant has been built or is to be built to the atmosphere, for the plant which has been built is measured in the stack, the emissions from out of the stack to the atmosphere and for the plant that is to be built is determined using with emission factors. If mass flow rate (kg/h) exceeds the values that is given Table 40.1, the values of contribution to air pollution of emissions is calculated considering per hours if it is possible or else per day per month and per years in the effect area of the plant.

If the values of contribution to air pollution of emissions are calculated considering per month, reaches the highest level, air quality is measured continuously during the one month time in two points in the inspection area. In the regions that the pollution of air changes and increases depending on months, authorized official is determined the time period of measurements. If the results of the measurements are higher that 60% long term standard limit values which are stated in “Industrial Originated Air pollution Control Regulations” the time period of air quality measurement is extended. Authorized official is determined the time period of measurements.
Table 4.1 Mass Flow Rate

<table>
<thead>
<tr>
<th>Emissions</th>
<th>Mass flows during hours of operation on weekdays under normal operating conditions (kg/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>From the stack</td>
</tr>
<tr>
<td>Dust</td>
<td>15</td>
</tr>
<tr>
<td>Lead</td>
<td>0.5</td>
</tr>
<tr>
<td>Cadmium</td>
<td>0.01</td>
</tr>
<tr>
<td>Thallium</td>
<td>0.01</td>
</tr>
<tr>
<td>Chlorine</td>
<td>20</td>
</tr>
<tr>
<td>Hydrogen Chloride and Gaseous</td>
<td>20</td>
</tr>
<tr>
<td>Inorganic Chlorine Compounds</td>
<td></td>
</tr>
<tr>
<td>Hydrogen fluoride and Gaseous</td>
<td>2</td>
</tr>
<tr>
<td>Inorganic Fluorine Compounds</td>
<td></td>
</tr>
<tr>
<td>Hydrogen Sulphur</td>
<td>4</td>
</tr>
<tr>
<td>Carbon monoxide</td>
<td>500</td>
</tr>
<tr>
<td>Sulphur Dioxide</td>
<td>60</td>
</tr>
<tr>
<td>Nitrogen dioxide [NOx (NO₂)]</td>
<td>40</td>
</tr>
<tr>
<td>Total Volatile Organic Compounds</td>
<td>30</td>
</tr>
</tbody>
</table>

Note. The emissions in the table are the hourly mass flows from the entire plant.

a) The matters that calculation of the value of contribution to air pollution:

  Contribution to air pollution is calculated for gases, suspended particulate matter and settling dust on the basis of the following factors

  1) The effects of the topographic structure in the plant effect area and the stack heights that stated in Article 42 are considered.

  2) The effect of the buildings in the inspection zone shall be borne in mind if stacks are located at a distance from buildings and towers of less than four times the height of such buildings or towers and if stack height is more than 1.7 times that of the building or 1.5 times that of the cooling tower, the effect of buildings shall be ignored.

  3) Conditions of prevailing weak winds shall be borne in mind. This shall apply if the average wind velocity given in 10-minute averages at the place where the plant is located is less than 1.0 m/sec for more than 30% of the hours in a year.

  4) Calculations shall be based on the assumption that the emissions discharged in a given inspection zone undergo no physical or chemical changes.

  5) In calculating the spread of emissions, the conditions of diffusion have been assumed to be stable in each situation.

a) Determination of the area that the calculation of the contribution to air pollution and measuring air quality is occurred:

  In the calculation of the emissions, which are given from the plant to the open air, the contribution values or measuring air quality, the plant effect area inspection area and peak points are considered.

  **The Plant Effect Area:**

  The plant effect area can be described as the area from the centre of the emissions in this regulation according to provisions of Article 42, stack height is determined by 50 times of radius. At
plants where the height of discharge ($\Delta h + h$) of the emission is less than 30 meters above the ground, the inspection zone covers a square area of 2 km on each side. If the surface distribution of the emission sources is greater than 0.04 km$^2$, the length of the sides of the inspection zone shall be 4 km. The plant area shall be the basis for determining the surface distribution of emission sources.

**Inspection area:**

In the plant effect area, is a square that the length of its side is 1 km. In special condition like there is no decree about pollution in the area, the inspection area can be determined by taking the side length as 0.5 km.

**Peak Point:**

The acceptance of the peak point is determined by the intersect with on the arch point that is drawn from the north source of emission clockwise 10 degree with consecutive angles to the source of emissions in the R m radius of circumference shape of square inside of the inspection area.

**Contribution values to air pollution:**

The contribution value to air pollution, in the effect area of the plant calculations of in every inspection area in all peak points and for all spreading conditions are arithmetical averages. This value is calculated by taking the values from General Meteorology Directorate that hourly or daily, monthly, annually.

**Air quality limits:**

**Long Term Standards (LTS):** Values that are the arithmetic average of all measurement.

Air quality limits: to protect human health and to prevent short and long term harmful effects on the environment, the levels of air pollutants, expressed in units of concentration and determined by taking into account their various harmful effects en they are found in combination in the atmosphere.

**Short Term Standards (STS):**

Values that must not exceed 95% of the measurement result when the numerical values of all measurement results.

**Total Pollution Level**

Total pollution level (TPL) is consists of the addition of The contribution to air pollution value (CAPV) which has been calculated in the plant effect area and Long Term Standard Value which has been found by measuring or calculating for the plants are to be built.

$$TPL = CAPV + LTSV$$

**Emission Sources and Mass Flow Rate:**

**Emission sources:** Emission sources are the places where air pollutants are discharged into the atmosphere from a plant. At plants which discharge their emissions from stacks, such stacks are known as point sources. At plants which discharge their emissions from out of the stacks or area of many small stacks that close to each other, such stacks are known as area sources. At plants which discharge their emissions from stacks that moving-polluting, such stacks are known as line sources.
Mass Flow Rate of Emissions

Mass flow rate of emissions is described as in operating conditions air pollutants which are given from emission sources to the open air, hourly averages of mass flow (kg/h). If there is the condition that in mass flow rate of Emissions less than one hour periods, diminishing or increasing waves, this average waving shall be determined as hourly mass flow rate. Such hourly averages are valid even if mass flows of emissions fluctuate with time. The mass flow of the plants that are given their emissions from stack outlet and the plant that is to be built can be found using with emission factors.

In the Plant Effect Area Measurement of the Air Quality, Calculation and Measurement Period:

In the plant effect area distribution models and methods which have been used widespread and agreed by international authorities and the principles in accordance with the Article 40, for the peak points of in inspection areas the calculation of highest value of contribution to air pollution, instructing at least two stations in one month period the air quality measure continuously. In the regions that the pollution of air changes and increases depending on months, authorized official is determined the time period of measurements. If the results of the measurements are higher that 60% long term standard limit values which are stated in “Industrial Originated Air pollution Control Regulations” the time period of air quality measurement is extended. Authorized official is determined the time period of measurements.

In The effect area of the plant that is to be built, in accordance with the Article 40 from paragraph (a) to (g), contribution to air pollution value is found. In addition to this in the effect area of the plant, considering exist all important air pollutants by calculating or measuring Long Term Standard Value (LTSV) is also found. Total pollution level (TPL) is consists of the addition of The contribution to air pollution value (CAPV) which has been calculated in the plant effect area and Long Term Standard Value which has been found by measuring or calculating for the plants are to be built. Depending on density of the pollutant source in the effect area of the plant that is to be built, if it is necessary, authorized official get a station to measure the air quality in one month period.

If arithmetical average of the one month results of the measurements are higher that 60% long term standard limit values which are stated in “Industrial Originated Air pollution Control Regulations” the time period of air quality measurement is extended by authorized official and the number of stations are increased.

If passive modelling method is used for the measurement of air quality, for two months at least period 8 (eight) modelling points shall be chosen. Depending on pollutant emission load the place and number and capacity of the plant can be increased authorized official.

h) Measurement of Settling Dust

During the measuring of settling dust, at least 2 (two) measurement points are taken into consideration the dominant winds in the plant effect area. In the same area, on the condition that the sources that causes dust emissions, for the determination of contribution to other sources that outside of the plant, measurement point number can be increased. Measurement period is two months that for
two-times measurement as per month. Average settling dust amount for a day shall be found divided by day number as monthly values.

As a rule, air quality measurements shall be made at heights of 1.5-4.0 m above the ground (or building, or cultivated area) and at least 1.5 m from the side of the building. Measurements in forests shall be made at higher level of the trees.

i) **Measurement Methods**

Agreeability of the methods are officially registered after standardized by Turkish standards and notified by Ministry. If the relevant Turkish standard is not exists, a method standards in accordance with DIN EPA norms shall be applied which agreed their reliability by Ministry. The methods are notified by a notification.

j) **Institution and Organization for Measurement**

In the effect area of the plant the air quality and emission measurements are to be done by the Institutions and Organizations that have the laboratories sufficiency approved by The Ministry.

**Determination of Emissions:**

- In Determination of Emissions (Article 41):
  
  a) **The Emission Measurement Places:**

  The Emission Measurement Places must be chosen in complying with Turkish standard, EPA, DIN, and CEN Norms, also faultless in technically and in the form that shall not create any danger, appropriate, accessible easily and enabling necessary connections for the measurements.

  a) **Measurement Programs:**

  Measurements to determine emissions should be made in such a way as to facilitate comparison of measurement results measuring devices and methods must conform to the principles laid down in Turkish standards, DIN, EPA, or CEN Norms. In general emission measurements at plants in continuous operation should include at least three measurements under the maximum permissible load and at least one measurement under each of the following conditions that cleanup, regeneration, soot discharge, start-up of long-term operation, etc. should be done.

  Emission measurements at plants working under changing operation conditions shall in general be made in sufficient numbers but at least under the conditions created when maximum emissions are produced.

  Emission measuring periods should be short. The measuring period should not exceed two hours under conditions when measurements of flue gas, waste gas and open air canal cross-sections are required or when measurement is difficult.

  c) **Evaluation and reports**

  In order for emission measurements and their results to be evaluated, the report must include the necessary detailed measurement data, the methods used and the operating conditions. The report should also contain information concerning the fuel, the raw and intermediate materials, and the operating conditions of the waste gas purification plant. If none of the emission levels measured
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exceeds the limits stated in the regulation, no procedures regarding emissions may be implemented for the plant.

d) Continuous monitoring of emissions

1) Recording or non-recording devices may be used to monitor continuously whether or not emissions exceed standards. Such measurements are also required in order to determine the effectiveness of waste gas purification facilities such as dust retention systems, gas washing and afterburners, and to determine the emissions stemming from raw materials and processes.

In the frame of continuous measurement evaluation of the results, considering one year operation hours if it meets the following needs,

- If any of calendar month average emission measurements doesn’t exceed the value of emission limit,
- For SO₂ (Sulphur Dioxide) and dust: If in 48 hours of all average values don’t exceed 97%, emission limit values 110%,
- For NO (Nitrogen Oxide): If in 48 hours of all average values don’t exceed 95%, emission limit values 110%, emission limit values shall be accepted as conformed.

Continuous measurement of dust Emissions

Furnaces and boilers burning solid fuel or fuel oil and having a thermal capacity of 100 GJ/h (27,778 kW) and above and plants with dust emissions of more than 15 kg/h should be equipped with a recording measuring device for measuring the concentration of dust emissions. To determine mass flow rate sourced by the plant the volumetric flow rate should also be measured continuously.

Daily emissions of these substances shall be determined at the plants with dust emissions mentioned in Article 39 paragraph (c) plants in Class I with emissions of over 2 kg/h, and plants in class II with emissions of more than 5 kg/h.

If a plants operating conditions change, the authorized official may request that the plant conduct continuous dust emission measurements in order to ensure that emissions originating from breakdowns at waste gas purification facilities do not exceed standards even for short periods of time, even if the thermal capacity of the plants combustion system is below, those stated in paragraph 1., and its mass flow of emissions below those stated in paragraph 2. Measurement figures shall be preserved for a minimum of 5 years

In case more than one firing facility is connected to one stack the total thermal capacity per stack will be used.

Continuous measurement of gaseous emissions

If emissions are released in an amount exceeding that stated for any of the substances listed below, these substances should be monitored continuously using recording measuring instruments. To determine mass flow rate sourced by the plant the volumetric flow rate should also be measured continuously.
Measurement figures shall be preserved for a minimum of 5 years.

**Continuous Measurement for Combustion Control**

Liquid and solid fuel-fired furnaces and boilers with a thermal capacity of 36 GJ/h (10 MW) and above should be equipped with a recording flue gas analyzer (CO₂ or O₂ and CO) for combustion control.

In case more than one firing facility is connected to one stack the total thermal capacity per stack will be used.

**Acceptable measurements**

When a plant is approved, the authorized official may ask that a company or agency to be chosen by the Prime Ministry General Directorate of Environment determine whether or not the envisaged emission standards are being exceeded at that plant within a period at most 3 months preceding and at most 12 months following the start-up of operations.

- **The plant that subject to permission (Article 42)**

  **Flue Gas Velocity**

  **Flue velocity result from combustion plant**

  Waste gases must be released into the atmosphere in such a way as to be borne without obstruction by free air currents. In general, a stack must be used for this purpose, and the release rate of gas from a stack should be at least 4 m/sec when a plant is operating at its rated power is over 500 kW. As required production and design for the plant not to be made narrow of the diameter and forcibly draw of the stack gas release rate should be at least 3 m/sec. At plants whose rated thermal power is between 300 kW and 500 kW the gas release rate should be at least 2 m/sec. However, at plants whose rated thermal power is below 300 kW, the gas release rate may be under 2 m/sec.

  **The Gas Release Rate Sourced Production Type:**

  Waste gases must be released into the atmosphere in such a way as to be borne without obstruction by free air currents. A stack must be used for this purpose; the gas release rate for the plants that their stacks not forcibly draw should be at least 3 m/sec.

  **Stack Height:**

  **Minimum Shack Height in Small Sized Plants:**

  Minimum stack height above the roof at plants with a rated thermal power below 500 kW is determined as follows.
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**Sloping Roof**

Stack height must be at least 0.5 m higher than the highest point of the roof. The stack may be lower at plants with a rated thermal power below 500 kW, if it is not very near the highest point of the roof, and provided that it is at least 1 m higher than the lowest part of the roof.

**Flat roof**

Stack height must be at least 1.5 m higher than the highest point of the roof. However, stack height may be only 1 m if the plants rated thermal power is below 500 kW.

**Minimum stack height at medium-size plants**

Minimum stack height above the roof at plants with a rated thermal power of 500 kW and 1.2 MW must be as follows.

**Sloping roof**

Stack height on roofs that are either flat or have a slope of less than 20° must be at least 1.5 m higher than the highest point of a roof with an assumed 20° slope.

**Flat roof**

Stack height must be at least 2 m higher than the highest point of the roof.

**Minimum stack height at large plants**

Stack height at plants with a rated thermal power over 1.2 MW is determined according to the principles stated below. Stack height must be at last 10 m above the building foundation and at least 3 m above the roof. If the slope of the roof is less than 20°, Stack height will be calculated assuming that a 20° slope.

**Minimum stack height at large plants**

Stack height at plants with a rated thermal power over 1.2 MW is determined according to the principles stated below. Stack height must be at last 10 m above the building foundation and at least 3 m above the roof. If the slope of the roof is less than 20°, Stack height will be calculated assuming that a 20° of slope.

If the horizontal distance between stacks with the same type of missions and at almost the same height is less than 1.4 times stack height, and if the use of stacks of different heights is not considered necessary for preventing emissions from piling up in layers, a single stack shall be used.

If the stack height stated earlier in this paragraph is used, and if the total pollution level (TPL) stated in Article 40, exceeds the air quality standard envisaged in “Industrial Originated Air pollution Control Regulations”, then an effort shall first be made to lower this emission level. If this is economically or technologically unfeasible, the stack height shall be raised to prevent the air quality standard from being exceeded.

As determined below, if the stack height straightened according to unevenness of terrain take place in Article 16 does not come under the amendments contained in Article 16, it must not exceed 250 m.

If additional arrangements take place in Article 16, the stack height over 200 m recourse shall be had to emission-reducing measures of the appropriate the technological level.
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When the required stack height exceeds 250 m, recourse shall be had to emission-reducing measures of the appropriate technological level.

**Special emission standards for plants with major polluting properties ("Industrial Originated Air pollution Control Regulations", Madde 43)**

Plant emissions that are grossly polluting in terms of air pollution may not exceed the standards stated in this section.

The emission limits given in this annex for plants with major polluting properties shall take priority in implementation over the emission limits given in other parts of this regulation.

**A) GROUP ONE FACILITIES: Combustion Facilities**

In furnaces that will be used in plants; steam furnace and flue system are in harmony. In this topic relevant Turkish Standards must be carried out. From the point of view heat technique and economy of furnaces must be in accordance with relevant Turkish Standards. Steam furnaces operating, inspection and maintenance must be conformed to relevant Turkish Standards. In furnaces appropriateness heat efficiency related norms of DIN must be documented by the plant owners.

**Solid fuel-fired furnaces and boilers**

**Dust emissions:**

Dust emissions in flue gases of solid fuel-fired furnaces must not exceed the limits given below. In flue gases essential amount of volumetric oxygen is 6%.

In plants that fuel thermal power is \( \leq 500 \text{ kW} \) sootiness grade must be at most 4 on Bacharach scale

- In plants that fuel thermal power is \( 500 \text{ kW} < \) and \( \leq 5 \text{ MW} \) dust emissions should be under 200 mg/Nm\(^3\)
- In plants that fuel thermal power is \( 5 \text{ MW} < \) and \( \leq 50 \text{ MW} \) dust emissions should be under 150 mg/Nm\(^3\)
- In plants that fuel thermal power is \( \leq 50 \text{ MW} \) in flue gases dust emissions should be under 100 mg/Nm\(^3\).

**Carbon monoxide emissions:**

Carbon monoxide emissions in flue gases may not exceed 200 mg/m\(^3\).

**Nitrogen oxide (NOx) Emissions**

Nitrogen oxide emissions must be lowered by lowering flame temperature by means of flue gas feedback, secondary air combustion or other similar techniques.

The plants of furnaces with a thermal capacity of 50 MW and up, at where the amount of volumetric oxygen in flue gas is accepted as to be 6%:

- Nitrogen monoxide and nitrogen dioxide emissions from solid fuel-fired furnaces shall not exceed 800 mg/m\(^3\) (from over nitrogen dioxide).

**The facilities that use biomass as a fuel:**

As fuel biomass; vegetable churn sourced agricultural and forestry, vegetable churn, which obtain from food process industry, raw paper pulp, ad its vegetable churn, vegetable churn, which
obtain from bottle cork churn, wooden churn, wooden protective material treated or organic compound comprises, related to coating process, salty (with halogen) and this kind of churn comprises especially except from construction and destruction based wood.

As described above, using biomass procedures can be determined as follows:

The facilities that use biomass as fuel must have these properties that nominal heat power bigger than 500 kW, olive oil production facilities and other burning facilities (energy generation facilities, cement and lime factories etc.) Secondary air feed burning system. It must be provide chimney gas transmission values as given Table A-1.

In cement and lime factories must be obey the mandatory limit values chimney gas transmission, which explained before in the chapter of theirs, so it is not be obligatory.

Table A-1. Chimney/Stack Emission Limits

<table>
<thead>
<tr>
<th>The Pollution Parameters</th>
<th>CO (mg/Nm³)</th>
<th>NOx (mg/Nm³)</th>
<th>SOx (mg/Nm³)</th>
<th>HCl (mg/Nm³)</th>
<th>HF (mg/Nm³)</th>
<th>PM (mg/Nm³)</th>
<th>TOC (mg/Nm³)</th>
</tr>
</thead>
<tbody>
<tr>
<td>500kW-15 MW</td>
<td>460</td>
<td>-</td>
<td>200</td>
<td>-</td>
<td>-</td>
<td>375</td>
<td>-</td>
</tr>
<tr>
<td>15MW-50 MW</td>
<td>460</td>
<td>-</td>
<td>200</td>
<td>200</td>
<td>30</td>
<td>375</td>
<td>30</td>
</tr>
<tr>
<td>&gt;50 MW</td>
<td>460</td>
<td>400</td>
<td>200</td>
<td>200</td>
<td>30</td>
<td>280</td>
<td>30</td>
</tr>
</tbody>
</table>

Chimney gas can be considered 6% volume of oxygen and at 0°C and 1 atm pressure according to normal conditions at dry base.

Olive oil production facilities can be taken considered firstly, in the facilities, which uses (olive oil cake, sunflower coat cottonseed etc.) biomass as fuel, there are the criteria which must be obeyed with attention, as follows:

Olive oil cake, which used as fuel, must not be surpassed these values. It must have the humidity range to max. 15%, oil range (dry base) max 1.5% and calorific value (min) 3700 Kcal /kg, Sodium (Na) 300 ppm, ash 4%. The facilities that use olive oil cake as fuel must be ensured documents; including analyze of olive oil cake properties. If it is necessary the government can have it analyzed.

Biomass; can be used as fuel in facilities under this value that fuel feeding, secondary air feeding, burning system has nominal heat power 500 kW.

It has been given the permission of using olive oil cake as fuel in the olive oil production facilities (oil mills, oil store), which work 120 days as seasonal activities. Since these facilities are free from the transmission values given Table A-1, according to Bacharach scale the value of carbon black range in gas churn must be 4.

The prevention of the odour that bothers the environment and the drain caused by the rain, of olive oil cake that used as fuel in closed area must be stored and conserved.
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ATTACHMENTS

The list of facilities that have to get emission permission

A LIST
The permissions on this list are given by Ministry of Environment and Forestry

1. Energy Production
   1. 1. Steam power plants and thermal power stations that are using solid-fuel, liquid-fuel, gas-fuel:
      a) Solid (coated by coal, coke, coal bunker, peat, wood, plastic, and chemical substances and not treated wood waste, oil coke) and liquid (fuel oil, naphtha, diesel fuel, biodiesel, etc.) fuelled plants that thermal power of total combustion system is 50 MW or bigger than 1 MW and less than 50 MW.
      b) The plants that biomass used as fuels (olive oil cake, sunflower, cotton seed etc.) if combustion thermal power is bigger than 50 MW.

   1. 2. The plants that using fuels for combustion are given below:
      a) The plants that using fuels as coated by Coal, coke, coal bunker, peat, fuel oil, naphtha, diesel fuel, wood, plastic, and chemical substances and not treated wood waste, burning biodiesel oil or thermal power of total combustion system is 50 MW and more than that value.
      b) The plants that biomass used as fuels (olive oil cake, sunflower, cotton seed etc.) if combustion thermal power is bigger than 50 MW.

B LIST
The permissions for the plants on this list are given by authorized official that is governorship and local environment institution which is taken their point of view.

Steam power plants and thermal power stations that are using solid-fuel, liquid-fuel, gas-fuel:
   a) Solid (coated by coal, coke, coal bunker, peat, wood, plastic, and chemical substances and not treated wood waste, oil coke) and liquid (fuel oil, naphtha, diesel fuel, biodiesel, etc.) fuelled plants that thermal power of total combustion system is more than 1 MW and less than 50 MW.
   b) The plants that biomass used as fuels (olive oil cake, sunflower, cotton seed etc.) if combustion thermal power is bigger than 500 kW and smaller than 50 MW.

5. IDENTIFICATION AND ASSESSMENT OF POTENTIAL POLICY AND MARKET INSTRUMENTS

To set the stage for a discussion of policy and market instruments, it is important to clarify the overall, underlying drivers - or motivations - for exploitation of agricultural waste. Therefore, these drivers are introduced in Section 5.1 below, followed by potential agricultural, environmental, and energy policy and market instruments in Sections 5.2, 5.3, and 5.4, respectively. Research and development incentives are also significant for promoting agricultural waste exploitation, and these are covered in Section 5.5.

5.1 The Drivers in Agro-Waste Energy Usage

From the policymaker’s viewpoint, the use of agricultural waste for energy offers a number of national and international benefits. Benefits include:

- Lower emissions to the environment, in particular CO₂, the main greenhouse gas;
- Reduced energy cost to the user, providing additional competitiveness for industrial and commercial users, and offering affordable heat for domestic users;
- Large fuel cost savings;
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- An opportunity to move towards more decentralized forms of electricity generation, where a plant is designed to meet the needs of local customers, avoiding transmission losses and increasing flexibility in system use;
- Improved local and general security of energy supply;
- An opportunity to increase the diversity of power generation plant, and provide competition in generation;
- Increased employment, especially in rural and farming communities – a number of studies have now concluded that the development of biomass energy systems is a generator of jobs; and Economic development and growth in the agricultural sector.

In Turkey, there are also substantial areas of abandoned agricultural land that are not managed and are becoming overgrown. Creating demand for biomass fuel would help to bring these areas back into economic exploitation. Furthermore, development of new dedicated energy crops and/or an energy market for residues from existing crops would help farm income and reduce the rate of land abandonment.

From an investor’s viewpoint, the primary reason for investment is to achieve an appropriate rate of return that is commensurate with the risk involved. Investors, however, also have other motives, and these include protection of the environment, compliance with regulations, alignment with other business activities, and social responsibility – many of which are similar to the policymaker’s benefits identified above.

5.2 Potential Agricultural Policy and Market Instruments

In accordance with the findings of the EU agricultural policy and legislation, potential policy instruments appropriate for Turkey may include:

i. 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.

ii. A rural development policy that considers renewable energy source exploitation in general, including agricultural waste exploitation and energy crops.

iii. Development and compliance of existing Turkish legislation with EC directives.

iv. Animal by-products legislation that would include rules for managing animal manure, which is a viable agricultural waste for biomass energy generation.

Turkey’s agricultural industry and available rural land are both large and extensive. The policies/programs suggested in Items (i) and (ii) could have far-reaching effects on agricultural waste exploitation in Turkey. These policies/programs could also contribute to the growth of the agricultural sector and rural employment.

Costs associated with a compliance program for manure management could encourage consideration of alternatives uses of manure (to avoid costly disposal), including energy production.
Potential market instruments appropriate for Turkey could include: Financial incentives, by means of direct grants, loans, or subsidies, which would support better use of agricultural by-products (including residues and wastes) in a manner that promotes environmental protection, renewable energy, and overall performance efficiency.

5.3 Potential Environmental Policy and Market Instruments

In accordance with the findings of the EU environmental policy and legislation, potential policy instruments appropriate for Turkey might include:

i. Modifications or additions to existing waste management regulations which explicitly encourage the use of waste as a source of energy, along with general language promoting recycling and re-use with the relevant incentives.

ii. Modifications or additions to existing incineration and combustion plant legislation and air emission limits that explicitly consider biomass plants or biomass plants that co-incinerate, in order to ensure technologically and environmentally sound implementation.

iii. 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.

iv. Establishment of a ban on open burning of agricultural wastes and residues.

It should be noted that air emissions limits do exist in Turkey for biomass-fuelled plants, and with the exception of dust, it appears the limits are generally compliant with EU limits in the Large Combustion Plants Directive. EU incineration limits are not directly comparable. If the limits that can be specified in Turkey are not sufficiently protective, technological standards can also be developed.

Potential environmentally-related market instruments appropriate for Turkey could include: Negative financial incentives, that is, in the form of taxes or penalties, which would discourage landfilling or non-environmentally friendly management of agricultural wastes (e.g., landfill taxes, fines for open burning or non-compliance with plant emission limits).

5.4 Potential Renewable Energy Policy and Market Instruments

Currently, there are some incentives as mentioned earlier with the Electricity Market Licensing Regulation (such as not applying license fees and priority distribution connection for renewables). The law prepared by the Ministry of Energy and Natural Resources brought some incentives such as an obligation to purchase electricity from renewable energy sources, and purchasing of electricity from renewable energy sources with a higher price. This would also allow certain renewable energy projects to be built and operated by the private sector and would provide incentives for such a system.

The Ministry of Energy and Natural Resources (MENR), the State Planning Organization (DPT), and the Electric Power Resources Survey and Development Administration (EIEI) are
involved in renewable energy promotion policies. Currently, however, they have made more instruments and incentives available for the development and implementation of geothermal heat and solar thermal energy. These include low-interest loans for up to 45% of the capital cost for appropriate investments.

Turkey has many more incentives now in terms of research and development for renewable energy, including biomass.

As mentioned earlier, before the recent introduction of the Free Market Law of Electricity, the price of energy was decided as a result of negotiations between the energy production companies and the state, which is the buyer. Now, the price of the renewable energy will have to obey market conditions, emphasizing the need for additional policy and market instruments to improve the competitiveness of renewable energy sources.

In accordance with the findings of the EU energy policy and legislation potential energy policy instruments appropriate for Turkey may include:

i. Policy or legislation establishing a target (e.g., 10%) for the penetration of renewable energy sources into the gross domestic energy consumption by a given year, potentially with interim targets to ensure the country stays on track with the goal. This could include separate but integrated targets for heat and electricity produced from renewable energy sources. It could also include a separate but integrated target for biomass alone. For example, to meet the 12% overall renewables’ penetration target in the EU, the existing biomass market share (at the time of policy development) should increase by 300%.

ii. Policy or legislation establishing a target for the penetration of biofuels into the gasoline and diesel transport fuel market by a given year, potentially with interim targets to ensure the country stays on track with the goal.

Potential energy-related market instruments appropriate for Turkey could include:

i. Exemption or reductions in the level of taxation to electricity, heat, and/or transport fuels produced with biomass sources.

ii. Other financial support mechanisms such as soft loans, low-interest loans, credit guarantees, start-up subsidies and/or grants, and discounts for consumers willing to purchase related services.

Governmental support in the potential market instruments would not necessarily need to continue indefinitely. It may only be essential during periods of development and transition to obtain and maintain investor confidence.

5.5 Research and Development Incentives for Renewable Energy

With respect to R&D incentives for renewable energy, the Technology Monitoring and Evaluation Board (TIDEB) of TUBITAK, Electrical Power Resources Survey & Development (EIEI), and DPT act as implementing agencies. The applicable ministries also play a role. Overall, at present, about 15 types of legal and administrative incentives exist to promote R&D.
For example, TUBITAK-TIDEB has an R&D assistance program for industrial companies. This includes a financial contribution by TUBITAK and by the Undersecretary of Foreign Trade for up to 60% of the total eligible cost incurred over the duration of an individual R&D project (up to 36 months). Also, low-interest loans are provided by the Technology Development Foundation of Turkey (TTGV) for R&D projects within the scope of the decree.

The other legal and administrative incentives to promote R&D are:

- The Decree on Investment Incentives. The decree covers R&D, environmental and quality improvement, and small medium-sized enterprises (SMEs).
- A tax credit for R&D expenses: This credit makes it possible to postpone payment of annual corporate taxes for three years without interest up to an amount equivalent to 20% of R&D expenses.

Turkey has joined the European Union’s 6th Framework Programme. Turkey’s universities and research institutes received project funding from the EU through this program.

R&D projects proposed in the areas of cost-effective power production from municipal wastes and forest and agricultural residues, the development of fluidised bed technology for using biomass/coal blends in thermal power plants, the development of technologies using energy crops as fuel for power/heat production, and the development of technologies for pyrolysis, gasification and liquid fuel production from biomass are encouraged by TUBITAK-TIDEB and DPT.

Turkey has allotted 450 million YTL for the work of Research and Development inside of the country in 2005. This amount of money has been increased to 900 million YTL for the year 2006. The management of that source of money has been given to TUBITAK. Turkey’s priority about energy is renewable energy, which has a very important potential. The main supported renewable energy sources are solar energy, geothermal energy and wind energy. The development about biological based fuel technologies demonstration and R&D studies such as the direct energy production from biomass and the production of liquid biogas have been improved.

6. IDENTIFICATION OF BARRIERS TO AGRICULTURAL WASTE EXPLOITATION AND POSSIBLE SCENARIOS

Barriers inhibiting agricultural waste exploitation include: 1) Barriers in the institutional, legal, and administrative framework, and 2) Real and perceived risks and other inherent difficulties associated with promoting biomass energy.

6.1. 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
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- 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

6.2. 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. 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 bioenergy. Thus, to achieve favourable 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.
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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 bioenergy 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 bioenergy is “burning the trees”.

6.3 Possible scenarios

As stated in detail above, in order to remove administrative, technical and financial barriers, and expectations for future are summarized below:

Technology that is developed and/or transferred needs standardization and decrease cost of the production and widespread in the Country.

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.

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.

Expectations from this project are improving data availability, quality, and completeness will also reduce technical barriers.

Improved data includes residual or waste type, availability, quantities, and location.
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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.

Appropriate financial mechanisms must be implemented by the public sector to mitigate the risks of project investment.

- Financial incentives should increase (e.g., direct grants, loans, and/or subsidies) to support the better use agricultural by-products;
- Environmental taxes or penalties that would discourage land filling of agricultural waste or environmental unfriendly management of agricultural waste.
- Exemptions or reductions should be provided in the level of taxation for electricity, heat, and/or transport fuels produced with biomass sources.
- Energy investment-related financial support mechanisms such as special loans, start-up subsidies and/or grants should be increased.

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.

- 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
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- 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.

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.

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.

Technological standards and incentives supporting advancement in technology are recommended for implementation. 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. Existing approaches are inefficient, uneconomical, and environmentally undesirable since it is essentially open burning.

The role of the government in formulating and implementing favourable 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.

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 favourable environment for investment.

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.

7. INCENTIVES

In section 4 the law and regulations for the renewable energy are examined in detail. The incentives that this law and regulations provide are summarized below:
7.1 Support Mechanisms in the field of the law of using RES to generate electrical energy

A) The electrical energy generated from the renewable energy resources in the scope of this Law shall be purchased by the legal entities holding retail sale license on the basis of bilateral agreements to be concluded in pursuance with the provisions of paragraphs (i), (ii) and (iii) of this article:

i) Within the framework of prepared projection by the Ministry, the relevant information on amount of RES certified electrical energy, which shall utilize the implementations in the scope of this Law, shall be issued by EMRA annually. Each legal entity holding retail sale license shall be entitled to purchase RES certified electrical energy in an amount declared by EMRA considering the proportion of the energy amount he has sold within the previous calendar year to the total electrical energy amount which all legal entities holding retail sale license offered for sale in Turkey. In case the total electrical energy amount with RES certificate is sufficient, the legal entities holding retail sale license shall be entitled to purchase RES certified electrical energy not lower than eight per cent of the electrical energy they have sold in the previous calendar year.

ii) Until the end of 2011, the applicable price for the electrical energy to be purchased in pursuance with this Law within each calendar year shall be the Turkish average wholesale electricity price in the previous year determined by EMRA. The Council of Ministers is entitled to raise this price up to 20 % at the beginning of each year.

iii) As of the end of 2011, this pricing methodology shall not be applicable for the RES certified electrical energy generation plants which are under operation for more than seven years. The retail sale companies shall purchase the RES certified electrical energy, which they are obliged to purchase on the basis of the provisions of this Law, primarily from those plants which have not yet completed a business period of seven years, in accordance with the pricing methodology laid down in part (ii) of this article, and in case the purchased amount of electrical energy is less than the ratio specified in part (i) of this article, they shall buy the remaining amount, until reaching the ratio referred hereof, through bilateral agreements at the price formed in the market without exceeding the Turkish average wholesale electricity price.

B) In case of utilization of all sorts of property which is under the possession of Forestry or Treasury or under the sovereignty of the State for the purpose of generating electrical energy from the renewable energy resources in the scope of this Law, these territories are permitted on the basis of its sale price, rented, given right of access or usage permission by Ministry of Environment and Forestry or Ministry of Finance. Fifty percent deduction shall be implemented for permission, rent, right of access and usage permission in the investment period. ORKOY and forestation special allowance revenue shall not be charged in forested land (Article 8 Implementations related to Acquisition of Land).
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C) The heat energy needs of the residential areas in the boundaries of the province and municipalities in the regions with sufficient geothermal resources shall be met primarily by geothermal or solar thermal resources. (Article 7− Investment Period Implementations)

D) Within the framework of this Law; Investments on energy generation facilities, Procurement of domestically manufactured electromechanical systems, Investments on research and development and manufacturing in the scope of the electricity generation systems by utilizing solar cells and concentrated collectors, can benefit from the incentives determined by the Council of Ministers. (Article 7− Investment Period Implementations)

E) The real persons and legal entities establishing an isolated electricity generation plant and grid supported electricity generation plant by utilizing hydraulic resources with a maximum installed capacity of 1000 kW for meeting solely their own demands, shall not be claimed to pay the amounts of service for the projects, of which final designing, planning, master planning, preliminary surveying and first auditing were prepared by either DSI or EİE. (Article 7− Investment Period Implementations)

7.2 Support Mechanisms in the field of The Electricity Market Licensing Regulation

A) The legal entities applying for licenses to establish of facilities based on renewable energy resources shall only pay one percent of the total licensing fee.  

B) The generation facilities based on renewable and domestic energy resources shall not pay annual license fees for the first eight years following the facility completion date inserted in their respective licenses.

C) In the generation facilities based on renewable and domestic energy sources have a priority to be connected to the system by TEİAŞ and/or distribution licensees.  

D) Applicable for sales to non-eligible consumers; if the price of electricity generated at generation facilities based on renewable energy resources is equal to or lower than the sales price of TETAŞ and if there is no cheaper alternative, the retail licensees shall be obliged purchase such energy for the purposes of re-sale to the non-eligible consumers.

E) In one calendar year, the legal entities holding licenses to generate electricity from the renewable energy resources, can buy electric energy from a private sector wholesale company, in the condition of not to exceed the amount of their annual production which takes place in their license.

F) The electrical energy generated from renewable energy resources facilities are exempt from the obligation being balance unit in the scope of regulation of balance and conciliate under the article 18 of that titled “Balance Units and Registration Rules”.

G) In electrical market, in accordance with bulletin that about relating to financial conciliate method and principles; sales the generated electrical energy to the legal entity holding wholesale and retail sale, the facilities based on generation of wind energy and duct type hydro electrical energy are free of being applied and not to be subjected to financial conciliate until the regulations of balance and conciliate bulletin provisions comes into force.
8. CASE STUDIES FOR UTILISATION OF BIOMASS ENERGY

8.1. CUKOBIRLIK CASE: Obtaining energy from cotton processing waste

Cukobirlik on capacity of integrated facilities. Cukobirlik has a processing capacity was established in 1940, with its 41 cooperatives and 52,000 partners’ support to Turkish economy with huge production ranging from 100,000 to 150,000 tons unginned cotton and 50,000-60,000 tons ginned cotton per year. Central Oil Processing Plant capable of processing cottonseed, sunflower seed and soy beans using a modern extraction system, has a production capacity of 240ton/day and storage capacity of 18,000 ton.

Cotton seed oil factory has several potential alternatives to utilise own waste or by-products in energy production. It can invest on a new boiler fuelled by cleaning residue of the process (2500-3000 to/a). This fraction has no other use; the price of fuel is zero (it has to be considered only its transportation cost). However, annual volume of cleaning residue is not large enough to fulfil the need of heat of the plant. The second alternative is replacement of present oil fired boiler by biomass fired boiler with same capacity. Boiler could be fuelled by cleaning residue and taking part of cotton seed shell for energy production. This shell waste is presently sold (0.1 YTL/kg) to animal feed. The other potential fuel alternative is pressing residues but this is also sold to animal feed and its value is higher (0.25 YTL/kg). Needed capacity of the boiler should be roughly 5 MWth. This size of biomass fired boilers is typically based on grate firing, which has shown to be viable technology with difficult alkali containing fuels. Grate fired boilers are also available in Turkey but more or less similar boilers are manufactured especially in Spain (for orujillo, olive oil production residue) and in Denmark (straw fired boilers). The present oil fired boiler of company has a plan to replace it by a new boiler. The new boiler has initially been planned to be fuelled by natural gas. Technical risks related to natural gas fired boiler are very low and investment is lower than biomass fired boiler with the same capacity. However, price of natural gas is high, especially when compared to price of own wastes or by-products. It has to be mentioned once more that from technical point of view, cotton seed processing waste and by-products can be used for the cogeneration of heat and power. owns and operates seven ginning plants, each of them producing large volume of ginning wastes. Fuel characteristics of ginning waste are very close to fuel characteristics of cleaning residue of cotton seed processing plant. Technically, ginning waste could be utilised in the same plant than cleaning residue from cotton seed process. However, combined heat and power production requires significantly higher investment capital and strong technical experience in the implementation and operation of such a system. Efficient power production is based on efficient heat recovery and relatively high steam parameters of steam cycle. Technically this is more challenging than simplified production of hot water or low-pressure steam. In practice, technical risks related to high efficiency CHP production based on any high alkali biomass are higher than production of hot water or low-pressure steam. Based on the results of the pre-feasibility study, it seems that the installation of a 5 MW biomass boiler to for substitution of fuel oil (Scenario 2) is a very attractive investment and is still favourite in comparison with the installation of a natural gas boiler to meet the same needs when the natural gas price is higher than 0.37 €/Nm³.
Combined heat and electricity production: Cukobirlik is about 35 years old. This investment could be also a good start point for the exploitation of cotton processing residues in Cukobirlik cotton union in order to obtain know how experience for the implementation of large scale biomass systems for heat, electricity production.

<table>
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<th>Scenario 1</th>
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8.2. BOLTAC CASE: Exploitation of olive oil processing waste

BOLTAC Case: Boltac, is located in Tarsus/Mersin, Turkey. The company uses continue integral system to produce oil. The components of the system are: 1) hydro pneumatic washing machine & defoliator, 2) crusher elevator, 3) crusher & malaxer, 4) mono pump, 5) flow meter, 6) centrifugal decanter, 7) vibration, screen, 8) husk elevators (horizontal + vertical), 9) fruit water pump, 10) oil pump, 11) resting tank, 12) centrifugal separator, 13) oil tank (with a pump), 14) heating group, 15) electrical control panel.

Primary waste fraction of the process is solid residue from decanter separation of oil from pasta. This residue (pirina) consists of crushed skin, flesh, stone and water. In addition, pirina contains some residual oil. Properties of olive oil processing waste: Boltac processed 1 000 tons of olives in 2004. Due to periodicity of olive plant they are going to process less than 1 000 tons olives in 2005. One ton of processed olive corresponds to 400 kg of solid olive oil production residue, pirina. The number of effective working days within a year varies from 70 to 80 days. Electric consumption of Boltac was 3 500 kWh electric in 2004 for olive oil production. Their future plan is to increase the capacity of the plant. In addition to electricity the plant consumes process heat in order to increase yield of olive oil by heating crushed olive pasta prior oil separation.

The key component of the process is based on centrifugal separation of oil from heated pasta made of crushed olives. Pasta is first heated to 44 C by hot water. Boltac has invested on own hot water boiler (stoker), which is fuelled by own olive processing residue. Boiler has been manufactured by Turkish manufacturer Hakkı Usta. Feeding rate of the boiler is 40 kg/h corresponding to processing of 3 tons of olives per hour. Total production of waste is roughly 1 200 kg/h and so excess of olive residue is roughly 1 160 kg/h. Previously this was processed to briquettes and sold for fuel of stoves of private houses but briquetting was cancelled several years ago because of odour emissions. Today this excess of residue is mostly sold to other enterprises in order to recover some more olive oil by extractive processing. After this extraction residual olive waste contains approximately 1 % of residual oil. Since summer 2005 this olive oil processing residue is sold further to other industry to be used as a fuel.
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**Operation characteristics: Obtaining energy from olive oil processing waste**

Potential to increase use of olive oil processing residue in energy production Case study was focused on relatively small olive oil producer Boltac but it represents very well local olive oil producers. Most of these plants are small and therefore none of these small plants is not able establish larger scale energy production based on own waste only. However, centralised utilisation of olive oil residue from several sources could enable efficient and feasible energy production. It is estimated that within next three years volume of available olive processing residue in the surrounding (radius 90 km) of city Tarsus will be roughly 16,000 tons/a (moisture content 40 % i.e. dry matter 10,000 tons/a). In addition to olive oil processing residue other agrobiofuels could be co-combusted together with olive residue in order to assure availability of fuel and to increase capacity of plant. Larger size enables lower specific investment and higher power production efficiency.

**The evaluation of a CHP system:** Most probably no one of individual fuel suppliers will be able to invest on combined power plant but investor should be preferably some power company or industrial company who needs process steam/heat. From economic point of view, CHP agro waste fired seems to be an alternative for the development Tarsus. The feasibility indices of the prospective investments presented in the previous sessions are very attractive. Apart from the obvious benefit of fuel oil replacement that affects directly to the pay back time, the alternatives examined before provide an additional benefit which is the security of the energy supply and the independence from fuel price when own by-products are used for energy production. Volume of available olive residue is limited to below 10 MWth. From technical point of view this limitation does not set any specific restrictions to combustion technology. Based on assessment of volume of available olive oil processing residue in Tarsus area the most suitable technology will be based on stoker burner or grate firing. Based on the results of the pre-feasibility study, it seems that the installation of a MWth CHP biomass plant to Tursus for substitution of fuel oil and electricity production is a very attractive investment.

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9. **TECHNOLOGY REVIEW AND ASSESSMENT**

The most significant and commonly used thermal conversion method of biomass is combustion. Biofuels are utilised as a single fuel but they are also co-combusted with other fuels (coal, waste fractions, etc.). Co-firing is favoured especially in large scale when supply of large volumes of fuels is needed. Most of the biomass combustion technologies applied are different grate firing or fluidized bed boilers. Previously grate firing was the dominant technology but during last decades fluidised bed combustion has became more significant technology especially in larger scale. Fluidised bed technology is applied especially in modern large scale applications while small scale applications are
primarily based on grate firing. Fluidised bed technology enables excellent conditions for co-firing of biomass with other fuels.

The other technological thermal energy recovery alternatives are gasification and pyrolysis of biomass. Gasification will produce gaseous fuel, which can be used for co-firing in a large scale boiler or product gas can be utilised in district heating plants, industrial kilns or in other applications. Small-scale gasification technologies are usually based on different fixed bed gasifiers while in larger scale primarily on fluidised bed gasifiers.

9.1. Combustion Technologies

The most potential applications to utilise agrobiofuels in energy production in Turkey seem to be relatively small-scale applications. The most interesting size of the plant is below 10-20 MWth. This report will focus primarily on those small-scale applications but some large-scale information is also included.

9.1.1. Stoker burners

Stoker burners are well suitable for combustion of wood chips, pellets, and briquettes (Fig. 4.1). Stoker burners are used in output range from 10 kW up to 0.5–1.0 MW. Stoker is additional equipment attached to the boiler. A stoker consists of a screw feeder or a piston working in connection between a fuel storage and combustion chamber. The incoming fuel pushes fuel forward on the grate. Burning gases and combustion air are efficiently mixed by blowing combustion air into the fuel layer and into the gas combustion space. The output of a stoker burner can be easily varied from 0 to 100%. Reduced output neither does nor affect too much on total efficiency. This is a clear advantage compared to other technologies.

Most stoker burners cannot use fuels with a moisture content of more than 30-40%. Stoker burners are suitable for “fossil to biomass” conversion: it can be installed to existing oil or gas fired boilers.

9.1.2. Grate Boilers

In output range from 1 MWth up to 10-20 MW the prevailing technology in Europe is grate firing. The size range is broad: technology is available up to 150 MW. Grate boilers are suitable also
for wet fuels. Fuel preparation costs are low as the combustion process does not set very strict limitations for fuel particle size. On the other hand grate boilers are sensible to fuel quality changes and they are not as easy to control as the fluidised bed boilers.

There are various different grate boiler types. The most common are fixed sloping grate, moving horizontal grate, moving slope grate and multistage grate. One example of a boiler with mechanical grate is shown in Figure 4.2. Fuel is fed into the boiler with a hydraulically driven piston and is carried forward on the grate by movable fire bars. Preheated combustion air passes through the grate and speeds up the fuel drying.

One of the problems related to grate firing is the ash melting. Temperatures in the combustion chamber may reach 1300-1400°C. Ash melting problems may be reduced by using mechanical and water-cooled grates and by avoiding the use of preheated combustion air in the final burning area.

Grate boiler with moving grate is common technical solution for wood combustion. Through the movement of the grate, the fuel gets carried from the feeding point until the end of the grate. First the fuel dries, then pyrolyses and finally burns as it moves on the grate. Grate can be water-cooled if the fuel used has low ash melting point. Flue gas circulation is also used for temperature control in grate boilers.

A boiler with underfeeding grate is shown in Figure 4.2. Fuels with moisture content up to 65% (wet basis) can be used in this kind of boilers. Fuel is fed into the primary combustion chamber by a stoker screw through an inlet in the centre of the grate. Each grate sector can be programmed to rotate at a desired speed, which facilitates stable fuel feeding. From the secondary combustion chamber flue gases flow into a fire tube boiler.

9.2. Large Scale

9.2.1. Pulverised Fuel Boilers

There are several examples of coal fired pulverised-fuel (pf) boilers converted to co-firing of coal and biomass. Pf-boilers are typically very large-scale boilers, even hundreds of megawatts thermal. In pf boilers converted to co-firing, the share of biomass is not very high. In Danish Midkraft-
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Studstrup pf-fired boiler (150 MWe) straw (20% on an energy basis) is co-fired with coal. According to the Danish experiences the ash deposition or corrosion will probably not be major problems during coal-straw co-firing if high quality coal is used. More problematic are the fly ash quality aspects and poisoning of Selective Catalytic Reduction (SCR) catalyst for NOx reduction. In pulversed fuel combustion it is always important to bear in mind that the fuel preparation is very energy consuming.

9.2.2. Fluidised Bed Boilers

Fluidised bed technology is the most flexible for burning different types of fuels. Fluidised bed boilers can be designed to combust almost any solid, semi-solid, or liquid fuel as long as the calorific value is sufficient to heat the fuel, drive off the moisture and preheat the combustion air. Fluidised bed boilers are used mainly for capacities larger than 10 MW. They are suitable for many types of fuels, even for quite wet ones. The combustion temperature in a fluidised bed boiler is typically around 850 °C, so this may limit the use of many gramineous biomasses, as their ash softening may start in temperatures as low as 800 °C.

Fluidised bed boilers (Fig. 4.3) are commonly used in Scandinavian countries for wood biomass. In a fluidized bed boiler the fuel burns in a bed of sand and ash. Combustion air, blown through the nozzles in bottom of the boiler, keeps the bed material in continuous movement. The share of fuel in the bed is only about 2-5 %. The high share of hot sand and ash stabilises the combustion process. In bubbling fluidised bed boiler the fluidisation air velocity is low enough to keep the bed in desired level. In circulating fluidised bed the fluidising air velocity is considerably higher so that the gases leaving the bed area carry part of the bed material to the upper part of the furnace. The solid material is then separated in a cyclone and recycled to the lower section of the bed. Bubbling fluidised bed boilers suit especially for wet fuels with low calorific heating value. They also tolerate wider variation in fuel particle size distribution.

There are experiences on straw/coal co-firing in fluidised bed boilers. Danish power plant Grenå was designed to burn coal and straw (50/50 on energy basis) in 80 MWth circulating fluidised bed boilers. Because of heavy corrosion in the final superheater, some modifications were done after only 18 months of operation. There was also serious fouling of the cyclones and the superheaters in the convective path. Furnace temperature had to be decreased. Plant also changed to a low sulphur coal and better quality limestone. These measures worked in favour of reducing fouling significantly and corrosion by some level.
9.3. Gasification

Gasification is another thermal conversion technology, which can be used to recover energy from biomass. The primary product of gasification process is fuel gas, which can be used as a fuel in different power production processes or in industrial applications. Typical applications are combustion in a boiler or in industrial kiln and in small scale use as a fuel of engine. The most simple and usual applications are wood fuelled gasifiers connected directly to kilns but there are also very advanced high efficiency power production technologies based on gasification.

During last 10 years gasification process has been applied for producing fuel gas for co-combustion applications. Relatively large scale atmospheric pressure gasification is used for replacing part of the coal input of large scale PC boiler by biomass derived gas. This co-firing enables efficient utilisation of solid and poor quality biomass even in pulverised coal fired boilers without pulverising biomass. Risks related to corrosion and deposit formation by contaminants of biomass can be eliminated by cleaning the product gas prior co-combustion. Power production efficiency (from biomass to power) is high when large scale steam cycle can be applied. In addition, when the gasifier is equipped with gas filtration biomass ash can be separated from coal ash. In addition, fluidised bed gasifiers are very flexible to fuel selection enabling wide variety of biofuels separately or as a mixture.

Need of product gas cleaning prior co-firing with coal depends on the quality of the used biomass. Clean biofuels do not require any gas cleaning but demolition wood waste, straw and other biofuels containing harmful contaminants need. This technology is already in use in Finland, Netherlands and Austria and new plants are under design and commissioning phase.

9.3.1. Fluidised Bed Gasification

Fluidised-bed gasifiers can be divided into circulating fluidised-bed (CFB) and bubbling fluidised-bed (BFB) gasifiers. Principles of these techniques are equal to fluidised-bed (CFB and BFB) combustion. The BFB gasification technology seems to be economically more suitable to medium size applications (15–60 MW) while the CFB technology is most feasible on larger scale (40–100 MW). Similar dry gas cleaning technology can be applied for BFB gasification as for CFB gasifiers.
The principle of air blown atmospheric pressure CFB gasifier is simple. The system consists of a refractory-lined reactor where the gasification takes place, of a cyclone to separate the circulating material from the gas and of a return leg for returning the circulating material to the bottom part of the gasifier. The operating temperature in the reactor is typically 800–1000°C, depending on the fuel and the application. The fuel is fed into the lower part of the gasifier, above certain distance from the air distribution grid. When entering the reactor, the biofuel particles start to dry rapidly and the pyrolysis also occurs. The gaseous products of drying and pyrolysis flow upwards in the reactor. Most of the solids are separated from the gas in the cyclone and returned to the bottom of the bed, where the charcoal is combusted with the air that is introduced through the grid nozzles to fluidise the bed.

The CFB gasification concept without gas cleaning (like the one realised in Lahti) can be utilised only for woody biomass fuels and clean waste-derived feedstocks. Many potential biomass feedstocks, such as straw and many fast-growing energy crops as well as industrial and municipal waste-derived fuels often contain high amounts of impurities like chlorine, alkali metals, and aluminium, which have a tendency to cause severe corrosion and fouling problems in boilers.

Demolition wood waste is also locally important renewable feedstock, which is difficult to be introduced into ordinary coal-based combustion plants due to the relatively high content of heavy metals (Zn, Pb, Cd, As) and chlorine. The impurities may also effect on the usability of coal boiler ash for cement industry and construction purposes. Thus, in many cases, gas cleaning is required to avoid operation problems in the main boiler, to achieve the emission limits or to avoid the contamination of the coal ash by biomass alkalis or heavy metals from waste fuels. Most of the harmful impurities can be removed by filtering the gas at 350-450 °C (Figure 4.4).

9.3.2. Fixed Bed Gasification

The most economical gasification technology that can be realised in small scale is fixed bed gasification. However, most of the available biomass residues do not meet the requirements of
commercial fixed bed gasifiers. Usually the bulk density is low; the fuel is fibrous and also contains fines, which creates problems with the gas flow in gasifiers relying on gravity for fuel feed in the reactor. While there exist gasification technologies (e.g. fluidised bed) that are able to gasify these fuels, they are not suitable for small-scale plants due to high costs. Conversely, the fuels that commercial fixed bed gasifiers are able to use as feedstock, are normally not sufficiently cheap to make small gasifier driven combined heat and power plants competitive.

The largest and most important markets for the small-scale, fuel-flexible gasifier concept are in small-scale combined heat and electricity production. At present, conventional steam turbines are not economically attractive in small-scale (<3 MWe) applications, and units smaller than 1 MWe are difficult to find. However, the gasifier-engine concept can be realised also at this scale. Consequently, rapid development has been achieved in the development in small- and also in large-scale CHP processes.

Two basic types of traditional fixed-bed gasifiers are illustrated in Figure 4.5. Both reactor types are based on natural slowly descending fuel flow caused by gravity. The residence time of the fuel in the gasifier is long and the gas velocity is low. Generally these gasifier-types are used in small-scale energy production (< 10 MWth). The traditional fixed-bed gasifiers are suitable only for sized feedstocks, which have high enough bulk density to guarantee stable fuel flow. In an updraft gasifier the fuel is fed to the top of the gasifier, wherefrom the fuel flows down slowly through drying, pyrolysis, gasification and combustion zones. Ash is removed from the bottom, where the gasification air and steam are introduced. As the products of drying and pyrolysis zones are directly drawn into the product gas without secondary decomposition reactions, the product gas of an updraft gasifier contains an abundance of oils and tars. In addition, the product gas temperature is low (with biomass fuels 80–300 °C and with coal 300–600 °C). Bottom ash is usually completely oxidized and does not contain significant amounts of unburned carbon. Usually, the dust content of the product gas is rather low due to low gas velocities and due to "filtering effects" of the drying and pyrolysis zones.

![Figure 9.5. Conventional fixed-bed gasifier types.](image)
9.3. Biogas

One specific fraction of agricultural residues is animal manure. Traditionally manure has been utilized on the fields as a fertiliser but in many areas in Europe production of manure is locally larger than available surface area of the fields. This has led to situation that volume of manure to be used as a fertiliser has to be reduced. Thermal conversion (combustion and gasification) has been developed but heating value of wet manure is poor. In addition, ash behaviour is very problematic and risk for serious deposit formation is high.

The alternative treatment and utilisation method is anaerobic digestion (AD), which produces methane for energy purposes and residue is used for soil conditioning and as a fertiliser. Anaerobic digestion is widely used for treatment of sewage sludge but more and more plants have been constructed for treatment of animal manure, too. Anaerobic digestion of animal waste is utilised all over the world. For example in China it is estimated that more than 6 million farm scale biogas generators are in use. In developing countries biogas plants are primarily small farm-scale plants when in more developed countries plants are usually larger and co-operated by several farms. In developing countries gas is primarily utilised for cooking and lightning but in more developed countries gas is usually used to generate heat and electricity to run the farm and export.

Modern technology in agricultural waste digestion is based on the concept of centralised anaerobic digestion where many farms co-operate to feed a single larger digestion plant. The agricultural residues provided to these plants are mainly agricultural manures and they are often controlled by environmental legislation. AD treatment of these residues allow additional value to be gained through providing products and reducing the cost of disposal.

The produced biogas is very similar than natural gas. The primary product is methane, which makes it excellent fuel for many uses. In practice, cleaned biogas can be used for most of those applications where natural gas is used. One of the most common ways to utilise natural gas for power production is internal combustion engine. In smaller scale (< 200 kW) electrical conversion efficiency can be up to 25 % and in larger scale even 30-35 %. In addition to electricity the IC engine produces heat, which can be utilised for district heating or hot water production. The residue from AD process is solid material and liquid. Liquid phase contains most of the valuable nutrients and so this fraction can be utilised as a fertiliser. The solid fraction can be used on farm land or on gardens to provide bulky organic matter to improve soil quality and fertility.
Biogas production based on agricultural residues, especially manure, has been widely used especially in Denmark. About 20 centralised biogas plants are in operation, most of them co-digesting animal manure and small amounts of organic waste. In the further development of the biogas technology focus is now on further economic improvements that will enable new plants to be built without public investment grants.

10. EVALUATION OF INVESTMENTS

Energy conservation projects should be evaluated on the same merit as any other investment. Capital, material and manpower consigned in the initial phase of a particular project, are directly related to the money, material and manpower saved in the long run. Avoided energy costs and other savings, as a result of an energy conservation project, may be counted on an annual basis for the life cycle of the equipment or system. However, financial planning of specific projects is necessary in order to sure that the energy system improvements in an establishment will result in adequate capital recovery within a reasonable period of time. Well-planned energy conservation projects, that weigh the advantages and associated investment risks, will generally achieve a satisfactory return on the initial investment. Moreover, the integration of energy efficient equipment into an industrial process could increase productivity as well as improve the position of a specific establishment's impact on the environment. Therefore, feasibilities of both case studies (Çukobirlik and Boltaç cases) in terms of the economic and financial assessment of the investment for biomass utilization to obtain energy were evaluated using excel™ model specifically developed by EXERGIA. The model consists of two parts: input data and outputs:

Input data to the assessment model can be classified as following categories:

1. General economic data related to the capital investment structure (equity, grants, and loans), life cycle of the investment, annual rate of return, tax bracket and incentives, accounting periods, annual compound interest rate, annual depreciation value etc..
2. Energy data (energy needs, operating hours, energy costs, etc.)
3. Data concerning the biomass system (investment cost, operating cost, efficiency, properties of fuel, calorific values of biomass, amount of biomass etc.)

The outcomes from the assessment model can be classified as following categories:

1. Net Present Value (NPV): the annual net benefits of the investment. The net benefits are calculated based on the total annual savings, less the annual depreciation value, the operating cost, and the taxes paid every year.

2. Internal Rate of Return (IRR): The IRR method measures the annual project rate of return in present value terms. IRR is an annual compound interest rate that makes the stream of discounted benefits, expected from an investment, equal to the initial project costs.
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3. **Discounted Payback Period (DPB):** The pay back period economic evaluation index determines the required time period (years) in order to recover the initial investment through the net cash earnings of an investment.

4. **Cash Flow Analysis Table:** Economic evaluation of energy conservation projects requires a good comprehension of life-cycle costs and cash flow analysis that takes into account expenditures and profits realised through the economic life-cycle of the investment.

5. **Benefit to Cost Ratio:** The model compares conventional system (fuel oil or natural gas based) to biomass system in terms economical viability.

11. **BUILDING LINKAGES WITH ACTORS**

The addresses of the local actors related to biomass energy use in Turkey are given in Table 11.1. and Boiler Manufacturers in Turkey are given Table 11.2. EU manufacturers of the biomass sector are given Table 11.3.
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#### Table 11.1 The addresses of the local actors related to biomass energy use in Turkey

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<td>0312 315 76 22</td>
<td><a href="http://www.tagem.gov.tr">www.tagem.gov.tr</a></td>
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<td>Ziraat Mühendisleri Odası</td>
<td>Karanfil Sok. 28/12 06640 Kızlalı / ANKARA</td>
<td>0312 425 05 55</td>
<td><a href="http://www.zmo.org.tr">www.zmo.org.tr</a></td>
<td><a href="mailto:bilgi@zmo.org.tr">bilgi@zmo.org.tr</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0312 418 51 98</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Elektrik Mühendisleri Odası</td>
<td>İhlamur Sk. 10/1 06440 Yenisehir/ANKARA</td>
<td>0312 425 32 72</td>
<td><a href="http://www.emo.org.tr">www.emo.org.tr</a></td>
<td><a href="mailto:emo@emo.org.tr">emo@emo.org.tr</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0312 417 38 18</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Makine Mühendisleri Odası</td>
<td>Sümer 2 Sokak No: 36/1-A Demirtepe/ANKARA</td>
<td>0312.2313159</td>
<td><a href="http://www.mmo.org.tr">www.mmo.org.tr</a></td>
<td><a href="mailto:mmo@mmo.org.tr">mmo@mmo.org.tr</a></td>
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<tr>
<td></td>
<td></td>
<td>0312.2313165</td>
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<tr>
<td>Kimya Mühendisleri Odası</td>
<td>Karanfil Sok. No: 19 / 5 Kızlalı / ANKARA</td>
<td>0312 417 65 20</td>
<td><a href="http://www.kmo.org.tr">www.kmo.org.tr</a></td>
<td><a href="mailto:kmo@kmo.org.tr">kmo@kmo.org.tr</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0312 417 35 63</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Çevre Mühendisleri Odası</td>
<td>Atatürk 2 Sokak No:66/9 Kızlalı/ANKARA</td>
<td>0312 430 64 34</td>
<td><a href="http://www.cmo.org.tr">www.cmo.org.tr</a></td>
<td><a href="mailto:cmo@cmo.org.tr">cmo@cmo.org.tr</a></td>
</tr>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>Tarımsal Araştırmalar Genel Müdürlüğü</td>
<td>İstanbul Yolu Üzeri Bağdat Caddesi No:38, P.K.78, Yenimahalle/ANKARA</td>
<td>312 315 76 22</td>
<td><a href="http://www.tagem.gov.tr">www.tagem.gov.tr</a></td>
<td><a href="mailto:bilgi@tagem.gov.tr">bilgi@tagem.gov.tr</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>312 315 34 48</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TAGEM Tarsus Araştırma Enstitüsü</td>
<td>TARSUS/İÇEL</td>
<td>0324 644 60 91</td>
<td><a href="http://www.adaso.org.tr">www.adaso.org.tr</a></td>
<td><a href="mailto:adaso@adaso.org.tr">adaso@adaso.org.tr</a></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0324 644 60 90</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Adana Sanayi Odası (ASO)</td>
<td>Seyhan/ADANA</td>
<td>0322 436 63 63</td>
<td><a href="http://www.adaso.org.tr">www.adaso.org.tr</a></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td>0322 436 16 36</td>
<td></td>
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</table>
A Guide on Exploitation of Agricultural Residues in Turkey

Table 11.2 Boiler Manufacturers in Turkey

<table>
<thead>
<tr>
<th>Manufacturers</th>
<th>Adress</th>
<th>Phone ve Fax</th>
<th>Web.</th>
<th>E-mail</th>
</tr>
</thead>
<tbody>
<tr>
<td>BERSEY KAZAN</td>
<td>Kızılay Cad Karanfil Sok No:2 34160 Bayrampasa/ ISTANBUL</td>
<td>0212 576 35 37</td>
<td><a href="http://www.berseykazan.com">www.berseykazan.com</a></td>
<td><a href="mailto:akinerol@berseykazan.com">akinerol@berseykazan.com</a></td>
</tr>
<tr>
<td>ÇIFTEL MAKINA SAN.VE TIC.LTD.ŞTİ.</td>
<td>1482 Sokak No: 21 Doğanlar/Bornova/IZMİR</td>
<td>0232 479 11 21</td>
<td><a href="http://www.ciftemakine.com">www.ciftemakine.com</a></td>
<td><a href="mailto:info@ciftemakine.com">info@ciftemakine.com</a></td>
</tr>
<tr>
<td>DESA</td>
<td>Kemalpaşa cad. No:4 35060 Pınarbaşı/IZMİR</td>
<td>0232 436 15 00</td>
<td><a href="http://www.desa-otak.com.tr">http://www.desa-otak.com.tr</a></td>
<td><a href="mailto:info@desa-otak.com.tr">info@desa-otak.com.tr</a></td>
</tr>
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## Table 11.3 EU manufacturers of the biomas sector

<table>
<thead>
<tr>
<th>No</th>
<th>Companies</th>
<th>Country</th>
<th>Contact Person</th>
<th>Address</th>
<th>Contact Details</th>
<th>Description of Activities</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Binder</td>
<td>Austria</td>
<td>Josef Binder, Sales Manager</td>
<td>A-8572 Barnbach Mitterdorfer Strasse 5, Austria</td>
<td>Tel: +43 3142 22 5 44 Fax: +43 3142 22 5 44-16 Email: <a href="mailto:office@binder-gmbh.at">office@binder-gmbh.at</a> <a href="http://www.binder-gmbh.at">http://www.binder-gmbh.at</a></td>
<td>80KW-5MW biomass combustion systems. Combustion of any type of wood residues (chip boards and sawdust). Very moist fuel materials, Residue from fruit juice production</td>
</tr>
<tr>
<td>No</td>
<td>Companies</td>
<td>Country</td>
<td>Contact Person</td>
<td>Address</td>
<td>Contact Details</td>
<td>Description of Activities</td>
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<tr>
<td>2</td>
<td>ENTEC-Environment Technology, Umwelttechnik GmbH</td>
<td>Austria</td>
<td>Mr. Peter Stepney, Managing Director</td>
<td>Schilfweg 1, A-6972 Fussach Austria</td>
<td>Tel: +43 5578 7946 Fax: +43 5578 7946 800 Email: <a href="mailto:entec@biogas.at">entec@biogas.at</a> <a href="http://www.biogas.at">http://www.biogas.at</a></td>
<td>Anaerobic treatment technologies for organic wastewater, organic sludge and organic solids. ENTEC provides the following services: Process design Detailed plant design, Turnkey plants Finance on BOT services</td>
</tr>
<tr>
<td>3</td>
<td>FRÖLING Ges.m.b.H</td>
<td>Austria</td>
<td>Mr. Wolfgang Aichinger, Export manager</td>
<td>Industriestrasse 12 A-4710 Grieskirchen Austria</td>
<td>Tel.: +43 7248 606 – 0 Fax: +43 7248 606 – 600 Email: <a href="mailto:info@froeling.com">info@froeling.com</a> <a href="http://www.froeling.com">http://www.froeling.com</a></td>
<td>Wood log boilers 5-70 kW Wood pellet boilers 4-500 kW Wood chip boilers 15-1.000 kW</td>
</tr>
<tr>
<td>4</td>
<td>Kohlbach Group (KCO Kohlbach Cogeneration and Bioenergie GmbH, SMS Service Montage und Systemtechnik GmbH, HKI Heizkessel und Industrieanlagenbau GmbH)</td>
<td>Austria</td>
<td>Walter Kohlbach, Vice President</td>
<td>Grazer Str. 23 9400 Wolfsberg Austria</td>
<td>Tel: +43 4352 2157 – 0 Fax: +43 4352 2157 – 11 Email: <a href="mailto:office@kohlbach.at">office@kohlbach.at</a> <a href="http://www.kohlbach.at">http://www.kohlbach.at</a></td>
<td>Boiler manufacturer: 100-10.000 kW, fuel: biomass, Straw and Pellet boiler systems Complete Boiler housing and biomass fuel logistics Heat and Power Cogeneration Construction and installation of biomass-fired energy systems (heat and cogeneration)</td>
</tr>
<tr>
<td>5</td>
<td>MAWERA Holzfeuerungsanlagen GmbH</td>
<td>Austria</td>
<td>Claus Steurer, Managing director</td>
<td>Neulandsstrasse 30 A-6971 Hard Austria</td>
<td>Tel: +43 5574 74301 Fax: +43 5574 74301 20 Email: <a href="mailto:info@mawera.com">info@mawera.com</a> <a href="http://www.mawera.com">http://www.mawera.com</a></td>
<td>Planning, building, installing and commissioning of wood fired boiler systems</td>
</tr>
<tr>
<td>6</td>
<td>Perhofer Bio-Heizungs GmbH &amp; Co KG</td>
<td>Austria</td>
<td></td>
<td>Waisenegg 115 A-8190 Birkfeld Austria</td>
<td>Tel: +43 3174 3705 Fax: +43 3174 37058 Email: <a href="mailto:office@biomat.at">office@biomat.at</a> <a href="http://www.biomat.at">http://www.biomat.at</a></td>
<td>Pellet burning heating boiler Type PK-V15 Heating Boiler for pellets and chopped wood Type Kombi V15 Kitchen appliances for energy efficient cooking and heating</td>
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### A Guide on Exploitation of Agricultural Residues in Turkey

<table>
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<tr>
<th>No</th>
<th>Companies</th>
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<th>Contact Person</th>
<th>Address</th>
<th>Contact Details</th>
<th>Description of Activities</th>
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</table>
| 7  | Polyteknik              | Austria     | Mr. Thomas Hofmann, Mr. Dr. Bykov | Hainfelder str. 69-71 A-2564, Weizenbach Austria | Tel: +43 26 72 890 -0, Fax: +43 26 72 890-13, Email: office@polytechnik.at http://www.polytechnik.at | Biomass heating plants (50 kW-15.000 kW)  
Wood fired furnaces  
Long distance heating with biomass  
Cogeneration plants (electricity out of biomass) |
| 8  | Wildfellner Optimale Fördertechnik GmbH | Austria | Mr. Wildfellner André (export) | Niederlaaberstrasse 3 A - 4611 Buchkirchen Austria | Tel: +43 7242 28110-0, Fax: +43 7242 28757 Email: office@wildfellner.at http://www.wildfellner.at | Individual solutions & specific planning of shaftless spiral conveyor systems in normal and stainless steel or plastic.  
Conveyors for: Wood chips, Wood pellets, Sawdust, Shavings, Briquettes, (hot) ash, other biomasses – tobacco dust etc  
various conveying media up to 400 mm long, wet and/or dry |
| 9  | Windhager Zentralheizung AG | Austria | Mr. Bernhard Holzer, Export Manager | Anton-Windbager-Str. 20 A-5201 Seekirchen am Wallersee Austria | Tel: +43 6212 2341-0, Fax: +43 6212 4228 Email: holz@windhager-ag.at http://www.windhager.com | PMX – Wood pellet-fired heating system whose output may be modulated over the range 5-29,9 kW  
HMX – Wood gasification boiler with stainless steel filling space for billets (21-40 kW)  
MIRA – Oil fired boiler with Perpetum-Burner whose output may be modulated over the range 4,7-14 kW  
GENIO and XENTA – Gas firing condensing boilers (2,6-65 kW) |
| 10 | CSB                     | Belgium     |                                | Doorniksesteenweg 81A bus 7, 8500 Kortrijk, | Tel.: +32 56 21 66 60 Fax: +32 56 20 48 98 Email: | Grinders for waste wood and plastic  
Grinders for industrial waste  
Industrial granulators and |
### A Guide on Exploitation of Agricultural Residues in Turkey

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<tr>
<th>No</th>
<th>Companies</th>
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<td>shredders/grinders for preliminary size reduction; Revolving screens Industrial wood incineration plans with heat recuperation Conveyor systems, Special machines Industrial grinders</td>
</tr>
<tr>
<td></td>
<td>Seghers Keppel Technology Group</td>
<td>Belgium</td>
<td>Mrs. Tania Van Loon, Area Sales Manager</td>
<td>Hoofd 1 B-2830 Willebroek, Belgium</td>
<td>Tel: +32 3 880 77 00 Fax: +32 3 880 77 49 <a href="mailto:info_biosolids@seghegroup.com">info_biosolids@seghegroup.com</a> <a href="http://www.seghersgroup.com">www.seghersgroup.com</a></td>
<td>Seghers Keppel Technology provides innovative better technologies for: Treatment of all types of industrial, municipal and hazardous waste, biomass and sludge by transforming it into clean energy. Fluidised bed cleaning to remove paint and plastics from their metal tools Medical and hazardous waste incineration The complete water cycle: wastewater, process water, drinking water, water reuse, off-gas) Solutions for harbour &amp; highly industrialized zones including dredged sludge treatment and storage, liquid and solid waste processing, soil remediation and landfill</td>
</tr>
<tr>
<td></td>
<td>Xylowatt S.A.</td>
<td>Belgium</td>
<td>Ivan Sintzoff, CEO</td>
<td>2, Place du Levant B-1348 Louvain-la-Neuve, Belgium</td>
<td>Tel: +32 10 450 495 Fax: +32 10 451 794 Email: <a href="mailto:info@xylowatt.com">info@xylowatt.com</a> <a href="http://www.xylowatt.com">http://www.xylowatt.com</a></td>
<td>Design of wood energy solutions Supply of wood gasification power plants Customized solutions including third financing; Tele-monitoring,</td>
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### A Guide on Exploitation of Agricultural Residues in Turkey

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<th>No</th>
<th>Companies</th>
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<th>Description of Activities</th>
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<td>13</td>
<td>Alcon ApS Engineering</td>
<td>Denmark</td>
<td>Svend Bieggaard Kristensen</td>
<td>Frichsvej 11 DK 8464 Galten Denmark</td>
<td>Tel: +45 8666 2044, Fax: +45 8666 2954, Email: <a href="mailto:alcon@post6.tele.dk">alcon@post6.tele.dk</a>, <a href="http://www.alcon.nu">http://www.alcon.nu</a></td>
<td>Alcon boilers for wood, briquettes, coal, small &amp; big bales of straw, sawdust and grain etc</td>
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<td>Alcon straw boiler with and without water accumulator KSM mechanical stockers</td>
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<td></td>
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<td>Steel chimneys of special cornet steel</td>
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<tr>
<td>14</td>
<td>Argusfyr Energiteknik A/S</td>
<td>Denmark</td>
<td>T. Boss Nielsen, President</td>
<td>Lyngager 10 2605 Brøndby Denmark</td>
<td>Tel: +45 4343 2016, Fax: +45 4343 0289, E-mail: <a href="mailto:lr@argusfyr.dk">lr@argusfyr.dk</a>, <a href="http://www.argusfyr.dk">http://www.argusfyr.dk</a></td>
<td>The Argusfyr systems are suitable for hot water, steam or even hot oil boilers with a capacity from 0.1-15 MW. If required the systems can be adjusted to be build into existing boilers, either built into the combustion box or installed in water filled pre-stokers. Combustion emissions is guaranteed to keep the strictest requirements for outlet of CO and NOx</td>
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<td>Waste to energy systems</td>
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<td>Biomass energy systems</td>
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<td>Fluidized bed systems</td>
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<td>After-sales service</td>
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<tr>
<td>15</td>
<td>Babcock &amp; Wilcox Volund ApS</td>
<td>Denmark</td>
<td>Ager Danielsen, Sales manager</td>
<td>Head office: Falkevej 2 DK-6705 Esbjerg Ø Denmark.</td>
<td>Tel: +45 76 14 34 00, Fax: +45 76 14 36 00, Email: <a href="mailto:bwv@volund.dk">bwv@volund.dk</a>, <a href="http://www.volund.dk">http://www.volund.dk</a></td>
<td>Waste to energy systems</td>
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<td>Biomass energy systems</td>
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<td>Fluidized bed systems</td>
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<td>After-sales service</td>
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<tr>
<td>16</td>
<td>NIRAS A/S</td>
<td>Danish</td>
<td>Ager Danielsen, Sales manager</td>
<td>Head office: Falkevej 2 DK-6705 Esbjerg Ø Denmark.</td>
<td>Tel: +45 76 14 34 00, Fax: +45 76 14 36 00, Email: <a href="mailto:bwv@volund.dk">bwv@volund.dk</a>, <a href="http://www.volund.dk">http://www.volund.dk</a></td>
<td>Among others, renewable energy - including biogas and biomass plants, solar heating plants and local Combined Heat and Power (CHP) installations</td>
</tr>
<tr>
<td>17</td>
<td>Biowatti Oy</td>
<td>Finland</td>
<td>Fridrik Pressler, Development</td>
<td>P.O. Box 70, FIN-02020</td>
<td>Tel: +358 1 046 08, Fax: +358 1 046 58298</td>
<td>Marketing of wood fuels to heating</td>
</tr>
<tr>
<td>No</td>
<td>Companies</td>
<td>Country</td>
<td>Contact Person</td>
<td>Address</td>
<td>Contact Details</td>
<td>Description of Activities</td>
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<tr>
<td>18.</td>
<td>BMH Wood Technology Oy</td>
<td>Finland</td>
<td>Mr. Kari Haapanen, Director, Sales &amp; Marketing</td>
<td>P.O. Box 32 FIN-26101 RAUMA Finland</td>
<td>Tel: +358 2 83151 Fax: +358 2 8221327 Email: <a href="mailto:bmh@bmh.fi">bmh@bmh.fi</a></td>
<td>Bio-fuel handling systems Solid waste processing Heavy-duty crushers &amp; shredders Step feeders, Screens, Fuel silos &amp; other storages Stackers and reclaimers, Standard conveyors Automatic fuel feeding systems for boilers Ash handling, cooling &amp; humidifying</td>
</tr>
<tr>
<td>19.</td>
<td>Condens Oy</td>
<td>Finland</td>
<td>Ilkka Haavisto, Managing Director,</td>
<td>Talkkunapolku 6, FIN-13100 Hämeenlinna, Finland,</td>
<td>Tel: +358 3 65 33 111, Fax: + 358 3 65 33 110, Email: <a href="mailto:ilkka.haavisto@condens.fi">ilkka.haavisto@condens.fi</a></td>
<td>Biomass gasifiers Power plants based on biomass gasification Gas wet cleaning equipment Condensing heat recovery equipment for gases</td>
</tr>
<tr>
<td>20.</td>
<td>Enprima Ltd</td>
<td>Finland</td>
<td>Mr. Matti Lilja</td>
<td>P.O Box 61 Fin-01601 Vantaa Finland,</td>
<td>Tel: + 358 9 348 55 11, Fax: + 358 9 348 55 000, Email: <a href="mailto:matti.lilja@enprima.com">matti.lilja@enprima.com</a></td>
<td>Engineering and construction management for cogeneration, waste-to-energy and bioenergy projects. Solutions for conversion of existing coal or oil fired boilers to biomass combustion</td>
</tr>
<tr>
<td>21.</td>
<td>Laitilan Metalli Laine Oy</td>
<td>Finland</td>
<td>Atte Aarnio, Marketing Manager</td>
<td>Garpintie 130, 23800 Laitila Finland.</td>
<td>Tel: + 358 2 858 515 Fax: + 358 2 856 014 Email: <a href="mailto:atte.aarnio@laimet.com">atte.aarnio@laimet.com</a></td>
<td>Manufacturing of LAIMET Chippers Production of big chips for biomass,</td>
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## A Guide on Exploitation of Agricultural Residues in Turkey

<table>
<thead>
<tr>
<th>No</th>
<th>Companies</th>
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<th>Address</th>
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<th>Description of Activities</th>
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<td></td>
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<td>wood gasifying, district heating centres</td>
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<td></td>
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<td>Production of small chips to pulp/paper industry</td>
</tr>
<tr>
<td>22</td>
<td>Pentin Paja Oy</td>
<td>Finland</td>
<td>Mr Janne Häikö, Export and After sales service</td>
<td>Yritysajantie 13, FIN 80230 Joensuu Finland</td>
<td>Tel: +358 13 825 051, Fax: +358 13 825 053, Mob: +358 40 733 0405, Email: <a href="mailto:janne.haikio@kolumbus.fi">janne.haikio@kolumbus.fi</a>, <a href="http://www.kolumbus.fi/pentin.paja">http://www.kolumbus.fi/pentin.paja</a></td>
<td>Naarva felling and harvesting heads for early thinning and energy wood harvesting</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Steg-Master 2000-25: Light-weight pulse harvester; e.g for farm tractor; Naarva-Grip 1600-40:</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td>Accumulating felling head/grapple for energy wood</td>
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<td>Naarva - Grip 1500-25: Felling head/grapple</td>
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<td></td>
<td>Naarva – Grip 1000-23: Light weight felling head/grapple e.g. for farm tractors</td>
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<td></td>
<td></td>
<td>Naarva – cleaner for young stand forest</td>
</tr>
<tr>
<td>23</td>
<td>Raumaster Oy</td>
<td>Finland</td>
<td></td>
<td>Nortamonkatu 32, 26100 RAUMA Finland</td>
<td>Tel: +358 2 837 741, Fax: +358 2 822 3801, Email: <a href="mailto:material.handling@raumaster.fi">material.handling@raumaster.fi</a>, <a href="http://www.raumaster.fi">http://www.raumaster.fi</a></td>
<td>Fuel preparation and handling systems for biomass fuelled power plants</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Ash handling systems for biomass fuelled power plants, Modifications</td>
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<td></td>
<td></td>
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<td></td>
<td>After sales services</td>
</tr>
<tr>
<td>24</td>
<td>Vapo Oy Energia</td>
<td>Finland</td>
<td>Jaakko Silpola, Marketing Manager</td>
<td>P.O. box 22, FIN- 40101 Jyvaskyla Finland</td>
<td>Tel: +358 14 623 5644, Fax: +358 14 623 5707, Email: <a href="mailto:info@vapo.fi">info@vapo.fi</a>, <a href="http://www.vapo.fi">http://www.vapo.fi</a></td>
<td>Wood pellets, Wood briquettes</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>Wood-based fuels, Peat pellets</td>
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<tr>
<td></td>
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<td></td>
<td></td>
<td>Fuel peat, Reed Cnary grass</td>
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<td>Heat and Power</td>
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<tr>
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<tbody>
<tr>
<td>25</td>
<td>Wartsila</td>
<td>Finland</td>
<td>Marika Repka, marketing assistant</td>
<td>Arabianantusta 6 00560 Helsinki Finland</td>
<td>Tel: +358 10 709 0000 Fax: +358 10 709 5469 Email: <a href="mailto:biopower@wartsila.com">biopower@wartsila.com</a> Email: <a href="mailto:firstname.lastname@wartsila.com">firstname.lastname@wartsila.com</a> <a href="http://www.wartsila.com">http://www.wartsila.com</a></td>
<td>BioGrate combustion technology BioEnergy Thermal Plants range from 2-25MWth BioPower CHP Plants2-5MWe (5-15 MWth) BioPower Condenser Plants 2-5 MWe</td>
</tr>
<tr>
<td>26</td>
<td>Compte R. S.A.S.</td>
<td>France</td>
<td>M. Olivier Jacquo</td>
<td>Z.I. de Vautrail 63220 Arlanc France</td>
<td>Tel: +33 4 73 95 01 91 Fax: +33 4 73 95 15 36 Email: <a href="mailto:comptexport@wanadoo.fr">comptexport@wanadoo.fr</a> Email: <a href="mailto:oliverjako@aol.com">oliverjako@aol.com</a> <a href="http://www.compte-r.com">http://www.compte-r.com</a></td>
<td>Wood-waste boilers COMPACT C40 400-500 kW; C50 500-700 kW C70 700-900 kW; C90 900-1200 kW C150 1.5-2 MW ; C250 2.5-3 MW C350 3.5-4 MW; C450 4.5-5 MW</td>
</tr>
<tr>
<td>27</td>
<td>SAVOIE PAN S.A.</td>
<td>France</td>
<td>Maurizio Annovati, Managing director Nathalie Andre, Business manager</td>
<td>ZI 2 de Frontenex 73460 Tournon France</td>
<td>Tel: +33 4 79 38 58 04 Fax: +33 4 79 38 52 70 Email: <a href="mailto:bioenergie@savoiepan.com">bioenergie@savoiepan.com</a> <a href="http://www.savoiepan.com">http://www.savoiepan.com</a></td>
<td>Pellets production Wood pads production Containers and collecting systems Milling and transport Wood scrap recycling Trading</td>
</tr>
<tr>
<td>28</td>
<td>SOFFIMAT S.A.</td>
<td>France</td>
<td>Mr Claude Hamon, Project Manager</td>
<td>22, avenue de la Grande Armée 75017 – Paris France</td>
<td>Tel: +33 1 55 37 46 00 Fax: +33 1 55 37 46 36 Email: <a href="mailto:chamon@soffimat.com">chamon@soffimat.com</a> <a href="http://www.soffimat.com">http://www.soffimat.com</a></td>
<td>Gasification plant, Gas engineering Power generation Water treatment Waste treatment Services</td>
</tr>
<tr>
<td>29</td>
<td>HAMMEL Recyclingtechnik GmbH</td>
<td>Germany</td>
<td></td>
<td>Leimbacher Strasse 103 D-36433 Bad Salzungen Germany</td>
<td>Tel: +49 36 95 6991-0 Fax: +49 36 95 6991-93 Email: <a href="mailto:info@hammel.de">info@hammel.de</a> <a href="http://www.hammel.de">http://www.hammel.de</a></td>
<td>Manufacture and sales of: Shredding equipment (primary shredders, secondary shredders) Screening equipment (disc screens) Sorting equipment (sorting cabins,</td>
</tr>
<tr>
<td>No</td>
<td>Companies</td>
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<tr>
<td>30.</td>
<td>Heizomat GmbH</td>
<td>Germany</td>
<td>Stefan Hellmuth</td>
<td>Maicha 21 D-91710 Gunzenhausen Germany</td>
<td>Tel: +49 98 36 97 97 0 Fax: +49 98 36 97 97 97 Email: <a href="mailto:s.hellmuth@heizomat.de">s.hellmuth@heizomat.de</a> <a href="http://www.heizomat.de">http://www.heizomat.de</a></td>
<td>conveys) Planning, design, manufacture, assembly, commissioning of processing plants for: Wood waste (demolition wood, cable drums, root stocks, railway sleepers, pallets, green waste, etc) Waste (domestic, industrial, bulky waste, C&amp;D) Paper (industrial paper rolls, tetra pack) Stones &amp; soil</td>
</tr>
<tr>
<td>31.</td>
<td>ISET e.V. / Div. Energetic Use of Biomass Institut für Solare Energieversorgungstechnik (ISET) – Verein an der Universität Kassel e.V.</td>
<td>Germany</td>
<td>Mr. Bernd Krautkremer, Head of Division</td>
<td>Rodenbacher Chaussee 6 D-63457 Hanau Germany</td>
<td>Tel: +49 6181 58 2707 Fax: +49 6181 58 2702 Email: <a href="mailto:bkrautkremer@iset.uni-kassel.de">bkrautkremer@iset.uni-kassel.de</a> <a href="http://www.iset.uni-kassel.de">http://www.iset.uni-kassel.de</a></td>
<td>Burners and boilers from 15kW-500 kW Automatic feeding systems Shredders</td>
</tr>
<tr>
<td>32.</td>
<td>Lahmeyer International GmbH</td>
<td>Germany</td>
<td>Dr. Andreas Wiese Head of Department Renewable Energies</td>
<td>Friedberger Strasse 173 61118 Bad Vilbel Germany</td>
<td>Tel: + 49 6101 551 116 Fax: + 49 6101 552 101 Email: <a href="mailto:andreas.wiese@lahmeyer.de">andreas.wiese@lahmeyer.de</a> <a href="http://www.lahmeyer.de">http://www.lahmeyer.de</a></td>
<td>Biomass combustion Gasification Biogas and waste dump gas, Biofuel Feasibility studies Due diligence, Conceptual design Economic analysis</td>
</tr>
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### A Guide on Exploitation of Agricultural Residues in Turkey

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<td>33</td>
<td>Lambion GmbH</td>
<td>Germany</td>
<td>Axel Lambion</td>
<td>Auf der Waldme 1 D - 34454 Arolsen Germany</td>
<td>Tel: +49 5691 807 0 Fax: +49 5691 807 138 Email: <a href="mailto:office@lambion.de">office@lambion.de</a> <a href="http://www.lambion.de">http://www.lambion.de</a></td>
<td>Environment impact assessment Tendering, Site supervision Project management</td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
<td>Engineering Production of Plants and Components Burning solid biomass fuels like: Wood chips, Wood Pellets Bark, Bagasse, Choppings Draff and Marc, Husks and Shells Cardboard Products, Sander Dust, Coal Optimisation of Existing Plants Worldwide Delivery, Full Service</td>
</tr>
<tr>
<td>34</td>
<td>LIPP GmbH</td>
<td>Germany</td>
<td>Mr Roland Lipp</td>
<td>Industriestrasse 36 D-73497 Tannhausen Germany</td>
<td>Tel: +49 7964 9003 0 Fax: +49 7964 9003 27 Email: <a href="mailto:info@lipp-system.de">info@lipp-system.de</a> <a href="http://www.lipp-system.de">http://www.lipp-system.de</a></td>
<td>Biogas units (LIPP-Biogas – Technology) as single components or complete units for agriculture, civic communities or the waste disposal industry Containers and Units for municipal and industrial waste water treatment (particularly sludge silos, digestion tanks, gas containers, cover for large scale containers made of stainless steel) Containers and units for agriculture use Storage containers and units for a variety of bulk goods. System for reconstruction of steel &amp; concrete</td>
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<td>No</td>
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</table>
| 35. | WEISS Kessel-, Anlagen und Maschinenbau GmbH | Germany |  | Käferwerkstraße 6, 35684 Dillenburg – Frunhausen, Germany | Tel: +49 2771 393 0  
Fax: +49 2771 393 294  
Email: info@weiss-kessel.de  
http://www.weiss-kessel.de | BOILER Plants: Multicrat, turbocrat, Three Pass, Watertube boilers  
CHP-Plants: Thermal oil heaters, Hot gas generators, ORC-Turbogenerators  
FURNACES: Cyclone furnace, Rotary nozzle grate furnace, Cyclone burner furnace, Jet blower furnace, Push grate furnace  
SILO-OUTFEED DEVICES: Chain unloaders and discharge screws, push rod systems for flat bottom bunkers |
| 36. | N. Ach. Philippopoulos | Greece | Nikolaos Philippopoulos, Managing Director | 1st km, Neochorouda P.O. Box 301, GR 57008 Thessaloniki Greece | Tel: +30 2310 78 58 40  
Fax: +30 2310 78 58 41  
Email: info@nphilippopoulos.gr  
http://www.nphilippopoulos.gr | Design-construction of complete plants involving:  
Boilers (Steam, water, thermal oil)  
Combustion equipment  
Biomass feeding systems  
Ash removal systems, Heat exchangers |
| 37. | Kerry Die Products | Ireland | Mr. Liam O’Connor / Mrs Tina Griffin | Fossa Killarney Co. Kerry Ireland | Tel: +353 64 44 233,  
Fax: +353 64 44 433,  
Email: kerrydie@iol.ie  
http://www.kerrydie.com | Manufacture of pellet mill dies for Biomass & Industrial Waste material |
### A Guide on Exploitation of Agricultural Residues in Turkey

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<tr>
<td>38.</td>
<td>ENERGÍA NATURAL DE MORASL</td>
<td>Spain</td>
<td></td>
<td>Crta. N-420, Km 821, 3 43040 Moras d’Elba (Tarragona) Spain  c/ Princesa, 2 3ª planta 08400 Granollers (Barcelona) Spain</td>
<td>Tel: +34 977 400 141  Fax: +34 977 401 112  Email: <a href="mailto:enamora@energiaverde.com">enamora@energiaverde.com</a>  <a href="http://www.energiaverde.com">http://www.energiaverde.com</a>  Tel: +34 938 702 462  Fax: +34 938 702 650  Email: <a href="mailto:licen@eqtec.es">licen@eqtec.es</a>  <a href="http://www.eqtec.es">http://www.eqtec.es</a></td>
<td>Biomass gasification power plants  Biomass gasification cogeneration power plants  Biomass gasification cogeneration heating and/or cooling plants  Gasification pilot plant to test alternative fuels, like RDF, dried water sludge, dried manure from farms, plastics, etc.</td>
</tr>
<tr>
<td>40.</td>
<td>Termisa Energia</td>
<td>Spain</td>
<td>José Mª Medina, Technical Manager</td>
<td>C/ Badal, 98-102, Esq. A, Entlo. 7ª 08014 Barcelona Spain</td>
<td>Tel: +34 93 331 55 12  Fax: +34 93 422 11 73  Email: <a href="mailto:termisa@termisa.es">termisa@termisa.es</a>  <a href="http://www.termisa.es">http://www.termisa.es</a></td>
<td>Water-tube boiler, Recovery boilers  Pyrotublar boilers  Biomass boilers and Urban waste incineration boilers, Burners  Boiler components and pressure parts  Repair, Starting, Inspection and reviewing, Maintenance, Modernization/organization of boilers and components</td>
</tr>
<tr>
<td>41.</td>
<td>TPS</td>
<td>Sweden</td>
<td>Michael Morris, Licensing Manager</td>
<td>Studensvik 611 82 Nyköping Sweden</td>
<td>Tel: +46 155 22 13 00  Fax: +46 155 26 30 52  Email: <a href="mailto:tps@tps.se">tps@tps.se</a>  <a href="http://www.tps.se">http://www.tps.se</a></td>
<td>Engineering services  Technologies know-how and licensing  Waste and biomass-fuelled furnace and boiler retrofits</td>
</tr>
<tr>
<td>No</td>
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<tr>
<td>42</td>
<td>BTG biomass technology group BV</td>
<td>The Netherlands</td>
<td>John Vos, Senior Consultant</td>
<td>P.O. Box 217 7500 AE Enschede The Netherlands</td>
<td>Tel: +31 53 489 2897 Fax: +31 53 489 3116 Email: <a href="mailto:office@btgworld.com">office@btgworld.com</a> <a href="http://www.btgworld.com">http://www.btgworld.com</a></td>
<td>Turnkey delivery of complete biomass burner installation</td>
</tr>
<tr>
<td>43</td>
<td>KARA Energy Systems B.V.</td>
<td>The Netherlands</td>
<td>G. Prinsen, Sales Manager</td>
<td>Plesmanweg 27 7602 PD Almelo The Netherlands P.O. Box 27 7600 AN Almelo The Netherlands</td>
<td>Tel: +31 546 876580 Fax: +31 546 870525 Email: <a href="mailto:info@kara.nl">info@kara.nl</a> <a href="http://www.kara.nl">http://www.kara.nl</a></td>
<td>Feasibility Studies and Technology Assessments Technology Research and Development System Engineering and Implementation Technical Assistance Consulting Business Development and Financing Greenhouse Gas Advisory Services</td>
</tr>
<tr>
<td>44</td>
<td>Thecogas Biogastechniek b.v.</td>
<td>The Netherlands</td>
<td>Theo Bijman, Director</td>
<td>Tramstraat 32 7241 CK Lochem The Netherlands</td>
<td>Tel: +31 573 256446 Mob: +31 6 53390667 Fax: +31 573 259048 Email: <a href="mailto:info@thecogas.nl">info@thecogas.nl</a> <a href="http://www.thecogas.nl">http://www.thecogas.nl</a></td>
<td>Turn-key Supply of Anaerobic Digestion of Manure and Biomass Plants</td>
</tr>
<tr>
<td>45</td>
<td>B9 Energy Biomass Ltd</td>
<td>UK</td>
<td>Mr. Mark Gallagher</td>
<td>Unit 27, Templemore Business Park Derry City Co. Londonderry N. BT48 OLD United Kingdom</td>
<td>Tel.: +44 2871 271520 Fax: +44 2871 308090 Email: <a href="mailto:m.gallagher@b9energy.co.uk">m.gallagher@b9energy.co.uk</a> <a href="http://www.b9energy.co.uk">http://www.b9energy.co.uk</a></td>
<td>Turnkey services Design, manufacture, installation and commission of fully automated, wood fuelled, CHP units Small scale gasification technology (130kWe-5Mwe), Quality O&amp;M training</td>
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</table>
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<tbody>
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<td>46</td>
<td>Biffa Waste Services Limited (not sure)</td>
<td>UK</td>
<td>Peter Jones, Director</td>
<td>Coronation Road Cressex High Wycombe Bucks HP12 3TZ United Kingdom</td>
<td>Tel: +44 (0) 1494 521221 Fax: +44 (0) 1494 463352 E-mail: <a href="mailto:peter.jones@biffa.co.uk">peter.jones@biffa.co.uk</a> <a href="http://www.biffa.co.uk">http://www.biffa.co.uk</a></td>
<td>Landfill gas, power generation-80 MW, aerobic &amp; anaerobic gasifier systems</td>
</tr>
<tr>
<td>47</td>
<td>Demag Delaval Industrial Turbomachinery Ltd</td>
<td>UK</td>
<td>Mike Welch, Market Development Manager</td>
<td>PO Box 1, Waterside South, Lincoln, LN5 7FD United Kingdom</td>
<td>Tel: +44 (0) 1522 584164 Fax: +44 (0) 1522 584946 <a href="mailto:mike.welch@power.alstom.com">mike.welch@power.alstom.com</a> <a href="http://www.alstom.com">http://www.alstom.com</a></td>
<td>Industrial gas turbines from 5MW to 15MW for power generation, cogeneration and mechanical drive</td>
</tr>
<tr>
<td>48</td>
<td>Talbot’s Heating Ltd</td>
<td>UK</td>
<td>Amy Fielding, Marketing Director</td>
<td>Drummond Road Astonfields Industrial Estate ST16 3HJ, Stafford United Kingdom</td>
<td>Tel.: +44 (0) 1785 213366 Fax: +44 (0) 1785 256418 E-mail: <a href="mailto:sales@talbotts.co.uk">sales@talbotts.co.uk</a> <a href="http://www.talbotts.co.uk">http://www.talbotts.co.uk</a></td>
<td>Range of units to utilise biomass fuels and waste including: Miscanthus, wood chips, pellets, sawdust, shavings dust, etc. To produce: Hot Air, Hot Water, Steam or Electricity</td>
</tr>
<tr>
<td>49</td>
<td>Waste-to-Energy</td>
<td>UK</td>
<td>Dr. Abdullah Malik, Projects Manager</td>
<td>Eyston, Borley Green, Sudbury Suffolk CO107AH United Kingdom</td>
<td>Tel: +44 (0) 1787 373 007 Fax: +44 (0) 1787 373 535 Email: <a href="mailto:amalik@aol.com">amalik@aol.com</a> <a href="http://www.waste-to-energy.co.uk">http://www.waste-to-energy.co.uk</a></td>
<td>Turnkey supply of complete fuel handling and pre-treatment and preparation gasification gas clean-up environmental control and power generation systems</td>
</tr>
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</table>
12. CONCLUSION:

This guide is a finding of the project results of entitled "Exploitation of Agricultural Waste in Turkey" by EU Life Third Countries conducted by The University of Cukurova, TUBITAK-MRC, EXERGIA and EMC's according to WP8's sub task.

First, this guide examines the agricultural biomass potential of Turkey. Then related agricultural waste managerial, institutional structure and legal arrangement are presented. Environmental arrangement and legal restrictions are given in detail. Therefore, it is aimed introducing the legal responsibilities those need to be obeyed by the investors from the level of getting license to building and operating of the plant. In this study also gives and summarizes the potential policies, market tools and barriers that influencing the use of agricultural waste and the new laws and regulations and incentives in Turkey. It is aimed that the use of biomass energy condition studies are carried out, biomass cycle technologies are introduced, evaluation of investments potential related institutions are listed and given.

It is hoped that this study will be a good guide for domestic or foreign investors or for people who is related.

REFERENCES

A Guide on Exploitation of Agricultural Residues in Turkey


