Gasification Survey Country: **Turkey**

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1. Policy

Lignite, biomass, hydraulic and renewable are the national energy sources of Turkey (Figure 1). However, oil and natural gas are import energy sources which are totally 62 % of the energy demand. Fossil energy sources contributed about 80% of total primary energy consumption in 2008. The majority of fossil energy sources were oil products (about 30%) such as heating oil, diesel, gasoline etc, Natural gas (32%) and coal (29%). Biomass contributed roughly 5% of the primary energy demand. In terms of house hold burning, wood is usually burnt in stove sand approximately 6.5 million homes in Turkey use biomass as their primary heating fuel.

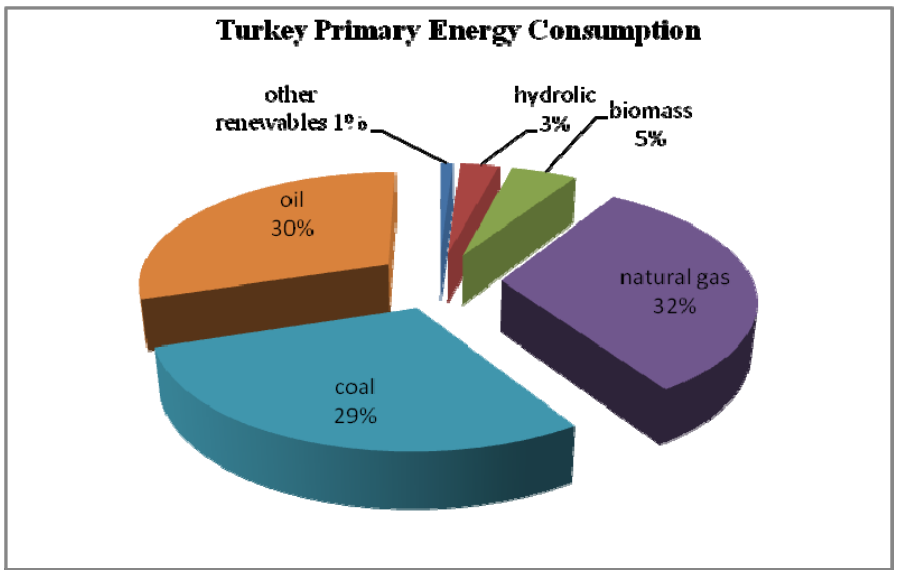

Figure 1. Turkey Primary Energy Consumption, 2008

In 2008, primary energy production and consumption has reached to 29,3 and 106.3 million tons of oil equivalents (Mtoe) respectively. Turkey's primary energy consumption in the long term is projected to grow at an average rate of almost 5.9% per year, from 106.3 Mtoe in 2008 to 222.4 Mtoe in 2020. Currently, substantial amount of fuel has been importing to meet the increasing energy demand.

Turkey's demand for electricity also has increased rapidly which has been growing about 6–8 % yearly. Turkey's electricity production was about 198.2 TWh in 2008 while it was only 30.6 TWh in 1984. In Turkey, approximately 60% of electricity generation is supplied by imported fossil fuels. In 2008, 82.6 % of the Turkish electricity power generation was made by thermal power stations and 16.7 % was made by hydroelectric power stations. The contribution of the stations based on wind and other renewable energy resources was 0.7 %.

In Turkey, biomass has great potential to provide improved rural energy services based on forest and agricultural residues. The annual biomass energy potential of Turkey is estimated as 32 Mtoe (2008). The total economically recoverable biomass energy potential is estimated as 17 Mtoe/year. However, the total biomass consumption in Turkey was 4.8 Mtoe /year at 2008. The recoverable biomass energy potential come from agricultural residues, farming wastes, forestry

and wood processing residues and municipal wastes. The largest portion of this product is used in rural areas for heating and cooking.

A gradual decrease in biomass share has occurred between 1990 and 2007. A growing rate of use of imported natural gas within the same period cannot be disregarded. The share of renewable energy in the energy mix has decreased from 18 % in 1990 to 13% in 2000 and later 9.5% in 2007. Despite the decline in biomass utilization in recent years, biomass is still one of the major renewable energy resources among geothermal, solar and wind in Turkey. According to the Ministry of Energy and Natural Resources (MENR)'s 2020 projections, renewable energy sources will account for less than 9% of primary energy in 2020.

In 2010, Turkey has constituted two new regulations to encourage the biomass usage for electricity generation. First one is about the usage of renewable energy sources for electricity generation up to 500 kWe for individual producers/users. There is no obligation for being authorized by government and no obligation for being a company for generating electricity no more. This regulation allows the small scale electricity generation/cogeneration for local applications. Individuals can generate electricity for both their self electricity consumption or can connect to the grid and sell the excess electricity production.

Second one is about the electricity selling price regulations that are generated with the usage of the renewable energy sources (hydraulic, wind, geothermal, biomass, solar). Renewable electricity production is supported by feed-in rates. The feed-in rates for the different types of renewable electricity generation are shown in Table 1.

Electricity generation with different renewable energy sources	Selling prices ($ cent/kWh)
a. Hydraulic Power	7.3
b. Wind Power	7.3
c. Geothermal Power	10.5
d. Biomass/Biogas Power	13.3
e. Solar Power	13.3

Table 1. Regulated selling prices of renewable electricity energy

As shown in Table 1, electricity production with biomass sources can be sold with the price of 13.3 $ cent/kWh. This selling price is for both gasification and combustion applications. Legislation has been recently approved by Turkish Assembly at the end of 2010. With this attempt, Turkey is newly on the way of subsidizing renewable energy entrepreneurs and of increasing the usage of biomass as well.

2. R&D Institutes

TUBITAK – Marmara Research Centre (MRC), Kocaeli
Energy Institute – Combustion and Gasification Research Group

Marmara University, İstanbul
Department of Mechanical Engineering

İstanbul Technical University, İstanbul
Department of Chemical Engineering

Middle East Technical University
Department of Environmental Engineering

Anadolu University, Eskisehir
Department of Chemical Engineering

Bosphorus University, İstanbul
Institute of Environmental Sciences

İstanbul University, İstanbul
Faculty of Forestry

Bartın University, Bartın
Faculty of Forestry

Ege University, İzmir
Biomass Energy Technologies

3. Industries

ALYAK Ltd.Sti.
http://alyakbioyakit.com/
Biomass fuel.

BIYOSFER Ltd.Sti.
http://www.biyosfer.com.tr/en/index.html
Biomass farming.

MIMSAN Ltd.Sti.
http://www.mimsan.net/en/default.asp
Power plant.

OYKA KAGIT AMBALAJ A.S.
http://www.oyka.com.tr/en/index.asp
Paper production, power plant.

RELIGHT ENERJI URETIM A.S.
http://relight.com.tr/default.aspx?dil=tr
Biomass energy.

S.H. GERI DONUSUM SISTEMLERI Ltd.Sti
http://www.shgeridonusumsistemleri.com/
Feedstock preparation.

YEMTAR MAKINE SANAYI A.S.
http://www.yemtar.com
Feedstock storage,preparation,feeding.

4. Projects

In parallel to increase in energy consumption, carbon dioxide (CO_2) emissions of Turkey have grown. In this regard, renewable energy resources appear to be the one of the most efficient and effective solutions for clean and sustainable energy development in Turkey.

In Turkey, direct combustion of biomass has been used for many years. Direct burning process used fuel wood, animal wastes, agricultural crop residues and logging wastes. These sources are often called non-commercial energy sources. However, fuel wood is a tradable since it is one of the primary fuels for rural and urban poor districts. Having a strong background on direct combustion of biomass, much of the research and development work carried out was the improvement of traditional biomass combustion stoves in the past.

Landfill potential exists in large municipalities such as Istanbul, Izmir, Bursa, Adana and Antalya. Another biomass power project is under development in Adana province at an installed capacity of 45MW. Two others projects are presently going on. At a total capacity of 30MW, are at the feasibility study stage in Mersin and Tarsus provinces. In brief, electricity production from biomass has been found to be a promising method in the nearest future in Turkey.

In 2008, Turkey's first biomass not gasification but combustion plant was put into operation. The plant was built in Caycuma, Zonguldak. It is a combined heat and power plant which has a 32 MW thermal capacity and 10 MW electrical capacities. The outputs of the plant were utilized by OYKA, which was also the owner of the plant. OYKA is a paper production factory.

Another issue is the energy forestry. The energy forestry in Turkey was first initiated in 1978 by Turkey's General Directorate of Forestry (GDF). In 2009, the area of energy forests has reached a value of 620 000 hectare.

In addition to pre-commercial big scale applications, there are also laboratory scale and pilot scale applications carried out at MRC listed below;

Marmara Research Centre, Energy Institute

- Integrated Biomass Gasification with Power Technologies BIGPOWER, EU FP 6 Project, 2005-2008.
- The Integrated European Network for Biomass Co firing, NETBİOCOF, EU FP 6 Project, 2005-2008.
- Designing and Manufacturing of 400 kWth Fixed bed Biomass Gasifier, Industrial Project, 2009-2010.
- Coal and Biomass Gasification, Gas Cleaning and Integrated Energy Production, Nationally Funded Project, 2005-2009.
- Designing and Manufacturing of 250 kWe Fixed bed Biomass Gasifier, Industrial Project, 2009-2010.
- Combustion of Biomass and Lignite in Circulating Fluidized Bed, National Funded Project, 2007-2010.
- Liquid Fuel Production From Coal and Biomass, National Funded Project, 2009-2013.
- High Added Value Materials From Waste Tyre Gasification Residues, EU FP 7 Project , 2009-2012.
- Designing and Manufacturing of 2 MWe Fluidized Bed Gasifier, Industrial Project, 2009-2011.

5. Implementations

Currently, a power plant with 20MW-e capacity was established in Ankara-Mamak. The plant uses landfill gas generated by garbage. Plant has started with 5 MW then arrived to 10 MW, and finally it has reached to 20 MW.