

Country Report Turkey

IEA Bioenergy Task 42

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Country introduction

Turkey has a young, growing “energy thirsty” population of 72 million (61% are under the age of 35) coupled with a rapidly growing economy. Over the past decade, its GDP has increased at an exceptional rate compared to other OECD countries that makes Turkey the 17th largest economy of the world.

In the year 2008 the total primary energy consumption of Turkey was 4522 PJ (108 MTOE), and its production was 1215 PJ (29 MTOE). Turkey depends on imports for 72% of its TPES, including for practically all oil and natural gas and most coal.

The Turkish Government is very concerned with developing its energy independence as a major requirement and gear to the further development of its economy and is engaged in a thorough review and reassessment of its renewable energy infrastructures.

Turkey offers excellent conditions for renewable energy sources. The country has a very high natural level of renewable energy resources that can give a huge contribution to the total energy network of the country. About two-thirds of current renewable energy production is already obtained from bioenergy, which is used to meet a variety of energy needs, including generating electricity, heating homes, providing process heat for industrial facilities and fueling vehicles. However, bioenergy potential in the country is not being used sufficiently Turkish bioenergy market. Is still nascent and more investments are required.

Table TR1. Characteristics of Turkey.

	Total area [10 ³ km ²]	Population [10 ⁶]	Utilized Agricultural area [10 ³ km ²]	Forest land [10 ³ km ²]
Turkey	785.347	72	267.0	212.0

Energy production and consumption based on biomass

Turkey's total primary energy supply (TPES) was 4145 PJ (or 99 MTOE) and total final consumption of energy (TFC) was 3308 PJ (79 MTOE) in 2008.

Fossil fuels accounted for 90% of TPES in 2008. Oil, coal and natural gas together provided 30% of the total, while renewable energy sources provided the remaining 10%. Since 2000, the increase in TPES can be attributed to the growing use of just two fuels: natural gas, up by 754 PJ, and coal, up by close to 293 PJ. The other primary energy sources remained practically unchanged with the exception of traditional biomass (firewood), the use of which inevitably declines as the economy develops.

As regards energy source, oil provided 37% of TFC in 2008, electricity and natural gas 18% each, coal 17%, biomass and waste 7% and the other sources 3%. The share of natural gas has increased significantly since 1990, and that of electricity has grown markedly from 10% in the mid-1990s. Reflecting the diversification of the energy mix, oil has lost ground, down from 50% in the early 1990s. Traditional biomass is also declining. In its projections made before the economic downturn, the government foresaw TFC more than doubling from 2008 to 6824 PJ in 2020, with most growth coming from the use of coal, oil and electricity.

In 2009, renewable sources provided 37.8 TWh of electricity (136 PJ), or 19.6% of the total power generation in Turkey. Hydropower accounted for 95% (129 PJ) of this total and wind power for 4% (5.4 PJ). The remaining 1% came from biomass (1.08 PJ) and geothermal energy (1.8 PJ).

Biomass energy includes agricultural residues, municipal wastes, fuelwood, animal wastes and other fuel derived from biological sources. The total recoverable bioenergy potential is estimated to be about 720 PJ. 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.

Firewood is the largest source of heat from renewable sources. In 2008, 209 PJ of firewood was used for residential heating in rural areas. Other forms of biomass are negligible.

As in many other countries, natural gas has become the fuel of choice for power generation in Turkey. It is also replacing more inefficient and polluting sources for heating. Another fast-growing source for electricity is coal. From 2000 to 2009, gas-fired generation grew by 173 PJ (48 TWh), accounting for 72% of total incremental power generation. Coal-fired grew by 61.2 PJ (17 TWh), accounting for a quarter of the incremental demand. Hydropower generation varies according to annual hydrological conditions, and increased by 18 PJ (5 TWh) from 2000. Oil-fired generation peaked in 2002 and is steadily declining.

In 2008, Turkey's total final consumption of energy (TFC) was 3308 PJ, up by 86% from 1990. Industry and the residential sector were the largest users, accounting for almost a third each. Transport's share was 20% and the other sectors (services and the primary sector) used around 17% of the total. For comparison, the IEA averages in 2008 were close to a third each for industry,

transport and other sectors. Over the past two decades, the sectoral breakdown of TFC in Turkey has remained remarkably stable

The graphic revealing the primary energy resources production and the covering of the primary energy demand with importation in the period from 2000 to 2008 has been provided below (Figure TR1).

Biofuels use for transport is marginal and amounted to 15 kt (0.564 PJ) in 2008, most of which was domestic biodiesel. There is no biomass or biofuels import.

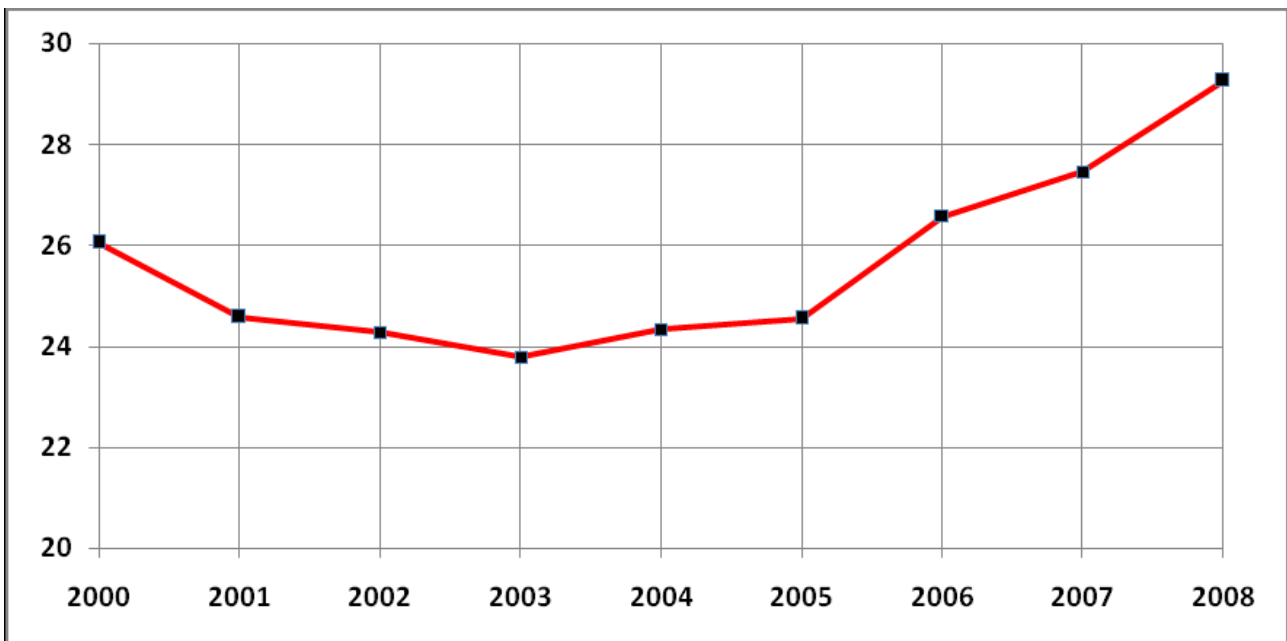


Figure TR1: Primary Energy Resources Production (2000-2008) (MTOE, 1 MTOE = 41.868 PJ)

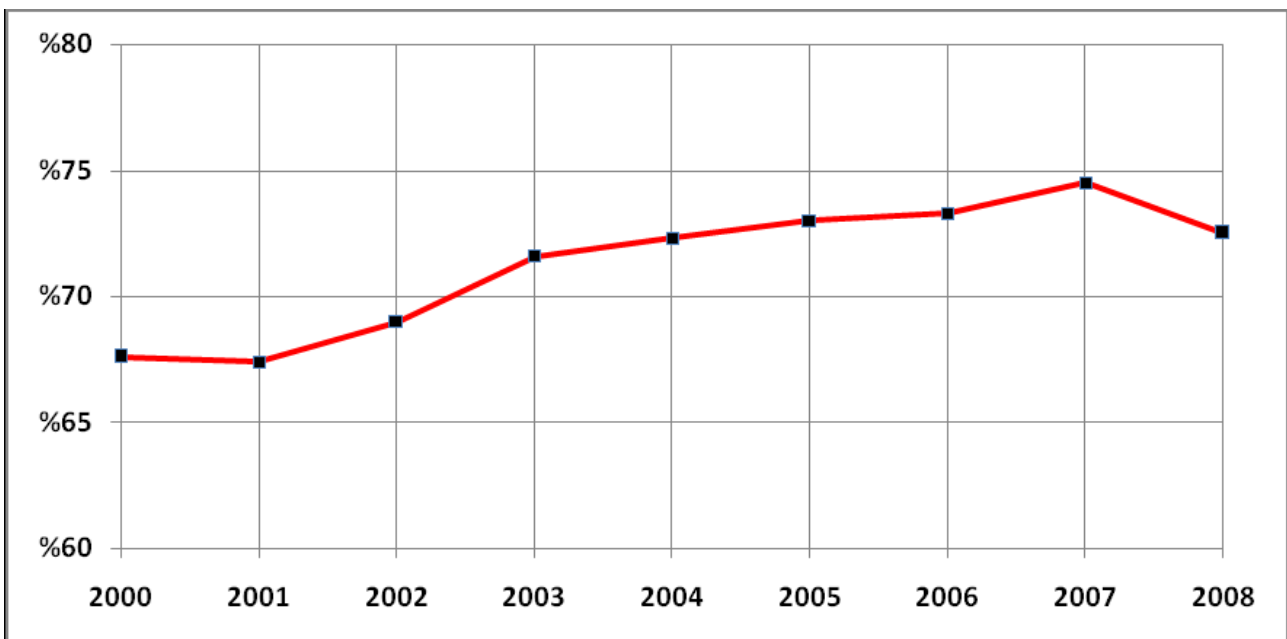


Figure TR2: Rate of Foreign Dependence (2000-2008) (%)

The relative insufficiency of the domestic resources of Turkey especially in terms of oil and natural gas in proportion to the rising energy demand in our country brings about the importation of oil and natural gas. Currently, the rate of dependence of our country is 72% (Figure TR2).

Breakdown of national biomass energy use on feedstock:

Firewood is the largest source of heat from renewable sources. In 2008, 209 PJ of firewood was used for residential heating in rural areas. Other forms of biomass are negligible.

Table TR2. Status of biomass energy in Turkey:

	1999	2000	2002	2003	2004
Production of total energy from biomass (TJ)	301 722	272 732	251 924	241 929	232 688
Production of electricity from biomass (GWh)	–	220	174	116	104
Production of heat from biomass (GWh)	83 818.37	75 544.95	69 810.49	67 091.88	64 536.73
<i>Net generating capacity (MW)</i>					
Industrial waste	–	19	19	19	
Municipal solid waste	–	–	–	–	
Solid waste	–	72	72	72	
Gas from biomass	–	4	9	9	
Comb. renewable non-specified	–	–	–	–	
Total biomass	–	95	100	100	
<i>Total electricity (GWh)</i>					
Industrial waste	–	54	45	36	28
Municipal solid waste	–	–	–	–	–
Solid waste	–	145	103	48	46
Gas from biomass	–	21	26	32	30
Comb. renewable non-specified	–	–	–	–	–
Total biomass	–	220	174	116	104
<i>Electricity only plants (GWh)</i>					
Industrial waste	–	38	32	24	
Municipal solid waste	–	–	–	–	
Solid biomass	–	–	–	–	
Gas from biomass	–	–	3	7	
Comb. renewable non-specified	–	–	–	–	
Total biomass	–	38	35	31	
<i>Combined heat and power (CHP) plants (GW h)</i>					
Industrial waste	–	16	13	12	
Municipal solid waste	–	–	–	–	
Solid biomass	–	145	103	48	
Gas from biomass	–	21	23	25	
Comb. renewable non-specified	–	–	–	–	
Total biomass	–	182	139	85	

Table TR3. Turkey's annual biomass energy potential:

Turkey's annual biomass energy potential

Type of biomass	Annual potential (million tons)	Energy potential (Mtoe) ^a
Annual crops	55	14.9
Perennial crops	16	4.1
Forest residues	18	5.4
Residues from agro industry	10	3.0
Residues from wood industry	6	1.8
Animal wastes	7	1.5
Other	5	1.3
Total	117	32.0

^aMtoe: million tons of oil equivalent.

Table TR4. Total amount of crop, fruit & poultry residues in Turkey:

Biomass	Total amount of biomass (Mteo)	Shares of biomass (%)
Crop residues	22.8	62.78
Fruit residues	7.51	20.68
Poultry residues	6.01	16.55
Total	36.32	100

Biomass used for non-energy purpose

Table TR5. Biomass used for non-energy purpose:

Use*	Year	Unit	Amount
Wood for particle boards	2008	m ³	2 407 156
Wood for pulp and paper	2008	m ³	5 816 522
Wastes from pulp and paper			n.a.
Chemicals from biomass			n.a.
Cereal production	2008	Mtons	29,5
Sugar production	2008	Mtons	2,33
Starch production	2008	tons	266 700
Oilseed production	2008	Mtons	1,3
Algae production	-	-	-

Sugar beet is the feedstock for sugar production. There are 33 sugar beet refineries in Turkey and five starch based sugar (SBS) producers. The state-owned Turkish Sugar Corporation (TSC) owns 25 of the sugar beet refineries.

Policy issues related to biomass, bioenergy or biorefineries

Turkey aims to utilize its energy potential in a cost-effective manner, including from renewable sources. To promote renewable energy, the government has focused on electricity, but has recently started to pay more attention to heat (geothermal and solar). Biofuels for transport are hardly used, and remain marginal in the policy debate.

Turkey's energy policy principally aims:

- providing safe, green, cost-efficient and sustainable energy for our country,
- securing a strong position for our country in regional and global trade of energy,
- increasing energy efficiency.

In line with its new environmental strategy, the Turkish Government through its agency EMRA (Energy Market Regulatory Authority), is proposing new regulations and policies to help ease the process for launching bioenergy projects, smooth environmental planning applications and encourage private investment.

The energy supply security, which sets the basis for the debates on the energy sector both across the world and in single countries, is also significant for Turkey. Within the context of the energy supply security, in recent years, legal and technical studies have been intensified for the purpose of restructuring Turkish energy market with a market understanding that is based on competition and transparent, detecting and using domestic and renewable resources potential, integrating the nuclear energy into the electricity production, and utilizing the new energy technologies.

Law on Utilization of Renewable Energy Resources for the Purpose of Generating Electrical Energy (2005) is a milestone for promotion of renewable energy in Turkey.

- Feed-in tariffs and purchase obligations;
- Connection priority;
- Reduced license fees;
- Exemptions from license obligation for small-scale generators;

Reduced fees for project preparation and land acquisition

are the main instruments to increase the share of the renewable energy resources within the energy supply within this legislation.

With the Law for the Utilization of the Renewable Energy Resources for the Electricity Energy Production that was enforced in 2005, the opportunity for the production of electricity energy from the renewable energy resources by the private sector has been provided. Main target for the renewable energy resources is to provide 30% share of these resources in the electricity energy production.

In long-term planning work, it is foreseen to achieve the following targets in 2023, which is the 100th anniversary of our Republic:

- To be able to make complete use of the potential of indigenous coal and hydraulic resources,
- **To make maximum use of renewable resources,**
- To incorporate nuclear energy into electricity generation within the period until 2020,
- To secure rapid and continuous improvement in energy efficiency in a way that parallels EU countries

Turkey does not have a broad policy on promoting biofuels for transport.

Biorefinery related funding programs

There are not any biorefinery specific funding programs in Turkey. All kinds of research activities/intentions on biorefinery or other bioenergy related topics can get foundation. Bioenergy project has a priority in energy field. Universities, private sector or governmental/nongovernmental research institutes can apply for foundation for their bioenergy projects.

Financing of R&D projects is offered via national funds by DPT, TUBITAK and research funds of universities. The budgets can be quite small. International co-operation is sought not only in terms of funds but also in terms of knowhow exchange.

The Ministry of Energy and Natural Resources (MENR), the State Planning Organization (DPT) and the Electric Power Resources Survey and Development Administration (EIEI) are all involved in renewable energy promotion policies. Some promotions and related policies exist with respect to the development and implementation of geothermal heat and solar thermal energy production. Low-interest loans up to 45% of the capital cost are applicable to appropriate investments.

Technology and innovation funding programs directorate (TEYDEB) of TUBITAK has an R&D assistance program for industrial companies. It is targeted to increase research-technology development capability, innovation culture, and competitiveness of Turkish companies. This includes a financial contribution by the Scientific and Technical Research Council of Turkey (TÜBTAK) 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.

Running commercial biorefineries

There is not a running biorefinery of any size neither commercial nor demo plants yet. There are only three commercial bioethanol producers using sugar cane as feedstock.

Table TR6. bioethanol producers:

Company	Feedstock	Products	Description	Size
PANKOBİRLİK	Sugar cane			capacity of 80 000 tons ethanol/year
TARKİM	Sugar cane			capacity of 30 000 tons ethanol/year
TEZKİM	Sugar cane			capacity of 40 000 t tons ethanol/year

Demo and pilot plants

A couple of private sector companies are in contact with TUBITAK MRC Energy Institute to develop some demonstration plants using lignoselulosic wastes as feedstocks. Also using algae first for CO₂ capture and then energy production from the algae biomass is of interest for some private sector companies but still there are not any studies in practice.

There is an ongoing project in TÜBİTAK MRC Energy Institute named Liquid Fuel Production from Biomass and Coal Blends (TRIJEN) focusing on 2.generation liquid fuels production from biomass and/or biomass-coal blends. The project started in June 2009. The project aims to develop integrated technologies on fuel feeding, gasification, gas cleaning, gas conditioning and separation, liquid fuel production systems, and heat and electricity generation systems. First lab scale systems such as gasification, gas cleaning, gas conditioning and FT reactor units including catalyst for Fischer Tropsch synthesis will be developed and then to demonstrate the project outcome a pilot scale plant will be constructed (2013).

Major RTD activities

Table TR7. Major RTD activities:

Name of project	Type of project	National coordinator	Description	Duration	Size (€s, US\$)
TRIJEN Liquid Fuel Production from Biomass and Coal Blends	RTD	TÜBİTAK MRC Energy Institute	<p>TRIJEN is a project focusing on second generation liquid fuels production from biomass and/or biomass-coal blends.</p> <p>The aim of this project is:</p> <ul style="list-style-type: none"> • to develop the lab scale systems such as gasification, gas cleaning, gas conditioning and FT reactor units including catalyst development for Fischer Tropsch synthesis • to demonstrate the project outcome at the pilot scale. • 	4 years	8,5 M €
DAY Combustion of Biomass and Lignite in Circulating Fluidized Bed	RTD	Middle East Technical University (METU)	<p>In the scope of DAY project, there are multi fuel (biomass/coal) design of circulating fluidized bed combustion and gas cleaning systems for CHP applications.</p> <p>A 5 kg/h fuel feeding capacity CFB combustor and a 750 kW_{th} CFB combustion system have been designed and manufactured in the TUBITAK MRC campus.</p>	3 years	2,5 M €
DPT	RTD	TÜBİTAK MRC	Convert the biomass and Turkish lignites	4 years	1,5 M €

Coal and Biomass Gasification, Gas Cleaning and Integrated Energy Production, National Project (SPO)		Energy Institute	<p>into syngas by using fixed bed and CFB Gasifier were the main objectives of the Project. The scope of the Project consists of:</p> <ul style="list-style-type: none"> • Cogeneration application by using ICE and micro turbine, • Design and development of novel gasification technologies for different applications, • Dissemination of the results to increase the public awareness and improve the competitiveness of Turkish Industry, • Develop market to create new job areas, • Multi fuel (biomass/coal) design fluidized bed gasifier and gas cleaning systems for CHP applications. <p>A 100 kW_e (450 kW_{th}) fluidized bed gasifier was designed and manufactured in the TUBITAK MRC campus.</p>		
BIGPOWER - Integrated Biomass Gasification with Power Technologies, EU 6th FP, SSA	RTD	TÜBİTAK MRC Energy Institute	<p>The main objective of BIGPOWER Project is to improve the research capacity of the excellence center on Biomass Gasification, Gas Cleaning and Integration with related power systems</p> <p>Improvement of the infrastructure,</p> <ul style="list-style-type: none"> • Support of young researchers, • Enlargements of EU consortiums for R&D projects, • Establishment of exchange programs <p>Fixed Bed Gasification studies in TUBITAK MRC was started with BIGPOWER Project. Main aim is to create an excellence center on biomass</p>	3 years	700 000 €

			gasification. 50 kW _e fixed biomass gasifier (10-50kg/hr) was designed and manufactured in the TÜBİTAK MRC campus.		
SHAP Supply of Fixed Bed Gasifier with 400 kW _{th} Capacity to Provide Hot Raw Gas	RTD	TÜBİTAK MRC Energy Institute	<p>The scope of the project is to carry out the design of a fixed bed gasifier with 400 kW thermal capacity. The gasifier is to operate with woodchips and is to give hot raw synthesis gas which will be coupled with a coal combustion system. As the synthesis gas is to be burned in a combustor, the gasification system does not include any gas cleaning system. The gasifier will be built in Environmental Protection Agency (EPA) North Caroline, USA.</p> <p>The fixed bed gasification system is to be designed for a woody biomass with a humidity up to 15% in order to produce a hot raw synthesis gas with a 4-6 MJ/Nm³ heating value.</p>	4 months	24 000 €
Supply of Fixed Bed Gasifier with 250 kW _e Capacity to Provide Heat and Electricity	RTD	TÜBİTAK MRC Energy Institute	The scope of the project is to carry out the design of a fixed bed gasifier with 250 kW _e capacity. The gasifier is to operate with woodchips and is to give hot raw synthesis gas which will be coupled with a gas cleaning and an engine system. The gasifier was transferred to Germany.	4 months	12 000 €
NETBIOCOF Integrated European Network for Biomass Co-firing, 6. FP CA Project	RTD	TÜBİTAK MRC Energy Institute	<p>The objectives of the project are;</p> <ul style="list-style-type: none"> • European co-operation between research organizations devoted to biomass co-firing, • The uptake of innovative technologies to expand the use of biomass co-firing in new and existing power plants, • Identification of Successful 	2 years	1,1 M €

			<p>Experiences in Europe Under the scope of identification of barriers of implementation a survey of the Turkish legal framework</p> <ul style="list-style-type: none"> • Formation of research clusters according to the field of research (Task Leader) • Co-ordination of current and future research activities • Recommendations for future research and set up of a roadmap for biomass co-firing implementation • Scientific & technological strategies for the development of biomass co-firing and setup technical recommendations for optimum plant configuration • Dissemination 		
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Stakeholders

Table TR8. Major stakeholders in the Turkey:

Name	Short Description
Industry	
TÜPRAŞ-Turkish Petroleum Refineries	<p>Operating four oil refineries, with a total of 28.1 million tons annual crude oil processing capacity, Tüpraş is Turkey's largest industrial enterprise. In addition, a 50,000 ton capacity petrochemical production facility, a majority stake (79,98 %) in shipping company DİTAŞ and 40% share ownership of petrol retailer OPET, creates synergies and adds value to the operations.</p> <p>As a result of increasing climate change concerns carbon capture and carbon market is getting more and more important each day. Due to its emissions the company is a potential bioenergy investor and has started preliminary studies on possible applications.</p>
Zorlu Energy	<p>Zorlu Energy, the original company from which Zorlu Energy Group was formed was set up as an auto producer to generate the electricity and steam needed by Zorlu Group textile factories. As time passed, the Company began supplying electricity and steam to non-group industrial concerns as well. Today the Company's 6 natural gas power plants have an aggregate installed capacity of 420 MW. With the addition of 9 more plants (141 MW capacity) to the generation portfolio through privatization deal in 2008, installed capacity within the Group reached 561 MW.</p>
Tarmsal Kimya	<p>TARKİM produces bioethanol from wheat and corn in its plant at Bursa. TARKİM is a initiated its investments in 2001 after considering rapidly increasing production and usage of bioethanol worldwide and in view of its added value on Turkish economy and the environment. Having made partnership agreements with international bioethanol technology companies, TARKİM has commissioned its bioethanol production facility equipped in 2004.</p>
TEZKİM	<p>TEZKİM is a producer of bioethanol. It has been constructed in 2005 and has started the production in 2007.</p>
Research Institutes	
TÜBİTAK MRC Energy Institute	<p>The Scientific and Technological Research Council of Turkey (TUBITAK) was founded in 1963 with the aim of developing, promoting, planning and coordinating the R&D activities in the area of positive sciences, in respect of the priorities for Turkey's development. Marmara Research Center (MRC) is the largest research organization under TUBITAK. Energy Institute (EI) is one of the seven existing research institutes under MRC. There are several completed and on-going national and international projects on different areas such as fuel cells (PEMFC and MCFC for both mobile and stationary applications), hydrogen production and storage, biofuel production, electric vehicle, power electronic and coal/biomass combustion-gasification-pyrolysis, liquid fuel production from biomass etc. and so on. Institute has grown out in recent years and gain important expertise on design, integration, demonstration and</p>

	<p>testing of system and sub systems. The design, simulation, modeling and characterization activities are supported by extensive test facilities and softwares for component and full-size system levels.</p> <p>Research activities related to this project are mainly focused on the areas of simulation, design, demonstration and testing of the systems related to biofuel production, gasification and diesel fuel processing technologies. Since 1998 about 135 scientists and technicians are researching on these areas.</p>
Universities	
Istanbul Technical University	
Middle East Technical University	
Governmental Organisations	
EİE(General Directorate Of Electrical Power Resources Survey And Development Administration)	<p>Electrical Power Resources Survey and Development Administration (EIE) founded on June 24, 1935 under law No. 2819 EIE, being governed by the provisions of private law and administrated in accordance with commercial methods, having the status of a juridical person and being bound to the Ministry of Energy and Natural Resources, carrying out engineering service with opportunity of production of electrical energy is an investor public organization.</p> <p>Main tasks of EIE are to research the water sources other energy sources to determine if they are convenient for producing electrical energy, to make hydrological studies and Geotechnical researches, to execute Engineering services and design studies for dams and HEPPs, to make researches and studies for new and renewable energy resources (wind power, solar energy, e.t.c.), to make surveys and application studies for the rational use of energy resources, to make studies of education , to research and to make people conscious of energy conservation at the sector of industry, residence, transportation, to execute nationalizing process, control of plant of HEPP realized based on Built-Operate-Transfer (BOT) Project, to make investigation and researches at the special fields for association and establishment against payment. In our country, energy conservation studies were got started in 1981 by EIE bounded to the Ministry of Energy and Natural Resources. At the beginning of the 1993, National Energy Conservation Center (NECC) is constituted by EIE owing to the fact that EIE's energy conservation activities is able to be executed more effective and more comprehensive all region of our country. Until now, Various international organization such as UNIDO, World Bank, EC, JICA has supported projects and (NECC) has executed several projects in order to get efficiency at sector of industry, transportation and building increased everywhere in our country.</p>
General Directorate of Agricultural Research	<p>The research organization that belongs to ministry of agriculture and rural affairs is consisted of ; general directorate of agricultural research , agricultural research council, research science comitees, programme coordinators, programme evaluation working groups, research institutes , central research institutes , regional research institutes, subject-oriented research institutes. Objectives of General Directorate of Agricultural Research; to set up priorities of Agricultural Research for the Country and allocate the available resources to the programmes and projects according to the priorities, to follow the implementation of the research projects, to disseminate and publish the research results, to improve the</p>

	<p>system for research administration and information and make available for the use of researchers, To improve the productivity and quality of agricultural products through research and to help improving the incomes of farmers, To protect the resources (including soil, water and genetic resources of plants and animals) and the environment for the sustainable use, To follow technological developments, including biotechnology, around the world and to adopt to our Country's conditions, To improve the scientific capacity of the researchers, to employ young scientists in research and to improve social and economic capacity of research staff, To improve research capacity and the productivity of Research Organization. Working Areas of General Directorate of Agricultural Research are Plant breeding and production, plant protection, animal breeding and husbandry, animal health, water product and aquaculture, food and feeding.</p>
Non-governmental Organisations (NGOs)	
Pankobirlik	<p>Pankobirlik is established on 1972 as a result of studies, took a period more than 2 years, by 19 beet cooperatives and Turkish sugar factories Inc. and today is an enormous establishment, which has approximately 1.700.000 beet grower partners, who are sowing sugar beet in 64 cities of our country and 7500 settlements unit, and of which 31 beet cooperatives have 290 sales shops, and which is serving to its country and nation without having any support from the government with 7 cooperative sugar factories (Adapazarı, Amasya, Kayseri, Boğazlıyan, Konya, Çumra) and more than 50 agricultural participations. Forming an example for all entities and organizations engaged with business in the country with its democratic structuring. Pankobirlik is the largest farmer organization of Turkey. Pankobirlik also have a bioethanol factory in Konya, Turkey.</p>
Others	

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