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Assessing of energy policies based on Turkish agriculture: current status and some implications

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Abstract

In this study, the current energy status of Turkey and the effects of national energy policies on Turkish agricultural support policies are discussed for both current and future requirements. Turkey is an energy-importing country producing 30 mtoe (million tons of oil equivalent) energy but consuming 80 mtoe. The energy import ratio of Turkey is 65–70% and the majority of this import is based on petroleum and natural gas. Furthermore, while world energy demand increases by 1.8% annually, Turkey's energy demand increases by about 8%. Although energy consumption in agriculture is much lower than the other sectors in Turkey, energy use as both input and output of agricultural sector is a very important issue due to its large agricultural potential and rural area. Total agricultural land area is 27.8 million hectares and about 66.5% of this area is devoted for cereal production. On the other hand, Turkey has over 4 million agricultural farm holdings of which 70–75% is engaged in cereal production. Machinery expenses, mainly diesel, constitute 30–50% of total variable expenses in cereal production costs. It is observed that energy policies pursued in agriculture have been directly affected by diesel prices in Turkey. Therefore, support policy tools for using diesel and electricity in agriculture are being pursued by the Turkish government.
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Keywords: Energy policy; Agricultural policy; Energy usage; Turkey

1. Introduction

Energy is needed for almost every stage of modern life and accessing appropriate energy has gained more attention for both producers and consumers. In addition, the energy consumption level is used as the criteria to indicate the development level of the countries. The level of energy dependency and the quantity of energy consumption in many developed countries are higher than developing countries. However, energy demand is growing sharply in developing countries in order to fulfill the requirement for modern technology. The majority of energy consumption is based on fossil energy sources. To utilize energy from renewable sources is not enough to meet world-wide energy demand. For this reason there is a requirement for management of limited fossil energy sources using international energy policies. National energy policies may also change in the context of global energy policies. Moreover, the impacts of national energy policies on sectors are different. These different effects on national economic sectors should be considered by determining and implementing the national energy policies.

In the literature, there has been a considerable amount of research carried out focusing on general energy policies and energy use in agriculture. However, little attention has been paid to rural and agricultural energy policies. It is well known that agriculture has a dual role, with respect to the energy user and supplier. These characteristics can play a very important role in terms of reducing environmental emissions. On the other hand, Turkey is an agriculture-based country. The number of farms was 3.1 million in 1963 and it reached

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4.1 million in 1991. Agriculture is still Turkey's largest employment provider and a significant contributing sector to gross domestic product (GDP), imports and exports. The share of agriculture in GDP at current prices was 14.1% in the year 2000. The contribution of agricultural commodities in total exports was 10.6% and more than 40% of the total population was engaged in agriculture (Ozkan et al., 2004).

The main objectives of this paper are to assess how the Turkish agricultural sector was affected by the energy policy at all levels, to discuss developments of energy issues at the global level and present status of Turkey, to highlight the relationship between energy and agriculture and to review energy polices and new approaches in the context of national energy policies pursued in agricultural support polices.

2. Overview of energy supply and consumption in the world

Energy supply and consumption are the major economic factors in the world, while the dynamics of energy markets are driven by supply and demand equivalence. Total primary energy supply (TPES) of the world was 10 038 mtoe (million tones of oil equivalent) in 2001. The shares of oil, natural gas and nuclear energy in TPES are 35%, 21.2% and 6.9%, while renewable energy supply accounts for only 13.5% of TPES (Fig. 1) (IEA, 2002, 2003a). The solid biomass is the largest renewable energy source, accounting 10.4% of the world TPES (Fig. 1), or 77.4% of global renewable energy supply (Fig. 2) (IEA, 2003a).

Based on the country groups, OECD has the highest proportion (53.2%) of TPES in 2001 followed by Asia (11.5%) and China (11.5%) (Fig. 3) (IEA, 2003b). Half of the total renewable energy supply is provided from Africa. Asia (33.3%), Latin America (27.9%) and (20.8%) China are other important world renewable energy suppliers (Fig. 3) (IEA, 2003a). Most of the renewable energy supply is provided from combustible renewable and waste (CRW) (79.9%) in the world (Table 1) (IEA, 2003a).

While annual average growth rate of world total energy supply was 1.4% from 1990 to 2001, renewable energy sources have more growth rate of 1.7%. Despite the amount of production, the most significant growth rate (19.1%) has occurred for solar, wind and tide (IEA, 2003a). However, fuel energy proportion of TPES is not expected to change in the near future (IEA, 2003b).

World total final consumption (TFC) was 6 995 mtoe in 2001 and OECD countries consume more than half of the energy sources. The fuel share in TFC consists of oil (43%), gas (16.3%), electricity (15.6%), CRW (14.2%) and coal (7.4%) (IEA, 2003b). The fuel consumption is more different in developing countries than developed ones. For example, Africa has the highest biomass share (60%) in TFC. However, the shares of biomass are 34% and 25% in Asia and Latin America, respectively (FAO, 2000). Household consumption accounts for 68% of total energy consumption in African countries. Industry, transportation and agriculture are relatively small energy users. This energy pattern is similar to the majority of the other developing countries. Average household energy demand in developed countries is around 40% of total energy usage followed by industry

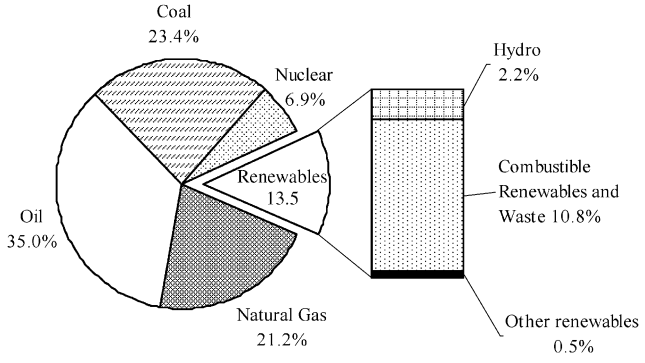

Fig. 1. Products' shares in the world total energy supply in 2001 (IEA, 2002, 2003a).

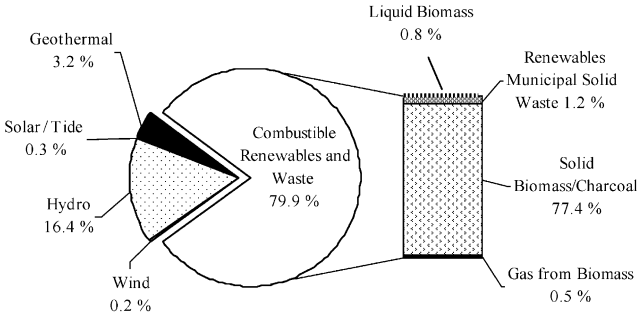

Fig. 2. Products' shares in the world renewable energy supply in 2001 (IEA, 2003a).

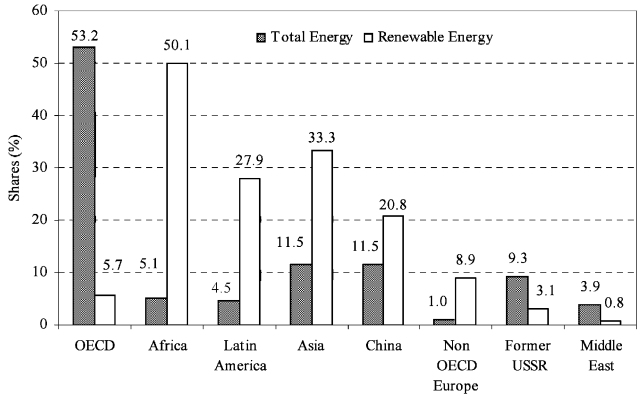

Fig. 3. The supply shares of total primary energy and renewable energy in the world regions in 2001 (Adopted from (IEA, 2003a, b)).

Table 1
The shares of primary energy supply from different renewable sources by countries (2001)[a]

	Ren. CRW[b]	Hydro	Wind	Solar/Tide	Geothermal	Total
World	79.9	26.4	0.2	0.3	3.2	100.0
OECD	53.6	34.8	1.0	1.0	9.6	100.0
EU	58.9	33.8	2.7	0.6	4.0	100.0
USA	67.6	17.5	0.5	1.4	13.0	100.0
Turkey	67.4	22.1	0.1	3.1	7.4	100.0

[a]*Source*: Adopted from IEA (2003a).
[b]CRW: Combustible Renewable and Waste.

Table 2
Schematic energy policy methods[a]

	Affecting supply	Affecting demand
Short-term to mid-term	Strategic Petroleum Reserve Allowing high prices to allocate and price scarce energy.	High energy prices due to unfettered market forces or taxation energy "Green" policies promoting conservation and more energy-efficient choices.
Mid— to Long-term	Tax incentives to promote production. Open new areas to leasing and exploration. Research and development. Market pricing of energy.	Corporate average fuel economy standards. Tax incentives to encourage less, or more efficient consumption. Efficiency standard, labeling. Research and development in efficiency technologies.

[a]*Source*: Bamberger (2002).

and transportation energy demand with 30% each (FAO, 2000).

As a matter of fact, 59.2% of renewable energy is used by the residential, commercial and public sectors. On the other hand, 21.2% of renewable energy sources is used for world-wide electricity production, while the share of renewable energy in world electricity production was 18.1% in 2001. The largest contributor to global electricity production is coal with a share of 38.7% followed by gas with a share of 18.3% (IEA, 2003a). Some predictions indicate that the contribution of renewable energy to world total energy market will reach 15–20% in 2010, 25% in 2050 and 40% in 2060. This contribution for the world electricity market will be around 60% in 2050 (FAO, 2000).

To reach plentiful and inexpensive energy sources became vital after several energy crises and interruptions. After the oil crises in 1973, energy policies have emerged in the world. There is widespread concern regarding whether the country has an energy policy or not. Energy policy is generally designed based on price-based measurements. Several countries developed some energy policy tools, regulations and measurements according to time longevity to reach optimal energy efficiency (Table 2) (Bamberger, 2002).

After the oil shock of the mid- and late 1970s, attention given to alternative fuels—including solar, geothermal, wind, clean coal, synthetic fuels, alcohol-based fuels and technologies to improve the efficiency of energy use has increased considerably (Bamberger, 2002). It is projected that fossil fuels such as petroleum and natural gas will be exhausted in the world, growing demand will expand strategic importance of energy and developments will lead to high energy prices. A method of preventing this problem is investigation of renewable energy sources finding alternative sources of fossil fuels and making them ready to use. Certainly, not only for exhausting probability of fossil fuels but also because of some reasons, such as supply security, environmental contamination, global heating, dependence on importing, renewable energy has gained significant importance in terms of sustainable development (Azar, 2003; Dincer, 2003; EC, 2002; Kaygusuz, 2003).

Hence, many developed countries like USA encourage investments for renewable energy such as wind power, solar energy and biomass energy. State support policies are generally based on various incentive tools concerning production of solar heat collectors, wind turbines and energy crops. The EU and many developed countries' state support policies are generally focused on

some fiscal and tax regulations for investments, renewable energy domestic consumption prices, new technologies for obtaining energy from renewable sources and research-development studies (Durak and Caldag, 2003; Reiche and Bechberger, 2004; Upreti and Horst, 2004; Kwant, 2003).

3. Energy supply and demand in Turkey

Based on the 2002 values, Turkish energy consumption consists of petroleum (40%), coal (25%), natural gas (21%) and others (14%). The share of natural gas in total consumption has increased gradually (TPC, 2003). When current energy consumption is investigated by sectors, it can be seen that the industry sector is the leading sector (28%), followed by household (25%), transportation (16%) and agriculture (4%). The energy consumption composition by sectors in Turkey have not changed since 1990, except the industry sector (Fig. 4) (MENS, 2004). Turkey is facing a rapidly rising growth of demand for energy by 8% per annum (Demirbas, 2001), whereas the world average is 1.8%. As of 2002, total energy consumption was about 80 mtoe and it is expected to reach 179 mtoe by 2010 and 319 mtoe by 2020. The Natural gas demand of Turkey is estimated to rise to 55 bcm (billion cubic meters) by 2010 and 83 bcm by 2020 (MFA, 2003).

There is a gap between energy demand and supply in Turkey. Basically, consumption is based mainly on import. Therefore, Turkey is a net importer country for energy. Domestic energy production based on lignite (approximately 45%) is insufficient to meet rapidly growing domestic energy consumption. Hydropower and wood are the other important domestic sources in total energy production as a kind of renewable energy (Table 3) (Kaygusuz, 2003; Xiaohua and Zhenmin, 2000). Hydropower and lignite, besides natural gas, are also the most important sources, which have a share of 50% in obtaining electrical energy in Turkey (SIS, 2003). Electrical energy takes a big share in the total consumed energy in Turkey. Domestic resources are relatively sufficient to produce electrical energy except natural gas.

Turkey has great potential and different combinations for renewable energy sources owing to the presence of different geographic regions. The share of energy from renewable sources in total energy production and consumption in Turkey are around 35% and 13–15%, respectively (Table 3). This potential provides important

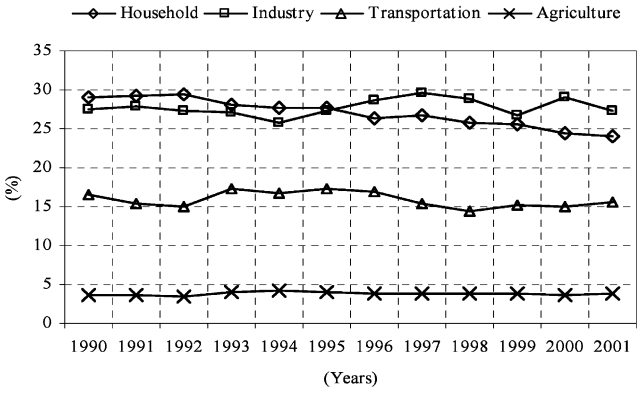

Fig. 4. The distributions (%) of energy consumed by sectors in Turkey (thousand toe) (adopted from MENS (2004)).

Table 3
Primary energy production and consumption in Turkey (1997–2000)[a]

	Energy production (ttoe)				Energy consumption (ttoe)			
	1997	1998	1999	2000	1997	1998	1999	2000
a.Hard coal	1347	1678	2729	1769	8495	8160	11286	8149
b.Lignite	11759	12514	12685	12830	12280	12414	12984	12830
c.Oil	3630	3230	3056	2925	30515	32083	32916	34893
d.Natural gas	230	684	662	631	9165	10635	12902	14071
Total fossil	16966	18106	19132	18155	60455	63292	70088	69943
e.Hydropower	3424	3632	2982	2656	3424	3632	2982	2656
f.Geothermal	179	256	274	286	179	256	274	286
g.Solar	80	98	114	120	80	98	114	120
h.Wood	5512	5512	5293	5081	5512	5512	5293	5081
i.Waste and dung	1512	1492	1510	1376	1512	1492	1510	1376
Total reneawable	10707	10878	10650	9519	10707	10878	10650	9519
General total	27673	28984	29782	27674	71162	74170	80738	79462
Foreign trade[b]	Imports				Exports			
	45629	48325	52504	55879	1630	2398	2791	1584

[a] *Source*: Kaygusuz (2003).
[b] Thousand tons of oil equivalents (ttoe).

advantages for Turkey, particularly in the long term. The renewable energy potential of Turkey consists of 122.3 TWh/year of hydropower, 1.8 mtoe/year of geothermal power, 50 TWh/year of wind power, 32 mtoe/year of biomass and 35.2 mtoe/year of solar energy in usable and/or economic quantities (Kaygusuz, 2003).

Turkey produced about 30 mtoe per year from its own primary sources and consumed about 80 mtoe a year of primary energy. The proportion of domestic production to consumption is around 30–35% (Table 3) (Kaygusuz, 2003). As a matter of fact, Turkey has imported energy for a long time, a majority of the imported energy comprising of oil and natural gas (UTFT, 2004).

Energy import costs too much in the Turkish economy. The balance of payment is influenced negatively by energy import. For example, the share of energy import in payments for total Turkish import is around 15–20%, 25–30% in industry and 75–80% in the mining sector (UTFT, 2004).

It is expected that the primary energy production in the year 2020 will be 85 mtoe, while primary energy consumption will be 319 mtoe (Kaygusuz, 2003). Hence, the proportion of domestic production to consumption will be around 20–25%. This figure shows that Turkey will be forced to import energy in increasing proportion due to scarcity of its energy sources. Despite fossil energy sources running out, demand for energy consumption will increase because of increase in population and gross national product (GNP) (Fig. 5) (STRSCT, 2003). The main factors affecting energy consumption in the long term are population, per capita GDP and energy per unit of GDP (McVeigh et al., 1999).

Insufficiency in energy production-based fossil fuels arises from lack of investments, especially with regard to energy sector in Turkey. Only 60–70% of investments have been realized until now in the energy sector since 1995 (SPO, 2000). There are some reasons for this insufficient development. The main factors influencing energy investments are lack of public policies pursued, legal and institutional regulations in order to provide the access private sector access to the energy market and methods to obtain privatization applications. On the other hand, energy investments will not be realized to fit the energy demand deficit in a short period due to its high costs, requiring a long time period and regulations for environment conservation (Serdengecti, 2000).

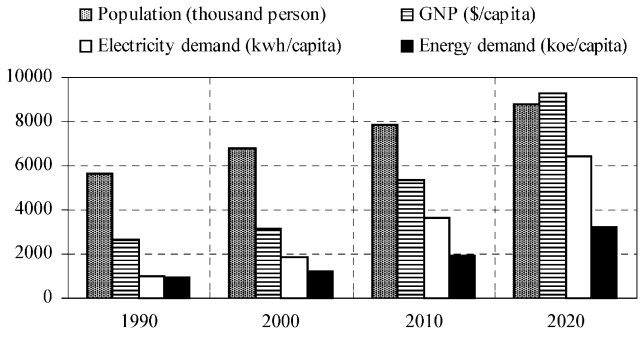

Fig. 5. The developments in total population, GNP (gross national products), electricity and energy demand per capita in Turkey (adopted from STRSCT (2003)).

4. Energy and agriculture

Besides industry and services, the agriculture sector is also one of three main economic sectors, which are final energy consumers (Schafer, 2003). According to general definition, energy is an input used for various reasons such as increasing productivity, enhancing food security and contributing to rural economic development in the agriculture sector (FAO, 2000). In rural areas, energy is mostly needed for cooking, lighting and heating by household, for tilling, irrigating, harvesting and processing by agriculture, for mechanical tools by the rural industry (Al-Mohammad, 2001, Schafer, 2003; FAO, 2000; Xiaohua and Zhenmin, 2000). At the same time, energy is an output of agriculture sector. Therefore, agriculture and energy relations have a complementary structure and affect each other (Ozkan et al., 2004). That structure is three dimensional:

- Energy consumption is a compulsory component for the many stages of agricultural activity. The petroleum, electricity and the other energy sources are used mainly and utilized from those too much in agriculture.
- Crop and animal residuals, vegetable oils, etc. which are necessary for some energy sources such as biogas, bio-diesel and petroleum are provided by agricultural production (Martinov et al., 2002).
- Agricultural production may be affected negatively by energy production and consumption. On the other hand, agriculture production contributes to mitigation of climate change threat related energy by CO_2 substitution (FAO, 2000; Martinov et al., 2002).

The energy in the agriculture sector can be used for providing extensively mechanical energy, heating and lighting, drying and cleaning by direct and indirect. The usage of mechanical energy is more preferred than others and it leads to high consumption of petroleum to obtain mechanical energy. On the other hand, electricity, natural gas and other sources, such as wind, solar and biomass within renewable energy are less compared to petroleum for providing mechanical energy. Mostly, mechanical energy is needed for agricultural activities, such as land preparation, threshing, harvest, transportation, freight, irrigation, cultivation and milking.

Furthermore, geothermal energy is used for heating, especially in greenhouse products and aquaculture.

Electricity is more preferred for storage and protection of agricultural production and also for lighting.

Energy is not only important for agriculture but also for other sectors using agricultural products as the raw materials and providing inputs to agriculture. Human being and animals are used as power source excluding mechanical energy in agriculture. However, usage proportions and their priorities could change according to regional structure, product variations and the kind of agricultural activities. For instance, mechanical energy is used more intensively than the others in crop production.

In general, modern agriculture applied in developed countries requires more energy input use than to traditional agriculture in developing countries (Turyareeba, 2001). This is true in almost all developed countries including OECD, EU and USA (IEA, 2003a, b). On the other hand, Turkish agriculture needs more energy consumption by the increased development of the technical level in agriculture.

4.1. Energy in Turkish agriculture as an input

Energy affects agricultural production cost directly and indirectly as a major input of agriculture. This interaction is seen more clearly directly in the case of diesel and indirectly in the chemical fertilizer case.

4.1.1. Direct effect on agricultural production cost

The connection between energy and agriculture is very strong. Particularly, mechanical energy usage in crop production is very important. There is no doubt that diesel is the most important primary energy source in obtaining mechanical energy for crop production. Diesel is used mostly in tractors for tillage in agriculture. The number of agricultural farms in Turkey is about 4 million and about 70–75% of the farms are engaged in cereal production. The total agricultural land area in Turkey is 27.8 million hectares and majority (66.5%) of the area is devoted to cereal production. Wheat has the biggest quantity in total cereal production area of 68% (SIS, 2001).

Machine power takes considerable share in wheat production costs in Turkey. Machinery expenses constitute 20–25% of total production expenses and 30–50% of total variable expenses in wheat production cost (AERI, 2001). The machinery expenses mainly consist of diesel expenses. Thus, changes in diesel prices affect machinery expenses directly and the price changes lead to increases in wheat production costs. Diesel price in the domestic market is affected by general price policies pursued in Turkey and the world. Generally, diesel price increases more than agricultural production prices due to high inflation and import rates. The parity price of diesel and wheat is around $\frac{1}{4}$. In other words, it is necessary to sell 4 kg wheat to buy 1 l diesel in Turkey (MARA, 2003).

When considering the necessity of machine power and diesel in crop production, price increases in diesel directly affect agricultural production cost. Therefore, policies pursued in agriculture can be directly affected by diesel price policies.

4.1.2. Indirect effect on agricultural production cost

The other extent of the connection between energy and agriculture can be observed, for example, in the chemical fertilizer used for crop production in Turkey. Out of the total national fossil fuel consumption, the total fossil fuel energy input in agriculture rose from 2.63% (in 1970) to 3.98% (in 1997). Application of irrigation and fertilizer requires a large amount of energy consumption and is associated with large CO_2 emissions (Evrendilek and Ertekin, 2002).

As mentioned previously, agricultural production cost of agricultural crops is influenced by energy prices directly. Increasing the productivity per unit area is necessary due to the limitations of arable land and continuous increase of the world population. The chemical fertilizer is utilized with other inputs to increase agricultural productivity. Chemical fertilizers make an important contribution to agricultural productivity and increase the agricultural production because of their high nutrient content effects on crops in a short time (Sayin, 1999).

About 75% of gross value of agricultural production is obtained from crop production in Turkey. The main cost elements in the production are diesel, chemical fertilizer and seeds, respectively. Cereal, particularly wheat, is very important in crop production. In the last decade, the share of cereals in total chemical fertilizer usage in Turkey is around 60%, of which 85–90% is used for wheat production. In the same period, nitrogen fertilizers account for more than 60% in total fertilizer consumption (Sayin, 1999) because about 75% of arable agricultural land in Turkey needs nitrogen nutrients (Eyuboglu, 1998).

Nitrogen fertilizers play an important role in wheat production cost, in addition to its necessity in agricultural productivity. The chemical fertilizers in wheat production involve mostly nitrogen fertilizers constituting 20% and 15% of total variable expenses and total expenses for wheat production cost (UTCA, 2003). The high fertilizer price like diesel prices leads to cause high production cost and high commodity prices.

As a result of the price increase of nitrogen fertilizers, fertilizer production costs increases. Natural gas and ammonia are the main raw materials for chemical fertilizer production and the proportion of those raw materials is around 80% for fertilizer production cost (Sayin, 1999). Almost all nitrogen fertilizers are produced from ammonia.

Natural gas is preferred as an energy source for ammonia production due to low investment cost and the possibility of production with less energy. Natural gas is used not only for nitrogen fertilizer but also for production of all kinds of fertilizers energy sources. A majority of natural gas is imported by Turkey, the high foreign exchange ratio of which is generally common, pushing nitrogen fertilizer production costs more. To prevent high fertilizer prices and its reflection on agriculture, government gave price subsidies to farmers. In fact, the chemical fertilizer had the highest proportion with 85% in agricultural input subsidies until 2000 (Sayin, 1999).

As a consequence, crop production is directly affected by diesel prices and indirectly by chemical fertilizer prices. This case arises once diesel and fertilizer have the highest production cost in crop production. Therefore, there are some direct relationships between energy price policies and agricultural subsidy policies.

4.2. Energy as an output in Turkish agriculture

Energy is an important agricultural output, in addition to its use as input in agriculture. Biogas is a well-known energy source provided by crop and animal residuals. Furthermore, wood and vegetable oils such as copra, palm, groundnut, cottonseed, rapeseed, soybean and sunflower are other renewable energy sources produced from forestry and agricultural production (Ali and Hanna, 1994; Knothe et al., 1992; GA, 2003; Vaitilingom and Liennard, 1997).

Biogas and biodiesel are obtained from vegetable oils. However, vegetable oil production is not sufficient in Turkey. Therefore, these products are imported due to its insufficient production level. In this case, biogas production from animal residuals is more important for Turkey. Biogas production has a direct relation with agricultural production. However, at present, industry and household residuals in big towns are also used for biogas production. At the world level, the new alternatives are continuously discussed and explored for solving environmental problems, which results in the increase of importance of energy production based on renewable sources. Biogas is also a kind of energy obtained from renewable sources. The environment and human health are better preserved by biogas production and consumption according to energies based on fossil.

Obtaining biogas from animal residuals is supplied from agriculture with bilateral contribution. First, energy is produced thus and used in agriculture. The second contribution is that the residual is qualified and used in agriculture again. These contributions are very important for the Turkish economy, since almost all kind of fossil energy is imported. Turkey has a great potential for biogas production due to its mainly agricultural and livestock production level. In Turkey, about 35% of population live in rural areas and engage in agriculture and the main source of income for rural areas is obtained in agriculture. Crop and livestock production have been carried out in the majority of (75%) of agricultural farms (SIS, 2002).

Biogas production from animal residuals is becoming more popular in many developing countries such as Turkey, India, Syria, etc. (Al-Mohammad, 2001; Turyareeba, 2001). Turkey's total recoverable bioenergy potential from animal wastes is 27.3 TWh (23.5 mtoe) (Evrendilek and Ertekin, 2003; Kaygusuz and Turker, 2002). On the other hand, biogas production potential in Turkey is estimated at 1.5–2 mtoe (Evrendilek and Ertekin, 2003; IEA, 2003c). In Turkey, the daily amount of animal waste obtained from the current animal population is around 50 million tons, of which 32% is lost outside the animal barns. If only dry matter is considered, the amount of animal waste is about 13 million tons (Sozer and Yaldiz, 2002). However, even though there is a great potential in Turkey in terms of animal waste, little attention has been paid on this issue. The reason for this result is insufficient knowledge and low technological level and lack of policies pursued for production. In rural areas, animal wastes with biogas energy potential is used as a farm fertilizer or dried fuel known as "tezek". Whereas it is known that farm yard manure called organic fertilizer positively affects agricultural production, but there is no legislation for prohibiting usage and incentive policies for alternative heating sources for rural areas. On the other hand, there is no sufficient infrastructure and knowledge about farm yard manure marketing. Farmers decide according to their needs and consumption structure and oversupplied farm yard manure is generally wasted.

5. Energy policies pursued in Turkey

The main objective of the Turkish energy sector is to continuously meet the energy demand of the increased population and developing economy at the lowest cost and with confidence in the supply system. For that reason, policies concerning mainly macrotargets are given below (SPO, 2000);

- To encourage private sector for energy investments by increasing privatization energy sector.
- To increase and provide energy investment continuously.
- To constitute new production possibilities for electricity and to decrease electrical energy cost.

Arrangements of domestic energy market, investment incentive policies and foreign trade regulations are the main policy tools to reach the determined targets. Domestic energy market arrangements are based on

Table 4
The main policy issues and tools in Turkish energy sector

Arrangements of domestic energy market	Investment incentive policies and tools	Foreign trade regulations
Legal and institutional regulations	Pursued policies for domestic investors	Duties for energy products
Privatization policy		
Price policies for energy use	Pursued policies for external capital	Arrangements for import and export

various legal and institutional regulations, privatization policies and price policies concerning energy consumption (Table 4).

5.1. Legal and institutional regulations

Electricity, natural gas and petroleum production are considered more important within all of policies pursued because consumption demand is increasing gradually and production and delivery network is expanding. These three energy sources have become the current issue in the Turkish energy market.

Some new legal and institutional regulations for designated energy sources have begun. For example, the Energy Market Regulation Authority (EMRA) was found in 2001 for the adjustment, coordination and control of natural gas and electricity market in Turkey. The Electricity Market Law (4628) and the Natural Gas Market Law (4646) were put into effect in 2001 (TOJ, 2001). The public sector is dominant in the domestic natural gas and electricity market but it is aimed to increase the share of private sector with new regulations.

The Petroleum Pipeline Corporation (PPC—BOTAS in Turkish) has an important role in natural gas market regulation in Turkey. BOTAS which is a State Economic Enterprise (SEE) was a monopoly before 2001 and then free market regulations began in the natural gas market. In addition to this, it is aimed that BOTAS market share will be decreased to 20% with suitable privatizing programs (PPC, 2003).

Electricity market regulations in Turkey are realized by the two main SEEs called the Turkish Electricity Generation and Transmission Corporation (TEGTC—TEAS in Turkish) and the Turkish Electric Distribution Company (TEDC—TEDAS in Turkish). TEAS was restructured into separate public organizations, namely, The Turkish Electricity Generation Company (TEGC—TEUAS in Turkish) and Turkish Electricity Transmission Company (TETC—TEIAS in Turkish). These companies conduct some activities, such as electricity generation, transmission, trade and distribution. Currently, privatization of TEAS and the TEDAS are planned in order to realize the liberal market system in electricity sector in Turkey (EMRA, 2003; Ozkivrak, 2003). At present, the role of the private sector in electricity generation and distribution is about 6% and 9%, respectively.

The other energy source in Turkey is petroleum. Some activities in the petroleum market in Turkey, such as investigation, drilling, transportation, refining and marketing have been carried out within the scope of the new Petroleum Market Law (5015) since 2003 (TOJ, 2003b). According to new law, EMRA is responsible for adjusting the petroleum market in Turkey. Before 1986, the petroleum market in Turkey had been directed by the Turkish Petroleum Corporation (TPC—TPAO in Turkish), which is an SEE; after that, new enterprises were established depending on TPC and they were privatized partially in order to reduce effects of public sector on the Turkish petroleum market (TPC, 2003). In this manner, passing to the liberal market system by increasing the share of the private sector in marketing of petroleum products being electricity or natural gas in Turkey was targeted. Nowadays, studies on this subject are continuing intensively according to the new Law (5015).

5.2. Privatization policies

Another macropolicy constituted for domestic market regulation in the energy sector is the privatization of SEEs engaged in natural gas, petroleum products and electricity. The main policy pursued is privatizing all SEEs in the energy sector under an appropriate privatization program and to dominate liberal market conditions. Liberalization of the energy sector and privatization activities have been carried on. In order to overcome financial constraints, some incentives were provided through formulas like "build-operate-transfer (BOT)", "build-own-operate (BO)" and "transfer of operating rights (TOOR)" in the electricity sector (WECTNC, 2004). According to this policy, privatization of some foundations and activities belong to The Turkish Petrochemical Holding (PETKIM in Turkish) and the Turkish Petroleum Refineries Corporation (TUPRAS in Turkish) involved in the oil sector were planned in 2003 (TPA, 2003). All privatization rules are regulated by the Turkish Privatization Administration (TPA) established in 1994. The main principles for privatization under The Privatization Law (4046) were put into practice in 1994 (TOJ, 1994) and were revised by Law (4971) in 2003 (TOJ, 2003c).

5.3. Price policies for energy use

The third policy tool within domestic market regulation in the energy sector is price policy concerning energy consumption. The product prices in energy sector are regulated by the EMRA (WEC, 2001). The tariffs are set by a distribution firm according to costs that come into force after the government has approved them. For example, in the electricity market, Turkey has differential tariff structures for different customer segments such as housing, industry, agriculture, commercial building, etc. Furthermore, provinces under development have lower tariff (about 40–50%) than other provinces. Turkey has established capacity and energy tariffs, varying by voltage of supply and time of usage. In addition, agriculture and government organizations pay lower tariffs than industry and residential customers. The household tariff is higher than industrial and other customer segments. On the other hand, some different tariffs based on time usage and level are used. Tariffs are adjusted regularly for changes in cost levels (BSREC, 2003).

5.4. Investment incentive policies

One of the important policy tools within general energy policies is the investment incentive policies for the energy sector. New investments are needed in order to provide sufficient in energy production and to diminish energy dependency on other countries. The general investment incentive policies contain energy investments, in addition to the other investment subjects. Furthermore, energy investments are defined in *"sector investments with special importance"* (Serdengecti, 2000). However, the subjects of investment incentive are determined annually, according to economic conditions occurring in Turkey. According to the latest version of Council Regulation (2002/4367) about investment incentives, *"investments with incentive certification"* are benefited from some support policy tools applied, such as exemption and exception on various taxes concerned with investment and credit allocation, etc. (TOJ, 2002). Support proportions by the government may change according to the welfare of the regions, total investment and employment rate. In general, a majority of investment supports based on the energy sector is used for developing infrastructure concerned with natural gas and electricity (TT, 2003).

Not only Turkish investors but also external capital are attracted by the investment incentive policies. Similarly, "*Reform Program for Improving Investment Climate*" (CCIIC, 2003) and *"The Foreign Direct Investment Law (4875)"* have been applied in 2001 and 2003 (TOJ, 2003d). Encouragement of foreign capital includes incentives, such as investment allowance, custom exception, postponement of Value Added Tax (VAT) for the imported material, and VAT support for purchase of local machinery and equipment (BSREC, 2003).

Currently, implementing of energy policies without considering environmental effects is not possible. For example, in Turkey, The Environment Law (2872) (TOJ, 1983) promulgated in 1983 and some regulations related to the law such as Environmental Impact Assessment are taken into consideration for energy investments (TOJ, 2003a). In addition to the project called as "Turkish Environmental Strategy and Action Plan" is supported by the World Bank, which has great importance with regard to relationships between energy and environment (BSREC, 2003; Karaata and Ekmekci, 2002; Tutunlu et al., 2003; WEC, 2003).

In Turkey, although there is no direct support policy for producing renewable energy, renewable energy investments are supported in the scope of general investment support policies. However, this support is not comprehensive and sufficient as it is in developed countries. Turkey does not have a specific and comprehensive law for renewable energy sources development. Therefore, there is a crucial need to accept and implement law considering renewable energy development and sustainable energy policies (Refocus, 2003).

5.5. Foreign trade regulations

The other policy tool pursued in the Turkish energy sector is foreign trade regulation. Import policies concerned with coal, petroleum and natural gas have a great importance because those are mostly imported. These products are commonly used in many sectors as raw materials or semimanufactured goods in Turkey. For that reason, custom duty exempt or custom duty is applied for import of those products (UTFT, 2004). On the contrary to import policies, various restrictions are used by the government in order to control export of some renewable energy sources in many ways. For example, firewood and charcoal are prohibited to export, natural manure is in the pre-permission list to export (TOJ, 1996).

6. Support policies for energy consumption in Turkish agriculture

Agricultural production is supported by the Turkish government like many other countries. Support proportions and its variety change continually in relation to the economic conditions of the country. General agricultural support policies were based on agricultural input subsidy, purchase some commodities to support by government and some direct payments related to production for farmers until 2000 (Table 5) (Sayin, 2003).

Table 5
The main issue and tools of old agricultural support system in Turkey[a]

Purchase some products to support	Subsidy for some agricultural inputs	Direct payments related to production and other supports
	Chemical fertilizer	*Incentive premium* for meat and milk
Cereals	Seeds	
Tobacco	Animal feed	*Deficiency payments* for cotton, sericulture, wool, olive oil,
Sugar beets	Artificial insemination	sunflower, soybeans, rapeseed
	Stud animal	
	Pest control	
	Electricity	*Compensatory payments* for tea, tobacco and hazelnut
	Agricultural irrigation	
	Agricultural credit	*Supports* for some investments and tax

[a]*Source*: Adopted from Sayin (2003).

Although agricultural input subsidies were applied due to higher shares of some inputs such as fertilizer, chemical and seed in production cost, government support purchases were applied in providing market guarantee and price stability for some commodities, such as cereals, sugar beet and cotton (Sayin, 2003). Although it was planned gradually to give up from these input subsidies and support purchasing policies to enable the transition of agriculture to free market conditions for many years, the change in the support policies was continued until 2000.

In 2000, the agricultural support system was completely changed by government, except for direct income payments and some input subsidies such as electricity, natural gas and water for irrigation. Various internal and external factors have played an important role in this policy change.

The mainly domestic reasons are as follows (SPO, 1999; Sayin, 2003):

- The support system was complex and confusing in terms of legal, institutional and financial structures.
- Agricultural support payments did not reach farmers who needed support mainly due to lack of good "farmer registration system pursued by the Ministry of Agriculture and Rural Area (MARA)" in the form of a statistical data base including several information on farm holdings, livestock number, crop pattern and farmers.
- The old agricultural support policies have created fiscal burden terms of sustainable economic development.

The main external factors lead to new approaches for agricultural support policies. These are General Agreement on Tariffs and Trade (GATT), Common Agriculture Policy of European Union and stabilization programs to International Monetary Found (IMF).

The implementation of IMF stand-by agreement, started in 2000 has significantly influenced agricultural supporting policies. In this agreement, it was stressed that endogenous factors in the agricultural sector, especially input subsidies and supporting purchases had negative impacts on the Turkish economy, therefore, structural changes in Turkish agriculture supporting policies were proposed. During the period 1999–2001, the shares of total producer supporting total agricultural production value and gross domestic products were realized as 21% and 5%, respectively (OECD, 2002).

Instead of the old agricultural support system, decoupled payment called Direct Income Support (DIS) system by farmers has been started as country level (Sayin, 2003). DIS is not contingent on input use or output production decisions of the farmer. According to DIS, the farmers are eligible to receive a fixed amount (about $100/ha for a year) of payment for up to 50 ha of cultivated land (Cakmak and Kasnakoglu, 2002; TOJ, 2003e). With this method, besides compensation of producer income losses by giving up the old agricultural support system, it is aimed to convey the support payments directly to farmers who really need support.

However, the subsidies applied in the old system for some agricultural inputs were not abandoned with the new agricultural support policy because they have a small share in total agricultural support payments. These subsidized inputs in extent are electricity, natural gas and water for irrigation. At later stages, in addition to these inputs, diesel support was also added.

The support payment for diesel used in agricultural production by farmers has begun since 2003. The reason behind the diesel support is that the proportion of diesel input in the total production cost as emphasized previously is very high (20–25%) (AERI, 2001). The main reason for high cost was that diesel was provided mainly by import (65–70%) (Kaygusuz, 2003). Within the context of the diesel support, about $30/ha is paid

for farmers by the government. The upper limit for land for support payment is 50 ha for each farmer. This support payment is a kind of subsidy for farmers. The only requirement requested from farmers to benefit from support payment is that being included in the farmer registering system implemented by MARA (TOJ, 2003f). In Turkey, an average 80 l diesel was used in crop production per hectare. Diesel usages are 300 l for cotton and 150 l for wheat production. In 2003, the diesel amount that could be purchased by diesel support was 3 l. However, this amount constitutes 35%, 20% and 10% of diesel consumption of wheat and cotton production, (Cine-Tarim, 2004).

Another supported input is water for irrigation from the scope of energy sources. Although about 8.5 million hectares of arable land can be irrigated, currently only half of this area is irrigated. Therefore, it is obvious that irrigation subsidy is very important. Large-scale irrigation investments are carried out by General Directorate of State Hydraulic Works (GDSHW—DSI in Turkish) in Turkey. Farmers do not pay for investment expenses. Furthermore, the necessary annual care and repairing activities for irrigation investments are carried out by DSI. However, only some parts of expenses resulted from repairing are taken from farmers as irrigation cost and the rest of the expenses are paid by DSI as an irrigation subsidy as well (Sayin, 2003). The irrigation fee was determined every year depending on the irrigated crop. The main irrigated crops are cotton, sugar beet, potato, sun flower and cereals. Farmers producing sugar, beet and cotton have to pay two times more irrigation fee in comparison with others. For example, based on 2002, the irrigation fee was determined at nearly $250/ha (MARA, 2004).

Electricity usage in agricultural production is supported by the government. Since 1997, low electricity tariffs have been applied for some limited areas such as aquaculture and poultry activities. Similar applications have survived for cold storage facility in the agriculture sector (Sayin, 2003).

In addition, although it has not been put into application, it was planned to serve liquefied petroleum gas (LPG) prices less than market tariffs used in greenhouse production for heating. An important part of Turkish fresh vegetables was produced in greenhouses. The aims of the LPG support are to decrease production costs in greenhouse products and increase the competitive power of the products.

All of these supports are directed towards energy usage to reduce production costs. As a consequence, crop production is directly affected by diesel, electricity, LPG, water for irrigation prices and indirectly by chemical fertilizer prices. This case is much clearer in case of diesel and fertilizer usage due to their higher ratio in crop production cost. Therefore, there are some direct relationships between energy price policies and agricultural subsidy policies. Furthermore, national support policies pursued in agriculture can be affected by national energy price policies. In general, agricultural support ratio increases if some energy prices of used inputs in agriculture increase.

7. Conclusions

World energy demand is mainly provided by fossil energy sources. Although the proportion of renewable energy supply in the total energy supply is increasing gradually, it is estimated that fossil energy sources will be used to meet world population energy demand in the long term. This situation implies that energy-importing countries will heavily depend on fossil energy import to meet their energy requirements from energy rich countries for the future. The energy dependency level of the countries leads to economic dependency on other countries. On the other hand, some environmental problems have emerged from fossil-based energy production and consumption. Therefore, it is pointed out that a new approach for a solution to environment problems will be one of the current global issues for a long time. To produce and consume renewable energy from national resources seems to be a partial solution of these problems. Therefore, some incentive policy instruments to produce renewable energy and use are implemented in the EU and USA.

In Turkey, not only industry and service sectors but also agriculture sector is influenced by energy dependency. While Turkey has affluent renewable energy potential, it has not been utilized sufficiently, so the energy demand will be met by fossil-based energy sources, even in the long term. It means that Turkish energy policies will be strongly affected by global energy policies.

Since energy is an important input affecting all sectors in the country, implemented energy policies have gained more attention. In this regard, the agricultural sector, as one of the energy consuming sectors, should be considered in terms of sustainable energy use. Some important energy inputs are used in agriculture, such as diesel, chemical fertilizer, electricity and irrigation water. Currently fossil-based energy inputs are used heavily in Turkish agriculture and price increases in these inputs affect production costs, both directly and indirectly. The increase in production costs leads to high commodity prices. The food industry is also affected negatively by high prices due to use of agricultural products as raw materials. As a consequence, consumers purchase agricultural products with high prices. The Turkish government gives support payment for diesel, electricity and irrigation water used in agriculture. Especially diesel support policy in cereals should be given high priority due to cereals being the main stable

food for Turkish people. Alternative agricultural policy instruments should be developed to prevent negative effects of energy policies for Turkish agriculture.

Turkish agriculture will be inevitably affected by energy policies being an energy importing country. However, if the renewable energy production and consumption increases the total energy, the negative effects of fossil fuels may be controlled or reduced. Considering the energy needs of Turkey, it will continue to depend on mainly fossil fuels due to the shortage of domestic fossil fuel resources. It is suggested that an effective and sustainable energy policy is a serious requirement for Turkey not only for industry, household and transport sectors but also the agricultural sector. Turkey is an agriculture-based country; the residuals of agricultural activities such as animal waste can be used as energy source. If all energy use strategies are implemented simultaneously the level of imported fossil energy and environmental emissions can be reduced.

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