Energy market reforms in Turkey: An economic analysis

Erdogdu, Erkan

University of Surrey, UK, Energy Market Regulatory Authority, Republic of Turkey

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School of Human Sciences

Department of Economics

Energy Market Reforms in Turkey: An economic analysis

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Erkan ERDOGDU

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Abstract

In the early 2000s, the Republic of Turkey has initiated an ambitious reform program in the most important segments of her energy market; namely, electricity, natural gas, petroleum and liquefied petroleum gas industries, which requires privatization, liberalization as well as a radical restructuring of these industries. However, there is no consensus that the measures introduced are optimal. The present dissertation attempts to answer, first, whether or not recently introduced energy market reforms in Turkey are optimal from an economic perspective to ensure a fully functioning energy market; and second, what still needs to be done to improve them. The dissertation not only provides an economic analysis of these reforms but also lists some policy suggestions with crucial importance. Since the rapid electricity demand growth is the most contentious reason behind the recent reforms; the dissertation specifically focuses on the issue by both providing an electricity demand estimation and forecast, and comparing the results with official projections. The study concludes that despite relatively good legislative framework, in practice, the reforms in Turkey are far from ideal as they are mainly in the form of "textbook reforms"; and therefore a significant amount of work still lies ahead of Turkey to set up a fully-fledged energy market.

Keywords: *Turkish energy market, regulation, restructuring, privatization, competition, electricity, natural gas, petroleum, LPG, energy demand, partial adjustment model, cointegration, ARIMA modelling*

Statement of Originality

I certify that this dissertation and the results obtained here are the product of my own work, and that any ideas or quotations from the work of other people, published or otherwise, are fully acknowledged in accordance with the standard referencing practices of the discipline. I also declare that this dissertation has not been submitted for the award of any other degree.

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Acronyms and Abbreviations

ADF	Augmented Dickey-Fuller
AEG	Augmented Engle-Granger
APM	Automatic Pricing Mechanism
ARDL	Autoregressive Distributed Lag
bcm	billion cubic meters
BOO	Build Operate and Own
BOT	Build Operate and Transfer
BOTAS	Turkish Pipeline Corporation
CHP	Combined production of heat and power (when referring to industrial CHP, the term “co-generation” is used)
cm	cubic meters
CNG	Compressed Natural Gas
DGES	Director General of Electricity Supply (UK)
DIE	State Institute of Statistics (Turkey)
DPT	State Planning Organization (Turkey)
EC	European Commission
ECM	Error Correction Model
EML	Electricity Market Law
EMRA	Energy Market Regulatory Authority (Turkey)
EU	European Union
EUAS	Electricity Generation Company (Turkey)
GCV	Gross Calorific Value
GDP	Gross Domestic Product
GWh	Gigawatt-hour
IEA	International Energy Agency
IMF	International Monetary Fund
JML	Johansen Maximum Likelihood
kcal	kilocalorie
ktoe	thousand tonnes of oil equivalent
kWh	kilowatt-hour
LE	Real net electricity consumption per capita
LNG	Liquefied Natural Gas
LP	Real electricity prices
LPG	Liquefied Petroleum Gas
LPGML	Liquefied Petroleum Gas Market Law
LY	Real GDP per capita

mcm	million cubic meters
MENR	Ministry of Energy and Natural Resources (Turkey)
mtoe	million tonnes of oil equivalent
MW	Megawatt
NGML	Natural Gas Market Law
OECD	Organisation for Economic Co-operation and Development
OFFER	Office of Electricity Regulation (UK)
OFGEM	Office of Gas and Electricity Markets (UK)
PML	Petroleum Market Law
PPP	Purchasing Power Parity
rTPA	Regulated Third Party Access
STSM	Structural Time Series Model
TEAS	Turkish Electricity Generation-Transmission Corporation
TEDAS	Turkish Electricity Distribution Company
TEIAS	Turkish Electricity Transmission Company
TEK	Turkish Electricity Administration
TETAS	Turkish Electricity Trading and Contracting Company
TFC	Total Final Consumption
TL	Turkish Lira (old, before 1 January 2005 revaluation)
toe	tonnes of oil equivalent
TOOR	Transfer of Operating Rights
TPA	Third Party Access
TPES	Total Primary Energy Supply
TSO	Transmission System Operator
TWh	Terawatt-hour
UEDT	Underlying Energy Demand Trend
US	United States
YTL	New Turkish Lira (new, after 1 January 2005 revaluation)

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Chapter 1: Introduction

The Republic of Turkey[1] (hereafter Turkey) has initiated a major reform program of the regulatory framework surrounding the most important segments of her energy market; namely, electricity, natural gas, petroleum and liquefied petroleum gas industries. The reform program entails privatization, liberalization as well as a radical restructuring of the whole energy industry. Also, an autonomous regulatory body, Energy Market Regulatory Authority[2] (EMRA), was created to set up and maintain a financially strong, stable, transparent and competitive energy market.

No academic work has been done to determine whether or not recent market reforms mentioned above are optimal from an economic perspective to ensure a fully functioning energy market in Turkey or what still needs to be done to improve them[3]. The present dissertation aims at providing answers to these questions[4].

The most controversial reason behind, or justification for, recent reforms has been the endeavor to avoid so-called “energy crisis”. Therefore, the dissertation specifically focuses on the electricity demand in Turkey by presenting an electricity demand estimation and forecast.

Although there exists a huge literature on market regulation; to the best of my knowledge, so far, no scholar has studied and analyzed energy market reforms in Turkey from an academic perspective. Since it is obvious that these reforms will have important implications for the future of the country, the dissertation will be an important contribution not only to the existing literature but also to the energy policy formulation process in Turkey.

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[1] It is strongly advised that those who are not familiar with the basic facts about Turkey and her energy market should consult Appendix 1.

[2] The author himself is working for the EMRA.

[3] The present dissertation is a reduced version of a more comprehensive paper that aims at providing anyone with or without a background in general principles of regulation with an economic analysis of recent reforms in Turkey. However, due to space limitations, it was not possible to present the literature review in regulation here; therefore, I assume that the reader is familiar with the basic concepts in regulation theory. For those without such knowledge, Appendix 2 constitutes an internal part of the dissertation.

[4] The views, findings and conclusions expressed in this dissertation are entirely those of the author and do not represent in any way the views of any institution he is affiliated with.

The dissertation is organized as follows. The next chapter presents the historical background of Turkish energy market starting from the early 1920s up to the present time. To alleviate the controversy surrounding the electricity demand in Turkey, chapter 3 provides an electricity demand estimation as well as a forecast for the period 2005-2015. Given the demand forecast and current regulatory policy in Turkey, chapter 4 critically analyzes the compatibility of regulatory practice in Turkey with the theory of regulation. To improve current regulatory framework, this chapter also lists some policy suggestions with crucial importance. The final chapter concludes.

Chapter 2: Historical Background and Recent Reforms

2.1 Introduction

This chapter reviews the history of Turkish energy market and briefly summarizes the recent reforms to provide a background to Turkish energy market[5].

2.2 The History of Turkish Energy Market

Hepbasli (2005) reports that in Turkey "the first electric generator was a 2 kW dynamo connected to the water mill installed in Tarsus" in 1902; and, he continues, "[t]he first bigger power plant was installed in Silahtaraga, Istanbul, in 1913". The following evolution of Turkish energy market may be summarized as follows.

The Republic of Turkey was founded in 1923, and until the 1930s the electricity industry[6] was heavily dependent on foreign investment as the country was trying a liberal economy. In the 1930s, there was a widespread belief all over the world in the benefits of public ownership of the electricity industry. Following this trend, nationalization of Turkish electricity industry started in 1938 and, by 1944, almost all electricity industry had been placed within the public domain.

In the 1960s, the government started the "development plans era". The Ministry of Energy and Natural Resources (MENR) was established in 1963, and was responsible for Turkey's energy policy. This was followed in 1970 by the creation of Turkish Electricity Administration (TEK), which would have a monopoly in the Turkish electricity sector at almost all stages apart from distribution, which were left to the local administrations[7].

[5] However, an in-dept analysis of these topics is definitely outside the scope of this chapter. For a more detailed study of these subjects, please see IEA (2005b), OECD (2002), World Bank (2004), EMRA (2003), Hepbasli (2005), Ozkivrak (2005), Krishnaswamy and Stuggins (2003); and Atiyas and Dutz (2003).

[6] As the main reform process has concentrated around electricity industry, the main focus of the dissertation in general and that of this chapter in particular will be on that segment of Turkish energy market.

[7] In 1982, however, distribution was also transferred to TEK, thus making TEK a national vertically integrated monopoly fully owned by the state.

In the early 1980s, as was the case in many European countries, the Turkish electricity industry was dominated by a state-owned vertically integrated company, TEK. Starting from the 1980s, the government sought to attract private participation into the industry in order to ease the investment burden on the general budget. In 1982[8], the monopoly of public sector on generation was abolished and the private sector was allowed to build power plants and sell their electricity to TEK. In 1984, TEK was restructured and gained the status of state-owned enterprise.

Various private sector participation models short of privatization were put into practice. The first law setting up a framework for private participation in electricity industry was enacted in 1984 (Law No. 3096). This Law forms the legal basis for private participation through Build Operate and Transfer (BOT) contracts for new generation facilities, Transfer of Operating Rights (TOOR) contracts for existing generation and distribution assets, and the autoproducer system for companies to produce their own electricity. Under a BOT concession, a private company would build and operate a plant for up to 99 years (subsequently reduced to 49 years) and then transfer it to the state at no cost. Under a TOOR, the private enterprise would operate (and rehabilitate where necessary) an existing government-owned facility through a lease-type arrangement (Atiyas and Dutz, 2003).

In 1993, TEK was incorporated into privatization plan and split into two separate state-owned enterprises, namely Turkish Electricity Generation Transmission Co. (TEAS) and Turkish Electricity Distribution Co. (TEDAS). However, the constitutional court of Turkey issued a series of rulings in 1994 and 1995 making the privatization almost impossible to implement in electricity industry. Therefore, in August 1999, the parliament passed a constitutional amendment permitting the privatization of public utility services and allowing international arbitration for resolving disputes. However, during this interval, Turkey not only lost five invaluable years in terms of reform process that could never get back but also, and more importantly, tried to enhance the attractiveness of BOT projects by providing “take or pay” guarantees by the Undersecretariat of

[8] In that year, natural gas was introduced for the first time in Turkey.

Treasury for adding new generation capacity to meet anticipated demand. An additional law, namely the Build Operate and Own[9] (BOO) Law (No. 4283), for private sector participation in the construction and operation of new power plants was also enacted in 1997 again with guarantees provided by the Treasury[10]. Current structure of the contracts concluded based on these laws acts as a major barrier to the development of competition in the electricity sector.

2.3 Reasons for Energy Market Reform in Turkey

Given the historical background, the reasons that triggered the reform process in Turkey may be listed as follows in order of importance:

1. The rapid growth in electricity demand combined with the inability of the government to meet that demand through previous structure based on public or Treasury-guaranteed private investments

   In Turkey, however, there exists no consensus over the actual size of the problem of "rapid electricity demand growth". Even some argue that, the official electricity projections have overestimated electricity demand to justify the construction of new power plants to use excess amount of natural gas (Ozturk et al., 2005).

2. Foreign influence

   The need for an energy market reform has regularly been underlined by various international institutions (especially IMF, World Bank and OECD) that have supported Turkey during her frequent economic crises. The reform was also a precondition for Turkey's longer term objective of EU

[9] Under the BOO model, investors retain ownership of the facility at the end of the contract period. That is, it is a kind of licensing system rather than a concession award.

[10] A typical BOT, BOO or TOOR generation contract, signed between the private party and TEAS or TEDAS, includes exclusive "take or pay" obligations with fixed quantities (in general, 85% of the plant output) and prices (or price formulas) over 15-30 years. That is, under these models, the government retains most commercial risks while providing the private sector with substantial rewards. Also the situation was worse in Turkey as, in Turkish case; there was no requirement for prequalification or even for a competitive open tender to conclude these contracts (Atiyas and Dutz, 2003), which resulted in onerous terms and high electricity prices.

membership[11], which requires progressive liberalization of energy markets. Although this foreign influence factor resulted in considerable skepticism in Turkey about the real aims of the reforms[12]; the recent reforms constitute the only reasonable way to meet growing energy demand in Turkey[13].

3. Fiscal problems

   A third rationale in reform process has been budget deficit problems. The government simply recognized that it cannot finance the capacity expansions necessary to meet future energy demand.

4. Planning and operational inefficiencies in public sector

   Like any other developing country, state monopolies in Turkey have been inefficient and politicians have been ready to tolerate this inefficiency.

5. Possibility of monopoly abuse

   Although the objective of preventing monopoly abuse is regarded as the primary reason for market regulation in the literature; in Turkey, its influence has been extremely limited, if any, in current reform process.

2.4 Recent Reforms

By the end of the 1990s, it became clear that quasi-privatization with Treasury guarantees was not going to be feasible given the rapidly deteriorating fiscal situation. Therefore, Turkey turned to a *radically* different framework for the design of her energy market.

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[11] On 3 October 2005, accession negotiations are scheduled to be opened with Turkey, who has been an associate member of the EU since 1963 and an official candidate since 1999. For a more detailed discussion of EU-Turkey relations, see Erdogdu (2002).
[12] Even still some regard whole reform process as a Western plot designed to control Turkish energy market through multinational corporations.
[13] Moreover, without doubt, one of the most significant benefits of EU accession process for Turkish energy sector would be the stability provided by anchoring Turkish regulations to EU norms.

On 3 March 2001, Electricity Market Law (EML, No. 4628) came into force and aimed at establishing a financially strong, stable, transparent and competitive electricity market. In line with new law, TEAS was restructured to form three new state-owned public enterprises, namely Turkish Electricity Transmission Co. (TEIAS), Electricity Generation Co. (EUAS) and Turkish Electricity Trading and Contracting Co. (TETAS). The new law also created an autonomous regulatory body, namely Electricity Market Regulatory Authority.

Along the lines of developments in electricity sector, some other reforms were also introduced in other segments of the energy industry. On 2 May 2001, Natural Gas Market Law (NGML, No. 4646) also came into force and aimed at achieving similar objectives in natural gas market. It also renamed the regulatory body as Energy Market Regulatory Authority (EMRA). As a final step, Petroleum Market Law (PML, No. 5015) and Liquefied Petroleum Gas Market Law (LPGML, No.5307) came into force on 20 December 2003 and 13 March 2005 respectively and the EMRA was granted the responsibility to regulate these markets as well.

Having briefly summarized the developments in Turkish energy market, let me focus on the specific reforms in each sector, starting from electricity industry.

2.4.1 Reforms in Turkish Electricity Market

Electricity Market Law[14] (EML) made former laws on private investment in the electricity sector obsolete. The main issues and building blocks of the new system are given below.

2.4.1.1 Market Opening and Market Design

Currently, on the demand side, consumers that consume more than 7.8 GWh per annum[15] are designated as “eligible consumers” that are free to choose

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[14] EML is, for the most part, compatible with the EU Electricity Directive of 2003 with the main exception that it does not allow state-owned generation companies to sell electricity directly to the eligible consumers but only to the wholesale company.
[15] See Appendix 1.

their suppliers[16]. The ultimate aim is stated as 100% market opening. On the supply side, the authorization-type licensing framework was established in the new regime, which provides entry opportunities into generation, wholesale supply, distribution, retail supply, import and export of electricity. Transmission remains as a state monopoly.

At the heart of the new regime is a bilateral contracts market where generation companies contract with wholesale trade companies (TETAS and any eventual new entrants), distribution companies, any new independent retail supply companies, and eligible consumers. As for end-users, eligible consumers may not only buy electricity from their regional distribution/retail supply company, but also may buy directly from a wholesale company, a new independent retail supply company or an independent generator. Captive (or non-eligible) consumers, on the other hand, must buy their electricity from the distribution/retail supply company in their region, but they also have the right to buy from any retail supply company operating in the region.

The EML requires the regulated third party access (rTPA) regime for access to the transmission and distribution system. The regulatory body (the EMRA) will carry out the function of dispute settlement between parties.

As for public service obligations, the EML only allows for an explicit cash subsidy in the form of direct cash refunds to consumers without affecting the price structure in cases where some consumers need to be supported based on non-economic objectives.

The current market design does not envisage a centralized pool or power exchange. The actual real-time equality of demand and supply, given the bilateral contracts, will be carried out by the system operator (that is, TEIAS) through purchases and sales in a balancing market. For this purpose, a "System Balancing and Settlement Center" is to be established within TEIAS. In short, it is expected that the market would be mostly by bilateral contracts and pool would be limited to balancing transactions only.

[16] As of October 2004, about 270 eligible consumers signed a bilateral contract with a new supplier (IEA, 2005b, p 147).

2.4.1.2 Restructuring (or Unbundling)

As discussed above, TEAS has been further unbundled into EUAS (generation), TETAS (wholesale trading and contracting) and TEIAS (transmission), each organized as a separate legal entity.

Under the new structure, EUAS will take over existing public power plants that are not transferred to the private sector. TETAS is created to carry out wholesale operations and it seems that it will dominate wholesale market in the near future. TETAS is also the holder of all previous BOO, BOT and TOOR contracts, including long-term power purchase agreements with Treasury guaranties; and will assume other stranded costs[17]. TEIAS is responsible for transmission and, critically, for the balancing and settlement procedure that will balance the power transactions among parties, both physically and financially, in the new framework. That is, TEIAS is the transmission system operator (TSO) in Turkey.

2.4.1.3 Privatization

The new regime envisages eventual direct privatization in generation and distribution. Transmission assets are to remain under government ownership. In March 2004, the government issued the Strategy Paper Concerning Electricity Market Reform and Privatisation, which outlines the major steps to be taken during the period up to 2012 and addresses various issues, including the privatisation of distribution assets and power plants. According to the strategy paper, privatisation will start in the distribution sector in 2005 and will be completed in 2006. After the privatization of distribution assets, generation privatisation will start in mid-2006. Generation assets will be brought together into several groups composed of different types of assets for privatisation to

[17] Stranded costs are defined as the costs incurred within the previous market structure that cannot be economically recovered within a competitive market structure. In Turkish case, the long-term power purchase obligations from private generators with high prices constitute the main stranded cost element in the new system. Other stranded costs include high operating costs of old and inefficient generators, removal of production subsidies, the debts and employment liabilities of public electricity utilities and so on.

enhance competition. Seventeen hydropower plants (which total 7,055 MW of capacity[18]), the transmission system and market operator, TEIAS, will remain in state ownership (IEA, 2005b, p 144).

2.4.1.4 Independent Regulator

As mentioned before, the new regime established the Energy Market Regulatory Authority (the EMRA), governed by its own 9-member board. The main functions of the EMRA include:

- setting up and maintaining new licensing framework,
- preparing secondary legislation,
- enforcing rTPA,
- applying a new transmission and distribution code,
- determining eligible customers over time,
- regulating tariffs for transmission and distribution activities as well as provision of retail services to non-eligible customers,
- regulating the wholesale tariff of TETAS,
- performing tenders for gas distribution networks,
- monitoring the performance of all actors in the market,
- protecting customer rights,
- applying sanctions to parties that violate the rules.

The EMRA has administrative and financial autonomy; it receives no financing from the state budget. It collects its revenues principally from electricity and gas licensing fees and from a surcharge on electricity TPA tariff (maximum 1%). Its total number of staff in August 2005 was 301 (EMRA, 2005a).

2.4.2 Reforms in Turkish Natural Gas Market

Turkey's indigenous gas production corresponds to 2.6% of the total gas demand making the country almost fully dependent on gas imports[19]. The

[18] This figure equals to 19.5 % of total installed capacity in Turkey.

government owned Turkish Pipeline Corporation[20] (BOTAS) is monopoly in almost all segments of the industry. Although its monopoly rights on importation, distribution, storage and the sale of natural gas have been abolished by the new law, the BOTAS is still Turkey's sole natural gas importer and has a *de facto* monopoly of all gas supply in the country. It has eight long-term natural gas sales and purchase contracts[21] with six different supply sources[22]. In 2003, the shares of these sources were the Russian Federation 59.8%, Algeria 18.2%, Iran 16.6% and Nigeria 5.3% (IEA, 2005b).

The objectives of the reform in Turkish gas industry closely accord with those in electricity and regulatory arrangements are also substantially parallel[23]. Consumers whose annual consumption is above the threshold set by the EMRA, or eligible consumers, have the right to choose their own gas suppliers. At present, the gas market opening rate is 80% but eligible consumers cannot currently choose their suppliers because of the *de facto* monopolistic position of the BOTAS in import and trade[24].

As of February 2005, the EMRA granted 65 licences for different natural gas market activities, namely storage, importation (all for the BOTAS), exportation, wholesale, distribution, transmission (only for the BOTAS) and CNG operations (IEA, 2005b).

A key element of the reform is a requirement for a phased divestment of import contracts by the current monopoly importer, the BOTAS. The NGML requires the BOTAS to transfer part of its import contracts every year through a tendering process (the gas release programme). The first attempt to transfer 10% of the BOTAS's contracts was recently launched; however, the process

[19] See Appendix 1.
[20] BOTAS was founded in 1974 and initially focused on the transport of Iraqi crude oil, diversifying into the gas sector after 1987. It was transformed into a state economic enterprise in 1995. Currently, it owns pipeline infrastructure for oil and gas transmission, LNG terminals, and gas distribution.
[21] Supply prices in these contracts are confidential and, in general, they are indexed to oil prices.
[22] See Appendix 1-D.
[23] The new law meets the requirements of the 2003 EU Gas Directive.
[24] See Appendix 1.

has been delayed due to the complexity of the issue and the reluctance of the BOTAS to release its contracts[25].

Under the new law, the EMRA is also responsible for organizing tenders for natural gas distribution licences in the cities. The tender process was carried out in 17 cities in 2003 and in almost 20 cities in 2004 (IEA, 2005b).

Finally, despite the fact that gas demand has been growing rapidly for the last two decades; now, there is some risk of oversupply due to the overestimated demand forecasts. It is estimated that the existing contracts outstrip demand over the next 2 to 3 years by 9 to 13%, reaching 20% later in the decade[26] (IEA, 2005b).

2.4.3 Reforms in Petroleum and LPG Markets

The Turkish historian Evliya Celebi first mentioned the existence of oil in Turkey in the 18th century. Exploration began in the second half of the 19th century, when both domestic and foreign companies carried out exploration in Thrace, where the first productive well was also located.

In 2002, Turkey's oil production was 2,420 thousand tons, which corresponds to 8% of the total oil demand[27]. In the coming years, oil production is expected to decrease due to the natural depletion of the fields (Hepbasli, 2005, p 327).

As for LPG (or liquefied petroleum gas); since the beginning of the 1960s, it has been used as an alternative to gas and kerosene in Turkey, while the first LPG use in cogeneration plants took place in 1996. In Turkey, LPG is marketed in three different segments, namely LPG cylinder, bulk storage (storage container), and autogas. Among these, autogas (or automotive LPG) is the

[25] An amendment to NGML, which is obviously supported by BOTAS and would have significantly reduced the scope of the gas release programme if implemented, was proposed earlier in 2004 but was withdrawn because of heavy opposition from the EMRA and other parties (IEA, 2005b).
[26] This is an enormous risk because contracts concluded by the BOTAS are long-term take-or-pay contracts, meaning that, unless necessary steps are taken, Turkey may find herself in a position in which she needs to pay for the gas that she will never use.
[27] See Appendix 1.

branch that has grown the most of the three segments in recent years. In 2000, the consumption of petroleum products was 30 million tons, of which nearly 87% was accounted for by liquid fuel, while LPG constituted the rest (Hepbasli, 2005, p 326).

The Petroleum Market Law (PML) and Liquefied Petroleum Gas Market Law (LPGML) have liberalized market activities in petroleum and LPG markets respectively. Especially, PML lifted price ceilings[28] and removed import quotas on petroleum products at the beginning of 2005. The EMRA has also been assigned the responsibility to regulate these markets as well.

Actually, unlike electricity and gas markets, the petroleum market has been operating in a relatively liberalized manner for quite some time before the recent reforms. In fact, recent reforms in petroleum market have aimed at solving one of the most important problems of Turkish economy in general: large-scale fuel smuggling. The recent introduction of a national chemical oil marker also targets the same aim. The PML requires the EMRA to take measures to prevent fuel smuggling and those to introduce and implement national chemical marker system in relevant oil products.

2.5 Conclusion

Having reviewed the reform process and before turning to the economic analysis of the reforms, let me focus on the electricity demand in Turkey, the most controversial one among the factors that triggered the whole reform process.

[28] In Turkey, the Automatic Pricing Mechanism (APM) was operational from July 1998 until the end of 2004 to establish ceiling prices for gasoline, diesel, kerosene, heavy fuel oil, heating oil and LPG. The APM linked ex-refinery prices to CIF Mediterranean product prices. Since the abolition of the APM in the beginning of 2005, prices can be set freely provided that they reflect the developments in the world oil markets.

Chapter 3: Electricity Demand in Turkey

3.1 Introduction

Given the controversy surrounding the actual electricity demand growth rate in Turkey; it is obvious that a reliable electricity demand estimation and forecast is crucial to the objectives of present dissertation as it will provide us with results based on econometric principles to compare with official projections. Besides, the econometric analysis here will also contribute to extremely limited literature in Turkish energy demand estimation.

The next section presents a literature review in energy demand studies. Section three concentrates on the scope of the study. Section four specifies the study methodology. In section five, study results are presented and evaluated. The last section concludes.

3.2 Literature Review

Most of the studies on energy demand have their origins from the time of the first major oil price increases of the early 1970s. Since then, various studies of energy demand in terms of estimating energy price and income elasticities have been undertaken using various estimation methods[29].

In most cases, energy demand studies have adopted two different types of modeling; namely; "**reduced form model**" and "**structural form model**". The first model is a double-log linear demand model under which energy demand is assumed to be a direct linear function of energy price and real income. Kouris (1981), Drollas (1984) and Stewart (1991) have employed this model in their studies. Moreover, Dahl and Sterner (1991) report that more than sixty published studies applied the reduced form model. The second model is a disaggregated demand model based on the idea that the demand for energy is derived demand; that is, energy is not demanded for its own sake rather for the services it provides such as lighting, heating and power. It separates energy demand into several number of demand equations and treats it as an indirect,

[29] Since economic theory and a priori knowledge indicates that the demand for energy in general depends on price and income, most of the studies in this area have been concentrated on these two variables as the major determinants of energy demand.

rather than direct, function of energy price and real income. Pindyck (1979) provides a detailed discussion of the structural form model. Although structural form model has various advantages over reduced form model from an economic point of view, its widespread utilization has been limited by the fact that it requires a large number of variables compared to the reduced form model.

The third model for energy demand estimation, namely "**irreversibility and price decomposition model**", was first proposed by Wolffram (1971) and developed by Traill et al. (1978). Originally, it was based on the assumption that the response to price reductions would be less than that to price increases. This model was further improved by Dargay (1992) and Gately (1992), who introduced three-way price decomposition to isolate the effects on demand of price decrease, price increase below and above the historic maximum. Some of the work using this method includes that of Dargay and Gately (1995a, 1995b), Haas and Schipper (1998), Ryan and Plourde (2002), just to mention a few. However, it is important to note that most of the studies that applied this method could not find evidence of irreversibility.

The first three methods, in general, have utilized time series data to estimate energy demand but they did not analyze the data to establish its properties and therefore they implicitly assumed the data to be stationary, meaning that their means and variances do not systematically vary over time. However, this attractive data feature has been lacking in most cases. Engle and Granger (1987) have developed a technique, popularly known as "**cointegration and error correction method** (ECM)", for analyzing time series properties and estimating elasticities based on this analysis, which enables full analysis of the properties of the relevant data before actual estimation. In their study, Engle and Granger have devised a model estimation procedure and recommended a number of tests, among which the most notable and commonly used is the Augmented Dickey-Fuller (ADF) test. Subsequent improvements related to this approach have been in the form of inclusion of more specific energy-related variables in the model and the development of new methods to identify cointegrating relationships, amongst which the Autoregressive Distributed Lag

Model (ARDL) and the Johansen Maximum Likelihood Model (JML) – as outlined in Johansen (1988) – are especially popular.

Since the late 1980s, especially cointegration analysis has become the standard component of all studies of energy demand; and most scholars have done their data analysis based on cointegration. The papers written in this area include that of Engle et al. (1989); Hunt and Manning (1989), Hunt and Lynk (1992), Bentzen and Engsted (1993, 2001), Fouquet et al. (1993), Hunt and Witt (1995); and Beenstock and Goldin (1999).

The popularity and widespread use of the cointegration originate from the fact that it justifies the use of data on non-stationary variables to estimate coefficients as long as the variables are cointegrated; that is, they have a long-run equilibrium relationship.

Despite its popularity; some scholars, like Andrew Harvey[30], have disputed the cointegration and some critics argue that in most of the analyses the demand equation is specified as a double-log linear function, as a way to get elasticities directly from its coefficients, and the parameters are estimated using data whose time length is rather long, going beyond forty years in some cases. The long time span covered by these studies, they continue, raises severe concerns about the soundness of the fixed coefficients assumption in the demand equation. This assumption in a double-log functional form of demand simply implies constant elasticities for the entire sample period under consideration. This feature of the model is indeed problematic in light of the changes that could have taken place in the economy over such a long period of time affecting the demand for electricity[31].

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[30] Harvey (1997) states that: "A casual inspection of many economic time series shows that they have trends. It is equally apparent that, unless the time period is fairly short, these trends cannot be adequately captured by straight lines. In other words, a deterministic linear time trend is too restrictive. … Since a deterministic time trend is too restrictive, the obvious thing to do is to make it more flexible by letting the level and slope parameters change over time. … Testing for unit roots has become almost mandatory in applied economics. This is despite the fact that, much of the time, it is either unnecessary or misleading, or both. … The recent emphasis on unit roots, vector autoregressions and co-integration has focused too much attention on tackling uninteresting problems by flawed methods."

[31] Specific examples of the determinants for such changes may include the efficiency improvements in energy-consuming equipments, the developmental stage of the economy (whether the economy is in transition to later stages of development or not), the government

To sum up, Harvey and other scholars critical of previous methods maintain that time trends are not static, but rather tend to evolve gradually through time and thus they constantly modify the responses of the demand to variations in income and prices. Hence, if the data to estimate a demand function is collected over a relatively long time period, it is much better to use **structural time series model** (STSM), which makes time trend more flexible by letting the level and slope parameters change over time.

STSM focuses on the concept of underlying energy demand trend (UEDT). In addition to price and income, UEDT also recognizes other variables, such as trends, economic structure, energy efficiency, technical progress and consumers' tastes, as factors that affect demand for energy. Any change in these variables, ceteris paribus, results in a shift of the energy demand curve either to the left or to the right.

As STSM is the most recent method and was developed relatively short while ago, the number of studies that employed this method is limited. The best examples to such academic works include Thury and Witt (1998), Hunt et al. (2000, 2003); and Hunt and Ninomiya (2003).

3.3 Scope of Study

One of the aims of this chapter is to estimate a model of electricity demand in Turkey using quarterly time series data on real electricity prices, real income and electricity consumption with a view to obtaining short and long run estimates of price and income elasticities. Also, an electricity demand forecast constitutes another aim of the chapter.

The data covers the period from the first quarter of 1984 to the last quarter of 2004, a total of 84 observations. This period has been chosen as it is the longest and the most recent one for which the data is available on all the

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energy policy and the habit persistence of consumers. For a detailed discussion of the subject, see Haas and Schipper (1998).

variables under consideration. Coincidentally, most of the efforts to liberalize Turkish energy sector occurred during this period.

The model to be employed in demand estimation[32] is a dynamic version of reduced form model, namely “partial adjustment model”. Also, a cointegration analysis will be carried out to analyze the properties of the data. Furthermore, an annual electricity demand forecast will be developed and presented based on autoregressive integrated moving average (ARIMA) modelling[33].

3.4 Study Methodology

3.4.1 Partial Adjustment Model

As maintained by Poyer and Williams (1993), there is no consensus in the literature over the most appropriate functional form of a model constructed to estimate energy demand. However, a consensus exists over the idea that an appropriate model should be able to produce unbiased and efficient energy demand elasticities. In line with economic theory and a priori knowledge, this study will start with a single equation demand model expressed in linear logarithmic form linking the quantity of per capita electricity demand to real energy price and real income per capita.

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[32] Structural form model requires data on stock, utilization and efficiency of electricity-using appliances and, likewise, a meaningful STSM necessitates data on such variables as economic structure, efficiency, technical progress, consumers’ tastes, government energy policy and so on. Since it is impossible to obtain this kind of data for Turkish electricity market, these two methods could not be employed in this study. As for irreversibility and price decomposition model, it is also not applied because there is nothing in both economic theory and a priori knowledge to justify the very basic assumption of the model; that is, the effects of price decrease, price increase below and above the historic maximum on energy demand are diverse. Moreover, during the sustained periods of falling prices or periods in which prices fluctuate without reaching their previous maximum, it is hard to work out how a maximum price that occurred years ago can still have effects years later. For instance, in Turkey, the highest electricity price figure (0.48 YTL/kWh, at 2004 prices) belongs to the fourth quarter of 1994 and, according to this model, this figure still had an impact on the consumption decisions of consumers ten years later, in 2004. The possibility that consumers have such long memories is extremely limited.

[33] Actually, in literature, there are five main approaches to economic forecasting based on time series data; namely, (1) exponential smoothing methods, (2) single-equation regression models, (3) simultaneous-equation regression models, (4) autoregressive integrated moving average models (ARIMA), and (5) vector autoregression. The reason why ARIMA modelling is selected among the alternatives is explained in A-3.5 section of the Appendix 3. For a rather general discussion of other modelling techniques, see Gujarati (2003).

The simplest model can be written as:

$$\ln E_t = \alpha + \beta_1 \ln P_t + \beta_2 \ln Y_t + u_t \quad (1)$$

where E_t is per capita demand for electricity, P_t is the real price of electricity, Y_t is real income per capita, u_t is the error term, the subscript t represents time, α is intercept term; and finally β_1 and β_2 are the estimators of the price and income elasticities of demand respectively.

This simple "static" model (1) does not make a distinction between short and long run elasticities. Therefore, instead of this static one, a dynamic version of reduced form model, called "**partial adjustment model**", will be used in this study in order to capture short-run and long run reactions separately. The partial adjustment model assumes that electricity demand cannot immediately respond to the change in electricity price and real income; but gradually converges toward the long run equilibrium. Suppose that E'_t is the desired or equilibrium electricity demand that is not observable directly but given by:

$$\ln E'_t = \alpha + \beta_1 \ln P_t + \beta_2 \ln Y_t + u_t \quad (2)$$

and the adjustment to the equilibrium demand level is assumed to be in the form of

$$\ln E_t - \ln E_{t-1} = \delta(\ln E'_t - \ln E_{t-1}) \quad (3)$$

where δ indicates the speed of adjustment ($\delta > 0$). Substituting equation (2) into equation (3) gives:

$$\ln E_t - \ln E_{t-1} = \delta(\alpha + \beta_1 \ln P_t + \beta_2 \ln Y_t + u_t - \ln E_{t-1})$$
$$\ln E_t = \delta\alpha + \delta\beta_1 \ln P_t + \delta\beta_2 \ln Y_t + \delta u_t - \delta \ln E_{t-1} + \ln E_{t-1}$$

$$\ln E_t = \delta\alpha + \delta\beta_1 \ln P_t + \delta\beta_2 \ln Y_t + (1-\delta)\ln E_{t-1} + \delta u_t \quad (4)$$

where $\delta\beta_1$ and $\delta\beta_2$ will be the short-run price and income elasticities respectively. The long-run price and income elasticities will be given by β_1 and β_2 correspondingly. Since the error term δu_t is serially uncorrelated, consistent estimates of α, β_1, β_2 and δ can be obtained by OLS (Ordinary Least Squares).

3.4.2 Autoregressive Integrated Moving Average Modelling

The publication authored by Box and Jenkins (1978) ushered in a new generation of forecasting tools, technically known as the ARIMA methodology, which emphasizes on analyzing the probabilistic, or stochastic, properties of economic time series on their own rather then constructing single or simultaneous equation models. ARIMA models allow each variable to be explained by its own past, or lagged, values and stochastic error terms[34].

If we have to difference a time series *d* times to make it stationary and apply the ARMA(p,q) model to it, we say the original time series is ARIMA(*p,d,q*). The important point to note in ARIMA modelling is that we must have either a stationary time series or a time series that becomes stationary after one or more differencing to be able to use it[35].

3.5 Presentation and Evaluation of Study Results

Based on the principles outlined above, the actual estimation is carried out for Turkish electricity demand and the results are provided below[36].

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[34] ARIMA models are sometimes called atheoretic models (meaning models with no basis in theory) as they are not derived from any economic theory.
[35] Because of space limitations, the steps in ARIMA Modelling are provided in A-3.2 section of Appendix 3.
[36] Again due to space limitations, steps and tests in cointegration analysis, overview of the data used and actual procedure in both demand estimation and forecasting are presented in A-3.1, A-3.3, A-3.4, A-3.5 sections of the Appendix 3, respectively.

Table 1. Elasticities of Electricity Demand in Turkey

	Short-run	**Long-run**
Price Elasticity	-0.041	-0.297
Income Elasticity	0.057	0.414

Table 2. Demand Forecast for Turkey, 2005-2015

Year	**Forecasted Net Electricity Consumption** *(GWh)*	**Annual % Change**	**Index** (2004=100)
2005	130,204.9	11.7	111.7
2006	134,876.5	3.6	115.7
2007	142,091.6	5.3	121.9
2008	152,696.9	7.5	131.0
2009	153,897.4	0.8	132.0
2010	167,413.7	8.8	143.6
2011	170,957.3	2.1	146.7
2012	176,576.5	3.3	151.5
2013	192,011.2	8.7	164.7
2014	187,387.9	-2.4	160.8
2015	205,108.1	9.5	176.0

Note: Average annual % change is ***5.4***

Having obtained both the elasticities of electricity demand in Turkey and forecasted values for this demand, let me interpret the results and compare them with the official estimates available from TEIAS (2005c).

The estimated elasticities indicate that the price and income elasticities of electricity demand in Turkey are quite low, meaning that there is definitely a need for regulation in this market. Otherwise, since consumers do not react much especially to price increases, the firms with monopoly power (or those in oligopolistic market structure) may abuse their power to extract “monopoly rent”. To provide a more precise picture of price and income elasticities, the figures below are provided[37].

[37] Since we are concentrating on elasticities; the units of price, income and demand are not important; and, therefore, they are not specified in the figures.

Figure 1. Price Elasticities of Electricity Demand in Turkey

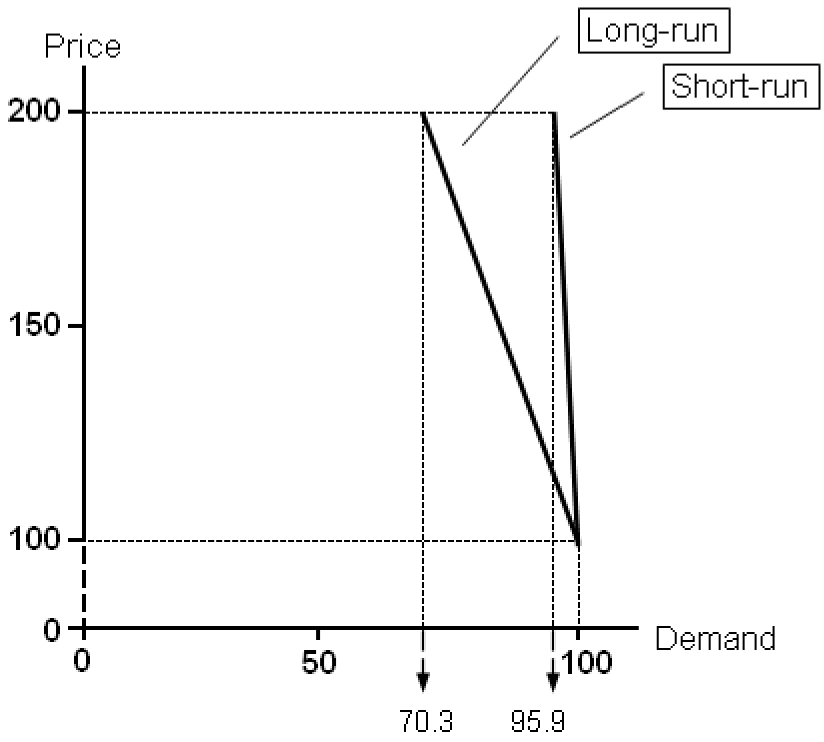
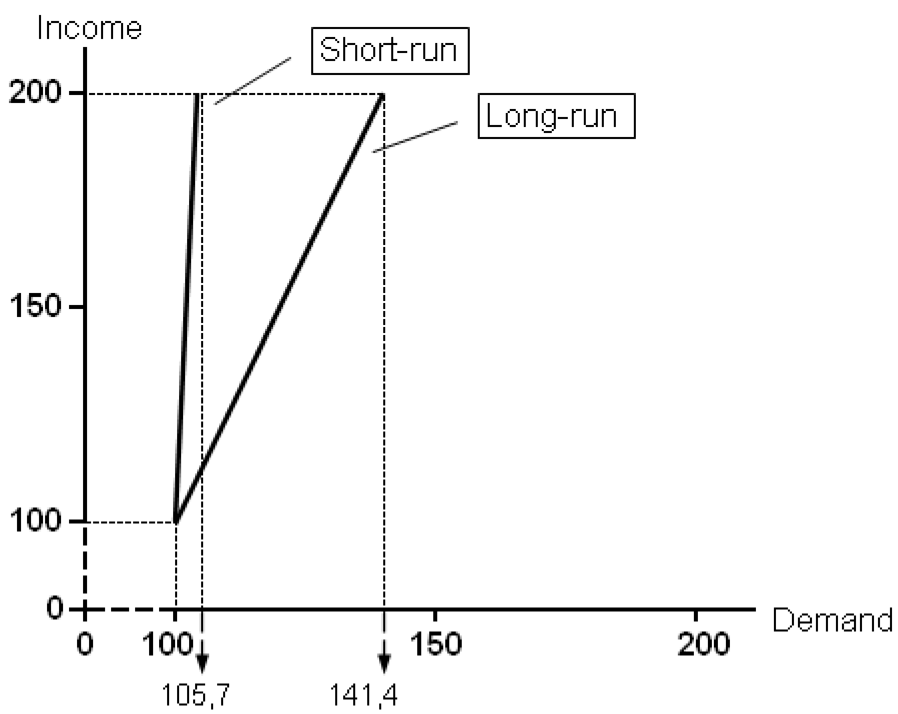


Figure 2. Income Elasticities of Electricity Demand in Turkey



As to forecasted net electricity consumption values, it is obvious that there exists a rapid electricity demand growth in Turkey; and in the following 11-year period (i.e., 2005-2015), based on ARIMA modelling, we may argue that the demand will continue to increase at an annual average rate of 5.4% and will turn out to be 205,108 GWh in 2015, corresponding to a 76% increase compared to 2004 demand level.

As for comparison of our results with official demand projections, the official projection is available from TEIAS (2005c) but the official forecasts are for gross demand; and, therefore, they need to be converted into net consumption for a meaningful comparison. The details of this conversion are provided in Appendix 6-H and the result is presented below.

Table 3. The Comparison of the Results with Official Projections

	Official Projection of Gross Demand *(GWh)*	**Average Total Int. Cons. and Net. Losses as a % of Gross Demand**	**Official Projection of Net Cons.** *(GWh)* (e)	**Forecasted Net Electricity Cons. based on ARIMA Modelling** *(GWh)* (f)	**Difference** *(GWh)* (g=e-f)	**Difference as a % of forecasts based on ARIMA Modelling**
2005	168,262	22.3	130,739.6	130,204.9	534.7	0.4
2006	185,600	22.3	144,211.2	134,876.5	9,334.7	6.9
2007	204,150	22.3	158,624.6	142,091.6	16,533.0	11.6
2008	224,300	22.3	174,281.1	152,696.9	21,584.2	14.1
2009	246,150	22.3	191,258.6	153,897.4	37,361.2	24.3
2010	269,842	22.3	209,667.2	167,413.7	42,253.5	25.2
2011	295,800	22.3	229,836.6	170,957.3	58,879.3	34.4
2012	323,200	22.3	251,126.4	176,576.5	74,549.9	**42.2**

The most outstanding outcome from the comparison is the fact that there is a substantial difference between official projections and forecasts based on ARIMA modelling. Ozturk (2005) had concluded that official total electricity demand projection for the period of 1996–2001 overestimated demand by 36%. In line with this conclusion; in this study, we have found that the official net electricity consumption projection for 2012 again overestimates demand by 42.2% compared to the forecasted value based on ARIMA modelling.

3.6 Conclusion

The main goals of this chapter have been to estimate short and long run price and income elasticities of electricity demand in Turkey; and to forecast future growth in this demand using ARIMA modelling.

In the course of study, elasticities are obtained and it is found out that they are quite low, implying that consumers' respond to price and income changes is quite limited; and, therefore, there is a need for regulation. Then, an ARIMA model is developed and used to forecast future net electricity consumption in Turkey. Based on forecasts obtained, it has been seen that the current official projections highly overestimate the electricity demand in Turkey. It is believed that the elasticities and forecasts presented here would be helpful to policy makers in Turkey for future energy policy planning.

Chapter 4: Critical Analysis and Policy Suggestions

4.1 Introduction

Given that we have confirmed both a rapid electricity demand growth (though it is overestimated) and a need for regulation in Turkey, now we may turn to our main objective of answering two crucial questions mentioned in the introduction chapter. The first section of this chapter deals with the first question and other question is left to the second one.

The economic analysis throughout this chapter will be based on the literature in market regulation, an overview of which is provided in Appendix 2[38].

4.2 Critical Economic Analysis of Recent Energy Market Reforms

4.2.1 Key Issues in Turkish Regulatory Policy

On paper, recent reforms clearly aim for liberalization of Turkish energy market and the ultimate target is deregulation in the long run. However, deregulation, which requires development of effective competition in a fully functioning market, is a very distant objective in Turkish case as Turkey does not have a fully functioning (or even just functioning) market, let alone effective competition in that market. Hence, Turkey needs to follow the necessary steps to create the conditions for deregulation starting from restructuring and privatization, followed by enhancement of competition where possible and (effective) regulation where unavoidable; and finally introducing deregulation in the long term when the market is ready to do so. Since Turkey is still at the very beginning of this process (despite the fact that she started the process 5 years ago), I will only concentrate on the first few steps; namely, restructuring and privatization; competition; and regulation.

[38] Appendix 2, first, presents the problem of natural monopoly; and then concentrates on key concepts in regulatory policy, the reasons and objectives of regulation; and finally focuses on some major topics in regulation literature and economic regulation methods.

4.2.1.1 Restructuring and Privatization

Underlying structure of the particular industry being regulated is one of the most important determinants in the success of regulation in any market. In Turkish case, there is no need for restructuring in petroleum and LPG markets as they already have appropriate structure. In electricity market, restructuring is either completed or planned to be completed in the near future. However, there exists a grave mistake in the restructuring process: the preservation of TEIAS as a single entity, which makes the effective regulation in transmission system impossible by rendering the only possible effective price regulation method, namely yardstick competition, in this segment of the market impossible to implement. As for natural gas industry, there is a vital need for restructuring in that industry in which the BOTAS currently dominates the entire market.

As to privatization, all powerful economic rationales for privatization, discussed in Appendix 2, are also certainly valid in Turkish case. However; despite that, there are formidable political and institutional barriers to privatization in Turkey. Unless carefully managed; they can delay, or totally block, the process of privatization.

The first obstacle to privatization in Turkish case is the bureaucratic opposition from government owned utilities or labour unions, for instance, to maintain their privileged position in current public utilities, excessive work forces or wages above market rates. Although such an opposition is generally the case almost in all similar countries, it is especially strong in Turkey where bureaucrats are a politically powerful force in their own right.

The second source of opposition to privatization in Turkey originates from the concerns based on economic nationalism and the desire to control the destiny of the energy industries so central to the economic infrastructure. However, there are some simple ways that combine privatization with maintaining government control of the key elements of the power system. However, in practice, these kind of arguments are employed by the bureaucrats at the top of public companies; and they are likely to resist privatization on the pretext of the probability that companies with so-called “strategic importance” will be taken over by a foreign or multi-national firm, an argument that can easily be falsified by, for example, keeping a “golden share”.

The last problem with privatization relates the fact that subsidization, especially of consumer prices, is common in Turkey. It poses a major barrier to efficient privatization; and the elimination of the subsidies may be very difficult politically.

Regarding the progress made so far in terms of privatization, in electricity industry, the government plan of privatizing distribution company (TEDAS) and generation company (EUAS) into several parts is a reasonable approach as it may bring immediate competition to the market and/or enable the regulator to compare the performance of newly created private companies. However, it seems that government intends to keep both transmission company[39] (TEIAS) and large parts of the hydro generation facilities. It is again a serious mistake with a huge potential to undermine the positive expectations about the future structure of the energy market, and thereby may undermine the whole reform process. In natural gas market, the BOTAS is still there but should be privatized as soon as possible in a way that does not let new players have a market power.

4.2.1.2 Competition

A kind of competition is possible in every segment of Turkish energy industry, including transmission and distribution of electricity and gas markets. Also, when we take into account the fact that even limited competition provides a regulator with some benchmarks against which to measure the performance of a dominant firm, gives consumers some alternatives, and forces the dominant firm to reduce costs, improve services, innovate and so on; the EMRA should take all necessary steps to enable effective competition in the markets it regulates. The markets currently regulated by the EMRA may be divided into four groups based on the possible type of competition:

[39] The EML does not presume a monopoly owned transmission system and it definitely allows for multiple transmission owners.

1. The markets in which actual competition exists

   Almost all market activities in Turkish petroleum and LPG markets fall into this group. Since competition already exists in these markets and the rule is "competition where possible, regulation only where unavoidable", the EMRA's role in these markets should be limited to further enhancement of competition and taking measures against possible threats to present competitive structure. Apart from these, regulation should be kept at minimum.

2. The markets which are currently not competitive but in which there is a potential for actual competition in the near future[40]

   All activities in electricity and natural gas markets with the exceptions of transmission and distribution may be placed into this group. Provided that EUAS and the BOTAS are privatized appropriately, there exists a huge potential for competition in these markets. Especially, electricity generation/supply and natural gas importation/supply seem to be highly competitive in the near future if necessary steps are taken. Nevertheless; until competition develops up to appropriate levels, the EMRA should employ proper economic regulation methods in these markets.

3. The markets in which one-to-one competition is not possible but there is a potential for *competition for the market* (franchising) and *competition via regulation* (yardstick competition)

   Electricity and natural gas transmission and distribution activities belong to this group. However; to activate "competition" in these sectors, the BOTAS's transmission arm should be separated from its other activities. Then, this new natural gas transmission company together with its counterpart in electricity industry (TEIAS) should be divided into enough number of parts in a way that makes effective comparison of performance among these newly

[40] When actual effective competition becomes operational in the future for the markets within this group; EMRA should again limit its role to further enhancement of competition and taking measures against possible threats to then existing competitive structure.

created companies possible. Finally, all distribution and transmission assets should be privatized as soon as possible.

4.2.1.3 Turkish Energy Market Regulation

The current Turkish regulatory framework may be evaluated as follows. First of all, the EMRA should keep it mind that regulation is unavoidably inefficient and therefore it should be confined to the core natural monopoly of the network minimizing the extent of regulatory inefficiency. That is, the most important feature of regulation must be that there should be as little of it as possible, which involves the identifying the precise sources of market failure in industries and targeting regulation specifically on these areas. The EMRA also needs to realize that regulation in essence is a kind of incentive mechanism design, which needs to reflect the consensus among all related parties such as consumers, firms, politicians, academicians and so on. Therefore, the EMRA should take all necessary steps to create a platform in which everyone related with energy industry may express their ideas with a view to reaching such a consensus.

Second, the EMRA needs to put into practice an information program to alleviate the problem of asymmetric information in a manner mentioned in Appendix 2.

Third issue relates what is called regulatory commitment. The EMRA must ensure that it is committed to the ultimate aim of economic efficiency by taking all necessary measures. To do so, first of all, all decisions and procedures applied by the EMRA should be transparent, which entails that the EMRA is required to explain and justify its decisions. The EMRA should also realize that without transparency in the regulatory process it is impossible to ensure regulatory commitment and, therefore, to realize economic efficiency. Moreover a body of precedent should be created to ensure consistence in regulatory practice. If the EMRA rejects transparent procedures, it may lose the public credibility, on which its success and acceptance so crucially depend. The second measure to guarantee regulatory commitment should be in the form of creation of effective appeal procedures for the firms, consumers or any other related parties against the decisions of the EMRA. Under current framework, lawsuits against the EMRA's decisions may be filed in the Council of State (in Turkish, "Danistay"), a high court in Turkish legal system. However, the Council of State is not well suited to review the decisions of the EMRA due to technical nature of the matters and the need for speedy resolution of outstanding issues. Therefore, as also underlined by OECD (OECD, 2002, p 37), in Turkey, there is a need for establishment of a specialist regulatory appeal body with suitable expertise in regulatory issues. The appeals against the decisions of the EMRA should be in the first instance to this appeal body that acts with similar discretion and flexibility to that of the EMRA, not to the Council of State. Furthermore, the relation between the EMRA and the firms should be based on what is called "regulatory contract" to further guarantee regulatory commitment. Current practice of provision of licences whose terms are unilaterally determined (and also may be altered) by the EMRA undermines the regulatory commitment, let alone reinforcing it. If a firm considers that licence terms so crucial to its future profit level may easily be changed by the EMRA at any time, it is almost impossible to provide it with incentives to act properly. Finally, to prevent any confusion and opportunistic behaviour by firms, the appropriate division of labour between, on the one hand, general competition authority in Turkey (that is, Turkish Competition Authority) and, on the other hand, the specialist regulator in Turkish energy market (that is, the EMRA) should be clearly determined by a protocol to be signed between these two institutions.

The fourth major issue in Turkish regulatory framework is the question of how to prevent regulatory capture and regulatory failure. To prevent regulatory capture by the industry it regulates, the EMRA should not only encourage but also take concrete measures (if necessary) to set up and institutionalize consumer concern to enable active consumer participation in the regulatory process. But while doing so, it should pay due attention not to push regulation into social, and away from economic, matters; and ensure that consumer representatives' attention is confined to economic matters and does not spread over political or non-economic ones. As discussed before, regulatory capture by government is also a threat to regulatory process especially in Turkey where government traditionally has strong powers. To prevent this, ministerial and other political influences must be constrained as far as possible to roles that do not allow them to influence regulatory decisions. That is, the EMRA should be independent while making decisions concerning the markets it regulates. However, this does not mean unaccountability. The EMRA, like any other public body in Turkey, must be held accountable for its actions and be subject to adequate controls. In short, the EMRA should take appropriate steps not to be captured either by energy industry or its employees or by politicians or by other particular interests, or by self-interest at all costs.

As for regulatory failure, the EMRA should make a clear distinction between its responsibilities concerning economic and non-economic regulation; and should delegate the latter to appropriate bodies as soon as possible. Otherwise, its discretion is sooner or later jeopardized by unwise extensions of non-economic regulation. Also, the EMRA should always keep in mind that a regulatory system which has objectives that either in principle or in practice differ from that of economic efficiency spells regulatory failure from an economic perspective.

The final critical issue in Turkish regulatory framework is about the quality of the persons in the position of regulators (that is, the members of the Energy Market Regulatory Board) and the staff of the EMRA. As also indicated in OECD report (OECD, 2002, p 24), it is important for the credibility of the EMRA that not only the members of its Board but also its staff are highly qualified, which requires strict merit selection and performance management. The EMRA should seek to recruit a high level of expertise and pay very close attention to establish a merit based personnel system.

4.2.2 Economic Regulation Methods

In line with our classification made in “competition” section of this chapter, the appropriate action for the EMRA in terms of economic regulation may be summarized as follows.

For the first group of markets; the EMRA should do nothing but just taking measures for the preservation and further enhancement of competition. That is, in these markets, the rule should be *laissez-faire*. For the second group, the EMRA should always remember that a system of price regulation should be evaluated in terms of incentives it provides the regulated firm to achieve economic efficiency. Therefore, the EMRA should apply incentive based regulation (for instance, RPI-X or price cap regulation) wherever possible and try to avoid cost-plus regulation and its various different forms[41]. Finally, for the markets in which one-to-one competition is not possible, the EMRA should apply franchising and yardstick competition methods to simulate effective competition in these markets. But as mentioned above, this option is only operable if all distribution and transmission assets in both electricity and natural gas industries are privatized in an appropriate way.

4.3 Policy Suggestions

Based on our analysis up to here, the answers to the question that what still needs to be done to improve recent energy market reforms in Turkey may be divided into three parts according to their urgency, degree of importance, and the responsible body to implement them.

4.3.1 Policy Suggestions for the EMRA

Policy suggestions under this heading require immediate and effective action by the EMRA, and therefore need to be implemented as soon possible. Otherwise, all reform process may face failure at the very beginning due to the EMRA's actions or lack of action. To prevent this outcome, first of all, the EMRA must take all necessary steps to create a platform in which everyone related with Turkish energy industry may express their ideas with a view to reaching a consensus[42]. Second, the EMRA also needs to ensure regulatory commitment,

[41] In Turkish case, the laws are not specific as to whether 'incentive based' or 'cost-plus' regulation is to be applied in tariff determination process, so this issue is a matter for EMRA to determine in deciding general tariff principles.
[42] Within such a platform; EMRA needs to persuade government, employees, managers, taxpayers, potential investors, customers, the financial markets, annalists, media commentators and all other related parties of the advantages of the reform process.

which requires particularly transparency, creation of a body of precedent and effective appeal procedures for the firms in the market. Moreover, the EMRA must change, in the medium term, its licencing procedure into one based on the logic of private contracts, which is called "regulation by contract"[43]. Fourth, the EMRA has to introduce all necessary measures to prevent regulatory capture and regulatory failure discussed before. Furthermore, it needs to prepare and publish a plan which specifies its short, medium and long term objectives in detail so as to strengthen regulatory commitment. Sixth, the EMRA must put into practice the information program mentioned before to alleviate the problem of asymmetric information. Additionally, the EMRA has to implement strict merit selection and performance management in its human resources policies. Eight, the EMRA needs to clearly separate economic and non-economic issues and take appropriate steps to delegate the latter to suitable bodies. In addition, the EMRA must carry out economic regulation in line with suggestions made before. Tenth, the EMRA must continue natural gas distribution tenders in the form of "franchising" but also develop the mechanisms to introduce "yardstick competition" as soon as the construction of distribution networks are completed. Finally, it has to restrict the scope of regulation in petroleum and LPG markets due to reasons discussed before.

4.3.2 Policy Suggestions for Turkish Government

Although the discretion of the EMRA is limited in terms of the policy suggestions under this heading; the EMRA still must take appropriate steps to supervise, encourage and facilitate the realization of these suggestions that are crucial for the outcome of the reforms.

The privatization of energy industry, including TEIAS, BOTAS and all hydro generation facilities, must be completed as soon as possible in an appropriate way after restructuring where necessary. As discussed before, the opposition to privatization of some bureaucrats will definitely be formidable. To counter this, a chairman who is more favorable to privatization may be appointed to the enterprises to be privatized. Second, the government must not intervene in the

[43] For a detailed discussion of "regulation by contract", see Bakovic et al. (2003).

EMRA's decisions concerning economic regulation of energy markets. If it disagrees with the EMRA in any issue, the government should have recourse to appropriate appeal procedures. The government also needs to delegate all non-economic responsibilities of the EMRA to related bodies. In particular, it must prepare and put into force the necessary legislation that removes the EMRA's non-economic responsibilities in petroleum market, especially, the implementation of national chemical marker system and prevention of fuel smuggling in Turkey[44].

The government must appoint the members of the EMRA's board based on strict merit norms. The consequences of political appointments to the EMRA may turn out to be destructive for the future of the country as a whole. Also, when all privatizations are completed, the energy sector and other related interests should be represented in the Board as well, which requires that some members of the Board should be selected by these interest groups. The government also needs to establish a specialist regulatory appeal body with suitable expertise in regulatory issues.

BOTAS's share in imports must also be reduced, which is absolutely necessary for the market liberalization to be successful and competition to develop. Finally, the government must stop all forms of subsidy that affect price structure and provide subsidies only in the form of direct cash refunds if necessary.

4.3.3 Other Policy Suggestions

The policy suggestions under this heading are deemed beneficial for the future progress of Turkish reforms from an economic perspective but they also need to be further discussed among related parties before actual implementation.

[44] Up to now, EMRA has distributed almost 10.000 licences just to prevent fuel smuggling in Turkey. However, since this was an irrational step from the very beginning especially when we take into account the fact that an institution with only 300 people cannot effectively monitor the implementation of licence terms of so many licences (let alone their enforcement); the EMRA has already had to delegate most of its responsibilities in this area to the Ministry of Internal Affairs via a protocol signed between EMRA and the Ministry. So, what is suggested here is just the reflection of actual practice into legal system (EMRA; 2005b,c).

All persons or bodies that do not have sufficient expertise in issues related with energy markets but whose ideas or decisions have still a vital effect on the energy market should consult those with expertise before revealing their ideas or making some decisions with an (sometimes, profound) effect on the energy market. The decisions of courts are especially critical in this respect.

All related bodies in Turkey should take necessary steps to find out the reasons for apparently misleading demand forecasts both in electricity and natural gas markets; and develop accurate demand projections. While doing so, the emphasis should be on the development and use of appropriate data and econometric techniques which is open to debate, rather than some computer packages for demand estimation provided by various international organizations or, even worse, the methods in which the demand is determined as a result of a bargaining process among various public bodies.

The EMRA should also prepare and publish a timetable indicating the process of reducing eligibility threshold to zero both in electricity and natural gas markets. Current “Strategy Paper” is not enough in this perspective.

The EMRA and Turkish government should deal with the problem of “stranded costs” in a way that does not undermine the trust in the system and within the boundaries of the principle of “rule of law”.

The EMRA should manage to ensure consistency in the decisions of its multi-member board. If this cannot be done, the practice of “regulation by an individual”, rather than “regulation by a board”, should be considered as an alternative.

The EMRA should initiate the process of signing a protocol with Turkish Competition Authority to determine appropriate division of labour between them.

4.4 Study Limitations

Although the main objectives have been clearly achieved in the dissertation, limitations of the study should be kept in mind while evaluating (and perhaps, utilizing) the results.

First of all; due to space limitations, it was not possible to present a detailed literature review in regulation, lack of which may render the understanding of analysis difficult for those without a background in regulatory economics. Limited time available for the preparation of the dissertation also constituted another limitation; which prevented detailed analysis of some issues in full sense.

The final limitation relates the estimation and forecasting section. In the study, an aggregate demand estimation approach is adopted; but, as suggested by Pindyck (1979), there are some problems related to such an approach. Perhaps, separate estimations for each group of consumers (e.g., industry, households etc.) may yield better results. Moreover, forecasting, especially in energy demand, is considered more an art than a science; therefore, some variations between forecasted and actual demand levels are to be expected. Like all other models, ARIMA modelling is based on some assumptions and, of course, there is a direct link between the accuracy of the forecast and the validity of the underlying assumptions. The main assumption behind ARIMA modelling is that the already existing trends in electricity consumption will more or less repeat themselves in the future. Although this is a widely used, essential and reasonable assumption; some unanticipated events may occur and it is always very difficult, if not impossible, to foresee such "unexpected" events that have a potential to completely change the electricity demand trend in Turkey reducing the precision of the forecasts presented here[45]. Furthermore, due to nature of ARIMA modelling and the low elasticities obtained, present study only used net total consumption data for forecasting. When we take into account the

[45] For instance, the success (or, lack of success) of recent energy market reforms will have definitely an impact on future electricity demand in Turkey, which is a variable ignored by ARIMA model developed here.

fact that there exist various important determinants of energy demand, there is an apparent need for further work with more variables.

Chapter 5: Conclusion

Despite relatively good legislative framework, the current regulatory policy in Turkey towards the energy industry in practice seems to be far from ideal. The reforms are mainly in the form of “textbook reforms”, meaning that they are simply copied from regulation literature with some modifications but in practice the crucial underlying economic logic behind them is not taken into account either by the EMRA or by the Turkish government. It should not be forgotten that every new structure entails new understanding of the issues. However; in Turkish case, new reform has been tried to be implemented within previous degenerated bureaucratic understanding, which is simply impossible. As long as the vital decisions regarding the future of energy industry have been taken in the depths of some government departments, including those of the EMRA; it is definitely impossible to create a fully functioning market and the result may turn out to be a disaster for the country as a whole. On the other hand, the energy industry is a complex one; and the creation of a market for energy, where none previously existed, is no easy task. Not surprisingly, there will be problems but most of them will disappear with the growth of more effective competition provided that necessary change in understanding mentioned above is materialized.

If reforms are practiced by taking into account their underlying economic logic, there is no reason not to believe that the domestic and foreign investors will be greatly interested in entering a market with excellent growth potential, like Turkish energy market. If implemented properly, the reforms my transform Turkey from a simple so-called “Eurasia energy corridor” into an “energy base” where electricity is produced and exported to various regions surrounding the country, especially Europe.

Also, one should not blame the bureaucrats in the Turkish energy industry, its unions, and others for trying to protect what they see as their interests by persuading the government to retain previous structure as much as possible. But it will be a catastrophe for the country as a whole if they are successful in doing so as the way would be open for continued government manipulation of these public corporations.

As no meaningful competition has developed so far, a significant amount of work still lies ahead. It should not be forgotten that the true test of regulatory success comes in the form of whether a structure in which generators, suppliers, customers and other actors in the market can all freely negotiate, each taking their own view of the prices, risks, opportunities and threats that a competitive market offers is created or not.

References

Agrell, P.; Bogetoft, P. (2004), Evolutionary Regulation: From CPI-X towards contestability, A Position Paper for ENCORE (The Economics Network for Competition and Regulation), Netherlands, 2004.

Armstrong, M.; Cowan, S.; Vickers, J. (1994), Regulatory Reform: Economic Analysis and British Experience, London: Cambridge, Mass: MIT Press, 1994.

Atiyas, I.; Dutz, M. (2003), Competition and Regulatory Reform in the Turkish Electricity Industry, A Paper Prepared for presentation at the Conference on EU Accession: Turkey, 2003.

Averch, H.; Johnson, L. L. (1962) 'Behavior of the Firm under Regulatory Constraint', American Economic Review, Volume 52, Issue 5, 1962.

Bakovic, T.; Tenenbaum, B.; Woolf, F. (2003), Regulation by Contract: A New Way to Privatize Electricity Distribution?, The World Bank Group, The Energy and Mining Sector Board Discussion Paper, Paper No. 7, May 2003.

Baumol, W. J. (1982), 'Contestable Markets: An Uprising in the Theory of Industry Structure', The American Economic Review, March 1982.

Baumol, W. J.; Panzar J. C.; Willig R. D. (1982), Contestable Markets and the Theory of Industry Structure, New York: Harcourt Brace Jovanovich, 1982.

Beenstock, M.; Goldin, E. (1999), 'The demand for electricity in Israel', Energy Economics, Volume 21, Issue 2, April 1999, pp 168-183.

Bentzen, J.; Engsted, T. (1993), 'Short- and long-run elasticities in energy demand: A cointegration approach', Energy Economics, Volume 15, Issue 1, January 1993, pp 9-16.

Bentzen, J.; Engsted, T. (2001), 'A revival of the autoregressive distributed lag model in estimating energy demand relationships', Energy, Volume 26, Issue 1, January 2001, pp 45-55.

BOTAS (2005a), Toplam Dogal Gaz Talep Tahmin Miktarlari (Total Natural Gas Demand Forecasts), accessed from http://www.botas.gov.tr/dogalgaz/dg_arztaleb_sen.asp on 16.08.2005 at 13:45.

BOTAS (2005b), Yillar Itibariyla Dogal Gaz Satis Miktarlari (Annual Natural Gas Sales), accessed from http://www.botas.gov.tr/faliyetler/dg_ttt.asp on 16.08.2005 at 13:46.

Box, G. P. E.; Jenkins, G. M. (1978), Time Series Analysis: Forecasting and Control, revised ed., Holden Day, San Francisco, 1978.

Chadwick, E. (1859), 'Results of Different Principles of Legislation and Administration in Europe; of Competition for the Field, as Compared with Competition within the Field, of Service', Journal of the Statistical Society of London, Volume 22, Number 3, September 1859, pp 381-420.

CIA (2005), The World Factbook 2005, accessed from http://www.cia.gov/cia/publications/factbook on 17.08.2005 at 14:19.

Dahl, C.; Sterner, T. (1991), 'Analysing gasoline demand elasticities: a survey', Energy Economics, Volume 13, Issue 3, July 1991, pp 203-210.

Dargay, J. M. (1992), 'The Irreversible Effects of High Oil Prices: Emprical Evidence for the Demand for Motor Fuels in France, Germany, and the UK', in David Hawdon (ed.), Energy Demand: Evidence and Expectations, London: Surrey University Press, 1992.

Dargay, J. M.; Gately, D. (1995a), 'The Response of World Energy and Oil Demand to Income Growth and Changes in Oil Prices', Annual Review of Energy and the Environment, Volume 20, November 1995, pp 145-178.

Dargay, J. M.; Gately, D. (1995b), 'The imperfect price reversibility of non-transport oil demand in the OECD', Energy Economics, Volume 17, Issue 1, January 1995, pp 59-71.

Demsetz, H. (1968), 'Why Regulate Utilities?', Journal of Law and Economics, Volume 11, Number 1, April 1968, pp 55-65.

Dickey, D. A.; Fuller, W. A. (1979), 'Distribution of the Estimators for Autoregressive Time Series With a Unit Root', Journal of the American Statistical Association, Volume 74, Number 366, January 1979, pp 427-431.

DIE (2005a), Enerji Istatistikleri Haber Bultenleri (Energy Statistics News Bulletins), accessed from http://www.die.gov.tr/TURKISH/SONIST/ENERJI/enerji.html on 24.06.2005 at 19:42.

DIE (2005b), Population by Census Year, accessed from http://www.die.gov.tr/IstTablolar/04nf023t.xls on 20.06.2005 at 23:09.

DIE (2005c), Kullanim Yerlerine Gore IV. Donem Elektrik Tuketimi, 2003-2004 (Electricity Consumption by Sectors, the 4th Quarter of 2004), accessed from http://www.die.gov.tr/TURKISH/SONIST/ENERJI/t4-23032005.xls on 21.06.2005 at 00:14.

DPT (2005), Gross Domestic Product (By Expenditures), accessed from http://ekutup.dpt.gov.tr/teg/2005/04/tii.7.xls on 29.06.2005 at 12:27.

Drollas, L. P. (1984), 'The demand for gasoline: Further evidence', Energy Economics, Volume 6, Issue 1, January 1984, pp 71-82.

EMRA (Energy Market Regulatory Authority) (2003), Electricity Market Implementation Manual, Ankara, 2003, accessed from http://www.epdk.org.tr/english/reports/electric/manualapril2003.pdf on 19.08.2005 at 15:24.

EMRA (Energy Market Regulatory Authority) (2005a), Kurum Bilgileri (Institutional Facts), accessed from http://www.epdk.org.tr/kurul/mali.html on 19.08.2005 at 15:45.

EMRA (Energy Market Regulatory Authority) (2005b), Petrol Piyasasi Lisanslari Hakkinda Aciklama (Announcement Concerning Petroleum Market Licences), accessed from http://www.epdk.org.tr/basin/2005basin/2005-03-26-lisans.html on 24.08.2005 at 11:27.

EMRA (Energy Market Regulatory Authority) (2005c), Basin Aciklamasi (Press Release), accessed from http://www.epdk.org.tr/basin/2005basin/2005-07-02-marker.html on 24.08.2005 at 11:3

Engle, R. F.; Granger, C. W. J.; Hallman, J. J. (1989); 'Merging short-and long-run forecasts: An application of seasonal cointegration to monthly electricity sales forecasting', Journal of Econometrics, Volume 40, Issue 1, January 1989, pp 45-62.

Engle, R. F.; Granger C. W. J. (1987); 'Co-Integration and Error Correction: Representation, Estimation, and Testing', Econometrica, Volume 55, Number 2, March 1987, pp 251-276.

Erdogdu, Erkan (2002), 'Turkey and Europe: Undivided but Not United', Middle East Review of International Affairs (MERIA), Volume 6, Number 2, June 2002, pp 40-51, (available online: http://meria.idc.ac.il/journal/2002/issue2/jvol6no2in.html).

European Commission (2001a), Electricity Liberalisation Indicators in Europe, produced by OXERA for DG Energy and Transport, October 2001, accessed from http://europa.eu.int/comm/energy/electricity/publications/doc/oxera.pdf on 17.08.2005 at 14:25.

European Commission (2001b), Report for the European Commission DG for Transport and Energy to Determine Changes after Opening of the Gas Market in August 2000, Volume I: European Overview, produced by DRI-WEFA for DG Energy and Transport, July 2001, accessed from http://europa.eu.int/comm/energy/gas/publications/doc/finalcor-vol1.pdf on 17.08.2005 at 14:29.

European Commission (2004), 2004 Regular Report on Turkey's Progress Towards Accession, SEC(2004) 1201, Brussels, 6.10.2004, accessed from http://europa.eu.int/comm/enlargement/report_2004/pdf/rr_tr_2004_en.pdf on 17.08.2005 at 14:38.

Evans, R. (1989), 'Property Rights, Markets and Competition in Electricity Supply', in Cento Veljanovski (ed.), Privatisation & Competition: A Market Prospectus, London: Institute of Economic Affairs, 1989.

Fouquet, R.; Hawdon, D.; Pearson, P.; Robinson, C.; Stevens, P. (1993), The SEEC United Kingdom Energy Demand Forecast (1993-2000), Surrey Energy Economics Centre (SEEC) Occasional Paper 1, Department of Economics, University of Surrey, Guildford, UK, December 1993.

Gately, D. (1992), 'Imperfect price-reversibility of U.S. gasoline demand: asymmetric responses to price increases and declines', Energy Journal, Volume 13, Issue 4, 1992, pp 179-207.

Granger, C. W. J. (1986), 'Developments in the Study of Cointegrated Economic Variables', Oxford Bulletin of Economics & Statistics, Volume 48, Issue 3, August 1986, pp 213-228.

Granger, C. W. J.; Newbold, P. (1974), 'Spurious regressions in econometrics', Journal of Econometrics, Volume 2, Issue 2, July 1974, pp 111-120.

Gujarati, D. N. (2003), Basic Econometrics, New York: McGraw-Hill/Irwin, 2003.

Haas, R.; Schipper, L. (1998), Residential energy demand in OECD-countries and the role of irreversible efficiency improvements, Energy Economics, Volume 20, Issue 4, September 1998, pp 421-442.

Harvey, A. (1997), 'Trends, Cycles and Autoregressions', The Economic Journal, Volume 107, Issue 440, January 1997, pp 192-201.

Helm, D. (2003), Energy, the State, and the Market: British energy policy since 1979, Oxford: Oxford University Press, 2003.

Hepbasli, A. (2005), 'Development and Restructuring of Turkey's Electricity Sector: A review', Renewable and Sustainable Energy Reviews, Volume 9, Issue 4, August 2005, pp 311-343.

Hunt, L. C.; Judge, G.; Ninomiya, Y. (2000); Modelling Technical Progress: An Application of the Stochastic Trend Model to UK Energy Demand, Surrey Energy Economics Discussion Paper, SEED No: 99, Department of Economics, University of Surrey, Guildford, UK, January 2000.

Hunt, L. C.; Judge, G.; Ninomiya, Y. (2003); 'Underlying trends and seasonality in UK energy demand: a sectoral analysis', Energy Economics, Volume 25, Issue 1, January 2003, pp 93-118.

Hunt, L. C.; Lynk, E. L. (1992), 'Industrial Energy Demand in the UK: A Cointegration Approach', in David Hawdon (ed.), Energy Demand: Evidence and Expectations, London: Surrey University Press, 1992.

Hunt, L. C.; Manning, D. N. (1989); 'Energy Price- and Income-Elasticities of Demand: Some Estimates for the UK using the Cointegration Procedure', Scottish Journal of Political Economy, Volume 36, Number 2, May 1989, pp 183-193.

Hunt, L. C.; Ninomiya, Y. (2003); 'Unraveling Trends and Seasonality: A Structural Time Series Analysis of Transport Oil Demand in the UK and Japan', Energy Journal, Volume 24, Issue 3, July 2003, pp 63-96.

Hunt, L. C.; Witt, R. (1995), An Analysis of UK Energy Demand Using Multivariate Cointegration, Surrey Energy Economics Centre (SEEC) Discussion Paper No: 86, Department of Economics, University of Surrey, Guildford, UK, December 1995.

IEA (2002), Energy Balances of OECD Countries, International Energy Agency, Paris, France, 2002.

IEA (2004a), Energy Balances of OECD Countries 2001-2002, International Energy Agency, Paris, France, 2004.

IEA (2004b), Electricity Information 2004, International Energy Agency, Paris, France, 2004.

IEA (2004c), Natural Gas Information 2004, International Energy Agency, Paris, France, 2004.

IEA (2004d), Oil Information 2004, International Energy Agency, Paris, France, 2004.

IEA (2004e), Energy Balances of OECD Countries 2001-2002, 2004 Edition, International Energy Agency, Paris, France, 2004.

IEA (2004f), Energy Statistics of OECD Countries 2001-2002, 2004 Edition, International Energy Agency, Paris, France, 2004.

IEA (2005a), Energy Prices and Taxes, accessed from http://www.sourceoecd.org on 20.06.2005 at 20:43.

IEA (2005b), Energy Policies of IEA Countries: TURKEY, 2005 Review, International Energy Agency, Paris, France, 2005.

IMF (2005), World Economic Outlook Database, April 2004, accessed from http://www.imf.org/external/pubs/ft/weo/2004/01/data/index.htm on 27.06.2005 at 17:28.

Jackson, P. M.; Catherine, M. P. (1994); Privatisation and Regulation: a review of the issues, Harlow: Longman, 1994.

Johansen, S. (1988), 'Statistical analysis of cointegration vectors', Journal of Economic Dynamics and Control, Volume 12, Issues 2-3, June-September 1988, pp 231-254.

Jones, T. M. (2003), 'Yardstick Competition and Efficiency Benchmarking in Electricity Distribution', in L. C. Hunt (ed.), Energy in a Competitive Market: Essays in Honour of Colin Robinson, Cheltenham: Edward Elgar, 2003.

Kouris, G. (1981), 'Elasticities - science or fiction?', Energy Economics, Volume 3, Issue 2, April 1981, pp 66-126.

Krishnaswamy, V.; Stuggins, G. (2003), Private Sector Participation in the Power Sector in Europe and Central Asia: Lessons from the Last Decade, World Bank Working Paper No: 8, The World Bank, Washington DC, USA, 2003.

Laffont, J. J.; Tirole, J. (1993), A Theory of Incentives in Procurement and Regulation, The MIT Press, Cambridge, Massachusetts, London, England, 1993.

Littlechild, S. C. (1983), Regulation of British Telecommunications Profitability, Department of Industry, 1983.

Littlechild, S. C. (1993), 'New Developments in Electricity Regulation', in M. E. Beesley (ed.), Major Issues in Regulation, London: Institute of Economic Affairs, 1993.

Newbery, D. M. G. (2000), Privatization, Restructuring and Regulation of Network Utilities, London, Cambridge, Mass.: MIT Press, 2000.

Newey, W. K.; West, K. D. (1987), 'A Simple, Positive Semi-Definite, Heteroskedasticity and Autocorrelation Consistent Covariance Matrix', Econometrica, Volume 55, Number 3, May 1987, pp 703-708.

OECD (The Organisation for Economic Co-operation and Development) (2002), Regulatory Reform in Turkey: Regulatory Reform in Electricity, Gas and Road Freight Transport, OECD Reviews of Regulatory Reform, 2002.

Ozkivrak, O. (2005), 'Electricity restructuring in Turkey', Energy Policy, Volume 33, Issue 10, July 2005.

Ozturk, H. K.; Ceylan, H.; Canyurt, O. E.; Hepbasli, A. (2005), 'Electricity estimation using genetic algorithm approach: a case study of Turkey', Energy, Volume 30, Issue 7, June 2005, pp 1003-1012.

Pindyck, R. S. (1979), The Structure of World Energy Demand, London, Cambridge, Mass.: M.I.T. Press, 1979.

Poyer, D. A.; Williams, M. (1993); 'Residential energy demand: additional empirical evidence by minority household type', Energy Economics, Volume 15, Issue 2, April 1993, pp 93-100.

Ramsey, J. B. (1969), 'Tests for Specification Errors in Classical Linear Least-Squares Regression Analysis', Journal of the Royal Statistical Society, Volume 31, Number 2, 1969, pp 350-371.

Ryan, D. L.; Plourde, A. (2002), 'Smaller and smaller? The price responsiveness of nontransport oil demand', The Quarterly Review of Economics and Finance, Volume 42, Issue 2, Summer 2002, pp 285-317.

Sargan, J. D.; Bhargava, A. (1983), 'Testing Residuals from Least Squares Regression for Being Generated by the Gaussian Random Walk', Econometrica, Volume 51, Number 1, January 1983, pp 153-174.

Shleifer, A. (1985), 'A Theory of Yardstick Competition', Rand Journal of Economics, Volume 16, Number 3, Autumn 1985.

Shleifer, A. (1998), 'State versus Private Ownership', Journal of Economic Perspectives, Volume 12, Number 4, Fall 1998, pp 133-150.

Smith, Adam (1776), The Wealth of Nations, New York: Bantam Dell, 2003.

Stelzer, I. M. (2002), 'A review of privatization and regulation experience in the UK', in C. Robinson (ed.), Utility Regulation and Competition Policy, Cheltenham: Edward Elgar, 2002.

Stewart, J. (1991), Econometrics, Hemel Hempstead: Philip Allan, 1991.

TEIAS (2005a), Annual Development of Installed Capacity, Gross Generation, Supply and Net Consumption In Turkey (1975 - 2003), accessed from http://www.teias.gov.tr/istatistik/30.xls on 20.06.2005 at 20:19.

TEIAS (2005b), Annual Development of Installed Capacity Gross Generation and Net Consumption in Turkey and Per Capita (1923-1974), accessed from http://www.teias.gov.tr/istatistik/29.xls on 13.07.2005 at 12:03.

TEIAS (2005c), Talep Gelisimi (Demand Development), accessed from http://www.teias.gov.tr/apkuretim/talepgelisimi.htm on 17.07.2005 at 09:08.

TEIAS (2005d), Annual Development of Electricity Generation, Consumption and Losses in Turkey (1970-2003), accessed from http://www.teias.gov.tr/istatistik/31-32(kayıplar).xls on 17.07.2005 at 14:00.

Thury, G.; Witt, S. F. (1998), 'Forecasting industrial production using structural time series models', Omega, Volume 26, Issue 6, December 1998, pp 751-767.

Traill, B.; Colman, D.; Young, T. (1978), 'Estimating Irreversible Supply Functions', The American Journal of Agricultural Economics, Volume 60, Number 3, August 1978, pp 528-531.

Undersecretariat of Treasury (2005), Gross Domestic Product by Expenditures (At Current Prices), accessed from http://www.hazine.gov.tr/yayin/hazineistatistikleri/1-4A.xls on 29.06.2005 at 12:16.

Wolffram, R. (1971), 'Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches-Some Critical Notes', The American Journal of Agricultural Economics, Volume 53, Number 2, May 1971, pp 356-359.

World Bank (2004), Turkey: Gas Sector Strategy Note, Report No: 30030-TR, Infrastructure and Energy Department, Europe & Central Asia Region, The World Bank, September 2004.

Yule, G. U. (1926), 'Why do we Sometimes get Nonsense-Correlations between Time-Series?--A Study in Sampling and the Nature of Time-Series', Journal of the Royal Statistical Society, Volume 89, Number 1, January 1926, pp 1-63.

Bibliography

Askin, B. A.; Kraft, J. (eds.) (1976), Econometric Dimensions of Energy Demand and Supply, Lexington, Mass., 1976.

Beenstock, M.; Willcocks, P (1981), 'Energy consumption and economic activity in industrialized countries: The dynamic aggregate time series relationship', Energy Economics, Volume 3, Issue 4, October 1981, pp 225-232.

Beesley, M. E.; Littlechild, S. C. (1989), 'The Regulation of Privatized Monopolies in the United Kingdom', RAND Journal of Economics, Volume 20, Number 3, Autumn 1989.

Beesley, M. E. (ed.) (1992), Privatization, Regulation and Deregulation, London: Routledge in association with the Institute of Economic Affairs, 1992.

Beesley, M. E. (ed.) (1994), Regulating Utilities: The Way Forward, London: Institute of Economic Affairs, 1994.

Beesley, M. E. (ed.) (1995), Utility Regulation: Challenge and Response, London: Institute of Economic Affairs in association with the London Business School, 1995.

Beesley, M. E. (ed.) (1996), Regulating Utilities: A Time for Change?, London: Institute of Economic Affairs, 1996.

Beesley, M. E. (ed.) (1997), Regulating Utilities: Broadening the Debate, London: Institute of Economic Affairs, 1997.

Beesley, M. E. (ed.) (1998), Regulating Utilities: Understanding the Issues, London: Institute of Economic Affairs in association with the London Business School, 1998.

Beesley, M. E. (ed.) (1999), Regulating Utilities: A New Era?, London: Institute of Economic Affairs, 1999.

Bell, M. (2003), 'Regulation in Developing Countries is Different: Avoiding negotiation, renegotiation and frustration', Energy Policy, Volume 31, 2003, pp 299-305.

Biglaiser, G.; Riordan M. (2000), 'Dynamics of Price Regulation', The RAND Journal of Economics, Volume 31, Number 4, Winter 2000, pp 744-767.

Bishop, M.; Kay, J.; Mayer, C. (1994), Privatization and Economic Performance, Oxford: Oxford University Press, 1994.

Bishop, M.; Kay, J.; Mayer, C. (1995), The Regulatory Challenge, Oxford: Oxford University Press, 1995.

Bohi, D. R. (1981), Analyzing Demand Behavior: A Study of Energy Elasticities, Baltimore, 1981.

Boyer, M.; Laffont, J. (2003), 'Competition and the reform of incentive schemes in the regulated sector', Journal of Public Economics, Volume 87, 2003, pp 2369–2396.

Butler, E.; Robinson, C.; Kay, J.; Gillick, D.; Call, M.; Veljanovski, C.; Booth, M. (1993), But Who Will Regulate the Regulators?, London: Adam Smith, 1993.

Cakarel, E.; House, J. (2004), IPP Investment in Turkey's Electric Power Industry, Working Paper No: 32, Program on Energy and Sustainable Development, Stanford University, November 2004.

Ceylan, H.; Ozturk, H. K. (2004); 'Estimating Energy Demand of Turkey Based on Economic Indicators Using Genetic Algorithm Approach', Energy Conversion and Management, Volume 45, 2004, pp 2525–2537.

Cook, P. (1999); 'Privatization and Utility Regulation in Developing Countries: The lessons so far', Annals of Public and Cooperative Economics, Volume 70, Number 4, 1999, pp 549-587.

Crew, M. A. (ed.) (1994), Incentive Regulation for Public Utilities, London: Kluwer Academic Publishers, 1994.

Cuaresma, J. C.; Hlouskova, J.; Kossmeier, S.; Obersteiner, M. (2004), 'Forecasting Electricity Spot-prices Using Linear Univariate Time-Series Models, Applied Energy, Volume 77, 2004, pp 87–106.

Dimitropoulos, J. (2003), Stochastic Trend Analysis of Annual UK Energy Demand Functions by Sector: A comparison with cointegration methods, M.Sc. Dissertation, University of Surrey, 2003.

Ediger, V. S.; Tatlidil, H. (2002); 'Forecasting the Primary Energy Demand in Turkey and Analysis of Cyclic Patterns', Energy Conversion and Management, Volume 43, 2002, pp 473-487.

Estache, A.; Pardina, M. R.; Rodríguez, J. M.; Sember, G. (2002), An Introduction to Financial and Economic Modeling for Utility Regulators, unpublished paper, November 2002.

Foster, C. D. (1992), Privatization, Public Ownership and the Regulation of Natural Monopoly, Oxford: Blackwell, 1992.

Fouquet, R.; Hawdon, D.; Pearson, P.; Robinson, C.; Stevens, P. (1995), The SEEC United Kingdom Energy Demand Forecast (1994-2000), Surrey Energy Economics Centre (SEEC) Occasional Paper 2, Department of Economics, University of Surrey, Guildford, UK, July 1995.

Fouquet, R.; Pearson, P.; Hawdon, D.; Robinson, C.; Stevens, P. (1997), 'The Future of UK Final User Energy Demand', Energy Policy, Volume 25, Number 2, 1997, pp 231-240.

Galindo, L. M. (2005), 'Short- and Long-Run Demand for Energy in Mexico: A cointegration approach', Energy Policy, Volume 33, 2005, pp 1179–1185.

Giannakis, D.; Jamasb, T.; Pollitt, M. (2005), 'Benchmarking and incentive regulation of quality of service: an application to the UK electricity distribution networks', Energy Policy, Volume 33, 2005, pp 2256-2271.

Gordon, R. L.; Jacoby, H. D.; Zimmerman M. B. (eds.) (1987); Energy: Markets and Regulation, London; Cambridge, Mass.: MIT, 1987.

Greene, W. H. (2003), Econometric Analysis, 5th edition, N.J.: Prentice Hall/Pearson Education International, 2003.

Hawdon, D. (ed.); Dargay, J. M.; Fouquet, R.; Henley, A.; Miller, K.; Peirson, J. (1993), Recent Studies of the Demand for Energy in the UK, Surrey Energy Economics Discussion Paper, SEED No: 72, Department of Economics, University of Surrey, Guildford, UK, November 1993.

Helm, D.; Jenkinson, T. (eds.) (1998), Competition in Regulated Industries, Oxford: Oxford University Press, 1998.

Hendry, D. F.; Juselius, K. (2000), 'Explaining Cointegration Analysis: Part I', The Energy Journal, Volume 21, Number 1, 2000.

Hendry, D. F.; Juselius, K. (2001), 'Explaining Cointegration Analysis: Part II', The Energy Journal, Volume 22, Number 1, 2001.

Hunt, L. C. (ed.) (2003), Energy in a Competitive Market: Essays in Honour of Colin Robinson, Cheltenham: Edward Elgar, 2003.

Hunt, L. C.; Dimitropoulos, J.; Judge, G. (2005); 'Estimating underlying energy demand trends using UK annual data', Applied Economics Letters, Volume 12, Number 4, March 2005, pp 239-244.

Jamasb, T.; Nillesen, P.; Pollitt, M. (2003), 'Gaming the Regulator: A Survey', The Electricity Journal, December 2003, pp 68-80.

Jamasb, T.; Nillesen, P.; Pollitt, M. (2004), 'Strategic Behaviour Under Regulatory Benchmarking', Energy Economics, Volume 26, 2004, pp 825–843.

Joutz, F. L.; Silk, J. I. (1997), 'Short and Long-Run Elasticities in US Residential Electricity Demand: A co-integration approach', Energy Economics, Volume 19, 1997, pp 493-513.

Kay, J., Mayer, C.; Thompson, D. (1986), Privatisation and Regulation: the UK Experience, Oxford: Clarendon, 1986.

Lanza, A.; Bosello, F. (2004), 'Modeling Energy Supply and Demand: A Comparison of Approaches', Encyclopedia of Energy, Volume 4, 2004, pp 55-64.

Lewis, T. B.; Sappington, D. E. M. (1989) ‘Regulatory options and price-cap regulation’, The RAND Journal of Economics, Volume 20, Number 3, Autumn 1989, pp 405-416.

Littlechild, S. C. (2000), Privatisation, Competition and Regulation, London: Institute of Economic Affairs, Occasional paper: 110, 2000.

Lyon, T. P. (1994), ‘Incentive Regulation in Theory and Practice’, in M. A. Crew (ed.), Incentive Regulation for Public Utilities, London: Kluwer Academic Publishers, 1994.

Maddala, G. S. (2001), Introduction to Econometrics, 3rd Edition, Chichester: Wiley, 2001.

Matupa, O. (2003), Modelling UK energy demand using irreversibility and price decomposition, MSc Dissertation, University of Surrey, 2003.

McAvinchey, I. D.; Yannopoulos, A. (2003), 'Stationarity, Structural Change and Specification in a Demand System: the case of energy', Energy Economics, Volume 25, 2003, 65-92.

Medlock, K. B. (2004), 'Economics of Energy Demand', Encyclopedia of Energy, Volume 2, 2004, pp 65-78.

Megginson, W. L.; Netter, J. M. (2001), ‘From State to Market: A Survey of Empirical Studies on Privatization’, Journal of Economic Literature, Volume XXXIX, June 2001, pp 321-389.

Moran, M.; Prosser, T. (eds.) (1994), Privatization and Regulatory Change in Europe, Buckingham: Open University Press, 1994.

Munasinghe, M.; Meier, P. (1993), Energy Policy Analysis and Modeling, Cambridge: Cambridge University Press, 1993.

Mwangonde, D. R. (2002), Industrial Energy Demand in The UK: A Comparative Study Using Cointegration and Stochastic Trend Analysis, MSc Dissertation, University of Surrey, 2002.

Newbery, D. M.; Pollitt, M. G. (1997), ‘The Restructuring and Privatisation of Britain’s CEGB - Was It Worth It?’, The Journal of Industrial Economics, Volume XLV, Number 3, September 1997, pp 269-303.

Pachauri, R. K. (1975), The Dynamics of Electrical Energy Supply and Demand: An Economic Analysis, New York: Praeger, 1975.

Pirie, M. (1988), Privatization, Aldershot: Wildwood, 1988.

Robinson, C. (2001), Regulating Utilities: New Issues, New Solutions, Cheltenham: Edward Elgar, 2001.

Robinson, C. (2002), Utility Regulation and Competition Policy, Cheltenham: Edward Elgar, 2002.

Sappington, D. E. M. (1991), 'Incentives in Principal-Agent Relationships', Journal of Economic Perspectives, Volume 5, Number 2, Spring 1991, pp 45-66.

Schmalensee, R. (1989), ‘Good Regulatory Regimes’, The RAND Journal of Economics, Volume 20, Number 3, Autumn 1989, pp 417-436.

Sharkey, W. W. (1982), The Theory of Natural Monopoly, Cambridge: Cambridge University Press, 1982.

Soytas, U.; Sari, R. (2003), 'Energy Consumption and GDP: causality relationship in G-7 countries and emerging markets', Energy Economics, Volume 25, 2003, pp 33-37.

Sozen, A.; Arcaklioglu, E.; Ozkaymak, M. (2005), 'Turkey's Net Energy Consumption', Applied Energy, Volume 81, 2005, pp 209–221.

Sterman, J. D. (1989), 'Modelling the Formation of Expectations: The History of Energy Demand Forecasts', International Journal of Forecasting, Volume 4, 1989, pp 243-259.

Stern, D. I. (2004), 'Economic Growth and Energy', Encyclopedia of Energy, Volume 2, 2004, pp 35-51.

Stock, J. H. (1987), ‘Asymptotic Properties of Least Squares Estimators of Cointegrating Vectors’, Econometrica, Volume 55, Number 5, September 1987, pp 1035-1056.

Tenenbaum, B.; Lock, R.; Barker, J. (1992), 'Electricity Privatization: Structural, competitive and regulatory options', Energy Policy, December 1992, pp 1134-1160.

Thomas, R. L. (1996), Modern Econometrics: An Introduction, Harlow: Addison-Wesley, 1996.

Veljanovski, C. (ed.) (1991), Regulators and the Market: An Assessment of the Growth of Regulation in the UK, London: Institute of Economic Affairs, 1991.

Verbeek, M. (2004), A Guide to Modern Econometrics, 2nd Edition, Chichester: Wiley, 2004.

Vickers, J., Yarrow, G. (1985), Privatization and the Natural Monopolies, London: Public Policy Centre, 1985.

Vickers, J.; Yarrow, G. (1988); Privatization: An Economic Analysis, London; Cambridge, Mass: MIT Press, 1988.

Vickers, J.; Yarrow, G. (1991), 'Economic Perspectives on Privatization', Journal of Economic Perspectives, Volume 5, Number 2, Spring 1991, pp 111-132.

Wamukonya, N. (2003), 'Power Sector Reform in Developing Countries: Mismatched agendas', Energy Policy, volume 31, 2003, pp 1273–1289.

Weyman, T. G. (1986), The Economics of Energy Policy, Aldershot: Gower, UK, 1986.

Yasushi, N. (1997), An Empirical Analysis of Petrol Demand in the UK Using the Reduced Form Model and the Structural Form Model, MSc Dissertation, University of Surrey, 1997.

Yoo, S. H. (2005), 'Electricity Consumption and Economic Growth: Evidence from Korea', Energy Policy, Volume 33, 2005, pp 1627–1632.

Appendices

Appendix 1: The Republic of Turkey

Appendix 1-A: Comparative Analysis of Turkey and Turkish Energy Market

The table below presents a comparative analysis of Turkey with respect to the United Kingdom, which not only is similar to Turkey in terms of population but also constitutes an excellent example for energy market reforms in Turkey with market opening rates of 100% in both electricity and natural gas markets.

Table 4. Turkey and the United Kingdom

	Turkey	Index (UK=100)	United Kingdom	Notes
Basic Facts				
· Population (July 2005 est.)	69,660,559	115	60,441,457	(1)
· Age Structure				
- 0-14 years (% of total population)	26.0	147	17.7	(1)
- 15-64 years (% of total population)	67.3	101	66.5	(1)
- 65 years and over (% of total population)	6.7	42	15.8	(1)
· Population Growth Rate (%, 2005 est.)	1.1	389	0.3	(1)
· Life Expectancy				
- total population (years)	72.36	92	78.38	(1)
- male (years)	69.94	92	75.94	(1)
- female (years, 2005 est.)	74.91	93	80.96	(1)
· Government type	Republican Parliamentary Democracy	-	Constitutional Monarchy	(1)
· Total Area (sq km)	780,580	319	244,820	(1)
· Coastline (km)	7,200	58	12,429	(1)
Economy				
· GDP (billion $, PPP, 2004 est.)	509	29	1,782	(1)
· GDP Real Growth Rate (%, 2004 est.)	8.2	256	3.2	(1)
· GDP per capita ($, PPP, 2004 est.)	7,400	25	29,600	(1)
· GDP Composition by Sector				
- agriculture (%)	11.7	1170	1.0	(1)
- industry (%)	29.8	113	26.3	(1)
- services (%, 2003 est.)	58.5	80	72.7	(1)
· Unemployment Rate (%, 2004 est.)	9.3	194	4.8	(1)
· Population Below Poverty Line (%, 2002)	20	118	17	(1)
· Inflation Rate (%, consumer prices, 2004 est.)	9.3	664	1.4	(1)
· Investment (% of GDP, gross fixed, 2004 est.)	17.3	107	16.2	(1)
· Public Debt (% of GDP, 2004 est.)	74.3	188	39.6	(1)
· Industrial Production Growth Rate (%, 2004 est.)	16.5	1833	0.9	(1)

· Current Account Balance (billion $, 2004 est.)	-15.3	46	-33.5	(1)
· Currency	New Turkish Lira (YTL)	-	British Pound (GBP)	(1) (2)
· Exchange Rates (per US dollar, 2004)	1.43	261	0.55	(1) (2)

Electricity Market Indicators

· Market Opening (share of eligible customers, %, 2004)	28	28	100	(3) (4)
· Eligibility Threshold (GWh per annum, 2004)	7.8	-	0	(3) (5)
· Gross Electricity Production (TWh, 2002)	129.4	33	387.1	(6) (7)
· Final Electricity Consumption (TWh, 2002)	101.5	31	332.7	(6)
· Electricity Exports (TWh, 2002)	0.4	50	0.8	(6)
· Electricity Imports (TWh, 2002)	3.6	39	9.2	(6)
· Transmission and Distribution Loses (TWh, 2002)	23.9	77	30.9	(6)
· Transmission and Distribution Loses (% of consumption)	23.5	254	9.3	
· Electricity Prices in 2003 for				
- industry in US Dollars/kWh	0.099	180	0.055	(8)
- households in US Dollars/kWh	0.106	91	0.116	(8)
- industry in US Dollars/kWh (using PPPs)	0.204	378	0.054	(8)
- households in US Dollars/kWh (using PPPs)	0.217	190	0.114	(8)

Natural Gas Market Indicators

· Market Opening (share of eligible customers, %, 2004)	80	80	100	(9) (10)
· Eligibility Threshold (million cm/year, 2004)	1	-	0	(9)
· Natural Gas Production (million cubic metres, 2003)	560	0.5	108,438	(11)
· Natural Gas Total Consumption (million cubic metres, 2003)	21,181	21	100,741	(11)
· Natural Gas Imports (million cubic metres, 2003)	20,650	263	7,851	(11)
· Natural Gas Exports (million cubic metres, 2003)	0	-	16,106	(11)
· Natural Gas Prices in 2003 (GCV basis) for				
- industry in US Dollars/10^7 kcal	228.9	142	161.4	(8)
- households in US Dollars/10^7 kcal	265.3	75	351.8	(8)
- industry in US Dollars/10^7 kcal (using PPPs)	469.7	295	159.3	(8)
- households in US Dollars/10^7 kcal (using PPPs)	544.4	157	347.3	(8)

Petroleum Market Indicators

· Oil Production (thousand metric tons, 2002)	2,420	2	116,063	(12)
· Oil Net Imports (thousand metric tons, 2002)	28,167	-	-39,775	(12)
· Oil Consumption (thousand metric tons, 2002)	30,148	38	78,555	(12)
· Gasoline Prices in 2004 (premium unleaded, 95 RON)				
- in US Dollars/litre	1.374	93	1.471	(8)
- in US Dollars/litre (using PPPs)	2.511	193	1.300	(8)

Notes

(1) Source: CIA (2005)
(2) On 1 January 2005, the old Turkish Lira (TRL) was converted to New Turkish Lira (YTL) at a rate of 1,000,000 old to 1 New Turkish Lira.
(3) Source: European Commission (2004, p 114)
(4) Source: European Commission (2001a, p 101)
(5) In 2005, eligibility threshold in Turkey further reduced to 7.7 GWh per annum by the Energy Market Regulatory Board Decision No: 427, dated 27.01.2005.
(6) Source: IEA (2004b)
(7) Gross production refers to total public and autoproducers' production, including production from pumped storage.
(8) Source: IEA (2005a)
(9) Source: European Commission (2001b, p 29)
(10) In European Commission's report, the level of domestic gas market opening for Turkey is given as 80%, which is calculated based on the eligibility threshold of 1 million cm/year. However, this threshold is only valid for those who acquired such rights before the enactment of Natural Gas Market Law. For all other domestic consumers, the threshold is 15 million cm/year. However, as also indicated in the report, the BOTAS still keeps its current monopoly position in domestic supplies. Therefore, in practice, no consumer in Turkey can switch his/her supplier, meaning that practically market opening rate is **0%** in Turkey. For details, see the Energy Market Regulatory Board Decision No: 408, dated 27.12.2004.
(11) Source: IEA (2004c)
(12) Source: IEA (2004d)

Figure 3. Map of Turkey

Appendix 1-B: Turkish Energy Industry Mile Stones

Date	Event
19th century	Oil exploration activities began in Turkey
1902	The first electric generator was introduced in Tarsus, Turkey
1913	The first power plant was installed in Silahtaraga, Istanbul
1923	The Republic of Turkey was founded and started to try a liberal economy
1938	Nationalization of Turkish electricity industry started
1944	Nationalization was completed
1960s	LPG started to be used as an alternative to kerosene (and later to gas) in Turkey
1962	The First 5-Year Development Plan was introduced, and thereby "development plans era" started
1963	The Ministry of Energy and Natural Resources (MENR) was established
1970	The Turkish Electricity Administration (TEK) was created
1974	The BOTAS was founded for the transport of Iraqi crude oil
1982	Distribution assets were transferred to TEK, thus making TEK a national vertically integrated monopoly fully owned by the state
1982	The monopoly of public sector on generation was abolished and the private sector was allowed to build power plants and sell its electricity to TEK
1982	Natural gas was introduced for the first time in Turkey
1984	TEK was restructured and gained the status of state-owned enterprise
1984	Law No. 3096, which forms the legal basis for BOT, TOOR and autoproducer system, was enacted
1984	The BOTAS started to diversify into the natural gas sector
1993	TEK was incorporated into privatization plan and split into two separate state-owned enterprises as TEAS and TEDAS
1994-5	The Constitutional Court of Turkey issued a series of rulings, which made the privatization almost impossible to implement
1994	Law No. 3996 and Implementing Decree 5907 were enacted to enhance the attractiveness of BOT projects by authorizing the granting of guarantees by the Undersecretariat of Treasury and providing some tax exemptions
1996	The first LPG use in cogeneration plants
1997	The Build Operate Own (BOO) Law (No. 4283) was enacted to enable private sector participation in the construction and operation of new power plants
August 1999	The parliament passed a constitutional amendment permitting the privatization of public utility services and allowing international arbitration for resolving disputes
3 March 2001	Electricity Market Law (EML, No. 4628) came into force
2 May 2001	Natural Gas Market Law (NGML, No. 4646) came into force
20 December 2003	Petroleum Market Law (PML, No. 5015) came into force
17 March 2004	Turkish government issued the Strategy Paper Concerning Electricity Market Reform and Privatisation, which outlines the major steps to be taken up to 2012
13 March 2005	Liquefied Petroleum Gas Market Law (LPGML, No.5307) came into force

Appendix 1-C: Current Market Structure in Turkish Electricity Industry

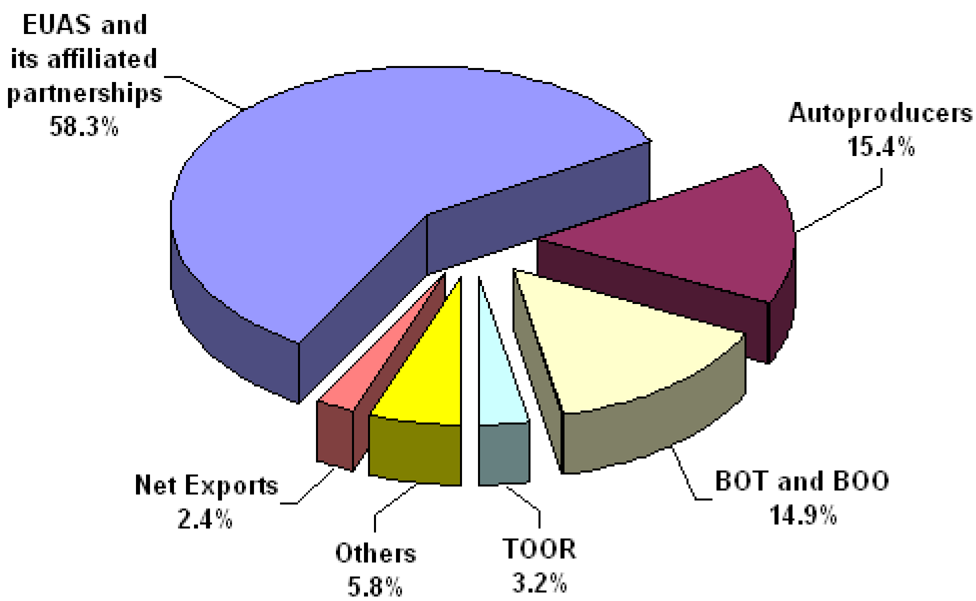
In generation, EUAS and its affiliated partnerships were responsible for 58.3% of total generation in 2002. Power plants under autoproducer system accounted for 15.4% of total production in the same year. Those under BOT and BOO contracts also supplied another 14.9%. The table and figure below show the distribution of electricity generation by utilities in Turkish electricity market.

Table 5. Distribution of Electricity Generation in Turkey (by utilities, 2002)

Utilities	Production (GWh)	Contribution to Turkey's Total Consumption (%)
Power plants of EUAS and its affiliated partnerships	77,332.1	58.3
Power plants of Autoproducers	20,446.6	15.4
Power plants of BOT and BOO	19,700.0	14.9
Power plants of TOOR	4,204.8	3.2
Others	7,716.0	5.8
Turkey's Total Production	**129,399.5**	**97.6**
Net Exports	-3,153.2	2.4
Turkey's Total Consumption	**132,552.7**	**100.0**

Source: Hepbasli (2005).

Figure 4. Distribution of Electricity Generation in Turkey (by utilities, 2002)



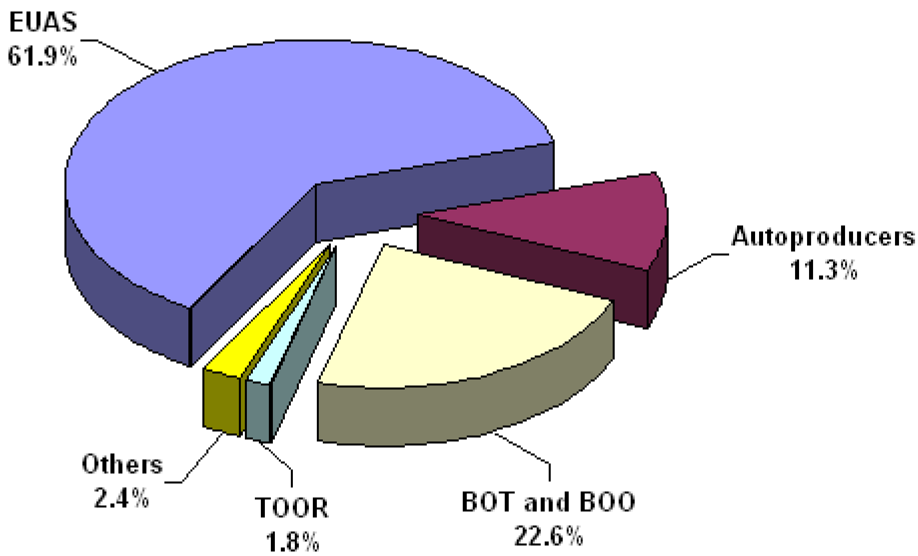
In terms of installed capacity, EUAS is again in a dominant position and controlled 61.9% of total installed capacity in 2003. Power plants under autoproducer system and BOT and BOO contracts accounted for 11.3% and 22.6% of installed capacity respectively in the same year. The following table and figure present the breakdown of Turkey's installed capacity by utilities in 2003.

Table 6. Breakdown of Turkey's Installed Capacity (by utilities, 2003)

Utilities	Installed Capacity (MW)	Contribution to Turkey's total Installed capacity (%)
Power plants of EUAS	22,333	61.9
Power plants of Autoproducers	4,084	11.3
Power plants of BOT and BOO	8,161	22.6
Power plants of TOOR	650	1.8
Others	878	2.4
Total Installed Capacity	**36,106**	**100.0**

Source: Hepbasli (2005).

Figure 5. Breakdown of Turkey's Installed Capacity (by utilities, 2003)



TEDAS and its affiliated regional distribution companies dominate the distribution and retail supply sector. Turkey's distribution network has been divided into 21 regions, one of which is currently operating under a TOOR contract. The government's objective is to privatise the remaining 20 distribution regions by the end of 2006 (IEA, 2005b).

Appendix 1-D: Natural Gas Import Contracts of the BOTAS

Agreement	Volume (bcm/year)	Signature date	Length (years)	Operation date	Volumes delivered in 2003 (bcm)
Russia (West)	6	February 1986	25	June 1987	11.4 (total Western pipeline)
Algeria (LNG)	4	April 1988	20	August 1994	3.8
Nigeria (LNG)	1.2	November 1995	22	November 1999	1.1
Iran	10	August 1996	25	December 2001	3.5
Russia (Black Sea)	16	December 1997	23	February 2003	1.2
Russia (West)	8	February 1998	23	March 1998	See above
Turkmenistan[46]	16	May 1999	30	-	0
Azerbaijan	6.6	March 2001	15	2006	0

Source: IEA (2005b)

[46] Contract suspended, among other things, for pending issue regarding the legal status of the Caspian Sea.

Appendix 1-E: Energy Balance Table for Turkey

Table below shows the energy balance table for Turkey, which sets out the energy flows in the Turkish economy from initial inputs to final consumption for the year 2001. The unit of measurement is thousand tonnes of oil equivalent (ktoe) on a net calorific value basis.

The initial inputs of energy to the economy are the primary fuels of coal; crude oil; petroleum products; natural gas; hydro; geothermal, solar etc.; combustible renewables and waste; and electricity. In Turkey, for the time being, there exists no *nuclear-generated* energy.

Indigenous production of primary fuels in Turkey is dominated by the coal, which is responsible for 53.7% of the total (row 1). It is followed by combustibles, renewables and waste (24.1%); crude oil (9.5%); hydro (7.9%); geothermal, solar etc. (3.8%) and natural gas (1%).

Row 2 shows imported inputs added to indigenous production. Of these, there is a negligible level of electricity imports and a large amount of crude oil and natural gas imports, which are responsible for 47.5% and 27.2% of total imports respectively. Coal (11.6%) and petroleum products (12.9%) are also significant trade items.

Row 3 shows exports of primary fuels. Petroleum products are responsible for almost all exports (98.6%). International marine bunkers (row 4) cover those quantities delivered to all sea-going ships; and petroleum products account for all quantity in this item.

Stock changes (row 5) reflect the difference between opening stock levels on the first day of the year and closing levels on the last day of the year of stocks on national territory held by producers, importers, energy transformation industries and large consumers. We can detect from the table that, during the year 2001, some crude oil and natural gas stocks were built in Turkey; while a stock draw occurred in coal and petroleum products.

Row 6 indicates total primary energy supply (TPES), which is made up of production + imports - exports - international marine bunkers ± stock changes. TPES points out the available supply both for direct consumption and for conversion into secondary fuels.

Row 7 shows transfers; which include interproduct transfers, products transferred and recycled products. However, there was not any kind of transfers in Turkey, in 2001.

Row 8 contains statistical differences, which include the sum of the unexplained statistical differences for individual fuels. Mainly, they arise because of the variety of conversion factors in coal and oil columns.

Table 7. 2001 Energy Balances for Turkey

SUPPLY and CONSUMPTION	Coal	Crude Oil	Petroleum Products	Natural Gas	Hydro	Geothermal Solar, etc	Combustible Renewables and Waste	Electricity	Total
1. Production	14,040	2,490	0	257	2,065	988	6,315	0	26,155
2. Imports	5,626	23,077	6,274	13,214	0	0	0	394	48,585
3. Exports	0	0	-2,583	0	0	0	0	-37	-2,620
4. International Marine Bunkers	0	0	-235	0	0	0	0	0	-235
5. Stock Changes	787	-188	77	-102	0	0	0	0	574
6. TPES	**20,453**	**25,379**	**3,533**	**13,369**	**2,065**	**988**	**6,315**	**357**	**72,459**
7. Transfers	0	0	0	0	0	0	0	0	0
8. Statistical Difference	-527	-136	0	0	0	0	0	0	-663
9. Electricity Plants	-10,618	0	-1,702	-6,680	-2,065	-83	-10	9,181	-11,977
10. CHP Plants	-514	0	-854	-2,153	0	0	-96	1,374	-2,243
11. Heat Plants	0	0	0	0	0	0	0	0	0
12. Gas Works	0	0	0	0	0	0	0	0	0
13. Petroleum Refineries	0	-25,349	25,836	0	0	0	0	0	487
14. Coal Transformation	-1,547	0	0	0	0	0	0	0	-1,547
15. Liquifaction Plants	0	0	0	0	0	0	0	0	0
16. Other Transformation	0	106	-106	0	0	0	0	0	0
17. Own Use	-225	0	-1,701	-73	0	0	0	-708	-2,707
18. Distribution Losses	0	0	0	-17	0	0	0	-2,007	-2,024
19. TFC	**7,022**	**0**	**25,006**	**4,446**	**0**	**905**	**6,209**	**8,197**	**51,785**
20. Industry sector	**5,379**	**0**	**5,556**	**1,466**	**0**	**118**	**0**	**3,870**	**16,389**
21. Transportation sector	**0**	**0**	**11,891**	**44**	**0**	**0**	**0**	**57**	**11,992**
22. Other sectors	**1,643**	**0**	**5,651**	**2,936**	**0**	**787**	**6,209**	**4,270**	**21,496**
23. Agriculture	0	0	2,689	0	0	0	0	275	2,964
24. Commercial and Public Services	0	0	0	616	0	0	0	1,516	2,132
25. Residential	1,643	0	2,962	2,320	0	787	6,209	2,026	15,947
26. Non-Specified	0	0	0	0	0	0	0	453	453
27. Non-Energy Use	**0**	**0**	**1,908**	**0**	**0**	**0**	**0**	**0**	**1,908**
28. *Electricity Generated-GWh*	38,417	0	10,417	49,550	24,010	152	179	0	122,725

(in thousand tonnes of oil equivalent (ktoe) on a net calorific value basis)
Source: IEA (2004e)

Row 9 refers to plants which are designed to produce electricity. Here, we can observe total electricity produced (output) and total sources used to produce that electricity (input). Transformation losses appear in the total column as a negative number. This row is especially important because it allows us to calculate thermal efficiency in electricity generation for Turkey as follows:

$$\text{Thermal Efficiency in Electricity Generation} = \frac{\text{Total Electricity Produced}}{\text{Total Sources Used to Produce Electricity}}$$

$$\text{Thermal Efficiency in Electricity Generation} = \frac{9{,}181}{10{,}618 + 1{,}702 + 6{,}680 + 2{,}065 + 83 + 10}$$

$$\text{Thermal Efficiency in Electricity Generation} = \frac{9,181}{21,158}$$

$$\text{Thermal Efficiency in Electricity Generation} = 43.4\%$$

Row 10 explains the role of combined heat and power (CHP) plants, which refers to plants which are designed to produce both heat and electricity; also known as co-generation power stations.

Row 11 shows the role of heat plants (those designed to produce heat only) in the conversion process. Row 12 does the same for gas works. If there is production of natural gas at gas works; the quantity produced appears as a positive figure in the natural gas column, and inputs as negative entries in the relevant columns. Also, conversion losses appear in the total column. However, as can be seen in the table, there are not any heat plants or gas works in Turkey.

Row 13 (petroleum refineries) shows the use of primary energy for the manufacture of finished petroleum products and the corresponding output. Thus, the total reflects transformation losses; and in general the data in the total column should be a negative number. However, here it is a positive one, indicating either a problem in the underlying energy data or a problem in the primary refinery balance!

Coal transformation (row 14) contains losses in transformation of coal from primary to secondary fuels. Liquifaction plants (row 15) include diverse liquefaction processes, such as coal liquefaction into oil, and natural gas to gasoline. However, there is no liquefaction plant in Turkey.

Row 16 covers other transformations that are not specified in previous rows.

Own use (row 17) contains the primary and secondary energy consumed by transformation industries for a variety of purposes (e.g. energy used for heating, lighting, oil and gas extraction etc).

Row 18 contains data regarding distribution and transmission losses that include losses in natural gas/electricity distribution and transmission.

The essential balance in the table is; **TFC (row 19) = TPES (row6) – (the sum of rows 7 to 18)**, and in turn row 6 is the sum of rows 1-5; row 19 is the sum of rows 20, 21, 22 and 27; while row 22 is the sum of rows 23-26. In this way, row 19 shows the consumption of energy by final users after the conversion process, and rows 20, 21, 22 and 27 indicate the distribution of this consumption among different market sectors.

When we examine the shares of different sectors in final consumption, it can be seen that dominant sectors are industry (31.6%), residential (30.8%) and transportation (23.2%). The remaining 14.4% consists of agriculture (5.7%), commercial & public services (4.1%), non-energy use (3.7%) and other non-specified (0.9%) sectors. Here we should note that non-energy use covers other use of petroleum products such as white spirit, paraffin waxes, lubricants, bitumen and so on.

Actually, the last row (row 28) is not a part of a standard energy balance table and even the unit of measurement in this row is not thousand tonnes of oil equivalent (ktoe) but it is GWh (1 ktoe = 11.63 GWh). It is added to the table because it provides very useful information by demonstrating Turkey's electricity generation by primary energy resources, which can be showed graphically as follows:

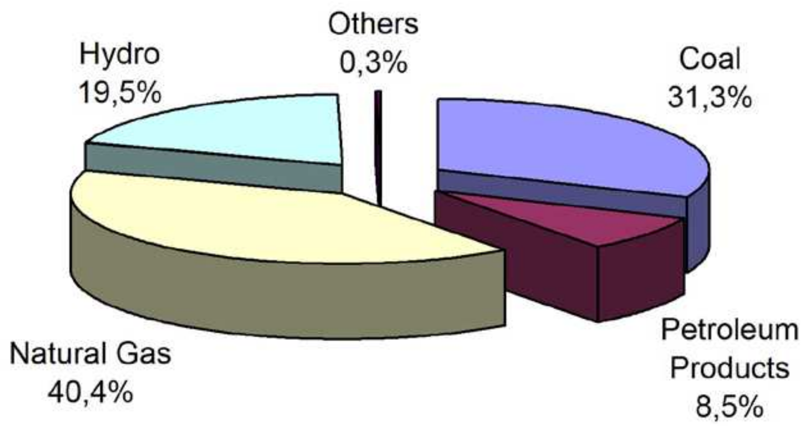


Figure 6. Electricity Generation in Turkey
(2001, by primary energy sources)

Primary energy demand in Turkey can also be showed graphically as follows:

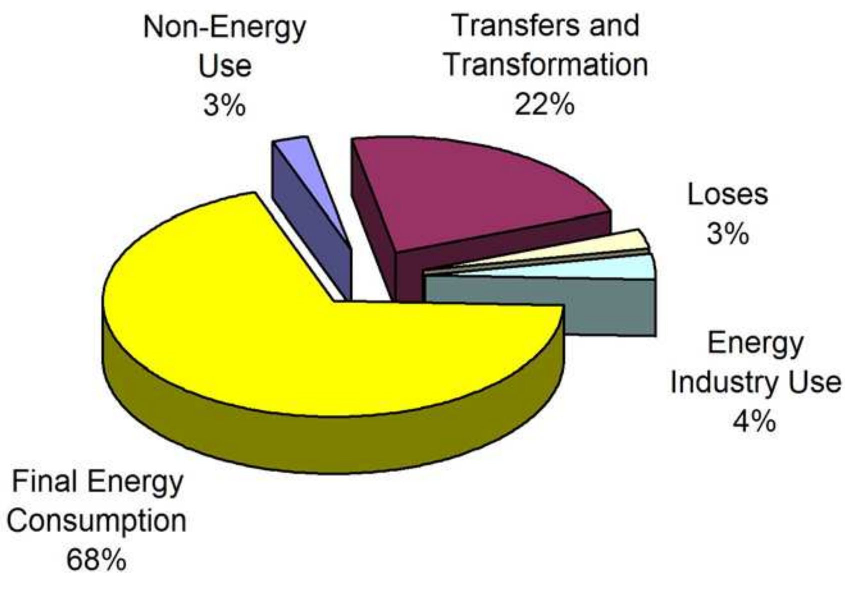


Figure 7. Primary Energy Demand in Turkey (2001)

Moreover, the distribution of final energy consumption among different market sectors (or, industries) can be seen in the figure below.

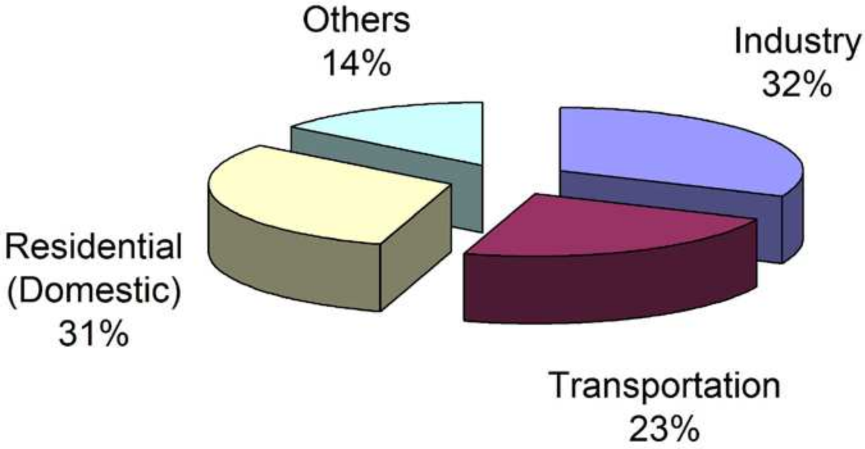


Figure 8. Final Energy Consumption in Turkey (2001, by industry)

Finally, the figure below shows the distribution of final energy consumption among different fuels.

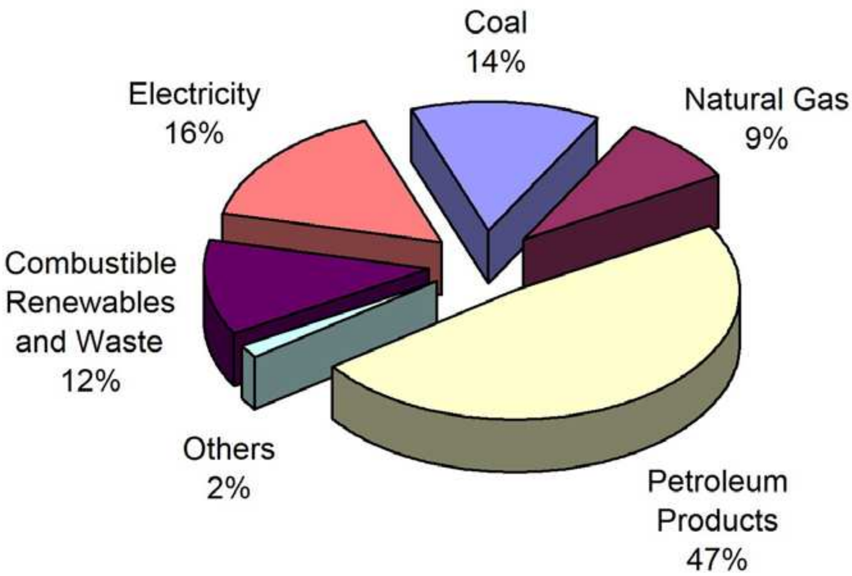


Figure 9. Final Energy Consumption in Turkey (2001, by fuel)

Appendix 1-F: The Trends in Energy Supply and Use in Turkey

Having discussed the current energy balance of Turkey, let me focus on the development of the supply and use of energy in Turkey since 1960.

First of all, I will review the trends in total primary energy supply. Then the trends regarding final energy consumption will be examined based on fuel and final user. Moreover, trends in the energy consumption of three important sectors - namely industrial, residential (domestic) and transportation - will also be discussed.

Table below shows distribution of fuels in total primary energy supply of Turkey during the period 1960-2001. The column "Others" reflects the sum of petroleum products; hydro; geothermal, solar, wind and electricity. The following two graphs were drawn based on these data.

Table 8. Total Primary Energy Supply in Turkey (by fuel)

	Coal	Crude Oil	Natural Gas	Combustible Renewables and Waste	Others	Total
1960	3,200	370	0	5,879	1,260	10,709
1961	2,940	592	0	5,950	1,385	10,867
1962	3,246	2,954	0	5,943	-290	11,853
1963	3,476	3,696	0	5,838	-567	12,443
1964	3,676	4,452	0	5,895	-912	13,111
1965	3,595	4,684	0	5,871	-352	13,798
1966	4,007	5,281	0	5,943	-48	15,183
1967	3,870	5,597	0	5,977	311	15,755
1968	3,925	6,491	0	5,968	165	16,549
1969	4,219	6,629	0	5,939	640	17,427
1970	4,245	7,378	0	5,972	607	18,202
1971	4,314	9,056	0	5,798	296	19,464
1972	5,097	11,194	0	6,246	-531	22,006
1973	5,149	13,267	0	6,452	-545	24,323
1974	5,588	13,255	0	6,574	-236	25,181
1975	5,760	13,346	0	6,819	810	26,735
1976	6,252	13,797	0	7,025	2,046	29,120
1977	6,581	14,881	0	7,193	3,302	31,957
1978	6,235	13,427	0	7,448	4,739	31,849
1979	6,551	11,392	0	7,741	4,601	30,285
1980	6,988	13,192	0	7,680	3,592	31,452
1981	7,159	13,939	0	7,722	2,896	31,716
1982	7,972	16,708	33	7,925	1,019	33,657
1983	8,845	16,624	58	8,055	2,053	35,635
1984	10,035	18,435	33	7,929	552	36,984
1985	12,055	18,542	55	7,746	735	39,133
1986	13,386	19,771	376	7,891	709	42,133
1987	14,031	23,699	599	7,892	447	46,668
1988	13,726	24,703	1,008	7,924	-263	47,098
1989	15,038	21,880	2,650	7,921	1,411	48,900

1990	16,944	23,596	2,855	7,205	2,050	52,650
1991	17,771	21,717	3,487	7,209	1,958	52,142
1992	17,287	22,369	3,814	7,206	2,916	53,592
1993	15,977	24,868	4,239	7,145	4,609	56,838
1994	15,969	24,711	4,519	7,137	3,706	56,042
1995	16,618	26,983	5,785	7,065	4,945	61,396
1996	18,904	26,193	6,984	7,043	7,744	66,868
1997	21,176	26,733	8,339	7,022	7,203	70,473
1998	21,992	27,361	8,943	6,986	6,407	71,689
1999	20,073	25,722	10,588	6,812	7,341	70,536
2000	23,459	23,851	12,635	6,475	10,685	77,105
2001	20,453	25,379	13,369	6,315	6,943	72,459

(in thousand tonnes of oil equivalent - ktoe)
Source: IEA (2004f)

The figures below show the development of total primary energy supply in Turkey in terms of fuel types in real values and percentages, respectively. It can easily be seen that primary energy supply increased over the last 40 years. The value of combustible renewables and waste has almost remained constant in real terms, which caused a sharp decline in percentages (from 54.9% in 1960 to 8.7% in 2001). In Turkey, natural gas was first introduced in 1982, and since then, its share has steadily increased and reached 18.5% in 2001. As for crude oil, its contribution to total primary energy supply has also increased over the years. Its share reached a peak (54.5%) in 1973; however, post-1973 oil price rises changed this trend and its share has fluctuated between 30.9% and 52.6% since then. In 2001, the figure was 35%. The coal has also increased its contribution over the years; its share has varied between 19.6 % and 34.1%. Actually, the share of coal in 2001 (28.2%) was very close to its value in 1960 (29.9%).

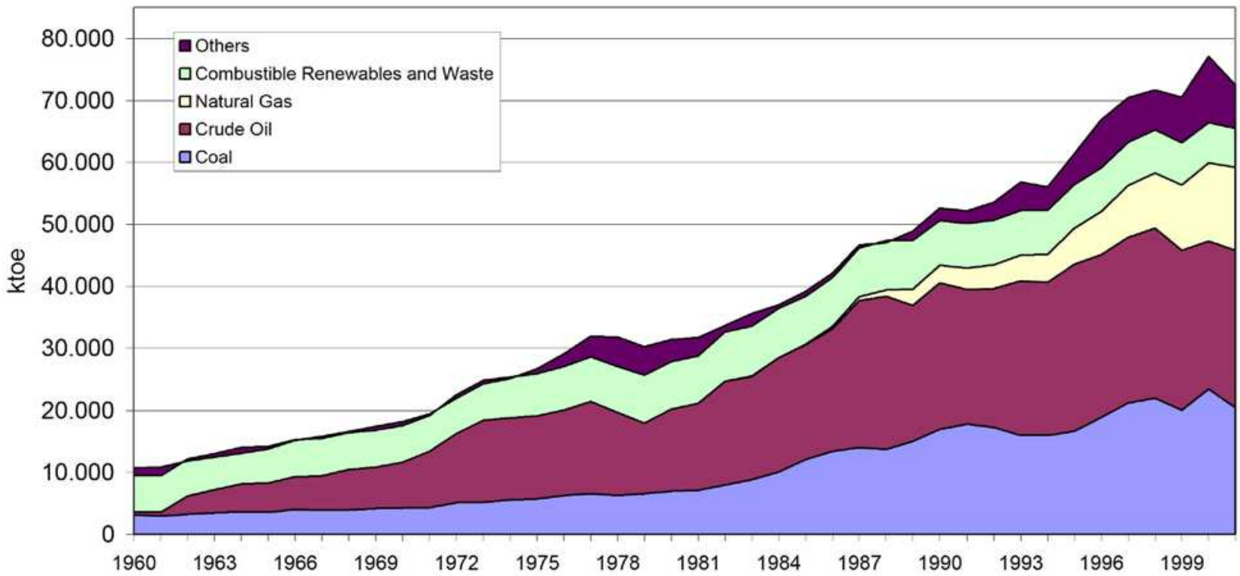


Figure 10. Total Primary Energy Supply in Turkey (by fuel)

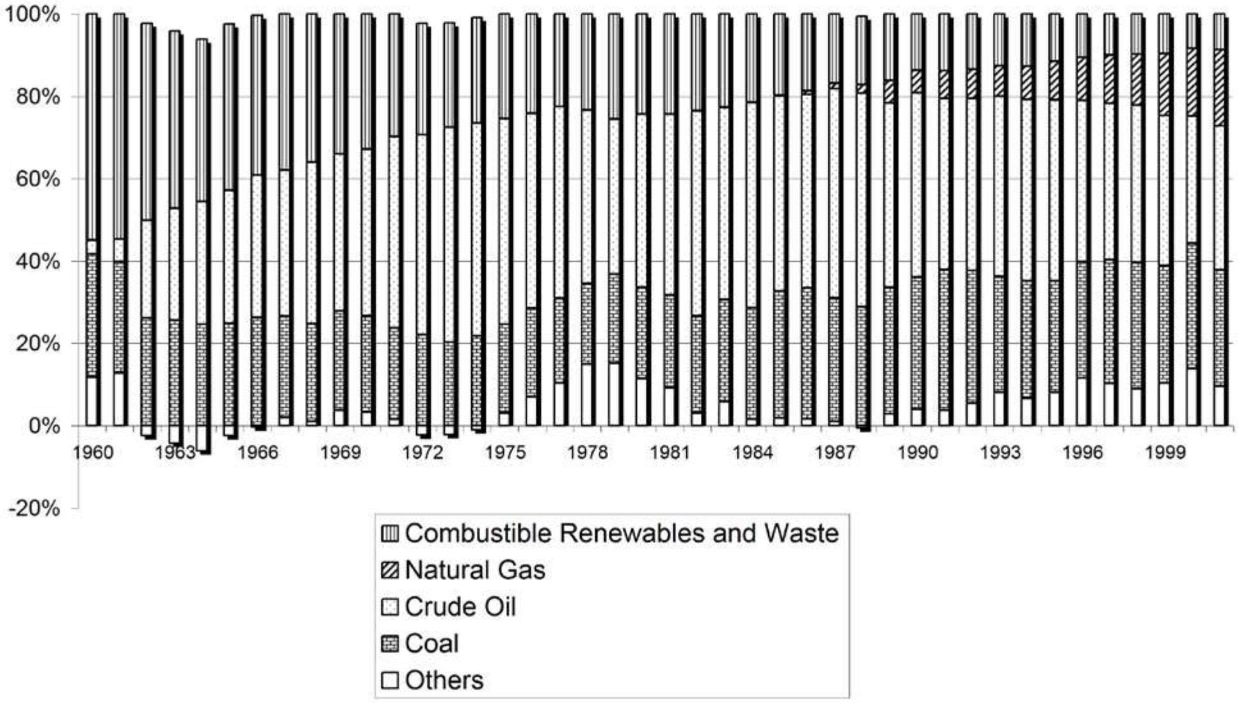


Figure 11. Total Primary Energy Supply in Turkey (by fuel, percentages)

The table below shows distribution of fuels in total final energy consumption in Turkey. The following two figures reflect these data.

Table 9. Total Energy Consumption in Turkey (by fuel)

	Coal	Petroleum Products	Natural Gas	Renewables and Waste	Electricity	Total
1960	2,280	1,405	31	5,879	184	9,779
1961	2,020	1,762	30	5,950	200	9,962
1962	2,044	2,219	30	5,943	239	10,475
1963	2,400	2,564	32	5,838	267	11,101
1964	2,300	2,827	33	5,895	298	11,353
1965	2,124	3,316	38	5,871	337	11,686
1966	2,263	3,946	39	5,943	376	12,567
1967	2,250	4,750	39	5,977	420	13,436
1968	2,235	5,247	40	5,968	471	13,961
1969	2,412	5,429	42	5,939	540	14,362
1970	2,447	6,155	41	5,972	593	15,208
1971	2,324	7,380	40	5,798	673	16,215
1972	3,146	8,528	41	6,246	779	18,740
1973	2,944	9,704	40	6,452	853	19,993
1974	3,119	9,895	38	6,574	918	20,544
1975	3,156	11,171	31	6,819	1,096	22,273
1976	3,536	12,524	41	7,025	1,317	24,443
1977	3,286	14,296	40	7,193	1,477	26,292

1978	3,506	14,288	41	7,448	1,557	26,840
1979	3,486	12,625	42	7,741	1,620	25,514
1980	4,191	12,910	39	7,680	1,681	26,501
1981	4,164	12,753	42	7,722	1,821	26,502
1982	4,799	13,554	74	7,925	1,949	28,301
1983	5,002	14,429	97	8,055	2,028	29,611
1984	5,628	14,201	76	7,929	2,290	30,124
1985	6,017	14,639	76	7,746	2,448	30,926
1986	5,912	16,022	72	7,896	2,650	32,552
1987	7,376	18,804	78	7,902	3,019	37,179
1988	7,652	18,944	203	7,937	3,269	38,005
1989	7,537	19,249	435	7,942	3,548	38,711
1990	7,566	20,797	724	7,242	3,866	40,195
1991	8,055	20,537	1,120	7,227	4,045	40,984
1992	7,540	21,514	1,638	7,238	4,449	42,379
1993	6,815	24,368	2,082	7,177	4,880	45,322
1994	5,657	22,909	2,014	7,198	5,074	42,852
1995	6,432	26,018	2,787	6,904	5,601	47,742
1996	7,918	27,315	3,394	6,995	6,143	51,765
1997	9,007	26,650	4,068	7,038	6,853	53,616
1998	9,050	26,046	4,113	7,155	7,376	53,740
1999	7,363	25,916	4,042	7,123	7,672	52,116
2000	10,219	26,924	4,492	6,820	8,245	56,700
2001	7,022	25,006	4,446	7,114	8,197	51,785

(in thousand tonnes of oil equivalent - ktoe)
Source: IEA (2004f)

In Turkey, total final energy consumption has increased more than 5 times during the period 1960-2001. Electricity consumption has gradually increased over the years not only in terms of real value but also in terms of percentages (from 1.9% in 1960 to 15.8% in 2001). As for renewables and waste, since their value has not changed a lot over the years; there is an enormous decline in their share in final consumption (from 60.1% in 1960 to 13.7% in 2001). Starting from the late 1980s, natural gas has progressively raised its share in terms of both real value and percentages; and in 2001 its share reached 8.6%. Consumption of petroleum products also increased in real terms; however, this increase slowed down, again, due to post-1973 oil price rises, which caused the share of petroleum products to remain the same since 1973. In 1973, their share in final consumption was 48.5% and in 2001 this figure was 48.3%. Regarding coal, its consumption increased too; however over the last 10 years its share has started to decline in percentage terms. The share of coal was 20.1% in 1988; but by 2001 it had decreased to 13.6%.

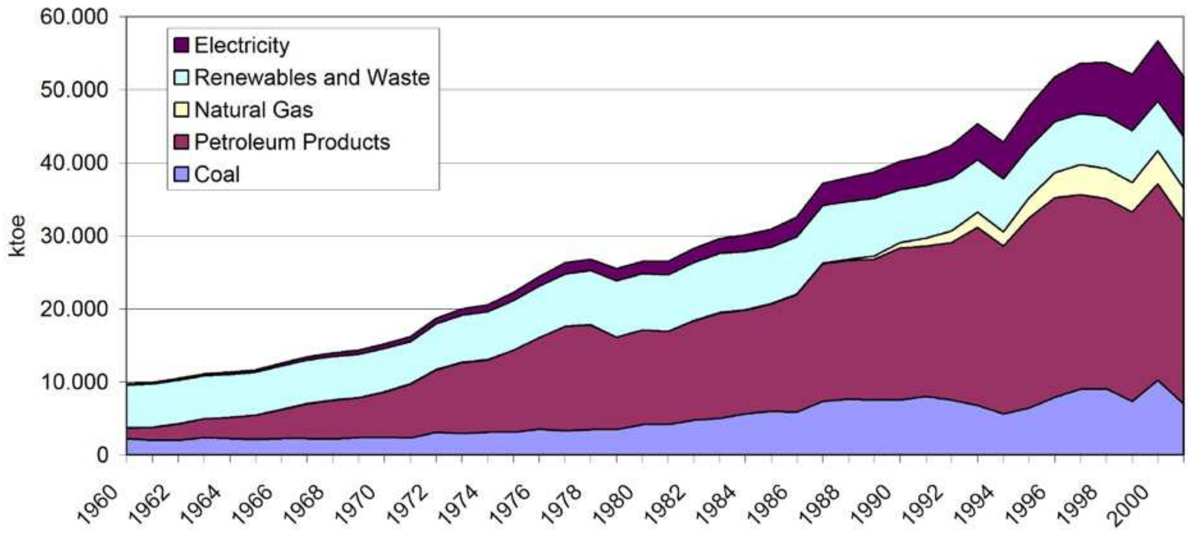


Figure 12. Total Energy Consumption in Turkey (by fuel)

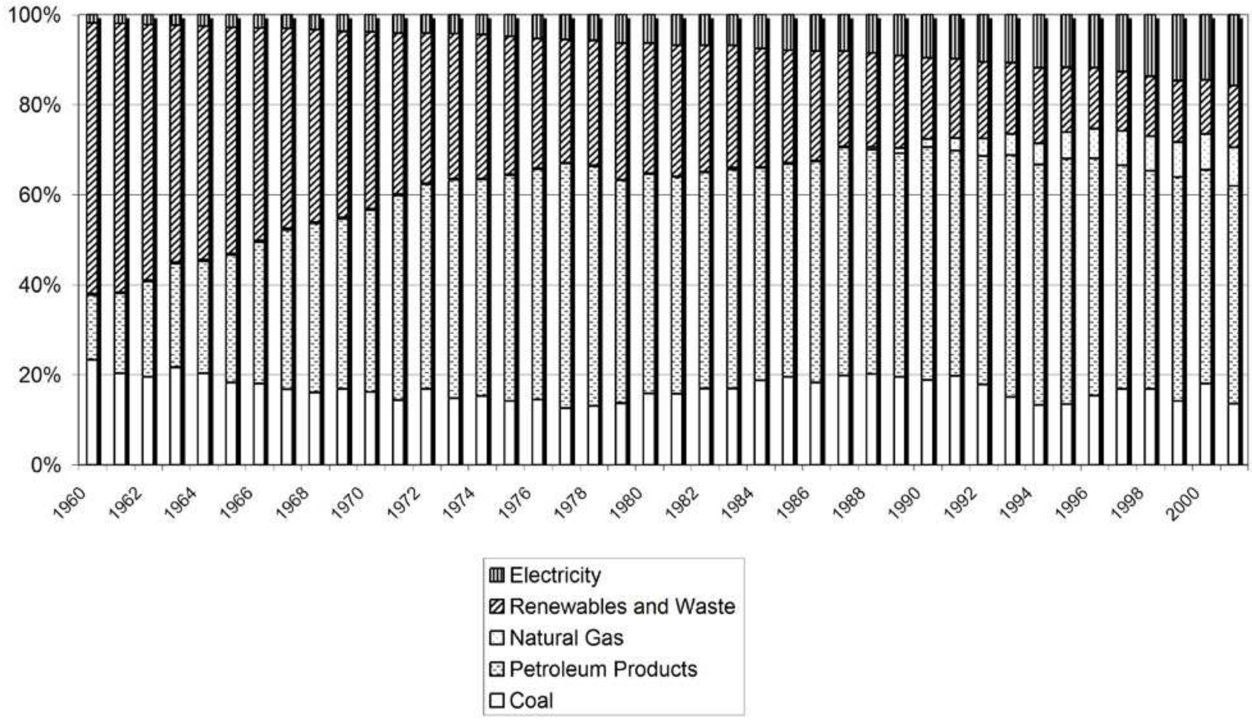


Figure 13. Total Energy Consumption in Turkey (by fuel, percentages)

The table below shows distribution of total final energy consumption among different sectors of Turkish economy. The following two figures depend on these data.

Table 10. Total Energy Consumption in Turkey (by final user)

	Industry	Residential (Domestic)	Transportation	Other	Total
1960	991	7,048	1,588	153	9,780
1961	931	7,058	1,649	325	9,963
1962	1,026	7,185	1,838	426	10,475
1963	1,224	7,382	1,953	542	11,101
1964	1,182	7,453	2,159	559	11,353
1965	1,234	7,418	2,398	636	11,686
1966	1,380	7,619	2,808	760	12,567
1967	1,638	7,994	2,899	906	13,437
1968	1,691	8,277	3,028	966	13,962
1969	1,949	8,424	2,965	1,024	14,362
1970	2,335	8,562	3,270	1,041	15,208
1971	2,790	8,746	3,551	1,128	16,215
1972	3,634	9,814	3,971	1,321	18,740
1973	3,881	10,076	4,486	1,551	19,994
1974	4,002	10,273	4,673	1,596	20,544
1975	4,611	10,436	5,386	1,840	22,273
1976	5,385	11,128	5,834	2,095	24,442
1977	5,772	11,428	6,691	2,401	26,292
1978	6,701	11,735	6,546	1,859	26,841
1979	6,415	11,593	5,877	1,628	25,513
1980	6,929	12,207	5,620	1,745	26,501
1981	7,034	11,932	5,656	1,880	26,502
1982	7,357	12,715	6,061	2,168	28,301
1983	7,656	13,202	6,348	2,405	29,611
1984	8,247	12,883	6,428	2,565	30,123
1985	8,296	13,291	6,653	2,685	30,925
1986	8,417	13,667	7,474	2,995	32,553
1987	10,315	14,859	8,513	3,491	37,178
1988	10,999	14,882	8,726	3,397	38,004
1989	11,770	14,912	8,858	3,171	38,711
1990	12,651	14,266	9,576	3,702	40,195
1991	13,255	14,526	9,204	3,998	40,983
1992	13,651	15,164	9,448	4,116	42,379
1993	13,761	15,085	11,245	5,232	45,323
1994	12,764	14,364	10,887	4,838	42,853
1995	14,455	15,679	12,197	5,411	47,742
1996	16,851	16,068	12,891	5,956	51,766
1997	18,093	16,831	12,193	6,498	53,615
1998	18,724	16,476	11,371	7,169	53,740
1999	16,940	16,592	11,864	6,720	52,116
2000	20,401	16,836	12,498	6,965	56,700
2001	16,389	15,947	11,992	7,457	51,785

(in thousand tonnes of oil equivalent - ktoe)
Source: IEA (2004f)

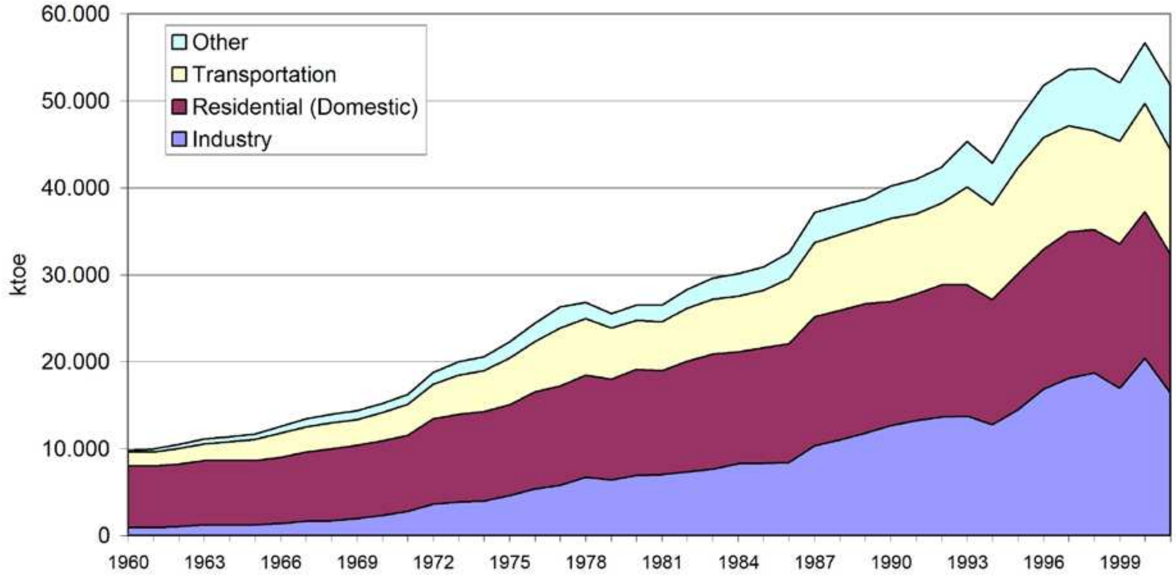


Figure 14. Total Energy Consumption in Turkey (by final user)

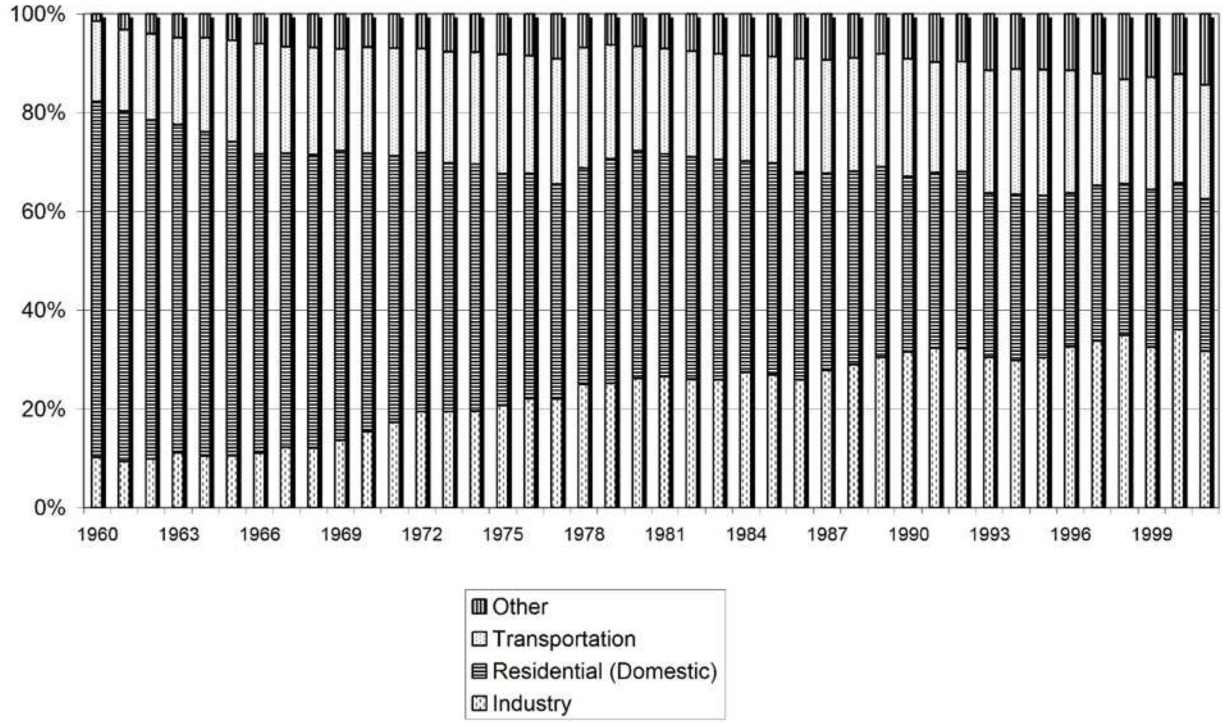


Figure 15. Total Energy Consumption in Turkey (by final user, percentages)

As can be seen in the figures above, energy consumption of the industry sector has increased more than 16 times in real terms over the last 40 years; and its share in final consumption reached 31.6% in 2001, which was just 10.1% in 1960. Although doubled in terms of real value, the share of domestic consumption has massively decreased in the same period (from 72.1% in 1960 to 30.8 % in 2001). As for transportation sector; although it was not as large as in the case of industry sector, there is an increase in the share (from 16.2% in 1960 to 23.2% in2001).

Since any discussion of trends in energy consumption is incomplete unless paying due attention to trends in the energy consumption of three important sectors - namely industrial, residential (domestic) and transportation; now let me turn to this task.

Table below shows distribution of fuels in industrial energy consumption. Following two figures are derived from this table.

Table 11. Industrial Energy Consumption in Turkey

	Coal	Petroleum Products	Natural Gas	Solar, Wind, Other	Electricity	Total
1960	734	132	0	0	125	991
1961	665	136	0	0	130	931
1962	677	192	3	0	154	1,026
1963	838	211	3	0	172	1,224
1964	728	259	3	0	192	1,182
1965	634	374	3	0	223	1,234
1966	705	432	3	0	240	1,380
1967	661	710	2	0	265	1,638
1968	639	749	3	0	300	1,691
1969	715	885	3	0	346	1,949
1970	754	1,203	3	0	375	2,335
1971	710	1,633	3	0	444	2,790
1972	1,142	1,983	3	0	506	3,634
1973	1,139	2,185	3	0	554	3,881
1974	1,188	2,218	3	0	593	4,002
1975	1,447	2,473	3	0	688	4,611
1976	1,519	3,026	3	0	837	5,385
1977	1,465	3,342	3	0	962	5,772
1978	1,791	3,911	3	0	996	6,701
1979	2,009	3,396	4	0	1,006	6,415
1980	2,173	3,708	3	0	1,045	6,929
1981	2,157	3,727	2	0	1,148	7,034
1982	2,258	3,836	36	0	1,227	7,357
1983	2,269	4,062	61	0	1,264	7,656
1984	2,982	3,765	36	0	1,464	8,247
1985	3,008	3,666	43	0	1,579	8,296
1986	2,893	3,808	40	0	1,676	8,417
1987	3,510	4,843	46	0	1,916	10,315
1988	3,995	4,805	172	2	2,025	10,999
1989	4,108	5,036	408	4	2,214	11,770
1990	4,520	5,100	671	8	2,352	12,651
1991	5,003	5,025	955	13	2,259	13,255
1992	4,283	5,532	1,300	17	2,519	13,651
1993	4,011	5,398	1,601	20	2,731	13,761
1994	3,494	5,062	1,458	20	2,730	12,764
1995	3,978	5,750	1,633	20	3,074	14,455
1996	5,705	5,869	1,952	24	3,301	16,851

1997	6,382	5,938	2,198	24	3,551	18,093
1998	7,057	5,925	1,917	24	3,801	18,724
1999	5,712	5,689	1,637	76	3,826	16,940
2000	8,533	6,049	1,758	97	3,964	20,401
2001	5,379	5,556	1,466	118	3,870	16,389

(in thousand tonnes of oil equivalent - ktoe)

Source: IEA (2004f)

As can be seen in the figures below, coal and petroleum products have dominated industrial consumption over the last 40 years. As expected, however, the share of petroleum products started to decline mid 1970s onwards due to oil price shock. Also, electricity has an important share in total industrial energy consumption and its contribution increased from 12.6% in 1960 to 23.6% in 2001. Moreover, since the early 1990s, natural gas has emerged as another fuel consumed by industry. In 2001, its share reached 8.9%. Unfortunately, the consumption of renewables (solar, wind and others) in industrial sector has always been so low that their total has never reached 1%; even their existence cannot be detected in the figures below.

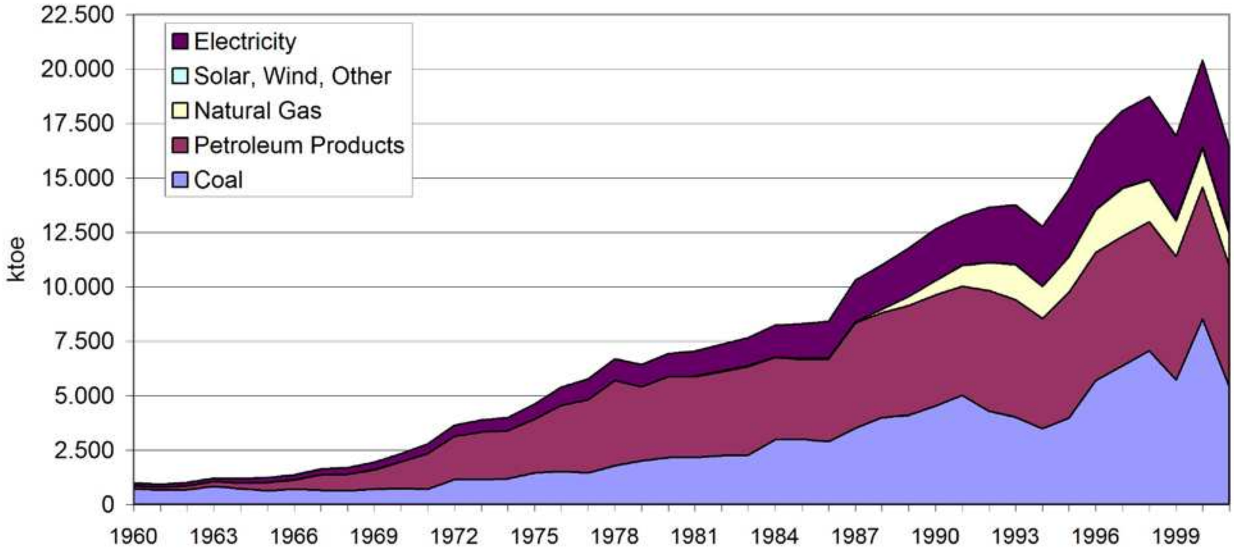


Figure 16. Industrial Energy Consumption in Turkey

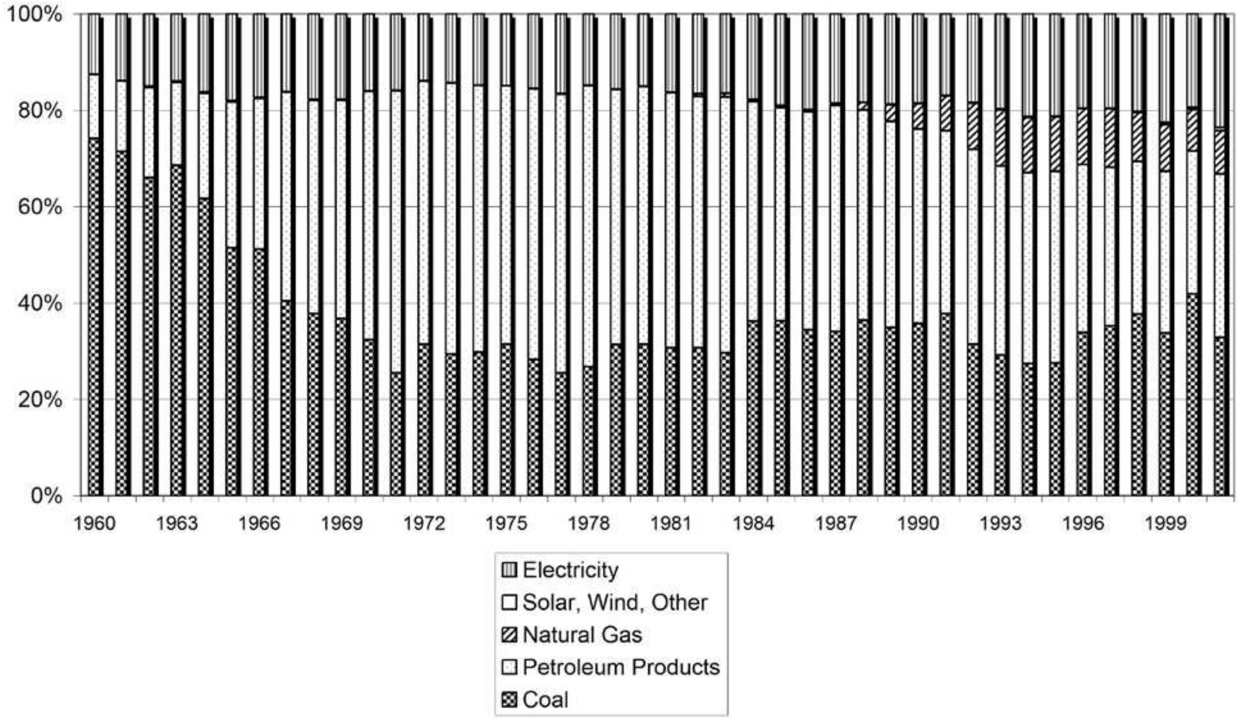


Figure 17. Industrial Energy Consumption in Turkey (percentages)

In the same way, table below shows distribution of fuels in residential (or, domestic) energy consumption. Following figures are obtained from this data.

Table 12. Residential (Domestic) Energy Consumption in Turkey

	Coal	Petroleum Products	Natural Gas	Renewables and Waste	Electricity	Total
1960	728	372	29	5,879	40	7,048
1961	661	375	29	5,950	43	7,058
1962	686	482	26	5,943	48	7,185
1963	911	553	28	5,838	52	7,382
1964	856	612	29	5,895	61	7,453
1965	797	651	33	5,871	66	7,418
1966	854	718	34	5,943	70	7,619
1967	1,016	884	35	5,977	82	7,994
1968	1,016	1,166	36	5,968	91	8,277
1969	1,107	1,232	37	5,939	109	8,424
1970	1,115	1,312	36	5,972	127	8,562
1971	1,044	1,740	35	5,798	129	8,746
1972	1,446	1,955	35	6,246	132	9,814
1973	1,282	2,189	33	6,452	120	10,076
1974	1,401	2,137	32	6,574	129	10,273
1975	1,258	2,170	26	6,819	163	10,436
1976	1,593	2,277	34	7,025	199	11,128
1977	1,532	2,439	34	7,193	230	11,428
1978	1,493	2,505	35	7,448	254	11,735

1979	1,276	2,266	35	7,741	275	11,593
1980	1,837	2,357	32	7,680	301	12,207
1981	1,797	2,062	36	7,722	315	11,932
1982	2,328	2,096	35	7,925	331	12,715
1983	2,531	2,237	33	8,055	346	13,202
1984	2,476	2,070	38	7,929	370	12,883
1985	2,886	2,201	30	7,746	428	13,291
1986	2,950	2,305	29	7,896	487	13,667
1987	3,808	2,559	30	7,902	560	14,859
1988	3,614	2,649	29	7,935	655	14,882
1989	3,405	2,833	25	7,938	711	14,912
1990	3,031	3,170	52	7,234	779	14,266
1991	3,040	3,176	164	7,214	932	14,526
1992	3,245	3,394	317	7,221	987	15,164
1993	2,794	3,604	450	7,157	1,080	15,085
1994	2,157	3,348	524	7,178	1,157	14,364
1995	2,451	3,975	1,123	6,884	1,246	15,679
1996	2,205	4,069	1,410	6,971	1,413	16,068
1997	2,620	3,770	1,835	7,014	1,592	16,831
1998	1,988	3,475	2,159	7,131	1,723	16,476
1999	1,647	3,588	2,368	7,047	1,942	16,592
2000	1,685	3,680	2,694	6,723	2,054	16,836
2001	1,643	2,962	2,320	6,996	2,026	15,947

(in thousand tonnes of oil equivalent - ktoe)
Source: IEA (2004f)

The most striking feature of domestic consumption is the huge share of renewables and waste. Although their share has decreased enormously over the years (from 83.4% in 1960 to 43.9% in 2001); they are still the most important fuels in terms of domestic consumption. The second important fuel in domestic consumption is petroleum products with a share of 18.6% in 2001, which was 5.3% in 1960. Coal has the next important figure with 10.3%. Although the share of coal has fluctuated over the years, in 2001 it returned exactly to its value in 1960, that is 10.3%. Starting with its introduction in 1980s, natural gas has also started to increase its share in domestic consumption and in 2001 it reached 14.5%. Finally, contribution of electricity to domestic consumption has increased gradually and in 2001 its share reached 12.7% from almost nothing in 1960.

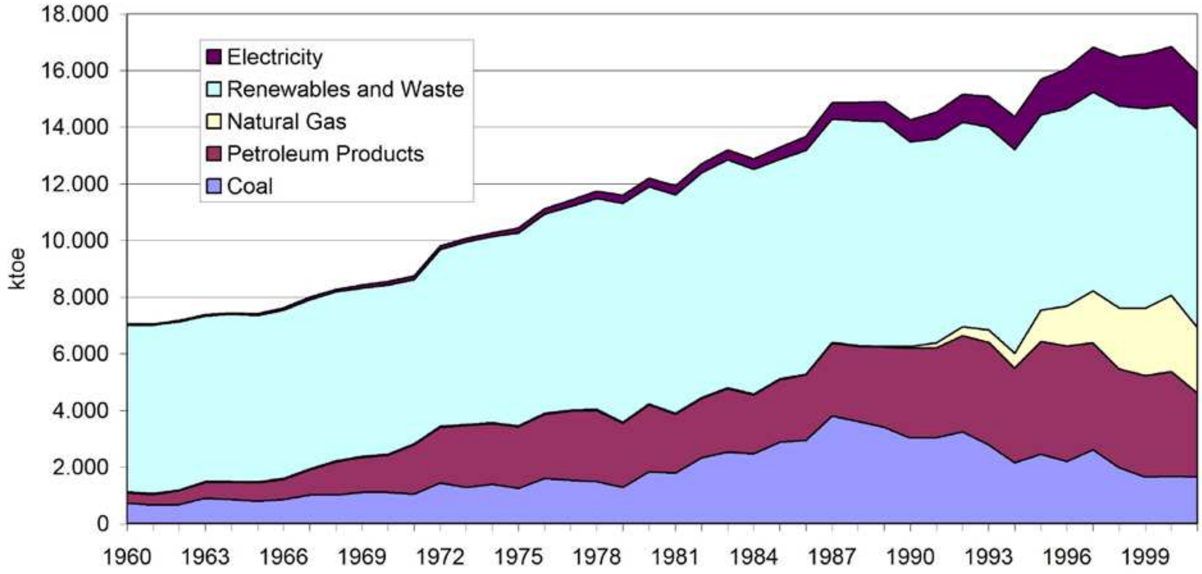


Figure 18. Residential (Domestic) Energy Consumption in Turkey

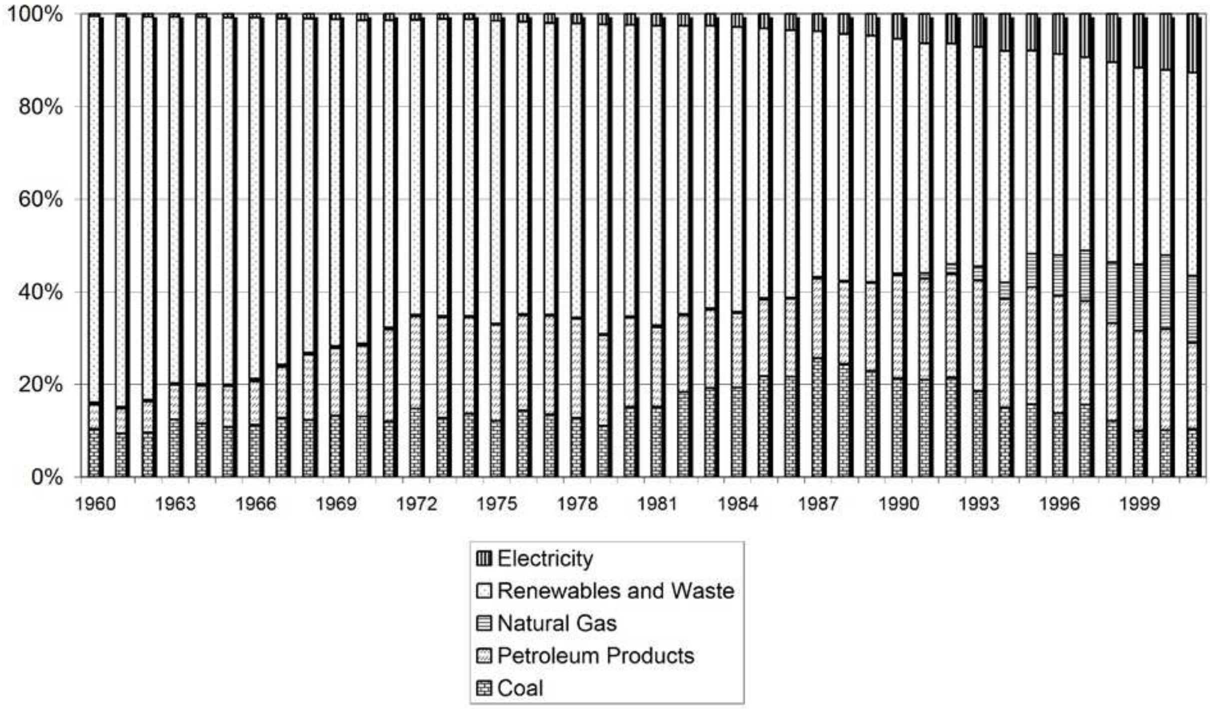


Figure 19. Residential (Domestic) Energy Consumption in Turkey (percentages)

The final sector that I focus on is transportation. Table below shows relevant data. In 2001, given over 99% dominance of petroleum products in this sector, we even do not need to look at graphs to see the importance of petroleum products. However, still I provide them so as to identify the development of petroleum products since 1960, when this figure was only 48.3%.

Table 13. Transportation Sector Energy Consumption in Turkey

	Petroleum Products	Others	Total
1960	767	821	1,588
1961	951	698	1,649
1962	1,152	686	1,838
1963	1,297	656	1,953
1964	1,437	722	2,159
1965	1,699	699	2,398
1966	2,087	721	2,808
1967	2,310	589	2,899
1968	2,431	597	3,028
1969	2,358	607	2,965
1970	2,673	597	3,270
1971	2,968	583	3,551
1972	3,400	571	3,971
1973	3,953	533	4,486
1974	4,133	540	4,673
1975	4,922	464	5,386
1976	5,395	439	5,834
1977	6,390	301	6,691
1978	6,310	236	6,546
1979	5,662	215	5,877
1980	5,426	194	5,620

	Petroleum Products	Others	Total
1981	5,432	224	5,656
1982	5,831	230	6,061
1983	6,128	220	6,348
1984	6,242	186	6,428
1985	6,512	141	6,653
1986	7,383	91	7,474
1987	8,430	83	8,513
1988	8,653	73	8,726
1989	8,803	55	8,858
1990	9,531	45	9,576
1991	9,158	46	9,204
1992	9,378	70	9,448
1993	11,164	81	11,245
1994	10,811	76	10,887
1995	12,132	65	12,197
1996	12,809	82	12,891
1997	12,135	58	12,193
1998	11,301	70	11,371
1999	11,788	76	11,864
2000	12,391	107	12,498
2001	11,891	101	11,992

(in thousand tonnes of oil equivalent - ktoe)

Source: IEA (2004f)

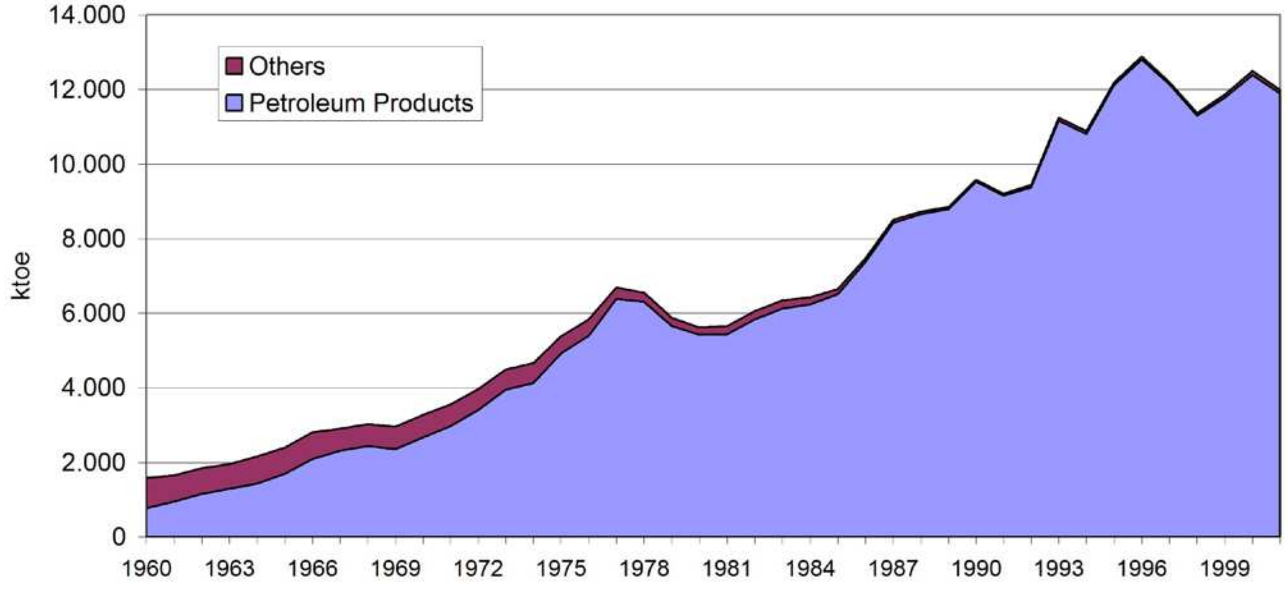


Figure 20. Transportation Sector Energy Consumption in Turkey

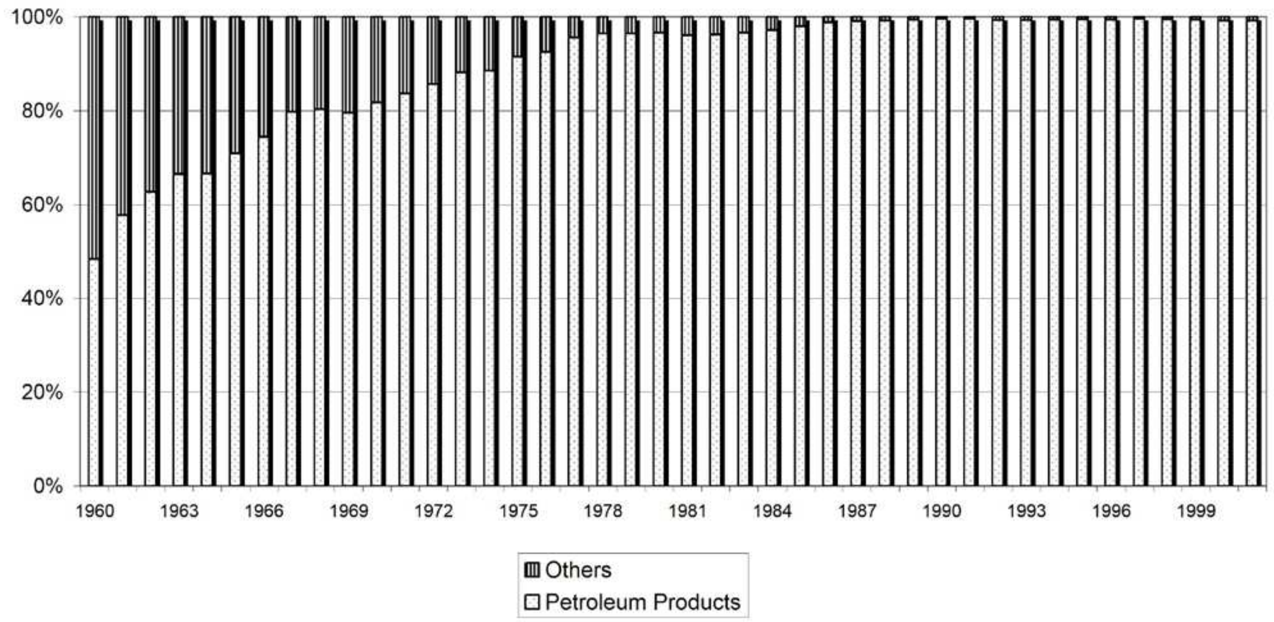


Figure 21. Transportation Sector Energy Consumption in Turkey (percentages)

Appendix 2: Literature Review in Regulation

A-2.1 Introduction

> "*Monopoly, besides, is a great enemy to good management, which can never be universally established but in consequence of that free and universal competition which forces everybody to have recourse to it for the sake of self-defence.*" (Smith, 1776, p 202)

The arguments for not allowing direct competition in businesses supplying "utilities", such as electricity and natural gas, and subjecting them to regulation have their origins even in The Wealth of Nations of 1776, the famous book of Adam Smith. Since then it has become a conventional wisdom that the market failures in the utility industries were so great as to legitimize intervention in free market in the form regulation.

The main purpose of this section is both to examine some of the underlying principles of any effective regulatory policy and to provide a theoretical background to the economics of regulation.

The next section offers both a definition of the problem of natural monopoly and a discussion of methods proposed to overcome it. Section 3 discusses some key concepts required for a full understanding of an evaluation of any regulatory policy. Section 4 focuses on the reasons for the need for a regulatory system. Section 5 reviews the objectives of regulation. The following section concentrates on some major topics in regulation; namely, the problem of asymmetric information, the principal-agent theory, regulatory commitment, regulatory capture, regulatory failure and, finally, the distinction between economic and non-economic regulation. The final section presents a review of methods employed in the economic regulation of electricity and natural gas utilities.

A-2.2 The Problem of Natural Monopoly

It is, by and large, an accepted wisdom that natural monopolies[47] need to be watched, or regulated. The logic behind this persuasion is that firms in monopoly positions, whether public or private, have a tendency to exploit their dominant position for their own benefit at the expense of consumers. Throughout the history, two main patters have been evolved to overcome the so-called "problem of natural monopoly"; namely, vertically integrated state monopolies and regulated private utilities. In the former case, state ownership of vertically integrated monopolies has been seen as a solution to the conflict between the private and public interests. However, the experience showed that public ownership tends to be trapped in an inefficient equilibrium that reflects the balance of power of the various interest groups. Therefore, the latter pattern acquired the dominance; and privatization, combined with restructuring, including vertical separation, of public utilities and liberalizing access to private

[47] In Economics, 'natural monopoly' refers to a case where a single firm can meet the entire market demand for a range of goods or services at lower total cost than any other combination of firms.

utilities have gradually been employed to disturb this inefficient equilibrium within a regulatory framework.

A-2.3 Key Concepts in Regulatory Policy

A-2.3.1 Liberalization

Liberalization means the opening up of a service or product to more than one supplier under the control of a regulator. It requires policy changes to reduce entry barriers to the industry, together with the replacement of government funding of investment projects by reliance on the private capital markets.

A-2.3.2 Restructuring

More than any other single factor, underlying structure of the particular industry being regulated defines the context in which regulatory agencies operate. A vertically integrated monopoly[48] is the most difficult of all “monsters” to regulate. Therefore, in almost all cases, it is vital to restructure (or, break-up) the industry before privatization to set up a viable regulatory system. However, it is not an easy task. Substantial reform of any public enterprise is a politically sensitive issue. Although no one defends the status quo as ideal, any deviation from it offends some interests too much.

Despite the fact that the break-up of monopolies does not necessarily result in direct competition, it has argued that even when there is no additional direct competition, break-up may still be beneficial. Smaller natural monopolies will have less ability to cross-subsidize than larger ones; thus, break-up may increase the possibility of future competition by making predation less possible. Moreover, there will be more innovation and greater diversity of operation if there are several operators than if there is just one. Also, most importantly, more than one monopoly makes inter-firm comparison possible; and, thereby, enables the regulator to compare performance.

A-2.3.3 Privatization

Privatization simply means the sale of at least more than 50% of a state-owned asset to private agents.

The balance between state and market experienced a radical shift with the fall of the Berlin wall in 1989. Since then, the boundaries of the state have started to shift; and the privatizations in Britain and the transition from state socialism to the market economy in Eastern Europe accelerated this shift. Within less then a decade, privatization spread around the world. Today, the English model of vertical separation succeeded by privatization and regulation is rapidly becoming the reference model for reform in both developed and developing countries.

[48] Vertically integrated private network utilities have many of the drawbacks of public monopolies, with the added disadvantage that the government no longer has the power to order their reorganization and restructuring.

The reasons for privatization are manifold. As will be argued shortly in this section, the ultimate and most important aim of economic regulation is ensuring “economic efficiency”; and it can be realized in full sense only by effective competition, which requires reducing the role of government in economic life as a whole. Shleifer (1998) underlines the reasons why privatization is not only desirable but also crucial to an efficient economy. The case for private ownership made in his paper rests essentially on the importance of **incentives to innovate** and **to reduce costs**. For him, the weak incentive of government employees concerning both cost reduction and innovation is the basic reason of superiority of private ownership. He argues that even the pursuit of "social goals" cannot be used to justify state ownership. The concerns, he maintains, that private firms fail to address "social goals" can be addressed through effective regulation, without resort to state ownership. He especially draws attention to non-benevolent government, which he describes as “more realistic”; and for him bureaucrats’ pursuit of political goals and personal income, as opposed to social wellbeing, makes the case for private ownership stronger. Even this point made by A. Shleifer alone is enough to privatize all energy assets in any country as without incentives to innovate and to reduce costs, which are definitely lacking in most public enterprises, economic efficiency is impossible to realize. In a state-owned company, prices do not reflect costs; and costs themselves are usually inflated through excessive employment and excessively expensive capital; incentives to innovate are reduced to minimum (or in worst cases to zero); quality of service is lower than in a competitive environment; and the number of choices available to consumers is extremely limited (or even reduced to one!). What is more striking and dangerous is that until the point when it is seen to be in crisis from outside, a public enterprise never feels a failure no matter what is the degree of its failure in realizing economic efficiency.

The other reasons for privatization cited in the literature may be summarized as follows. Privatization provides competition with a fertile ground to develop. Also, it is argued that the valuation of the company by movements in its share price in stock exchanges is potentially an important check on a privatized enterprise’s performance. Moreover, the possibility of a hostile takeover in a competitive market imposes a fierce discipline on the management and provides a powerful incentive to good management because a takeover usually leads to many changes near the top. Furthermore, some scholars claim that the most important effect of privatization is that the changes it brings about become practically irreversible. In the case of reforming public enterprises, the possibility is much greater that a change of government or even just a change in the opinion of the same government will undermine all reforms and may result in a return to the old interventionism and confusion. Privatization, on the other hand is less reversible not only because the legislation needed to reverse it would be more complex, and because in some cases the privatized bodies have disappeared into other firms or acquired overseas ownership, but also because too many interests have been created that are opposed to renationalization.

A-2.3.4 Regulation

Littlechild (1983) states:

> "*Competition is indisputably the most effective means – perhaps ultimately the only effective means – of protecting consumers against monopoly power. Regulation is essentially a means of preventing the worst cases of monopoly; it is not a substitute for competition. It is a means of 'holding the fort' until competition arrives.*"

The statement above well defines the role of regulation in a regulatory system; and implies that although the private industry with regulation is far from perfect, it is the best answer currently available to monopoly problem.

In line with the statement above, the experience so far has confirmed that regulation is a more efficient means of controlling monopoly power than state ownership; although competition is superior to both. So, regulation is not a perfect instrument for controlling monopoly power but it seems to serve the public interest better than state ownership (Stelzer, 2002).

Actually, regulation is unavoidably inefficient. The inherent sources of inefficiency in regulation are various. For instance, regulated prices may deviate from costs unless economic and non-economic objectives are clearly separated. Also, regulation is itself an expensive activity and easily spreads from economics into politics, if not properly managed. There are also other more fundamental problems inherent in any regulatory situation; namely, information asymmetries, commitment issues, the possibility of regulatory capture and/or failure; which will be discussed in the course of the paper in more detail. Despite the fact that there are no easy escapes from all these problems inherent in regulation, in industries with natural monopoly characteristics, the extension of competition requires regulation in order to be effective.

As suggested by Professor David M. Newbery (Newbery, 2000, p 134), since regulation is inherently inefficient, the rule for any regulatory system is simple: "competition where possible, regulation only where unavoidable". Therefore, all reform programs should aim at confining regulation to the core natural monopoly of the network and thereby minimizing the extent of regulatory inefficiency. So, the most important problem to address in any reform process is to choose the right structure for the industry that will limit the need for naturally inefficient regulation.

Actually, the main idea of this section may be put forward as follows: "the most important feature of regulation should be that *there should be as little of it as possible*, which involves the identifying the precise sources of market failure in industries and targeting regulation specifically on these areas.

Another crucial issue in the regulation of any industry is the independence of the regulator. The basic principle is that regulators have to be independent not only from the regulated but also from all other parties involved. Otherwise, conflicts of interests are unavoidable, and regulation is bound to deteriorate.

Therefore, careful design of regulatory institutions is needed to ensure effective independence of the regulator.

The independence of the regulator, however, needs to be differentiated from lack of accountability. Regulatory agencies, like any other public body, must be held accountable for their actions and be subject to adequate controls. Regulatory agencies built on the principles of independence and accountability have the highest potential to deal effectively with the regulatory challenges.

Another current theme in the regulation literature is the appropriate division of labour between, on the one hand, the general competition authorities and, on the other, the specialist regulators; or between “generalists” and “specialists”. The task of “regulation” to promote and maintain competition in the industries with dominant privatized firms should belong to the regulatory authority for that industry. Otherwise, the firms in the industry may be confused about whose decisions to obey; and more importantly, they may play one authority against the other if their interests require them to do so.

Finally, it is important to underline the fact that regulation may sometimes be essential to maintain freedom of entry even where competition is present. In most cases, the dominant firm(s) with market power in any market has at its disposal a variety of instruments of strategic entry deterrence and incentives for predatory behavior, which constitutes a potential threat to competition; and therefore regulation may be needed to defeat this threat even if competition exists.

A-2.3.5 Competition

Competition refers to a situation in which the price and quantity supplied is set at the economically efficient level and the price is beyond the influence of the firm(s), giving maximum incentive to reduce costs and innovate as the only ways to increase profits.

The competitive forces to be found in markets rather than bureaucratic structures produce a superior allocation of resources. Although privatization provides greater incentives for cost minimization, encourages more efficient managerial supervision; it alone is not sufficient for economic efficiency. Also, since regulation is inevitably inefficient, effective competition remains to be the only viable way to realize full economic efficiency. Actually, competition’s invisible hand is the best regulator because, under the pressure of competition, firms reveal more facts about their costs that can ever be extracted from them by regulation; and they will reduce costs to the minimum for fear that they will otherwise be undercut by rivals. And, provided that there is enough competition, it will be harder and less rewarding for firms to engage in anti-competitive practices. For instance, in electricity industry, it is not easy to ensure that utilities in monopoly positions operate their generation plant efficiently and at minimum cost. However, when a utility knows that it has no monopoly power and consumers may turn to other sources of supply if they think that there would be a benefit to them in doing so, the pressures to operate efficiently are much greater. Also, any utility would try to do its best to minimize its cost while generating electricity if it knew that its customers were able to switch to a lower-cost competitor. In short, the key innovation that makes a difference in terms of economic efficiency is the introduction of competition.

Despite its central role in provision of economic efficiency, it is imperative to realize that competition is not a panacea for all problems that a specific industry suffers from. One should be aware of what competition can and cannot achieve. Under competitive environment, prices tend to reflect costs more closely; investment and purchasing decisions tend to reflect the concerns of profit rather than political ones; management is under greater pressure to operate efficiently; there is a greater scope of choice for consumers, the terms and contracts offered increasingly reflect the latest most effective method of providing the specific good or service under consideration. Nevertheless, neither competition can automatically deliver price reductions nor should price reduction itself be an ultimate aim for regulators. If the market conditions require price increases, price rises may be beneficial as they convey signals to consumers concerning how to modify their consumption behavior at the benefit of general public. To make this point clearer, suppose that there is a dual-fired factory that can be run either by electricity or natural gas, and there occurred an unexpected increase in the price of inputs used to produce electricity. Under these circumstances, the most efficient policy to follow is to switch from electricity to natural gas as the latter is cheaper. However, without a working market, prices do not reflect the increase in input costs and the factory in our example continue to use electricity, which is inefficient for economy in general. On the other hand, in a market-based economy, as electricity prices are expected to reflect input cost rises, they increase concomitant with input prices, which motivates factory managers to switch to natural gas, therefore, helping to reach efficient allocation of resources. Therefore, unless there is a kind of market failure, it is better to let market determine the price.

As a final point, from a practical perspective, it is important to keep in mind the fact that the claim that competition is not possible in many so-called “natural” monopoly industries has been greatly exaggerated; and many of the so-called “natural” monopolies are not truly natural, but they are intentionally and artificially created. For instance, while a gas or electricity transmission network, under current technological conditions, may have natural monopoly features; it is doubtful that only one gas or electricity transmission company serving the whole country can be justified. Evans (1989), for example, reports that in Lubbock (Texas, USA), a city of some 150.000 people, two distribution companies operate in the market each using their own network; and that the competition still produces lower electricity prices and better service despite duplication of assets.

A-2.3.6 Deregulation

Deregulation refers to reducing the level of regulation and replacing regulation with competition and market forces. The wave of deregulation that started in the late 1970s in the US showed that markets are better than regulators at reducing prices and increasing efficiency. However, since deregulation is a very distant target for developing countries like Turkey, the details of deregulation will not be discussed here.

A-2.4 The Reasons for Regulation

In most cases, intervention in free market economy is rationalized by the existence of market failures. Since the main form of market failure in utilities is monopoly; in the past, the most powerful economic justification for public intervention was the prevention of possible monopoly abuse. However, a huge literature has documented how public-sector has been largely inefficient in reducing the impact of market failure. So, under these conditions, public ownership thought to be unjustifiable and a far better solution has turned out to be private ownership combined with regulation targeted directly on the identified sources of market failure.

To be brief, it may be argued that the only reason and valid justification for economic regulation is the existence of market failure in the form of abuse of monopoly power. If there is no actual or potential threat of monopoly, then there is simply no need for economic regulation and the policy should be *laissez-faire*[49] in the specific industry under consideration.

A-2.5 Objectives of Regulation

From a theoretical perspective, the objective of regulation[50] is essentially the realization of "economic efficiency", captured by the concept of "Pareto efficiency"[51].

In a practical perspective, on the other hand, the aim of regulation is to design an incentive mechanism so that individual economic actors making decisions in their own best interest achieve "economic efficiency" in general. To realize this, the regulatory approach should attempt to affect economic decisions of the *private* actors in the regulated industry both by placing constrains upon them and by providing them with incentives to act in accordance with the ultimate aim of "economic efficiency", but not by seeking to change their underlying objectives based on self-interest, which is not realistic and, in most cases, simply impossible.

A-2.6 Major Topics in Regulation

A-2.6.1 The Problem of Asymmetric Information

The effectiveness of regulation depends critically upon the information available to the regulators since a regulator can condition its policy only on what it knows.

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[49] Laissez-faire is short for 'laissez-faire, laissez-passer', a French phrase meaning idiomatically 'leave to do, leave to pass' or more accurately 'let things alone, let them pass'. First used in the eighteenth century as an injunction against government interference with trade, it is now used as a synonym for free market economics.

[50] Although the idea presented here is the dominant one in the theory of economic regulation, there are some other 'marginal' views of regulation based on various Marxist theories, which state that regulatory institutions are a part of oppressive institutions of capitalism and the function of regulation is simply to preserve the capitalist system by buying off potentially damaging opposition.

[51] Pareto efficiency refers to a situation in which it is impossible to make someone better off without making someone else worse off by re-arranging the firms, the flows, the production decisions, the consumption decisions or anything else in the economy.

If both the regulator and the firm had access to the same information about industry conditions, then the regulatory problem could be solved simply by directing the firm to implement the economically efficient plan given the common information available. In reality, however, the firm is much better informed about industry conditions than the regulator and its behavior can be monitored only imperfectly, meaning that, the regulator is unlikely to be able to regulate the firm's activities in full sense. The state of this unbalanced or "asymmetric" information benefits the regulated at the expense of not only the regulator but also actual and potential competitors and customers. Therefore, this so-called "asymmetric information problem" is at the heart of the economics of regulation[52].

The regulatory question is, then, how to motivate the managers of the regulated firm to exploit their superior information to advantage despite the problem of imperfect information and monitoring. From a practical point of view, to alleviate this problem, the regulators should make the regulated provide information and, as far as possible, the information provided must be relevant, periodic and produced as a matter of routine on the basis of agreed or established conventions.

A-2.6.2 The Principal-Agent Theory

Principal-agent theory tries to address the question: what is the optimal incentive scheme for the principal to design for the agent. The general description of the idea may be put forward as follows. There exists a principal and an agent, who have different - and probably conflicting - objectives. The principal needs to hire the "agent" with specific skills or knowledge to perform the tasks that are too complex or too costly to do by himself/herself, and wants to induce the agent to act in his/her interests. However, s/he does not have full information about the circumstances and behaviour of the agent, and therefore s/he has an information and monitoring problem.

Principal-agent theory can be used to analyze regulation too. In this context, the regulator is both an agent (for government) and a principal (of the firm); and the firm is the agent of the regulator. In the same way, the government may be regarded as an agent for voters and a principal of the regulator. The sequence of principal-agent relationship may be put down as follows:

Voters → Government → Regulator → Firm

With this perspective, again, a system of regulation can be regarded as an incentive mechanism design. The firm, say, is better informed than the regulator about cost conditions; and the regulator seeks to induce the firm to make its pricing, production, and investment decisions in accordance with the public interest. But the firm is interested in maximizing, say, its profits and will act in its own interests, irrespective of the regulatory regime that exists. Then, the major question again is how the principal (or, the regulator) can best induce the agent (or, the firm) to perform as the principal would prefer, taking into account the difficulties in observing the agent's activities.

[52] Actually, the problem of asymmetric information is one of the major sources of inefficiency inherent in regulation.

A-2.6.3 Regulatory Commitment

The history has shown that power corrupts and absolute power tends to corrupt absolutely. Since, within its area of regulation, the discretion of a regulator tends to be absolute; the seeds of decay are present in any regulatory system. Therefore, the any regulatory system should ensure that the regulator itself is committed to the ultimate aim of economic efficiency.

The regulatory system itself affects the cost of capital[53] and; especially, regulatory uncertainty may directly result in both economic inefficiency and, therefore, regulatory failure by creating significant increases in the cost of capital over and above those arising from normal economic uncertainty. Therefore, uncertainty in the regulatory process should be avoided at all costs. The only way to do so is to create a confidence in regulatory system to persuade all interested parties that the regulator is totally committed to the industry and all decisions made by it serve the objective of economic efficiency. So, another vital question in any regulatory structure is how to create and maintain "regulatory commitment" to prevent what is called regulatory opportunism.

Transparency in the regulatory process is an indispensable component of regulatory commitment and, without it, it is impossible to ensure regulatory commitment and, therefore, to realize economic efficiency. Transparency entails that the regulator is required to explain and justify its decisions and publish the evidence on which they are based; and also the process in which the regulatory decisions are made is open to public. It also puts a significant pressure on the regulator to ensure that its decisions are well thought out, and can be defended as rational and beneficial. Also, a body of precedent must be developed to provide some guide to industry and to separate acceptable from unacceptable behavior. By rejecting transparent procedures, any regulator definitely loses the public credibility, on which its success and acceptance so crucially depend.

The second component of regulatory commitment is the provision of some appeal procedures for the firms, consumers or any other related parties against the decisions of the regulator. Since regulation can never be an exact science and regulators can fail; the procedures for adjudicating disputes between regulators and the companies should be clear and fair for both sides, which reduces regulatory uncertainty and, therefore, strengthens not only the regulatory commitment but also the position of the regulator in the face of possible criticisms on the ground of arbitrariness in the decision making process.

The appeals, however, should be in the first instance to a tribunal that acts with similar discretion and flexibility to that of the first-tier regulator, not to a court. That is, it should be another body specializing in economic regulation. Of course, the regulated firms should also have a right of appeal to a court. However, the appeals on merits and interpretation of the law in the first instance should preferably be to another regulatory body with similar discretion and

[53] The cost of capital may be defined as the risk-adjusted return that investors in a firm expect to receive in a competitive market.

procedures; and a higher court may act as a court of appeal to deal with appeals against the decisions of the specialized body by the regulator, the firms or any other related party. The main reason for such a requirement is the fact that as courts, in general, do not have required expertise in the regulated areas; a body that is explicitly concerned with regulatory cases is able to provide expert analysis of the particular issues that confront regulated firms.

The third building block of "regulatory commitment" is an appropriate form of relationship between regulator and the regulated that guarantees security and certainty for the firm. In literature, the relation between the regulator and the firm is best thought of as a contract to avoid uncertainty in regulatory process. Actually, the design of a "regulatory contract" should be quite similar to drafting of a long-term contract between private parties that in essence addresses a number of issues to maximize the economic benefits of the relationship. Therefore, the licences granted by the regulator to the regulated, which allows the latter to operate in the market regulated by the former, should be in the form of a private contract, not that of a decree issued by the regulator that may unilaterally be amended or totally cancelled by the regulator at any time.

Since legislation can be changed easily as a result of a change in government or even a change in the opinion of the same government; then putting some guarantees in law does not provide much security for the firm. Therefore, the main body of regulation should be included in the kind of licences described above[54].

The fourth cornerstone in the construction of "regulatory commitment" is the quality of the person(s)[55] in the position of the regulator; that is, in any regulatory process, people definitely matter. For instance, the UK has been relatively successful in market regulation partly because she has managed to find a set of quite able, fair-minded regulators. Professor Stephen C. Littlechild, for example, was Director General of Electricity Supply (DGES), in charge of the Office of Electricity Regulation (OFFER), from its foundation in September 1989 to 1998[56].

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[54] Of course, here, I assume that the courts are independent and well able to enforce contracts. However, if that is lacking; then there may be no credible method of ensuring regulatory commitment at all. Actually, the institutional endowment of the country under consideration is critically important in the success of regulation. For instance, the UK has been relatively successful in regulation partly because she is a country with an independent judiciary, a competent administration, and a set of institutions to manage competition policy and resolve regulatory disputes.

[55] The regulator can be either a board (multi-person commission) or a single individual. The choice should be made based on the specific characteristics of each country provided that consistency in the regulatory process is guaranteed.

[56] In 1992, only two years after the introduction of new system in UK electricity market, the reform under his direction was so successful that he was able to state "[a]t first, there was considerable skepticism as to whether the new system would work at all. Some commentators feared that electricity supply would be disrupted because it was simply not possible to create a competitive market under which different companies generated and supplied electricity. Others worried that security of supply in the longer term would be threatened, because there were insufficient incentives for existing generators to build new plant or for new generators to enter the market. In fact, these worries have so far proven unfounded" (Littlechild, 1993, p.120).

To sum up, regulatory mechanisms in general are designed to constrain the power of private firms; but regulatory commitment also requires that the power of the regulators must be constrained too.

A-2.6.4 Regulatory Capture

The concept of "regulatory capture" refers to a situation in which the regulator becomes the firm's advocate and, therefore, an instrument for the maintenance of monopoly power, rather than controlling and diminishing it.

A regulated industry has many incentives to capture a regulator[57]. And it can attempt this by influencing the relevant legislation, by securing the appointment of a sympathetic regulator, by influencing the proceedings or by any other way available.

Regulatory capture by the regulated industry can be prevented by active consumer participation in the regulatory process. A regulator is less likely to want, or be able, to yield its discretion to the firm(s) it regulates if it is under a countervailing influence from consumers. Therefore, the consumer representation should be made effective. The idea is simply to institutionalize consumer concern so as to prevent regulatory capture. However, the consumer associations are expected to be a force pushing regulation into social, and away from economic, matters. Also, consumer bodies in practice do not escape political influence. Their concern is not economic efficiency, and they do not see it as part of their concern to give due weight to producer interests or directly to competition. That is to say, the regulatory capture by consumers is another critical issue to deal with; and it is hardly to be preferred to the one by the regulated firm(s). Therefore, it should be ensured that consumer commitees' attention is confined to economic matters (e.g. prices, quality and other related issues); and does not spread over political or non-economic matters.

Taking into account the concerns mentioned above, an ideal arrangement in the design of an economic regulatory system is to place the regulator in a position where representations are made to it by producers and informed consumer representatives in a context in which the key issues are economic.

Regulatory capture by government is also as much a threat to regulatory process as is capture by the industry or consumers. In countries where governments traditionally have strong powers, regulatory capture by government is a likely outcome. Furthermore, the government, rather than the regulator, may also be captured by the industry; and the firm(s) in the regulated industry may try to exercise power over the regulator indirectly via government they captured to influence regulatory decisions in line with their interests. To prevent all these, ministerial and other political influences must be constrained as far as possible to roles that do not allow them to influence regulatory decisions.

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[57] From a theoretical perspective, any regulated firm is ready to devote all positive economic rent to "capture" the regulator since, once it captures the regulator, the firm receives all the positive economic rent minus the expenses incurred to capture the regulator. In practice, this means that the firms have huge amounts of resources at their disposal to capture the regulator.

To sum it up, the regulator must not be captured either by the industry or its employees or by politicians or by other particular interests, or by self-interest. It should be kept in mind that if the regulator is captured, the situation turns out to be worse than the one under uncontrolled monopoly case as now the abuse by monopoly may be legitimized by the decisions of the captured regulator.

A-2.6.5 Regulatory Failure

A regulatory system which has objectives that either in principle or in practice differ from that of economic efficiency spells regulatory failure from an economic perspective. Apart from this, various other kinds of regulatory failure have been identified in literature.

First of all, there is a failure from the perspective of the industry where at worst it does not continue to be profitable enough to maintain its capital. This may be due to the arrival of new technology; a marked increase in competition; or major changes in economic circumstances to which regulatory mechanism does not adapt. Therefore, from this perspective, regulatory failure occurs when the regulatory system fails to adapt.

Also, since the effects of regulatory policy on social welfare depend critically on the investment behavior that it induces, the problem of underinvestment constitutes another source of regulatory failure. One of the major sources of underinvestment has been the fear of “unfair” future regulation. To prevent this, regulators have to make sure that the system does not result in profits inadequate to attract enough capital to survive.

Another form of failure emerges when the regulator cannot regulate. This occurs when courts reduce regulators to impotence or ministers use or abuse any powers to obstruct the regulator or to convert it into their agent. Moreover, regulatory failure arises when the regulator no longer commands enough political support for it to continue regulation. For other parties, regulatory failure emerges when they feel that a regulatory system does not reflect their interests. Since all these problems are country specific, each country should take necessary steps to prevent these kinds of failures.

The main regulatory failures, however, derive from the way in which the regulators were left to implement competition using too wide discretion granted to them by related laws. The exercise of this discretion is not easy for investors or entrants to predict, with the result that the cost of capital may be increased, and competition may be weaker. Additionally, regulatory failures are most in evidence where the form of privatization has been incorrect. Since the form of regulation is usually dictated by the structure of industries and the way they are privatized; if the form of privatization is incorrect, regulators may face impossible task of trying to compensate for the deficiencies of inappropriately structured private sectors. For instance, if state-owned monopoly industries are converted into monopoly private-sector utilities, opportunities for introducing competition are missed; and proper regulation becomes almost impossible.

A-2.6.6 Economic and Non-Economic Regulation

A distinction should be made in any regulatory system between economic and non-economic regulation. Economic regulation may be defined as the one that aims at realizing “economic efficiency”; non-economic regulation, on the other hand, deals with the promotion of non-economic objectives, such as, social justice, security, safety, environmental protection, the achievement of fairness between various interest groups, the enhancement of the status of certain groups, the redistribution of income, or the service of some other kind favored by the government. In an ideal regulatory design, these two should be clearly separated, the regulatory body should only be responsible for economic regulation; and other kinds of regulation should be left to related government departments.

However, in practice, the motives of those who set up and alter regulatory systems are not purely economic; and therefore, the relevant laws almost always admit other objectives (especially so-called “social” ones) besides economic ones, often inconsistently. Also, once a regulatory structure is set up, governments are tempted to use it for other purposes, especially for macro-economic policy objectives. Despite all such kind of practical difficulties, a regulator should do its best to keep non-economic regulation to the minimum. Otherwise, the regulator’s discretion is sooner or later jeopardized by unwise extensions of non-economic regulation. Also, a regulator is more likely to keep the independence he needs in order to use its discretion if it narrows its task down as far as possible to economic regulation.

A-2.7 Economic Regulation of Electricity and Natural Gas Utilities

Having briefly covered the key components of market regulation literature let me concentrate on price regulation methods that are employed in real life. However, before doing so, it is better to be aware of both the characteristics of the industries under consideration and basic evolution of price regulation techniques. Therefore, the first part of this section presents the characteristics of electricity and natural gas industries in a few words, followed by the second part that discusses the historical evolution of price regulation methods. The third part focuses on various price regulation methods, especially on those extensively used by regulators in actual life.

A-2.7.1 Characteristics of Electricity and Natural Gas Industries

Electricity is a product that is generally regarded as nonstorable[58]. Also, the demand for electricity fluctuates by time of day and year, as the weather varies, and randomly. Supply is also subject to unpredictable outages. However, the equilibrium between supply and demand, called "electrical equilibrium", must be maintained continuously and throughout the system, which calls for extremely close minute-by-minute coordination between generation and transmission.

In view of technical characteristics of the industry, a policy of vertically integrated monopoly has some attractions. The integrated generation/transmission company can easily run its power stations that meet demand at minimum cost at each point in time. Moreover, in the longer run, generation and transmission investment can be planned to give the optimal mix and capacity to meet prospective demand with reasonable security of supply. This is, actually, the main reason why the two activities have historically been vertically integrated. Nevertheless, since they allow no room for competition and its associated incentives, such schemes nowadays have started to be replaced by vertically separated private utilities with the aim of fostering competition in generation and supply[59]. Under contemporary structures, the economic activities related with electricity industry may be divided into four:

1) Generation: the production of electricity (wholesale supply),
2) Transmission: high-voltage transfer of electricity in bulk,
3) Distribution: lower-voltage delivery of electricity over local networks,
4) Retail supply: sale of electricity to final consumers.

The transportation activities of transmission and distribution are, in present market conditions and with current technologies, naturally monopolistic. On the other hand, both generation (wholesale supply) and retail supply are potentially competitive activities, which simply constitutes a general economic case for competitive markets.

As for natural gas industry, the demand for gas is also seasonal and stochastic, with demand on very cold days being up to a few times higher than on summer days. Actually, natural gas industry has many common features with electricity industry. Like electricity industry, the gas industry is a network industry in the sense that it also requires a network to operate. Also, the economic activities related with gas industry are similar to those of electricity industry with the exception that the gas is storable. So the economic activities related with gas industry may be grouped into five:

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[58] Armstrong et al. (1994, p 280) reports that there is a sense in which some hydroelectric power can be stored. In the UK, the National Grid Company has a pumped storage business in the Welsh mountains. Water pumped uphill at night can produce hydroelectric power the following day, thereby effectively storing some night-time electricity. This is economically efficient, provided that the day/night electricity price ratio is high enough.

[59] In fact, a central question for structural policy should be whether the gains from competition in generation and supply outweigh the costs of any losses in coordination between generation and transmission, which partly depends on how well they can be coordinated in the event of deintegration.

1) Production and Importation (wholesale supply),
2) Transmission,
3) Distribution,
4) Storage,
5) Retail supply.

As given above, any natural gas market is characterized by the successive vertical stages of importation, production, transmission, distribution, and supply. Natural gas must first be imported or extracted. Then, the gas is transmitted through national and regional high-pressure transmission networks[60] in bulk across the country up to the point where regional distribution pipelines start. Finally, the gas is distributed to consumers over low-pressure local networks. Within this structure, a retail supplier of gas imports the gas or purchases it from the producers, moves it through the transmission and distribution networks and sells it to final customers. Also, the supplier usually needs access to storage facilities to help to meet peak demands.

Both transmission and distribution activities have, in present market conditions and with current technologies, natural monopoly characteristics because pipeline costs are sunk, and it would be inefficient to have more than one network. On the other hand, if access to the transmission network is secured, then there can be many competing suppliers. Having access to the transportation network means that the supply of gas to final customers is potentially highly competitive. Sunk costs in supply are small as the main assets are just working capital and contracts with producers and customers. Also, since gas is a relatively homogeneous commodity, price competition in supply is likely to be strong.

To sum up, today, in both industries, although the transportation activities (transmission and distribution) are naturally monopolistic, wholesale supply (generation, production or importation) and retail supply are potentially competitive and there exists a lot to gain from competition in these activities.

A-2.7.2 Background to Price Regulation

Over the last century, two main competing traditions have dominated both regulation literature and practice of regulation. On the one hand, a tradition based on an “American” model of investor-owned monopoly utilities has been developed, and under this tradition the activities of private utilities have been regulated through politically accountable regulatory bodies which were, however, in most cases captured by the regulated firm(s). On the other hand, an alternative “Western European” model based on state-owned monopoly utilities has evolved in Europe, and within this structure, the state-owned monopolies have acted either as a government department or as a public enterprise subject to controls imposed by government on its pricing and investment policy.

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[60] Natural gas may also be transmitted and/or distributed in the form of liquefied natural gas (LNG), compressed natural gas (CNG) or by any other means available.

Each of these models has changed radically in the last 20 years. In Europe, until the early 1980s, almost all energy industries were vertically integrated statutory monopolies, operating either under state ownership or as regulated utilities in line with traditional "Western European" model. In 1989-90, the UK restructured its electricity industry, separating generation from transmission, allocating generation capacity between different companies, and creating a spot market for wholesale electricity to make generation competitive. She also moved gradually to privatize all assets that the government traditionally owned in gas and electricity industries. The successful privatization in the UK has given not only the other members of the European Union but also overseas governments the confidence to follow the example. As stated by Jones (2003), "[p]rivatization, market liberalization and deregulation have characterized the last decade of the [energy] industry's development in the European Union with its main different versions of the UK model of competitive generation and supply together with incentive-based regulation of transmission and distribution". Also, it is the same system based on British model that many economies in transition now aspire.

Meanwhile, the US did not privatize her energy industries as almost all utilities were already in the private sector in the US. Instead, the change there was in the form of liberalization. In the United States, liberalization in various industries began in the 1970s, but it was in the 1980s that liberalization became widespread. That is, the US never experienced the difficulties inherent in privatization and restructuring, the main problems of developing countries in the reform process. Therefore, although it may serve as an ideal target to achieve in the long-run, the US experience does provide little, if any, for developing countries in the short or medium term.

A-2.7.3 Price Regulation Methods

From the very beginning regulation has been perceived as a tool for controlling market failure; and even today this trend continues and the most important aim of the regulation is still to control market failure, especially to prevent possible abuse of monopoly power in the form of excessively high prices. Therefore, the underlying aim of price regulation is to keep prices, as well as profits, at certain levels which are regarded as "fair" and which will also not remove the firm's incentive to improve its efficiency. To realize these aims, various price regulation methods have been developed over time. From a theoretical perspective, price regulation methods may be divided into two groups based on the extent to which the firm's revenues are tied to its own costs, namely high-powered and low-powered incentive schemes. Let me explain what they mean.

Suppose that the regulator determines the revenue of the firm based on the following formula:

$$\text{Revenue} = a + b \times \text{Cost}$$

Traditional so-called "cost-plus" regulation, the weakest possible incentive scheme, sets b=1. Under this method, the firm has no incentive to hold down its costs as costs are passed through directly to consumers. Rate of Return Regulation (RoRR) is often said to be a form of cost-plus regulation.

An ideal high-powered incentive scheme, on the other hand, sets b=0. Under such a so called “fixed-price” regulation, the firm is like a price taker (as in the case of perfect competition), its revenues are outside its control and profits can only be increased by cutting costs. High-powered incentive schemes raise no problems in a static world of full information. However, when the regulator is imperfectly informed regarding the cost and demand conditions, it cannot determine the price level appropriately, causing allocative efficiency to deviate from the optimal path. At worst, the firm’s viability may be in question if large shocks occur in cost and demand conditions.

Between the cost-plus and fixed-price regulation are methods with $0 < b < 1$, such as profit-sharing (sliding-scale) schemes. Sliding-scale regulation imposes some limits on how much the firm can gain or lose, which are called “zones of reasonableness” or “dead-bands”. Profit sharing[61] helps alleviate the potential for large differences between prices and costs under an ideal high-powered incentive scheme; at the same time, it provides greater incentives for cost reduction than does a scheme based on “cost-plus” regulation.

After decades of criticism by academicians and practitioners, “cost-plus” regulation has gradually given way to what is called “incentive regulation”, an umbrella term used for various kinds of “fixed-price” regulation methods in which $0 < b \leq 1$. Incentive regulation covers such methods as RPI-X (price cap), yardstick competition and sliding-scale regulation. Under price-cap regulation, the average price of a “basket” of goods and services cannot rise faster than a benchmark level of inflation. Under yardstick competition, the firm’s prices are based on the costs of comparable firms, rather than the firm’s own costs. And finally, under sliding-scale regulation, profits outside a given range, called “deadband”, are shared between the firm and consumers.

Apart from the methods mentioned above, in literature, there exist many other techniques used to regulate monopolies such as franchising, marginal/average cost pricing, Ramsey pricing, two-part pricing, methods based on contestability theory and so on. Due to limited scope of this paper, only those methods widely used in practice will be discussed here; namely, rate of return regulation (RoRR), RPI-X (or, price cap) regulation, yardstick competition and franchising. Due to its theoretical importance, the theory of contestable markets will also be mentioned briefly at the end of this section.

A-2.7.3.1 Rate of Return Regulation (RoRR)

As mentioned above, historically, methods based on “cost-plus” regulation, and especially rate of return regulation (RoRR), are the most widely used form of price regulation. Rate of return regulation has been developed as a response to concerns about excessive profits and, therefore, allows the utility only charge a price that covers the cost of service and so limits profits. Under RoRR, the regulator periodically holds a rate review to establish the firm’s costs and to design a set of rates for the firm’s various services that will cover these costs. The rates typically remain in effect until there is a request for a new review, either from the firm or from customer representatives.

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[61] There is no presumption that 50/50 profit sharing is economically optimal. Given a tight ‘fixed-price’, it may be efficient for the firm to keep a larger share of gains.

The process just described creates incentives for the regulated firm to deviate from offering the best possible service at the lowest possible cost. First of all, under RoRR, the firm does not get the gains from cost reduction; its incentives to cut costs are limited. Second, as earnings are bounded both above and below, the firm's incentives for investment and risk-taking are distorted. The firm overcapitalizes and takes extremely high risks. Third, since fixed costs are typically allocated in proportion to output, excessive use of fixed costs relative to variable costs is encouraged. Therefore, it is argued that RoRR regulation is not socially optimal as it leads to inefficient use of resources, more specifically to "over-investment" (Averch & Johnson, 1962). Fourth, because rate review must rely on cost data from previous periods, price only gradually converges to average cost and the firm may have incentives to delay this convergence through wasteful expenditures. Fifth, RoRR creates obvious allocative distortions that result from setting prices at average and not marginal costs (Newbery, 2000). Sixth, it covers the whole industry, or a large part of it, and not focuses explicitly on the particular services where monopoly power exists (Armstrong et al., 1994). Finally, the inefficiencies of RoRR are masked when costs are falling and the regulated firm is a monopoly. In these circumstances, the firm may go for years without rate review and extract excessive rents.

A-2.7.3.2 RPI-X (Price Cap) Regulation

In response to the apparent problems of the cost-recovery methods, in 1983, Professor Stephen C. Littlechild proposed a "high-powered" incentive scheme, popularly known as RPI-X or price cap, in which the regulator caps the allowable price or revenue for each firm for a pre-determined period. The fundamental idea behind price cap is extremely simple: set a fixed ceiling on the price a regulated firm can charge, and the firm under consideration will optimize its efforts and minimize its costs just like a price-taking competitive firm as it is the only way available to maximize profits (Agrell and Bogetoft, 2004).

All price caps are expressed as a limit of RPI-X % on revenue where X represents a reduction in the real price level. X is determined by expectations of potential cost reductions, which in turn depend on changing technology and demand conditions. A firm subject to RPI-X regulation has to ensure that a weighted average of price increases in one year does not exceed the percentage increase in the retail price index (RPI) less X, which is reviewed and re-determined periodically. In practice, certain categories of costs are not subject to constraints either in full or in part, called "cost pass-through". The justification is that some costs are beyond the industry's control and cannot reasonably be reduced or absorbed (such as the costs of purchasing electricity from generators). So, risks are passed directly to consumers by exempting these elements from the price cap.

RPI-X regulation solves some problems inherent in "cost-plus" regulation. First of all, RPI-X regulation gives high-powered incentives to cut costs. Also, it is easy and cheap to monitor, so implementation costs are low for both the regulator and the regulated. Moreover, unlike rate of return, RPI-X applies only to monopolistic sectors.

RPI-X regulation, however, comes with its own problems. The first and maybe the most important problem with RPI-X is the difficulty related with determination of X factor. If it is too tight, it can lead to non-participation and bankruptcy. If, however, it is too loose, it gives excessive information rents. Second problem originates from the concept of “regulatory lag”, which has its roots in the fact that regulation does not occur in a continuous fashion; and normally, prices are set for an interval of time, during which the firm is free to choose whatever input combinations it wishes, until the next price review occurs. Regulatory lag allows the firm to get the benefits of improved cost efficiency until the next review. A longer lag increases the firm’s incentives to reduce its costs by innovation or better organization of factors of production, but it delays the time at which consumers benefit from this greater efficiency. On the other hand, a shorter lag means that consumers benefit sooner, but the incentive to cut costs is reduced. Also, another point to consider relates the behaviour of firm under a system involving regulatory lag. Under such a system, as time passes the firm’s calculations will be increasingly affected by the benefit to be gained from influencing the outcome of the next regulatory review. As review time approaches, the firm will have little or no incentive to reduce costs if its future prices are positively related to its current cost level. Even, in the worst case, the firm would come to a point where it favors higher costs when regulatory review is near at hand, introducing familiar incentives to overcapitalize[62].

The third problem in RPI-X is the fact that it does not encourage investment, and creates a mismatch between optimal investment and review periods, which reduce the incentives to invest (Helm, 2003). Moreover, by itself RPI-X does nothing to encourage quality. Low quality is rarely an issue under rate-of-return regulation because firms under RoRR have an incentive to expand their capital base; that is, they have an incentive to invest in quality wherever they can. The regulatory problem in RoRR is to prevent companies from making an excessively higher investment in quality than consumers would freely pay for. In contrast the incentive under RPI-X is to reduce quality. Once its value for X has been fixed, the firm has an incentive to underinvest in quality for the given price level, which results in a fall in quality that consumers are unable to avoid because of the lack of alternative suppliers (Jackson et al., 1994).

The fifth problem is that although it is argued that regulatory burden in RPI-X is light because RPI-X does not require the measurement of capital or rates of return; inevitably regulators, who are concerned about allocative efficiency, have had to consider such factors at review time. Also, the experience shows that complexity of RPI-X has so far increased over time in the UK. Now, regulators must decide which prices to be regulated, the extent of cost pass-through, how to regulate investment, the length of regulatory lag and so on. Finally, the benefits of RPI-X remain only so long as the determination of the level of price cap cannot be affected by the regulated firm. If the firm believes that the regulator uses past observations of the firm’s behaviour to update

[62] These considerations suggest three lessons. First of all, the incentive effects of regulatory lag are not necessarily always positive. Second, the potential losses from strategic behaviour are reduced when regulatory review is less sensitive to current cost conditions. Third, the timing of regulatory reviews is important.

beliefs about costs, a ratchet effect[63] operates, and the firm will try to hide some of its private information so as to earn high rents subsequently (Armstrong et al., 1994).

To sum up, it seems that initial enthusiasm for price cap regulation has overstated its advantages, particularly where there is uncertainty. Now, whether RPI-X will prove to have served the public interest better than its alternatives in the longer term is less clear. Actually, despite the important differences between rate of return regulation and RPI-X, both require negotiation between the regulator and the regulated. The ability of the regulator to conclude such negotiations in the consumers' interest depends crucially on the information available to it, which constitutes the weakest point in both methods. To overcome this common problem, yardstick competition method is developed.

A-2.7.3.3 Yardstick Competition

In fact, price cap regulation and yardstick competition are two different ways of separating the firm's revenues from its costs. Price cap indexes revenues to a historical base, while yardstick regulation indexes revenues to the performance of other firms.

Yardstick competition is a method to bring regulated monopoly units in submarkets into competition indirectly via the regulatory mechanism. Shleifer (1985) states that "[i]n the typical regulatory scheme a franchised monopoly has little incentive to reduce costs ... [yardstick competition] proposes a mechanism in which the price the regulated firm receives depends on the costs of identical firms. In equilibrium each firm chooses a socially efficient level of cost reduction".

Under yardstick competition, a firm is rewarded based on how well a set of similar (or yardstick) firms perform. Revenues are entirely divorced from the firm's own costs. The main advantage of this method comes from the fact that the revenue of the firm is not determined by its own cost, but by the performance of the market (the other firms), which not only improves the precision of the regulator's information about the firms but also helps prices stay in line with costs, at the same time giving firms incentives for cost reduction (Armstrong et al., 1994). That is, this method endogenizes the X-factor and limits the regulatory discretion at the same time.

The primary difficulty of yardstick competition, on the other hand, is the reality that firms do not fall perfectly into a fixed set of groups. Thus, a judgment is required in determining which firms to be grouped together and care must be taken to handle systematic differences between the firms in each group. The more closely one firm resembles the others within the same group, the more effective yardstick competition is. Then the rule is obvious: "use yardstick

[63] The idea behind the 'ratchet effect' may be summarized as follows: if the regulated firm produces at a low cost today, the regulator might infer that low costs are not that hard to achieve and tomorrow offer a demanding incentive scheme. That is, the regulated firm might be concerned about the possibility that it jeopardizes future rents by being efficient today (Laffont and Tirole, 1993).

competition if comparable firms exist, and be careful to adjust yardstick rates for special conditions beyond a given firm's control".

A-2.7.3.4 Franchising

One of the fundamental regulatory questions has been how to enjoy the cost benefits of single-firm production without suffering from monopolistic behaviour. Franchising provides an answer to that question in the form of a *competition for the market*, where several firms competing to be one that actually operates in the market.

Franchising involves conferring rights in the supply of a good or service to a sole producer for a specified period of time. It is regarded as an essential mechanism for introducing, *competition for the market* where *competition within the market* is not feasible or desirable. Natural monopolies are, therefore, obvious candidates for franchising.

The concept of "franchising" was first pronounced by Chadwick (1859) and popularized by Demsetz (1968). In a so-called "Chadwick-Demsetz" auction, competition takes place through bidding for the franchise contract, and the winner is the one who bids the lowest price to supply the good or service, or more generally, who offers the best price-quality package.

At first sight, franchising appears to provide a very attractive way of combining competition and efficiency without any heavy burden for regulators. The competition for market appears to destroy the undesirable monopoly of information that hinders conventional regulation, and price is set by competition, not by bureaucrats. Provided bidding is competitive, a Chadwick-Demsetz auction will reduce the profits to the normal competitive level by inducing bid prices equal to unit costs of production.

Nevertheless, franchising is not without some difficulties. First of all, as mentioned above, bidding must be competitive and cases of collusive bidding need to be prevented. There exist mainly two reasons why bidding for the franchise might fail to be competitive. First of all, there is a danger of collusion between bidders, especially if they are few in number[64], or if the firms are effectively in a repeated interaction (or, "game") with one another via frequent contracts. The second reason is that one firm might enjoy such strategic advantages in the competition for the franchise that other firms would be unwilling to compete with it. For instance, suppose that an incumbent firm is the holder of a franchise that is now up for renewal. Since, thanks to its past operation of the franchise, the incumbent has already reduced its costs; other firms will be unwilling to compete with the incumbent as they know that they are unlikely to win the competition. Also, another source of incumbent advantage may originate from asymmetries of information. The incumbent's knowledge of cost and demand conditions is likely superior to that of any other firm, which tends to deter others from competing with it for the future franchise.

[64] Since, in energy industries, the requisite skills and/or resources are rare; it is generally the case.

The merits of franchising are further reduced by the issues related with asset handover. Unless sunk costs are zero (an extremely unlikely event), efficiency requires that the new operator of the franchise takes over the assets from the incumbent[65]. Therefore, one needs to decide how the assets to be valued for this purpose. In such a case, there is a problem of bilateral monopoly. If incumbent has no alternative, it has to accept as little as the scrap value of the assets. If the new operator firm has no alternative, it has to pay as much as their replacement value. The gap between replacement value and scrap value is likely to be large if the assets involve sunk costs.

The last difficulty with franchising is the question of specification, administration and monitoring of franchise contract. The duration of franchise contract must also be considered. The difficulties of contract specification and administration perhaps suggest that short-term contracts have advantages, because fewer future unforeseeable events then need to be considered. Nevertheless, the organization of frequent contests for the franchise also involves major costs: all the problems of asset valuation and handover occur more often, and the industry would frequently be in a state of turmoil.

A-2.7.3.5 The Theory of Contestable Markets

The recent theory of "contestable markets", put forward by Baumol et al. (1982), suggests that the removal of entry barriers may ensure economically desirable behavior even in cases of natural monopoly, provided that the monopoly is "perfectly contestable". "A contestable market is one into which entry is absolutely free, *and exit is absolutely costless*" (Baumol, 1982, p 3, italics in original). Under these assumptions[66], if the incumbent raises prices above costs, it creates profitable opportunities for new entrants and becomes vulnerable to "hit-and-run" entry. Therefore, equilibrium in a perfectly contestable market implies that a natural monopolist makes only normal profits.

The theory has at least two policy implications. First, if a market is contestable, then there is no real need for regulation because the threat of entry disciplines the existing firm. Second, the same is true if a market can be made contestable by dismantling of entry barriers or by any other liberalization measures.

[65] Otherwise there will be inefficient duplication of assets.
[66] However, the theory of contestable markets has little to offer to policy makers concerned with energy industries where entry is not so free and, more importantly; exit is highly costly due to existence of huge sunk costs.

Appendix 3: Details of Electricity Demand Estimation for Turkey

A-3.1 Cointegration Analysis

A-3.1.1 Stationarity

Time series data consists of observations, which are considered as realizations of random variables that can be described by some stochastic process. The concept of "**stationarity**" is related with the properties of this stochastic process. A stochastic process is called "**strictly stationary**" if its properties are unaffected by a change of time origin; that is, the joint probability distribution at any set of times is not affected by an arbitrary shift along the time axis. However, in this study, the concept of "**weak stationary**" is adopted; meaning that the data is assumed to be stationary if the means, variances and covariances of the series are independent of time, rather than the entire distribution.

A-3.1.2 Unit Root Problem

Nonstationarity can originate from various sources but the most important one is the presence of so-called "unit roots". Before discussing this problem let me focus on some concepts required to explain "unit roots".

The process below is referred to as a first order autoregressive process or **AR(1) process**, where each observation in a time series depends linearly upon its previous value. Generally, if the value of Y at time t depends on its value in the previous p time periods, Y_t is referred to as p^{th} order autoregressive, or AR(p), process. Moreover, an AR(1) process is called "random walk with drift" when $\theta = 1$; and it is called "random walk without drift" when $\delta = 0$ and $\theta = 1$.

$$Y_t = \delta + \theta Y_{t-1} + \varepsilon_t \qquad (5)$$

where ε_t denotes a serially uncorrelated "white noise" error term with a mean of zero and a constant variance. The process above simply says that the current value Y_t equals a constant δ plus θ times its previous value plus an unpredictable component ε_t.

Another simple time series process is given below and it is known as the first order moving average process or **MA(1) process**.

$$Y_t = \mu + \alpha_1 \varepsilon_t + \alpha_2 \varepsilon_{t-1} \qquad (6)$$

where μ is a constant and ε, as before, is the white noise stochastic error term. Here, Y at time t is equal to a constant plus a moving average of the current and past error terms. More generally, if the value of Y at time t depends on the values of current and past error terms in the previous q time periods, Y_t is called q^{th} order moving average, or MA(q), process.

Of course, it is quite likely that Y has characteristics of both AR and MA and therefore ARMA. Y_t follows an **ARMA (1,1)** process if it can be written as:

$$Y_t = \delta + \theta Y_{t-1} + \alpha_1 \varepsilon_t + \alpha_2 \varepsilon_{t-1} \tag{7}$$

because there is one autoregressive and one moving average term. In the same way, in an ARMA (p,q) process, there will be p autoregressive and q moving average terms.

Now, consider the AR(1) process below:

$$Y_t = \theta Y_{t-1} + \varepsilon_t \tag{8}$$

if $\theta = 1$, equation (8) becomes a random walk without drift model. If θ is in fact 1, we face what is known as the **unit root problem**, that is, a situation of nonstationarity. The name "unit root"[67] is due to the fact that $\theta = 1$. If, however, $|\theta| \leq 1$, that is the absolute value of θ is less than one, then the time series Y_t is stationary. The stationarity of time series is so important because correlation could persist in nonstationary time series even if the sample is very large and may result in what is called spurious (or nonsense) regression, as showed by Yule (1926). Granger and Newbold (1974) argue that it is a good rule of thumb to suspect that the estimated regression is spurious if R^2 is greater than Durbin-Watson d value; that is R^2>d.

As easily be concluded from equation (8), the unit root problem can be solved, or stationarity can be achieved, by differencing and this can be indicative of the order of integration in the series. The number of differencing that is necessary to produce stationarity determines the order of integration. Generally, if a nonstationary time series has to be differenced d times to make it stationary, that time series is said to be integrated of order d. A time series Y_t integrated of order d is denoted as $Y_t \sim I(d)$. If a time series Y_t is stationary to begin with, it is said to be integrated of order zero, denoted by $Y_t \sim I(0)$. In practice, most economic time series are generally $I(1)$; that is, they generally become stationary only after taking their first differences.

The basic idea behind cointegration is that if a linear combination of nonstationary $I(1)$ variables is stationary; that is $I(0)$, then the variables are said to be cointegrated. So to speak, the linear combination cancels out the stochastic trends in the two $I(1)$ series and, as a result, the regression would be meaningful; that is, not spurious[68]. As Granger (1986, p 226) notes, "A test for cointegration can thus be thought of as a pre-test to avoid 'spurious regression' situations". Therefore, it is vital to specify whether each variable in the model is stationary or not in order to examine a possible cointegrating relationship between them. The established way to do so is to apply a formal unit root test in each series.

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[67] The terms 'nonstationarity', 'random walk', and 'unit root' can be treated as synonymous.

[68] As mentioned before, a regression of $I(1)$ variables that are not cointegrated produces spurious regression, and the results obtained have no interpretation.

A-3.1.3 The Augmented Dickey-Fuller (ADF) Test

We know that if $\theta = 1$; that is, in the case of unit root[69], the equation (8) becomes a random walk model without drift, which we know is a nonstationary process. The basic idea behind the unit root test of stationary is to simply regress Y_t on its (one-period) lagged value Y_{t-1} and find out if the estimated θ is statically equal to 1 or not.

For theoretical reasons, equation (8) is manipulated by subtracting Y_{t-1} from both sides to obtain:

$$Y_t - Y_{t-1} = (\theta - 1)Y_{t-1} + \varepsilon_t \qquad (9)$$

which can be written as:

$$\Delta Y_t = \delta Y_{t-1} + \varepsilon_t \qquad (10)$$

where $\delta = (\theta - 1)$ and Δ, as usual, is the first difference operator. So, in practice, instead of estimating equation (9), we estimate equation (10) and test the null hypothesis that $\delta = 0$. If $\delta = 0$, then $\theta = 1$, meaning that we have a unit root problem and time series under consideration is nonstationary. The only question is which test to use to find out whether the estimated coefficient of Y_{t-1} in equation (10) is zero or not. Unfortunately, under the null hypothesis that $\delta = 0$ (i.e., $\theta = 1$), the t value of the estimated coefficient of Y_{t-1} does not follow *t* distribution even in large samples; that is, it does not have an asymptotic normal distribution. Dickey and Fuller (1979) have shown that under the null hypothesis that $\delta = 0$, the estimated *t* value of the coefficient of Y_{t-1} in equation (10) follows the τ (tau) statistic. These authors have also computed the critical values of the τ (tau) statistic. In literature tau statistic or test is known as the Dickey-Fuller (DF) test, in honor of its discoverers.

In conducting DF test, it is assumed that the error term ε_t is uncorrelated. However, in practice the error term in DF test usually shows evidence of serial correlation. To solve this problem, Dickey and Fuller have developed a test, known as **the augmented Dickey-Fuller (ADF) test**. In ADF test, the lags of the first difference are included in the regression in order to make the error term ε_t white noise and, therefore, the regression is presented in the following form:

$$\Delta Y_t = \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \qquad (11)$$

To be more specific, we may also include an intercept and a time trend t, after which our model becomes:

[69] For a general preliminary discussion of the concept of "stationarity" and unit root problem, please see A-3.1 section in Appendix 3, which also include the equations that are mentioned but not provided here.

$$\Delta Y_t = \beta_1 + \beta_2 t + \delta Y_{t-1} + \alpha_i \sum_{i=1}^{m} \Delta Y_{t-i} + \varepsilon_t \quad (12)$$

The DF and ADF tests are similar since they have the same asymptotic distribution. In literature, although there exist numerous unit root tests, the most notable and commonly used one is ADF test and, therefore, it will be used in this study.

A-3.1.4 Cointegration Tests

On the basis of the theory that $I(1)$ variables may have a cointegrating relationship; that is, a stationary long-run linear relationship even though individually they are nonstationary, it is crucial to test for the existence of such a relationship. This section considers two tests of cointegration; namely Augmented Engle-Granger (AEG) test and cointegrating regression Durbin-Watson (CRDW) test.

A-3.1.4.1 Augmented Engle-Granger (AEG) Test

We have warned that the regression of a nonstationary time series on other nonstationary time series may produce a spurious regression. If we subject our time series data individually to unit root analysis and find that they are all $I(1)$; that is, they contain a unit root; there is a possibility that our regression can still be meaningful (i.e., not spurious) provided that the variables are cointegrated. In order to find out whether they are cointegrated or not, we simply carry out our original regression and subject our error term to unit root analysis. If it is stationary; that is, $I(0)$, it means that our variables are cointegrated and have a long-term, or equilibrium, relationship between them. In short, provided that the residuals from our regression are $I(0)$ or stationary, the conventional regression methodology is applicable to data involving nonstationary time series.

Augmented Engle-Granger test (or, AEG test) is based on the idea described above. We simply estimate our original regression, obtain the residuals and carry out the ADF test. In literature, such a regression is called “cointegrating regression” and the parameters are known as “cointegrating parameters”. However, since the estimated residuals are based on the estimated cointegrating parameters, the ADF critical values are not appropriate. Engle and Granger (1987) have calculated appropriate values and therefore the ADF test in the present context is known as Augmented Engle-Granger test.

A-3.1.4.2 Cointegrating Regression Durbin-Watson (CRDW) Test

An alternative method of testing for cointegration is the CRDW test, whose critical values were first provided by Sargan and Bhargava (1983). In CRDW, the Durbin-Watson statistic d obtained from the cointegrating regression is used; but here the null hypothesis[70] is that d=0, rather than the standard d=2.

[70] We know that $d \approx 2(1-\hat{\rho})$, so if there is to be a unit root, the estimated ρ will be about 1, which implies that d will be about zero.

The 1 percent critical value to test the hypothesis that the true d=0 is 0.511. Thus, if the computed d value is smaller 0.511, we reject the null hypothesis of cointegration at the 1% level. Otherwise, we fail to reject the null, meaning that the variables in the model are cointegrated and there is a long-term, or equilibrium, relationship between the variables.

A-3.2 Steps in ARIMA Modelling

ARIMA methodology includes four steps; namely, identification, estimation, diagnostic checking and, of course, forecasting. First of all, in the first step, we need to identify the appropriate values of our model; that is, *p*, *d* and *q*. The chief tools in identification are the autocorrelation function (ACF), the partial autocorrelation function (PACF), and the resulting correlogram, which is simply the plots of ACF and PACF against the lag length.

The ACF at lag *k*, denoted by ρ_k, is defined as

$$\rho_k = \frac{\gamma_k}{\gamma_0} \tag{13}$$

where γ_k is the covariance at lag k, γ_0 is the variance. Since both covariance and variance are measured in the same units, ρ_k is a unitless, or pure, number; and lies between -1 and +1.

In time series data the main reason of correlation between Y_t and Y_{t-k} originates from the correlations they have with intervening lags; that is, Y_{t-1}, Y_{t-2}, … , Y_{t-k+1}. The partial correlation measures the correlation between observations that are *k* time periods apart after controlling for correlations at intermediate lags; that is, it removes the influence of these intervening variables. In other words, partial autocorrelation is the correlation between Y_t and Y_{t-k} after removing the effect of intermediate Y's.

If we find out, as a result of visual inspection of correlogram and/or formal unit root tests, that our data is nonstationary; we need to make it stationary by differencing until nonstationary fades away. Then based on the stationary data after differencing and its correlogram, we identify the appropriate values of our model; that is, p, d and q.

In the second step; that is, estimation, the model based on the results from the first step is constructed and estimated, which is followed by diagnostic checking in the third step. To check whether the model is a reasonable fit to the data or not, we collect residuals from the estimation done in previous step and check whether any of the autocorrelations and partial correlations of the residuals is individually statistically significant or not. If they are not statistically significant, then it means that the residuals are purely random and there is no need to look for another ARIMA model. In the final step, forecasting is carried out based on the constructed and checked ARIMA model.

A-3.3 Overview of Data

This section describes the data used in the study. The data used in the estimation process is quarterly time series data on real electricity prices, real income (or real GDP per capita) and electricity demand (or net electricity consumption per capita) for the period 1984-2004, a total of 84 observations. The data was obtained from the "International Energy Agency" (IEA), the "Organisation for Economic Co-operation and Development" (OECD), the "International Monetary Fund" (IMF) and some other national institutions of Turkey; namely, the "State Institute of Statistics" (DIE), the "Turkish Electricity Transmission Company" (TEIAS), Undersecretariat of Treasury and State Planning Organization (DPT). The time plots of the data are provided in Appendix 4-D.

Since the data on net electricity consumption, population and GDP was not available quarterly, the annual series on these data were converted into quarterly data assuming that the change during the year is linear. It is also important to note that each data point in series shows the change in the last one year period, not only the last three months. For example, the electricity consumption by industry in the second quarter of 2004 is 53,935 GWh. This data represents the consumption between the period 01 July 2003 - 31 June 2004, not the one during 01 April 2004 – 31 June 2004. Specification of data and their sources are summarized below.

A-3.3.1 Real Electricity Prices

A single time series data on real electricity prices in Turkey is not directly obtainable. Therefore, it was calculated using available data. First of all a weighted average price is computed using the existing data on electricity prices for industry/households and electricity consumption by industry/households. Then, an inflation index is also computed using the data on annual percentage change in inflation assuming 2004 as the base year; that is 2004=1. Finally, real electricity prices are obtained by dividing weighted average price for each period by inflation index for the related year.

The quarterly data on *electricity prices for industry and households* was collected from IEA (2005a). All prices are electricity end-use prices in New Turkish Lira (YTL) per kilowatt hour (kWh). The annual data on *electricity consumption by industry and households* was taken from IEA (2002) for 1984-2000 and IEA (2004a) for 2001-2002. Moreover, the data for the period from the first quarter of 2003 to the last quarter of 2004 was collected from DIE (2005a). The data from DIE is in GWh; however, the original data from IEA is measured in ktoe. To get a single unit, the data from IEA was converted into GWh using the simple equality 1 ktoe = 11.63 GWh. Finally, the data on *annual percentage change in inflation* was taken from IMF (2005).

To get real electricity prices, first of all, a weighted average price was computed by using the available data on electricity prices and consumption. Then, an inflation index was also computed (assuming the year 2004 as the base year; that is, 2004=1) and it was used to obtain the data on real electricity prices in YTL/kWh at 2004 prices. All related data is given in Appendix 4-A.

A-3.3.2 Real Income

A single time series data on real income (or real GDP per capita) is also not directly available. Therefore, it was calculated by using available data on population, GDP per capita at current prices and annual percentage change in inflation. The annual time series data on Turkish *population* was collected from DIE (2005b). It is measured in thousand people. In Turkey, censuses are carried out once in every five years. The figures for years without a census are official estimates by DIE. The annual time series data on Turkish *gross domestic product (GDP) per capita* at current prices in YTL was obtained from the Undersecretariat of Treasury (2005) for 1984-2003 and from DPT (2005) for 2004.

To get real income, GDP per capita at current prices was calculated and the figures were converted into real prices by using the inflation index computed in the previous step. At the end, real GDP per capita at 2004 prices was obtained in YTL.

A-3.3.3 Electricity Demand

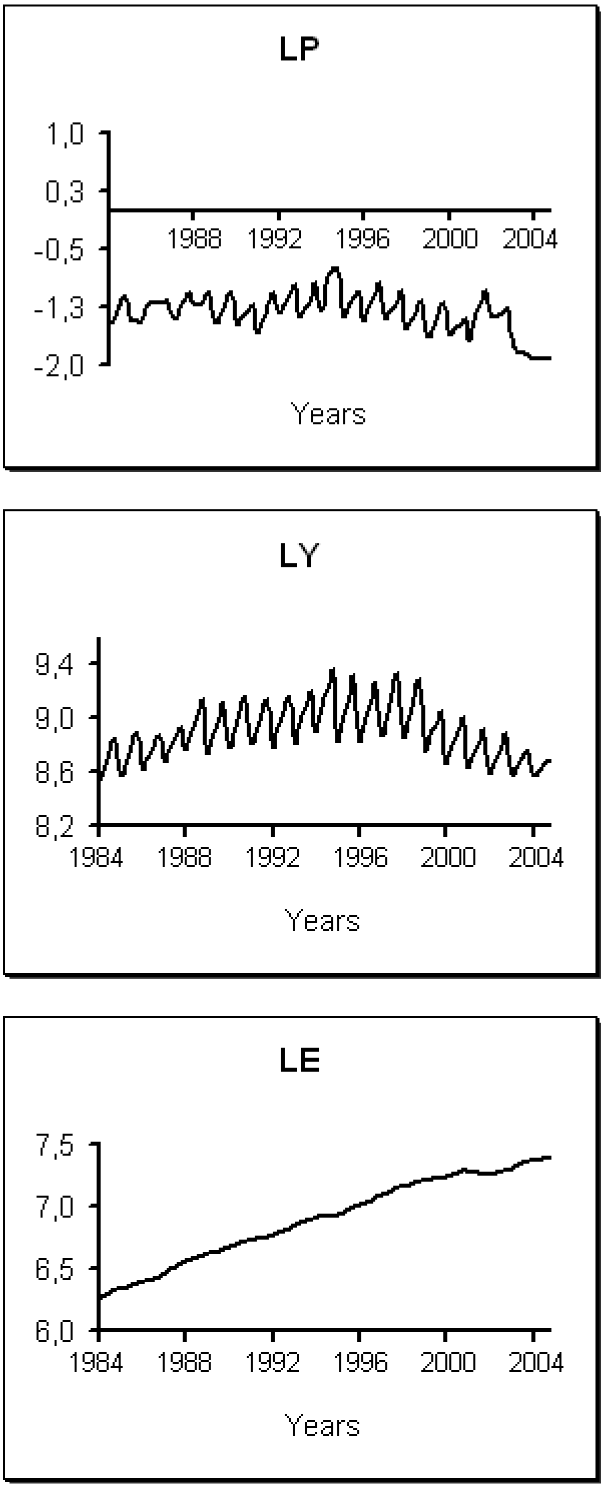
Electricity demand (or net electricity consumption per capita) is not directly accessible, so once more the data was worked out. The annual data on *net electricity consumption*[71] was collected from TEIAS (2005a) for 1984-2003 and from DIE (2005c) for 2004. All figures are measured in GWh. These figures were converted into kWh and then divided by population figures to get net electricity consumption per capita in kWh. The table showing real income and electricity demand figures is given in Appendix 4-B.

In forecasting section, besides annual net electricity consumption data from TEIAS (2005a), additional data from TEIAS (2005b) will also be used. Furthermore, the data to be used in this section is annual data for 1923-2004 period, rather than quarterly data from 1984 to 2004. The data to be used in forecasting process is given in Appendix 4-C.

Having discussed the data and their sources let me focus on the general view of the data to be directly used in the estimation. The graphs of the data are provided in Appendix 4-D. Since one of the main aims of this study is to get elasticities of electricity demand, the series were transformed into natural logarithms so that direct estimates of elasticities can be obtained. Graphs below show time series plots of natural logarithms of real electricity prices (**LP**), real GDP per capita (**LY**) and real net electricity consumption per capita (**LE**).

[71] Net electricity consumption is calculated by subtracting network loses from total supply.

Figure 22. Time Series Plots of Natural Logarithms of LP, LY and LE



A close look at the graphs reveals that there are trends in the variables with the exception of LP, which fluctuates within an interval. Visual inspection of the plotted data also indicates that LY and LE have non-constant means and non-constant variances; that is, they seem to be non-stationary.

A-3.4 Estimation and Presentation of Results

A-3.4.1 Partial Adjustment Model

Using quarterly data discussed in the previous section, the reduced form model is estimated[72].

Equation (1) is estimated as follows:

$$\ln E_t = -5.12 - 1.17 \ln P_t + 1.18 \ln Y_t \qquad (14)$$

The last column of the estimation output[73] gives the probability of drawing a t-statistic as extreme as the one actually observed. It is also known as the "p-value". For the parameters in our model, p-values of α, β_1 and β_2 are all within acceptable range and the null hypothesis that one of these coefficients is zero can be rejected at the 2% significance level.

As for summary statistics, "R-squared" measures the success of the regression in predicting the values of the dependent variable within the sample. It equals one if the regression fits perfectly. In our model, it is almost 0.38 and therefore it can be concluded that our model may predict dependent variable with 38% accuracy with given sample, which is not high enough for an appropriate model. Since "R-squared" never decreases as more regressors are added; "Adjusted R-squared", which penalizes for addition of irrelevant regressors, is a better measure of "goodness-of-fit". In our model, it is almost 0.36 and, therefore, it is also below the expected level, which is at least around 0.80.

Durbin-Watson statistic measures the serial correlation (or, autocorrelation), AR(1), in the residuals. As a rule, if it is less than 2, there is evidence of positive serial correlation. Durbin-Watson statistic in our estimation output is very close to 0.14, indicating the existence of serial correlation in the residuals. F-statistics and its p-value, Prob(F-statistic), comes from a joint test of the null hypothesis that all slope coefficients in the regression are zero. Since in our model p-value of the F-statistics is zero, we can reject the null hypothesis.

Although the coefficients of price and income have correct signs[74], econometric indicators imply that this equation may be misspecified. Therefore, the lagged dependent variable, $\ln E_{t-1}$, is added in the right-hand-side of the equation (1) so as to obtain partial adjustment model in equation (4), estimation of which gives the following result[75].

$$\ln E_t = -0.04 - 0.01 \ln P_t + 0.01 \ln Y_t + 0.99 \ln E_{t-1} \qquad (15)$$

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[72] Unless otherwise stated, all estimation throughout the study is carried out by EViews 5.1, the Windows-based forecasting and econometric analysis package.

[73] The estimation output is given in Appendix 5-A.

[74] The economic theory states that there is an inverse relationship between demand and price; and a positive relation exists between demand and income.

[75] The estimation output is given in Appendix 5-B.

This new model is clearly better than the first one. First of all, the coefficients of price and income have still correct signs. Second, p-values of all coefficients, with the exception of intercept term, are within acceptable range and they are significant at 2% significance level[76]. Third, "R-squared" and "Adjusted R-squared" measures in this model are about 1, meaning that the regression fits almost perfectly. Finally, p-value of the F-statistics is still zero.

Based on this model, the estimated short-run and long-run elasticities of demand are as follows[77]:

Table 14. Elasticities of Demand for Electricity in Turkey, based on Conventional Partial Adjustment Model

	Short-run	Long-run
Price Elasticity	-0.0123	-0.9079
Income Elasticity	0.0148	1.0947

There seems to be a substantial difference between short-run and long-run elasticities of demand because, in this model, the speed of adjustment to the long-run equilibrium demand level is so close to 0 ($\delta = 0.0135$). The other, and probably more striking, outcome from this model is the fact that although short-run elasticities are extremely low, less than 0.02; the long-run response to both price and income changes is exceptionally high. For instance, if real income doubles (or, increases by 100%) in Turkey, the demand for electricity will increase by 109% in the long run. Similarly, if real price of electricity declines by 100%, the demand will increase by 91% in the long run.

There is, however, a possibility that the OLS results may be misleading due to inappropriate standard errors because of the presence of heteroskedasticity. In order to test whether error terms are heteroskedastic or not, White heteroskedasticity test (without cross terms) was carried out and its result is given in Appendix 5-C. The top part of the output displays the joint significance of the regressors (excluding the constant term) for each test regression. Under the null of no heteroskedasticity (or, no misspecification[78]), the non-constant regressors should not be jointly significant. The probability value of 0.146 indicates that they are not jointly significant even at 10% significance level; meaning that error terms are not heteroskedastic in our model.

We need also to test for serial correlation. The Durbin-Watson statistic is not appropriate as a test for serial correlation in this case since there is a lagged dependent variable on the right-hand side of the equation. Therefore, another

[76] However, the p-value of the intercept term (0.44) is so high that we cannot reject the zero null hypothesis even at the 40% significance level!

[77] Relying on the notation in equation (4), estimated parameters are as follows:

$$\delta\alpha = -0.041010 \quad \delta\beta_1 = -0.012257 \quad \delta\beta_2 = 0.014779 \quad (1-\delta) = 0.986500$$

From above, it is obvious that $\delta = 0.0135$ and, therefore, $\beta_1 = -0.9079$ and $\beta_2 = 1.0947$.

[78] Since the White test is an extremely general test, it may also identify some specification errors (such as an incorrect functional form), as well as revealing heteroskedasticity.

test, namely Breusch-Godfrey Serial Correlation LM Test, was applied, which produced the output table in Appendix 5-D.

The top part of the output presents the test statistics and associated probability values. The statistic labeled “Obs*R-squared” is the LM test statistic for the null hypothesis of no serial correlation. The (effectively) zero probability value strongly indicates the presence of serial correlation in the residuals. In the presence of serial correlation, the OLS estimators are still linear unbiased as well as consistent and asymptotically normally distributed, but they are no longer efficient, meaning that standard errors are estimated in the wrong way and, therefore, usual confidence intervals and hypotheses tests are unreliable. Moreover, usually, the finding of autocorrelation is also an indication that the model is misspecified. Newey and West (1987) proposed a general covariance estimator that is consistent in the presence of both heteroskedasticity and autocorrelation. Thanks to Newey-West procedure[79], we can still use OLS but correct the standard errors for autocorrelation. The estimation output of OLS with Newey-West procedure is given in Appendix 5-E. As can be seen in Appendix 5-E; when we correct the standard errors for autocorrelation, p-values of all coefficients become insignificant even at 10% significance level, supporting the previous indication that the model is misspecified.

Since it is obvious that conventional partial adjustment model is not the appropriate one in our case; after experimenting with various functional forms, the model below is specified and estimated.

$$\ln E_t = \phi_0 + \phi_1 \ln P_t + \phi_2 \ln Y_t + \phi_3 \ln P_{t-2} + \phi_4 t + \phi_5 \ln E_{t-2} + \varepsilon_t \qquad (16)$$

where $\ln E_{t-2}$ and $\ln P_{t-2}$ are the second lag of natural logarithms of demand and real price respectively; and t is a simple trend that increases by one for each observation[80]. The OLS estimation output of this new model is provided in Appendix 5-F.

This last model is obviously the best one among all others. The coefficients of price and income have correct signs. P-values of all coefficients, without exception, are significant at 5% significance level. “R-squared” and “Adjusted R-squared” measures indicate that the regression fits almost perfectly. P-value of the F-statistics is zero. White heteroskedasticity test (without cross terms) and Breusch-Godfrey Serial Correlation LM Test were carried out once more for the new model and the results indicate that we have no heteroskedasticity in our model but there exists serial correlation in the residuals. In order to correct the standard errors for autocorrelation, the model was re-estimated by OLS with Newey-West procedure and, as can be seen in the test output table, all coefficients are still significant at 5% significance level. The test output tables are given in Appendix 5-G, 5-H and 5-I.

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[79] It is important to point out that the Newey-West procedure is strictly speaking valid in large samples and may not be appropriate in small ones. Since we have 84 observations, our sample may be regarded as reasonably large.

[80] The base period for the trend is the 29th observation, the 1st quarter of 1991; which has the lowest figure for real electricity price for the period 1984-1998. The trend in our model starts from -180 for the 1th quarter of 1984, then increases by one in each period; and at the end, 4th quarter of 2004, becomes -97.

Although all econometric indicators support the appropriateness of this model, a formal test for functional form is also carried out to make sure that our specification is correct. Ramsey (1969) has suggested the popular RESET test (regression specification error test) to check the functional form of a model. Ramsey's RESET test estimates a regression which uses powers of the predicted values of the dependent variable (which are, of course, linear combinations of powers and cross-product terms of the explanatory variables) as regressors as well as original independent variables; and tests for the hypothesis that the coefficients on the powers of fitted values are all zero. The output table of this test is given in Appendix 5-J. As can be seen in the test output table, this test does not indicate a specification problem in our model at the 5% level of significance. That is, the model appears to be free from misspecification.

Based on these results, it seems that we need to respecify reduced form model for Turkish case. First of all, we need to readjust the desired or equilibrium electricity demand level (E'_t) in partial adjustment model as follows:

$$\ln E'_t = \alpha + \beta_1 \ln P_t + \beta_2 \ln Y_t + \beta_3 \ln P_{t-2} + \beta_4 t + u_t \qquad (17)$$

Second, based on the model represented by equation (16), it is clear that partial adjustment process in Turkey operates as follows:

$$\ln E_t - \ln E_{t-2} = \delta(\ln E'_t - \ln E_{t-2}) \qquad (18)$$

Substituting equation (17) into equation (18) and rearranging gives:

$$\ln E_t = \delta\alpha + \delta\beta_1 \ln P_t + \delta\beta_2 \ln Y_t + \delta\beta_3 \ln P_{t-2} + \delta\beta_4 t + (1-\delta)\ln E_{t-2} + \delta u_t \quad (19)$$

In order to simplify notation, equation (19) can be rewritten as:

$$\ln E_t = \phi_0 + \phi_1 \ln P_t + \phi_2 \ln Y_t + \phi_3 \ln P_{t-2} + \phi_4 t + \phi_5 \ln E_{t-2} + \varepsilon_t \qquad (20)$$

where $\phi_0 = \delta\alpha$, $\phi_1 = \delta\beta_1$, $\phi_2 = \delta\beta_2$, $\phi_3 = \delta\beta_3$, $\phi_4 = \delta\beta_4$, $\phi_5 = (1-\delta)$ and $\varepsilon_t = \delta u_t$. In equation (20)[81], ϕ_1 and ϕ_2 are the short-run price and income elasticities respectively. The long-run price and income elasticities are given by β_1 and β_2 correspondingly. Therefore, based on our estimation results given below, the short-run and long-run elasticities of demand for electricity in Turkey are as follows[82]:

$$\ln E_t = 0.653\text{-}0.041\ln P_t + 0.057\ln Y_t + 0.017\ln P_{t-2} + 0.002t + 0.862\ln E_{t-2} \quad (21)$$

---

[81] Please note that equations (20) and (16) are identical.

[82] Relying on the notation in equation (20), elasticities are obtained as follows:

$$\phi_1 = \delta\beta_1 = \text{-}0.041 \quad \phi_2 = \delta\beta_2 = 0.057 \quad (1-\delta) = 0.862$$

From above, it is obvious that $\delta = 0.138$ and, therefore, $\beta_1 = \text{-}0.297$ and $\beta_2 = 0.414$.

Table 15. Elasticities of Demand for Electricity in Turkey, based on Readjusted Partial Adjustment Model

	Short-run	Long-run
Price Elasticity	-0.041	-0.297
Income Elasticity	0.057	0.414

Now, there seems to be less difference between short-run and long-run elasticities of demand because, in this new model, the speed of adjustment to the long-run equilibrium demand level ($\delta = 0.138$) is much higher, meaning that now it takes demand less time to reach long run equilibrium. Furthermore, it is clear that the long run demand is relatively elastic compared to short run demand. Moreover, the level of income has more effect on demand than that of prices. As also suggested by economic theory, the demand is most responsive to income changes in the long run. In Turkey, if real income increases by 100%, electricity demand increases by 41% in the long-run.

A-3.4.2 Cointegration Analysis

As indicated before, since it is critical to find out whether the results obtained from our model are meaningful (i.e., not spurious) or not, let me apply formal unit root tests in each series to test the reliability of our estimates.

A-3.4.2.1 The Augmented Dickey-Fuller (ADF) Test

The established standard procedure for cointegration analysis is to start with unit root tests on the time series data being analyzed. The augmented Dickey-Fuller (ADF) test is used to test for the presence of unit roots and establish the order of integration of the variables in the model. Tables in Appendix 5-K, 5-L and 5-M show the results of the unit root tests[83] from estimation of equation (12). The null hypothesis of the test is that there is a unit root against the alternative one that there is no unit root in the variables.

Table 16. Summary of ADF Tests for Unit Roots in the Variables (in level form with a trend and intercept)

Variable	ADF Test Statistic	Results
LNE	-1.008983	Fail to reject the null
LNP	-2.627504	Fail to reject the null
LNY	-2.614160	Fail to reject the null

Note: The ADF statistic at 5% significance is -3.466248.

The ADF statistics for the natural logarithms of electricity demand (LNE), real

[83] Since equation (20) implies that the electricity demand in time t is affected by the second lag of the variables; two lags have been used in ADF unit root tests.

electricity prices (LNP) and real income (LNY) are all insignificant at 5 percent level of significance, which leads to non-rejection of the null hypothesis that there is a unit root problem in the variables. Based on ADF test, it is obvious that the variables are non-stationary.

As mentioned previously, differencing has the effect of making the variables stationary. Tables in Appendix 5-N, 5-O and 5-P present the results of unit root tests for the differenced variables, which are summarized in the table below.

Table 17. Summary of ADF Tests for Unit Roots in the Variables (in 1st difference form with a trend and intercept)

Variable	ADF Test Statistic	Results
Δ LNE	-4.569026	Reject the null
Δ LNP	-13.98314	Reject the null
Δ LNY	-38.88917	Reject the null

Note: The ADF statistic at 5% significance is -3.466966.

The ADF statistics for the first difference variables are all significant at 5 percent level of significance, which leads to rejection of the null hypothesis that there is a unit root problem in the variables. Based on ADF test, it is apparent that the first difference variables are stationary, which implies that the variables are integrated of order one, $I(1)$.

A-3.4.2.2 Cointegration Tests

A-3.4.2.2.1 Augmented Engle-Granger (AEG) Test

The residuals from the estimation of equation (20) were used to test for the existence of cointegrating relationship between the variables. The null hypothesis is that the residuals have a unit root problem against the alternative that the variables cointegrate. The result of AEG test[84] is presented in Appendix 5-R.

Table 18. Summary of AEG Test Output for Equation (20)

Variable	ADF Test Statistic	Result
Residuals	-5.3643	Reject the null

Note: 95% critical value for the Dickey-Fuller statistic is -4.9387.

It is clear that absolute value of ADF test statistic is more than the critical value, meaning that the null hypothesis is rejected. To reject the null hypothesis implies that the residuals have not a unit root problem; i.e., they are stationary.

[84] The test is carried out by Microfit 4.1.

It can therefore be concluded that, based on the AEG method, the variables are cointegrated.

A-3.4.2.2.2 Cointegrating Regression Durbin-Watson Test

Since cointegration is very crucial to the reliability of estimated parameters, a second test, namely CRDW test, was carried out to make sure that the variables in this study are definitely cointegrated. The Durbin-Watson statistic for the regression represented by equation (20) is 0.559, which is above the 1% critical value (0.511). Therefore, we fail to reject the null hypothesis of cointegration at the 1% level, which reinforces the finding on the basis of the AEG test.

To sum up, our conclusion, based on both the AEG and CRDW tests, is that the variables LNE, LNP and LNY are cointegrated. Although they individually exhibit random walks, there seems to be a stable long-run relationship between them; they will not wander away from each other in the long-run.

Based on these results, we may conclude that the appropriate model for Turkish electricity demand is the one represented in equation (20) and that our estimates are reliable; that is, not spurious.

A-3.5 Electricity Demand Forecast for Turkey: 2005-2015

Before starting the forecast, it is important to make some points clear. First of all, data used here is annual data covering the period 1923[85]-2004, a total of 82 observations. Also, unlike previous section, the data here is not converted into natural logarithms and, therefore, the unit is GWh. Furthermore, the time plot of data is provided in Appendix 6-A to facilitate the understanding of current trend in electricity demand. As can easily be seen from the time plot, there exists a sharp sustained upward trend in electricity demand starting from the early 1960s and even this trend has become steeper in the last 20 years.

In literature, there are five main approaches to economic forecasting based on time series data; namely, (1) exponential smoothing methods, (2) single-equation regression models, (3) simultaneous-equation regression models, (4) autoregressive integrated moving average models (ARIMA), and (5) vector autoregression. Although still used in some areas, the first group of models is now supplanted by the other four methods; therefore, we will not use them in this study. Taking into account rather low estimates of elasticities obtained in previous section[86], it seems better not to include price and income variables in the forecasting process and "let the demand data speak for itself", which is the main philosophy behind ARIMA modelling. Since the second, third and the fifth group of models require the inclusion of price, income and some other variables in the forecasting process; they will also not be used here. In short, this section

[85] The Republic of Turkey was founded in 1923.

[86] Since the absolute value of the elasticities measure the relative change in the dependent variable (in our case, electricity consumption) due to a relative change in the independent variables (in our case, price and income); low elasticities imply that responsiveness of demand to price and income changes is rather limited, meaning that a forecast linking price and income to consumption will not produce healthy results.

will develop an electricity demand forecast for Turkey based on ARIMA modelling.

As mentioned before, ARIMA modelling consists of four steps. In the first step, namely **identification** step, we need to identify the appropriate parameters in our model, that is, ARIMA(*p,d,q*). The figure in Appendix 6-B provides us with the correlogram up to 40 lags, or the plots of ACF and PACF against the lag length of 40. The column labeled AC and PAC are the sample autocorrelation function and the sample partial autocorrelation function respectively. Also the diagrams of AC and PAC are provided on the left. The solid and dashed vertical lines in the diagram represent the zero axis and 95% confidence interval respectively. From this figure, two facts stand out: First, the autocorrelation coefficient starts at a very high value at lag 1 (0.937) and declines very slowly; and ACF up to 16 lags are individually statistically significant different from zero as they are all outside the 95% confidence bounds. Second, after the first lag, the PACF drops dramatically, and all PACFs after lag 1 are statistically insignificant. These two facts strongly support the idea that the electricity consumption time series is nonstationary. It may be nonstationary in mean or variance, or both.

Since the data is nonstationary we have to make it stationary. The figures in Appendix 6-C and 6-D show the correlograms of the first and second differenced data up to 40 lags. We still observe a trend in the first-differenced consumption time series but this trend disappears in the second-differenced one, perhaps suggesting that the second-differenced data is stationary. A formal application of the ADF unit root test shows that that is indeed the case. The output table of this test is given in Appendix 6-E.

In Appendix 6-D, we have a much different pattern of ACF and PACF. The ACFs at lags 1, 3 and 4; and PACFs at 1, 2, 4, 6 and 13 seem statistically different from zero. But at all other lags, they are not statistically different from zero. If the partial correlation coefficient were significant only at lag 1, we could have identified this as an AR(1) model. Let us therefore assume that the process that generated the second-differenced consumption is at the most an AR(13) process. Since from the partial correlogram we know that only the AR terms at lag 1, 2, 4, 6 and 13 are significant, we only need to include these AR terms. Therefore at the end of first step we may conclude that the original time series is ARIMA(13,2,0); that is, the second differenced stationary data can be modeled as an ARMA(13,0) process.

The second step in ARIMA modelling is **estimation**. Let E_t^* denote the second-differenced data. Then, in line with the conclusion in the first step, our model is:

$$E_t^* = \delta + \alpha_1 E_{t-1}^* + \alpha_2 E_{t-2}^* + \alpha_4 E_{t-4}^* + \alpha_6 E_{t-6}^* + \alpha_{13} E_{t-13}^* + u_t \qquad (22)$$

Using EViews, we obtained the following estimates[87]:

$$E_t^* = 275.93 - 0.56E_{t-1}^* - 0.44E_{t-2}^* - 0.62E_{t-4}^* - 0.56E_{t-6}^* + 0.54E_{t-13}^* \qquad (23)$$

[87] Estimation output table is given in Appendix 6-F.

In the third step; that is, **diagnostic checking**, we have obtained residuals from (23) and get the ACF and PACF of these residuals up to lag 40 in order to check that the model represented by equation (23) is a reasonable fit to the data. The estimated ACF and PACF are shown in Appendix 6-G. As can be seen in Appendix 6-G, none of the autocorrelations and partial correlations is individually statistically significant. In other words, the correlograms of both autocorrelation and partial autocorrelation give the impression that the residuals estimated from regression (23) are purely random. Hence, there is not any need to look for another ARIMA model.

The final step is forecasting. However, we need to integrate the second-differenced series to obtain the forecast of consumption rather than its changes. We know that[88]:

$$E_t^* = E_t - 2E_{t-1} + E_{t-2} \tag{24}$$

If we transform all variables in equation (22) based on this formula and rearrange it, our model becomes:

$$\begin{aligned} E_t \;=\; & \delta + (2+\alpha_1)E_{t-1} + (\alpha_2 - 2\alpha_1 - 1)E_{t-2} + (\alpha_1 - 2\alpha_2)E_{t-3} \\ & +(\alpha_2 + \alpha_4)E_{t-4} - 2\alpha_4 E_{t-5} + (\alpha_4 + \alpha_6)E_{t-6} - 2\alpha_6 E_{t-7} \\ & +\alpha_6 E_{t-8} + \alpha_{13}E_{t-13} - 2\alpha_{13}E_{t-14} + \alpha_{13}E_{t-15} + u_t \end{aligned} \tag{25}$$

The values of δ, α_1, α_2, α_4, α_6 and α_{13} are already known from the estimated regression (23) and u_t is assumed to be zero, which enables us to convert equation (25) into equation (26). Using equation (26), we can easily obtain the forecast values for the period 2005-2015, which are given in the table below.

$$\begin{aligned} E_t \;=\; & 275.93 + 1.44E_{t-1} - 0.32E_{t-2} + 0.32E_{t-3} - 1.06E_{t-4} \\ & +1.23E_{t-5} - 1.17E_{t-6} + 1.11E_{t-7} - 0.56E_{t-8} \\ & +0.54E_{t-13} - 1.08E_{t-14} + 0.54E_{t-15} \end{aligned} \tag{26}$$

[88] This formula to integrate data from second-differenced form into level form is produced by the author himself.

Table 19. Demand (Net Electricity Consumption) Forecast for Turkey, 2005-2015

Year	Forecasted Net Electricity Consumption *(GWh)*	Annual % Change	Index (2004=100)
2005	130,204.9	11.7	111.7
2006	134,876.5	3.6	115.7
2007	142,091.6	5.3	121.9
2008	152,696.9	7.5	131.0
2009	153,897.4	0.8	132.0
2010	167,413.7	8.8	143.6
2011	170,957.3	2.1	146.7
2012	176,576.5	3.3	151.5
2013	192,011.2	8.7	164.7
2014	187,387.9	-2.4	160.8
2015	205,108.1	9.5	176.0

*Note: Average annual % change is **5.4***

Appendix 4: The Data

Appendix 4-A: Real Electricity Prices at 2004 Prices (YTL/kWh)

Period	Electricity Prices for Industry (YTL/kWh)	Electricity Prices for Households (YTL/kWh)	Electricity Consumption by Industry (GWh)	Electricity Consumption by Households (GWh)	Weighted Average Price (YTL/kWh)	Inflation (Annual Change) %	Inflation Index (2004=1)	Real Electricity Prices (at 2004 Prices) (YTL/kWh)
1Q1984	0.000016	0.000013	15277	4096	0.000015	48.4	0.00007	0.235480
2Q1984	0.000017	0.000014	15860	4166	0.000016			0.250961
3Q1984	0.000020	0.000016	16443	4236	0.000019			0.293943
4Q1984	0.000022	0.000018	**17026**	**4306**	0.000021			0.324776
1Q1985	0.000024	0.000019	17360	4474	0.000023	45.0	0.00010	0.237263
2Q1985	0.000024	0.000019	17695	4643	0.000023			0.237112
3Q1985	0.000024	0.000019	18029	4811	0.000023			0.236968
4Q1985	0.000030	0.000022	**18363**	**4980**	0.000028			0.292180
1Q1986	0.000046	0.000030	18646	5151	0.000043	34.6	0.00014	0.302944
2Q1986	0.000046	0.000030	18928	5321	0.000042			0.302605
3Q1986	0.000046	0.000030	19211	5492	0.000042			0.302276
4Q1986	0.000048	0.000030	**19494**	**5663**	0.000044			0.312996
1Q1987	0.000053	0.000031	20192	5874	0.000048	38.8	0.00019	0.254201
2Q1987	0.000053	0.000031	20890	6085	0.000048			0.254174
3Q1987	0.000064	0.000038	21588	6296	0.000058			0.307574
4Q1987	0.000072	0.000040	**22286**	**6507**	0.000065			0.342701
1Q1988	0.000088	0.000046	22602	6784	0.000078	73.7	0.00026	0.298503
2Q1988	0.000088	0.000046	22918	7060	0.000078			0.297758
3Q1988	0.000095	0.000052	23233	7337	0.000085			0.322808
4Q1988	0.000102	0.000056	**23549**	**7613**	0.000091			0.345994
1Q1989	0.000120	0.000066	24098	7777	0.000107	63.3	0.00046	0.234443
2Q1989	0.000134	0.000075	24647	7940	0.000120			0.262533
3Q1989	0.000155	0.000088	25197	8103	0.000139			0.304390
4Q1989	0.000173	0.000102	**25746**	**8267**	0.000156			0.341801
1Q1990	0.000186	0.000114	26146	8465	0.000168	60.3	0.00074	0.226306
2Q1990	0.000204	0.000127	26547	8664	0.000185			0.248700
3Q1990	0.000222	0.000137	26947	8863	0.000201			0.270080
4Q1990	0.000245	0.000151	**27348**	**9062**	0.000222			0.297822
1Q1991	0.000268	0.000169	27078	9505	0.000242	66.0	0.00119	0.203123
2Q1991	0.000312	0.000235	26808	9948	0.000291			0.244105
3Q1991	0.000383	0.000328	26538	10392	0.000368			0.308127
4Q1991	0.000430	0.000375	**26268**	**10835**	0.000414			0.347041
1Q1992	0.000540	0.000500	27023	10997	0.000528	70.1	0.00198	0.266885
2Q1992	0.000591	0.000574	27779	11160	0.000586			0.296025
3Q1992	0.000665	0.000679	28535	11322	0.000669			0.337869
4Q1992	0.000742	0.000770	**29290**	**11484**	0.000750			0.378732
1Q1993	0.000836	0.000871	29908	11753	0.000846	66.1	0.00337	0.251153
2Q1993	0.000947	0.000985	30527	12023	0.000958			0.284367
3Q1993	0.001091	0.001133	31145	12292	0.001103			0.327463
4Q1993	0.001286	0.001336	**31763**	**12561**	0.001300			0.386040
1Q1994	0.001520	0.001503	31759	12784	0.001515	106.2	0.00559	0.270838
2Q1994	0.002356	0.002329	31755	13007	0.002348			0.419749
3Q1994	0.002565	0.002537	31751	13230	0.002557			0.457039
4Q1994	0.002706	0.002676	**31748**	**13452**	0.002697			0.482120
1Q1995	0.002932	0.002904	32749	13713	0.002924	93.6	0.01154	0.253462

2Q1995	0.003254	0.003238	33751	13974	0.003249			0.281686
3Q1995	0.003748	0.003729	34752	14234	0.003742			0.324439
4Q1995	0.004010	0.004004	**35753**	**14495**	0.004008			0.347481
1Q1996	0.005265	0.005328	36414	14979	0.005283	82.3	0.02233	0.236581
2Q1996	0.006514	0.006637	37075	15464	0.006550			0.293308
3Q1996	0.007550	0.007720	37735	15948	0.007601			0.340338
4Q1996	0.008752	0.008986	**38396**	**16433**	0.008822			0.395041
1Q1997	0.009923	0.010201	39121	16954	0.010007	85.7	0.04071	0.245804
2Q1997	0.010841	0.011149	39846	17475	0.010935			0.268594
3Q1997	0.011957	0.012347	40571	17996	0.012077			0.296644
4Q1997	0.014124	0.014711	**41296**	**18517**	0.014306			0.351392
1Q1998	0.015947	0.016614	42023	18897	0.016154	84.6	0.07560	0.213672
2Q1998	0.018344	0.019227	42751	19277	0.018618			0.246271
3Q1998	0.021088	0.022101	43478	19658	0.021403			0.283109
4Q1998	0.023201	0.024309	**44206**	**20038**	0.023547			0.311457
1Q1999	0.026351	0.027791	44277	20675	0.026809	64.9	0.13956	0.192099
2Q1999	0.030501	0.031974	44349	21313	0.030979			0.221977
3Q1999	0.035287	0.037179	44420	21950	0.035913			0.257328
4Q1999	0.040881	0.043072	**44491**	**22588**	0.041619			0.298214
1Q2000	0.045191	0.047657	44893	22914	0.046024	54.9	0.23013	0.199989
2Q2000	0.048402	0.051069	45294	23240	0.049306			0.214250
3Q2000	0.051589	0.054410	45696	23566	0.052549			0.228339
4Q2000	0.054770	0.057985	**46097**	**23892**	0.055867			0.242760
1Q2001	0.065051	0.068638	45825	23821	0.066278	54.4	0.35648	0.185924
2Q2001	0.092663	0.097735	45553	23751	0.094401			0.264816
3Q2001	0.108814	0.114671	45280	23680	0.110825			0.310889
4Q2001	0.123146	0.129758	**45008**	**23609**	0.125421			0.351833
1Q2002	0.135150	0.142237	45968	23609	0.137555	45.0	0.55040	0.249916
2Q2002	0.137850	0.145167	46927	23609	0.140299			0.254902
3Q2002	0.145180	0.152890	47887	23609	0.147726			0.268396
4Q2002	0.151385	0.159487	**48846**	**23609**	0.154025			0.279840
1Q2003	0.152610	0.160761	50253	23850	0.155233	25.3	0.79808	0.194507
2Q2003	0.123673	0.129624	51661	24090	0.125566			0.157334
3Q2003	0.123673	0.129624	53068	24331	0.125544			0.157306
4Q2003	0.119461	0.128515	**54475**	**24572**	0.122275			0.153211
1Q2004	0.142800	0.158300	54205	25111	0.147707	11.4	1.00000	0.147707
2Q2004	0.142800	0.158300	53935	25650	0.147796			0.147796
3Q2004	0.142800	0.158300	53664	26189	0.147883			0.147883
4Q2004	0.142800	0.158300	**53394**	**26728**	0.147971			0.147971

Appendix 4-B: Real GDP per capita at 2004 Prices (YTL) and Net Electricity Consumption per capita (kWh)

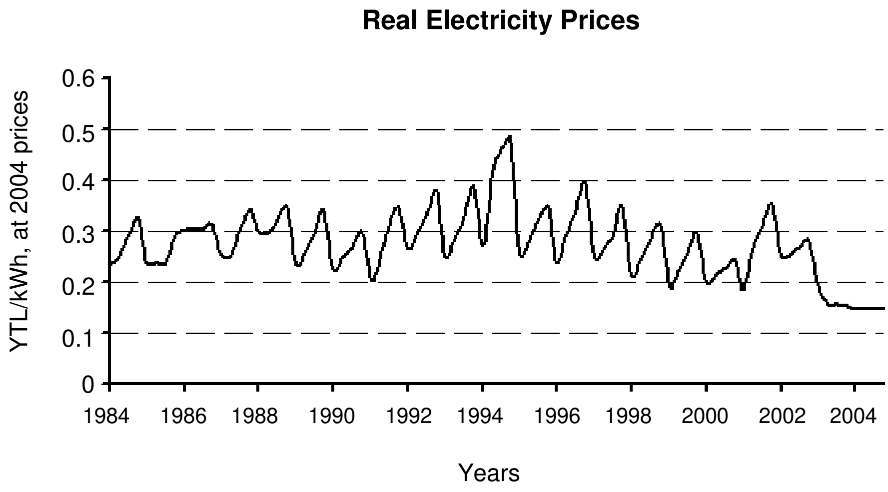
Period	Population (thousand people)	GDP at current prices (YTL)	GDP per capita at current prices (YTL)	Inflation (Annual Change) %	Inflation Index (2004=1)	Real GDP per capita (at 2004 Prices) (YTL)	Net Electricity Consumption (GWh)	Net Electricity Consumption per capita (kWh)
1Q1984	48166	15,928,750	0.331	48.4	0.00007	5068.1	25258	524.4
2Q1984	48467	17,951,500	0.370			5676.2	26050	537.5
3Q1984	48769	19,974,250	0.410			6276.6	26843	550.4
4Q1984	**49070**	**21,997,000**	0.448			6869.9	**27635**	563.2
1Q1985	49379	25,271,500	0.512	45.0	0.00010	5285.1	28154	570.2
2Q1985	49688	28,546,000	0.575			5932.8	28672	577.0
3Q1985	49997	31,820,500	0.636			6572.5	29190	583.8
4Q1985	**50306**	**35,095,000**	0.698			7204.3	**29709**	590.6
1Q1986	50588	39,091,000	0.773	34.6	0.00014	5503.4	30334	599.6
2Q1986	50870	43,087,000	0.847			6032.3	30959	608.6
3Q1986	51151	47,083,000	0.920			6555.5	31584	617.5
4Q1986	**51433**	**51,079,000**	0.993			7072.9	**32210**	626.3
1Q1987	51715	56,989,750	1.102	38.8	0.00019	5830.9	33332	644.5
2Q1987	51997	62,900,500	1.210			6400.7	34454	662.6
3Q1987	52279	68,811,250	1.316			6964.4	35575	680.5
4Q1987	**52561**	**74,722,000**	1.422			7522.1	**36697**	698.2
1Q1988	52850	88,347,250	1.672	73.7	0.00026	6372.5	37453	708.7
2Q1988	53138	101,972,500	1.919			7315.5	38209	719.1
3Q1988	53427	115,597,750	2.164			8248.1	38965	729.3
4Q1988	**53715**	**129,223,000**	2.406			9170.8	**39722**	739.5
1Q1989	54010	153,748,500	2.847	63.3	0.00046	6247.4	40571	751.2
2Q1989	54304	178,274,000	3.283			7204.8	41421	762.8
3Q1989	54599	202,799,500	3.714			8151.7	42270	774.2
4Q1989	**54893**	**227,325,000**	4.141			9088.6	**43120**	785.5
1Q1990	55223	268,758,750	4.867	60.3	0.00074	6540.6	44045	797.6
2Q1990	55553	310,192,500	5.584			7504.2	44970	809.5
3Q1990	55882	351,626,250	6.292			8456.4	45895	821.3
4Q1990	**56212**	**393,060,000**	6.992			9397.4	**46820**	832.9
1Q1991	56482	452,324,250	8.008	66.0	0.00119	6714.0	47436	839.8
2Q1991	56752	511,588,500	9.014			7557.6	48051	846.7
3Q1991	57021	570,852,750	10.011			8393.3	48667	853.5
4Q1991	**57291**	**630,117,000**	10.999			9221.0	**49283**	860.2
1Q1992	57563	745,929,750	12.958	70.1	0.00198	6544.7	50458	876.6
2Q1992	57835	861,742,500	14.900			7525.3	51634	892.8
3Q1992	58107	977,555,250	16.823			8496.7	52809	908.8
4Q1992	**58379**	**1,093,368,000**	18.729			9459.0	**53985**	924.7
1Q1993	58654	1,315,492,750	22.428	66.1	0.00337	6659.2	55298	942.8
2Q1993	58929	1,537,617,500	26.093			7747.3	56611	960.7
3Q1993	59203	1,759,742,250	29.724			8825.5	57924	978.4
4Q1993	**59478**	**1,981,867,000**	33.321			9893.5	**59237**	995.9
1Q1994	59755	2,453,507,500	41.059	106.2	0.00559	7339.7	59778	1000.4
2Q1994	60033	2,925,148,000	48.726			8710.0	60319	1004.8
3Q1994	60310	3,396,788,500	56.322			10068.0	60860	1009.1
4Q1994	**60587**	**3,868,429,000**	63.849			11413.5	**61401**	1013.4
1Q1995	60867	4,841,935,750	79.549	93.6	0.01154	6896.2	62899	1033.4
2Q1995	61147	5,815,442,500	95.106			8244.8	64397	1053.2
3Q1995	61426	6,788,949,250	110.522			9581.3	65896	1072.8
4Q1995	**61706**	**7,762,456,000**	125.797			10905.5	**67394**	1092.2
1Q1996	61990	9,514,869,500	153.490	82.3	0.02233	6873.1	69085	1114.5

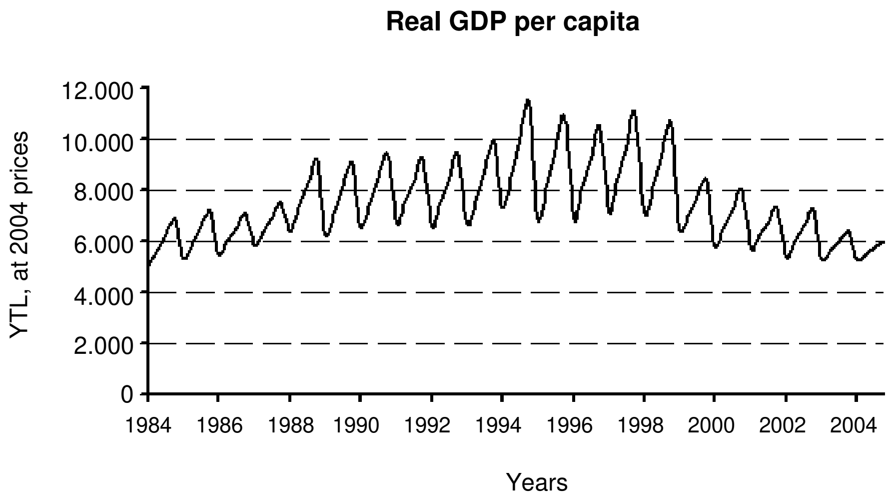
2Q1996	62274	11,267,283,000	180.931			8101.8	70775	1136.5
3Q1996	62557	13,019,696,500	208.125			9319.5	72466	1158.4
4Q1996	**62841**	**14,772,110,000**	235.071			10526.1	**74157**	1180.1
1Q1997	63128	18,288,053,250	289.698	85.7	0.04071	7115.9	76089	1205.3
2Q1997	63415	21,803,996,500	343.830			8445.5	78021	1230.3
3Q1997	63702	25,319,939,750	397.475			9763.2	79953	1255.1
4Q1997	**63989**	**28,835,883,000**	450.638			11069.0	**81885**	1279.7
1Q1998	64278	34,683,148,500	539.580	84.6	0.07560	7137.2	83340	1296.6
2Q1998	64567	40,530,414,000	627.726			8303.1	84795	1313.3
3Q1998	64856	46,377,679,500	715.087			9458.6	86250	1329.9
4Q1998	**65145**	**52,224,945,000**	801.672			10603.9	**87705**	1346.3
1Q1999	65435	58,522,526,750	894.361	64.9	0.13956	6408.4	88579	1353.7
2Q1999	65725	64,820,108,500	986.232			7066.7	89453	1361.0
3Q1999	66014	71,117,690,250	1077.312			7719.3	90328	1368.3
4Q1999	**66304**	**77,415,272,000**	1167.581			8366.1	**91202**	1375.5
1Q2000	66595	89,207,318,500	1339.550	54.9	0.23013	5820.7	92975	1396.1
2Q2000	66887	100,999,365,000	1510.000			6561.4	94749	1416.6
3Q2000	67178	112,791,411,500	1678.993			7295.7	96522	1436.8
4Q2000	**67469**	**124,583,458,000**	1846.529			8023.7	**98296**	1456.9
1Q2001	67756	138,040,703,250	2037.321	54.4	0.35648	5715.1	97989	1446.2
2Q2001	68044	151,497,948,500	2226.470			6245.7	97683	1435.6
3Q2001	68331	164,955,193,750	2414.061			6772.0	97376	1425.1
4Q2001	**68618**	**178,412,439,000**	2600.082			7293.8	**97070**	1414.6
1Q2002	68903	203,202,843,500	2949.115	45.0	0.55040	5358.1	98540	1430.1
2Q2002	69188	227,993,248,000	3295.272			5987.0	100009	1445.5
3Q2002	69472	252,783,652,500	3638.641			6610.9	101479	1460.7
4Q2002	**69757**	**277,574,057,000**	3979.157			7229.5	**102948**	1475.8
1Q2003	70039	298,121,274,250	4256.504	25.3	0.79808	5333.4	105153	1501.3
2Q2003	70321	318,668,491,500	4531.626			5678.1	107357	1526.7
3Q2003	70603	339,215,708,750	4804.551			6020.1	109562	1551.8
4Q2003	**70885**	**359,762,926,000**	5075.304			6359.4	**111766**	1576.7
1Q2004	71165	377,450,063,750	5303.872	11.4	1.00000	5303.9	112965	1587.4
2Q2004	71444	395,137,201,500	5530.726			5530.7	114164	1598.0
3Q2004	71724	412,824,339,250	5755.735			5755.7	115362	1608.4
4Q2004	**72003**	**430,511,477,000**	5979.077			5979.1	**116561**	1618.8

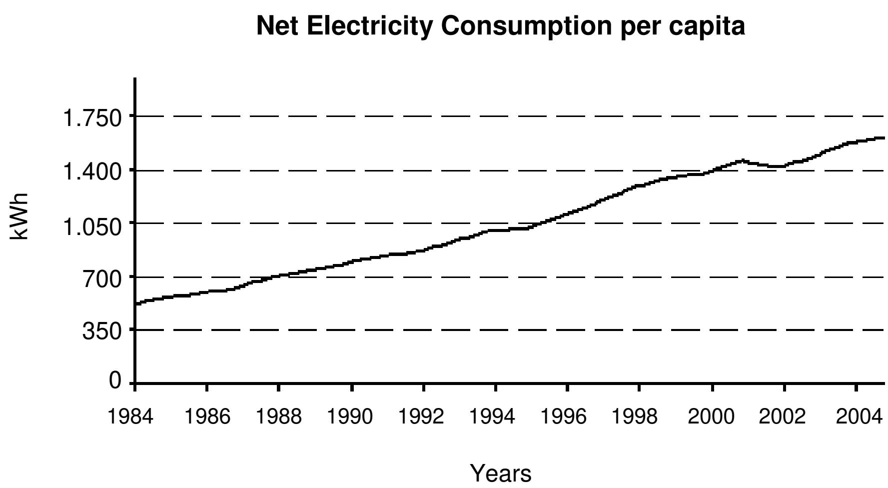
Appendix 4-C: Net Electricity Consumption in Turkey (1923-2004)

Year	Net Electricity Consumption *(GWh)*	Year	Net Electricity Consumption *(GWh)*	Year	Net Electricity Consumption *(GWh)*
1923	41.3	**1951**	764.0	**1979**	19,663.1
1924	41.3	**1952**	878.5	**1980**	20,398.2
1925	41.9	**1953**	1,012.5	**1981**	22,030.0
1926	60.6	**1954**	1,191.5	**1982**	23,586.8
1927	63.4	**1955**	1,347.3	**1983**	24,465.1
1928	81.4	**1956**	1,544.8	**1984**	27,635.2
1929	88.9	**1957**	1,757.0	**1985**	29,708.6
1930	96.7	**1958**	1,961.5	**1986**	32,209.7
1931	106.0	**1959**	2,170.5	**1987**	36,697.3
1932	117.5	**1960**	2,395.7	**1988**	39,721.5
1933	136.2	**1961**	2,585.4	**1989**	43,120.0
1934	157.7	**1962**	3,059.3	**1990**	46,820.0
1935	199.6	**1963**	3,406.3	**1991**	49,282.9
1936	206.8	**1964**	3,780.7	**1992**	53,984.7
1937	257.7	**1965**	4,236.8	**1993**	59,237.0
1938	279.9	**1966**	4,728.9	**1994**	61,400.9
1939	316.8	**1967**	5,269.2	**1995**	67,393.9
1940	359.3	**1968**	5,870.1	**1996**	74,156.6
1941	377.6	**1969**	6,679.0	**1997**	81,885.0
1942	372.5	**1970**	7,307.8	**1998**	87,704.6
1943	395.7	**1971**	8,289.3	**1999**	91,201.9
1944	429.9	**1972**	9,527.3	**2000**	98,295.7
1945	459.0	**1973**	10,530.1	**2001**	97,070.0
1946	487.0	**1974**	11,358.7	**2002**	102,948.0
1947	541.2	**1975**	13,491.7	**2003**	111,766.0
1948	585.7	**1976**	16,078.9	**2004**	116,561.0
1949	633.9	**1977**	17,968.8		
1950	678.8	**1978**	18,933.8		

Appendix 4-D: Time Series Plots of Real Electricity Prices, Real GDP per capita and Net Electricity Consumption per capita







Appendix 5: Estimation Outputs

Appendix 5-A: OLS Estimation Output for Equation (14)

Dependent Variable: LNE
Method: Least Squares
Sample: 1984Q1 2004Q4
Included observations: 84

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-5.124650	2.058049	-2.490052	0.0148
LNP	-1.167446	0.166995	-6.990908	0.0000
LNY	1.178790	0.212901	5.536795	0.0000

R-squared	0.378947	Mean dependent var	6.901568
Adjusted R-squared	0.363612	S.D. dependent var	0.338070
S.E. of regression	0.269692	Akaike info criterion	0.251986
Sum squared resid	5.891420	Schwarz criterion	0.338801
Log likelihood	-7.583411	F-statistic	24.71183
Durbin-Watson stat	0.138525	Prob(F-statistic)	0.000000

Appendix 5-B: OLS Estimation Output for Equation (15)

Dependent Variable: LNE
Method: Least Squares
Sample (adjusted): 1984Q2 2004Q4
Included observations: 83 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.041010	0.052322	-0.783804	0.4355
LNP	-0.012257	0.005074	-2.415843	0.0180
LNY	0.014779	0.006049	2.443350	0.0168
LNE(-1)	0.986500	0.002672	369.2103	0.0000

R-squared	0.999633	Mean dependent var	6.909270
Adjusted R-squared	0.999619	S.D. dependent var	0.332627
S.E. of regression	0.006495	Akaike info criterion	-7.188486
Sum squared resid	0.003333	Schwarz criterion	-7.071916
Log likelihood	302.3222	F-statistic	71655.72
Durbin-Watson stat	0.654315	Prob(F-statistic)	0.000000

Appendix 5-C: White Heteroskedasticity Test Output for Equation (15)

White Heteroskedasticity Test:			
F-statistic	**1.645829**	**Prob. F(6,76)**	**0.146190**
Obs*R-squared	9.544376	Prob. Chi-Square(6)	0.145197

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 1984Q2 2004Q4
Included observations: 83

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.000400	0.011245	-0.035613	0.9717
LNP	8.79E-05	0.000189	0.465490	0.6429
LNP^2	-1.73E-07	6.63E-05	-0.002605	0.9979
LNY	-9.98E-05	0.002609	-0.038238	0.9696
LNY^2	-2.02E-06	0.000146	-0.013868	0.9890
LNE(-1)	0.000427	0.001037	0.411713	0.6817
LNE(-1)^2	-2.81E-05	7.57E-05	-0.370882	0.7118

R-squared	0.114992	Mean dependent var	4.02E-05
Adjusted R-squared	0.045123	S.D. dependent var	4.68E-05
S.E. of regression	4.57E-05	Akaike info criterion	-17.06688
Sum squared resid	1.59E-07	Schwarz criterion	-16.86288
Log likelihood	715.2754	F-statistic	1.645829
Durbin-Watson stat	1.023832	Prob(F-statistic)	0.146190

Appendix 5-D: Breusch-Godfrey Test Output for Equation (15)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	69.04066	Prob. F(1,78)	0.000000
Obs*R-squared	**38.97136**	**Prob. Chi-Square(1)**	**0.000000**

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Sample: 1984Q2 2004Q4
Included observations: 83
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.070172	0.039270	1.786913	0.0778
LNP	0.006694	0.003805	1.759165	0.0825
LNY	-0.008219	0.004542	-1.809257	0.0743
LNE(-1)	0.001704	0.001969	0.865534	0.3894
RESID(-1)	0.706301	0.085004	8.309071	0.0000

R-squared	0.469534	Mean dependent var	1.43E-15
Adjusted R-squared	0.442331	S.D. dependent var	0.006375
S.E. of regression	0.004761	Akaike info criterion	-7.798390
Sum squared resid	0.001768	Schwarz criterion	-7.652677
Log likelihood	328.6332	F-statistic	17.26016
Durbin-Watson stat	1.878140	Prob(F-statistic)	0.000000

Appendix 5-E: Estimation Output of OLS with Newey-West Procedure for Equation (15)

Dependent Variable: LNE
Method: Least Squares
Sample (adjusted): 1984Q2 2004Q4
Included observations: 83 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.041010	0.074577	-0.549903	**0.5839**
LNP	-0.012257	0.008346	-1.468604	**0.1459**
LNY	0.014779	0.009852	1.500027	**0.1376**
LNE(-1)	0.986500	0.005095	193.6392	0.0000

R-squared	0.999633	Mean dependent var	6.909270
Adjusted R-squared	0.999619	S.D. dependent var	0.332627
S.E. of regression	0.006495	Akaike info criterion	-7.188486
Sum squared resid	0.003333	Schwarz criterion	-7.071916
Log likelihood	302.3222	F-statistic	71655.72
Durbin-Watson stat	0.654315	Prob(F-statistic)	0.000000

Appendix 5-F: OLS Estimation Output for Equation (16)

Dependent Variable: LNE
Method: Least Squares
Sample (adjusted): 1984Q3 2004Q4
Included observations: 82 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.653163	0.325404	2.007234	0.0483
LNP	-0.041065	0.008860	-4.634800	0.0000
LNY	0.057235	0.011819	4.842577	0.0000
LNE(-2)	0.861767	0.041823	20.60486	0.0000
LNP(-2)	0.017296	0.005998	2.883757	0.0051
@TREND(29)	0.001562	0.000587	2.660853	0.0095

R-squared	0.998977	Mean dependent var	6.916860
Adjusted R-squared	0.998909	S.D. dependent var	0.327363
S.E. of regression	0.010811	Akaike info criterion	-6.146136
Sum squared resid	0.008883	Schwarz criterion	-5.970035
Log likelihood	257.9916	F-statistic	14838.59
Durbin-Watson stat	0.558808	Prob(F-statistic)	0.000000

Appendix 5-G: White Heteroskedasticity Test Output for Equation (16)

White Heteroskedasticity Test:

F-statistic	**1.619995**	**Prob. F(10,71)**	**0.118502**
Obs*R-squared	15.23391	Prob. Chi-Square(10)	0.123764

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Sample: 1984Q3 2004Q4
Included observations: 82

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.017964	0.048179	-0.372861	0.7104
LNP	0.001680	0.000653	2.572813	0.0122
LNP^2	0.000539	0.000241	2.234292	0.0286
LNY	0.011808	0.007782	1.517289	0.1336
LNY^2	-0.000667	0.000435	-1.533302	0.1296
LNE(-2)	-0.010417	0.011962	-0.870873	0.3868
LNE(-2)^2	0.000770	0.000823	0.935601	0.3526
LNP(-2)	-6.05E-05	0.000557	-0.108620	0.9138
LNP(-2)^2	-2.99E-05	0.000215	-0.139264	0.8896
@TREND(29)	-2.94E-05	4.79E-05	-0.613819	0.5413
(@TREND(29))^2	-9.74E-08	2.08E-07	-0.467174	0.6418

R-squared	0.185779	Mean dependent var	0.000108
Adjusted R-squared	0.071100	S.D. dependent var	0.000133
S.E. of regression	0.000129	Akaike info criterion	-14.95567
Sum squared resid	1.17E-06	Schwarz criterion	-14.63282
Log likelihood	624.1826	F-statistic	1.619995
Durbin-Watson stat	1.196172	Prob(F-statistic)	0.118502

Appendix 5-H: Breusch-Godfrey Test Output for Equation (16)

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	80.72216	Prob. F(1,75)	0.000000
Obs*R-squared	**42.50659**	**Prob. Chi-Square(1)**	**0.000000**

Test Equation:
Dependent Variable: RESID
Method: Least Squares
Sample: 1984Q3 2004Q4
Included observations: 82
Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.097829	0.227590	0.429849	0.6685
LNP	0.006639	0.006234	1.065008	0.2903
LNY	-0.010279	0.008336	-1.233149	0.2214
LNE(-2)	1.24E-05	0.029218	0.000423	0.9997
LNP(-2)	-0.002559	0.004200	-0.609402	0.5441
@TREND(29)	8.00E-06	0.000410	0.019510	0.9845
RESID(-1)	0.737827	0.082122	8.984551	0.0000

R-squared	0.518373	Mean dependent var	1.35E-16
Adjusted R-squared	0.479843	S.D. dependent var	0.010472
S.E. of regression	0.007553	Akaike info criterion	-6.852331
Sum squared resid	0.004278	Schwarz criterion	-6.646880
Log likelihood	287.9456	F-statistic	13.45369
Durbin-Watson stat	1.553819	Prob(F-statistic)	0.000000

Appendix 5-I: Estimation Output of OLS with Newey-West Procedure for Equation (16)

Dependent Variable: LNE
Method: Least Squares
Sample (adjusted): 1984Q3 2004Q4
Included observations: 82 after adjustments
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.653163	0.322592	2.024731	0.0464
LNP	-0.041065	0.015544	-2.641829	0.0100
LNY	0.057235	0.018367	3.116284	0.0026
LNE(-2)	0.861767	0.043749	19.69790	0.0000
LNP(-2)	0.017296	0.006857	2.522487	0.0137
@TREND(29)	0.001562	0.000584	2.674101	0.0092

R-squared	0.998977	Mean dependent var	6.916860
Adjusted R-squared	0.998909	S.D. dependent var	0.327363
S.E. of regression	0.010811	Akaike info criterion	-6.146136
Sum squared resid	0.008883	Schwarz criterion	-5.970035
Log likelihood	257.9916	F-statistic	14838.59
Durbin-Watson stat	0.558808	Prob(F-statistic)	0.000000

Appendix 5-J: Ramsey's RESET Test Output for Equation (16)

Ramsey RESET Test:

F-statistic	**0.021673**	**Prob. F(1,75)**	**0.883357**
Log likelihood ratio	0.023692	Prob. Chi-Square(1)	0.877671

Test Equation:
Dependent Variable: LNE
Method: Least Squares
Sample: 1984Q3 2004Q4
Included observations: 82
Newey-West HAC Standard Errors & Covariance (lag truncation=3)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.550829	1.045948	0.526631	0.6000
LNP	-0.042883	0.023660	-1.812437	0.0739
LNY	0.059191	0.026327	2.248333	0.0275
LNE(-2)	0.900155	0.352927	2.550546	0.0128
LNP(-2)	0.017619	0.007356	2.395046	0.0191
@TREND(29)	0.001673	0.001046	1.599527	0.1139
FITTED^2	-0.003467	0.030929	-0.112082	0.9111

R-squared	0.998977	Mean dependent var	6.916860
Adjusted R-squared	0.998895	S.D. dependent var	0.327363
S.E. of regression	0.010881	Akaike info criterion	-6.122035
Sum squared resid	0.008880	Schwarz criterion	-5.916583
Log likelihood	258.0034	F-statistic	12206.32
Durbin-Watson stat	0.547331	Prob(F-statistic)	0.000000

Appendix 5-K: ADF Test Output for Variable LNE

Null Hypothesis: LNE has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-1.008983**	**0.9365**
Test critical values:	1% level	-4.075340	
	5% level	**-3.466248**	
	10% level	-3.159780	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNE)
Method: Least Squares
Sample (adjusted): 1984Q4 2004Q4
Included observations: 81 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNE(-1)	-0.014234	0.014107	-1.008983	0.3162
D(LNE(-1))	0.817644	0.112186	7.288264	0.0000
D(LNE(-2))	-0.152445	0.113974	-1.337541	0.1850
C	0.096042	0.088819	1.081326	0.2830
@TREND(1984Q1)	0.000155	0.000198	0.785676	0.4345

R-squared	0.590348	Mean dependent var	0.013318
Adjusted R-squared	0.568787	S.D. dependent var	0.007270
S.E. of regression	0.004774	Akaike info criterion	-7.791620
Sum squared resid	0.001732	Schwarz criterion	-7.643815
Log likelihood	320.5606	F-statistic	27.38080
Durbin-Watson stat	2.058138	Prob(F-statistic)	0.000000

Appendix 5-L: ADF Test Output for Variable LNP

Null Hypothesis: LNP has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-2.627504**	**0.2696**
Test critical values:	1% level	-4.075340	
	5% level	**-3.466248**	
	10% level	-3.159780	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNP)
Method: Least Squares
Sample (adjusted): 1984Q4 2004Q4
Included observations: 81 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNP(-1)	-0.328946	0.125193	-2.627504	0.0104
D(LNP(-1))	-0.128201	0.127760	-1.003448	0.3188
D(LNP(-2))	-0.231465	0.114701	-2.017989	0.0471
C	-0.346218	0.149123	-2.321697	0.0229
@TREND(1984Q1)	-0.002212	0.001047	-2.111976	0.0380

R-squared	0.258894	Mean dependent var	-0.008474
Adjusted R-squared	0.219888	S.D. dependent var	0.219296
S.E. of regression	0.193691	Akaike info criterion	-0.385362
Sum squared resid	2.851238	Schwarz criterion	-0.237557
Log likelihood	20.60717	F-statistic	6.637358
Durbin-Watson stat	2.260532	Prob(F-statistic)	0.000123

Appendix 5-M: ADF Test Output for Variable LNY

Null Hypothesis: LNY has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-2.614160**	**0.2754**
Test critical values:	1% level	-4.075340	
	5% level	**-3.466248**	
	10% level	-3.159780	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNY)
Method: Least Squares
Sample (adjusted): 1984Q4 2004Q4
Included observations: 81 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LNY(-1)	-0.314597	0.120344	-2.614160	0.0108
D(LNY(-1))	-0.284724	0.121798	-2.337673	0.0220
D(LNY(-2))	-0.357557	0.106247	-3.365347	0.0012
C	2.838351	1.072483	2.646524	0.0099
@TREND(1984Q1)	-0.000854	0.000785	-1.087170	0.2804

R-squared	0.365476	Mean dependent var	-0.000599
Adjusted R-squared	0.332080	S.D. dependent var	0.200999
S.E. of regression	0.164269	Akaike info criterion	-0.714880
Sum squared resid	2.050810	Schwarz criterion	-0.567075
Log likelihood	33.95265	F-statistic	10.94370
Durbin-Watson stat	2.658289	Prob(F-statistic)	0.000000

Appendix 5-N: ADF Test Output for Variable ΔLNE

Null Hypothesis: D(LNE) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-4.569026**	**0.0022**
Test critical values:	1% level	-4.076860	
	5% level	**-3.466966**	
	10% level	-3.160198	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNE,2)
Method: Least Squares
Sample (adjusted): 1985Q1 2004Q4
Included observations: 80 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNE(-1))	-0.431331	0.094403	-4.569026	0.0000
D(LNE(-1),2)	0.213854	0.112273	1.904765	0.0606
D(LNE(-2),2)	0.212534	0.112233	1.893676	0.0621
C	0.007902	0.002124	3.720568	0.0004
@TREND(1984Q1)	-5.13E-05	2.57E-05	-1.994177	0.0498

R-squared	0.217850	Mean dependent var	-0.000207
Adjusted R-squared	0.176135	S.D. dependent var	0.005203
S.E. of regression	0.004723	Akaike info criterion	-7.812458
Sum squared resid	0.001673	Schwarz criterion	-7.663581
Log likelihood	317.4983	F-statistic	5.222387
Durbin-Watson stat	2.055362	Prob(F-statistic)	0.000914

Appendix 5-O: ADF Test Output for Variable ΔLNP

Null Hypothesis: D(LNP) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-13.98314**	**0.0001**
Test critical values:	1% level	-4.076860	
	5% level	**-3.466966**	
	10% level	-3.160198	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNP,2)
Method: Least Squares
Sample (adjusted): 1985Q1 2004Q4
Included observations: 80 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNP(-1))	-2.788586	0.199425	-13.98314	0.0000
D(LNP(-1),2)	1.214362	0.143948	8.436115	0.0000
D(LNP(-2),2)	0.630397	0.088659	7.110329	0.0000
C	0.043001	0.037602	1.143573	0.2564
@TREND(1984Q1)	-0.001501	0.000769	-1.951425	0.0547

R-squared	0.807216	Mean dependent var	-0.001239
Adjusted R-squared	0.796934	S.D. dependent var	0.347902
S.E. of regression	0.156775	Akaike info criterion	-0.807553
Sum squared resid	1.843372	Schwarz criterion	-0.658677
Log likelihood	37.30213	F-statistic	78.50915
Durbin-Watson stat	1.180600	Prob(F-statistic)	0.000000

Appendix 5-P: ADF Test Output for Variable ΔLNY

Null Hypothesis: D(LNY) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		**-38.88917**	**0.0001**
Test critical values:	1% level	-4.076860	
	5% level	**-3.466966**	
	10% level	-3.160198	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNY,2)
Method: Least Squares
Sample (adjusted): 1985Q1 2004Q4
Included observations: 80 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNY(-1))	-3.793587	0.097549	-38.88917	0.0000
D(LNY(-1),2)	1.862172	0.069221	26.90186	0.0000
D(LNY(-2),2)	0.932547	0.040171	23.21437	0.0000
C	0.072953	0.014474	5.040253	0.0000
@TREND(1984Q1)	-0.001735	0.000295	-5.881906	0.0000

R-squared	0.968479	Mean dependent var	-0.000653
Adjusted R-squared	0.966798	S.D. dependent var	0.329185
S.E. of regression	0.059982	Akaike info criterion	-2.729082
Sum squared resid	0.269838	Schwarz criterion	-2.580205
Log likelihood	114.1633	F-statistic	576.0951
Durbin-Watson stat	0.728550	Prob(F-statistic)	0.000000

Appendix 5-R: AEG Test Output for Equation (20)

Unit root tests for residuals

Based on OLS regression of LNE on:

C	LNP	LNY	LNP(-2)	TREND_29	LNE(-2)

82 observations used for estimation from 1984Q3 to 2004Q4

	Test Statistic	LL	AIC	SBC	HQC
DF	-3.4922	276.6860	275.6860	274.5013	275.2114
ADF(1)	-3.8941	278.0639	276.0639	273.6944	275.1146
ADF(2)	**-5.3643**	284.6611	281.6611	278.1070	280.2372

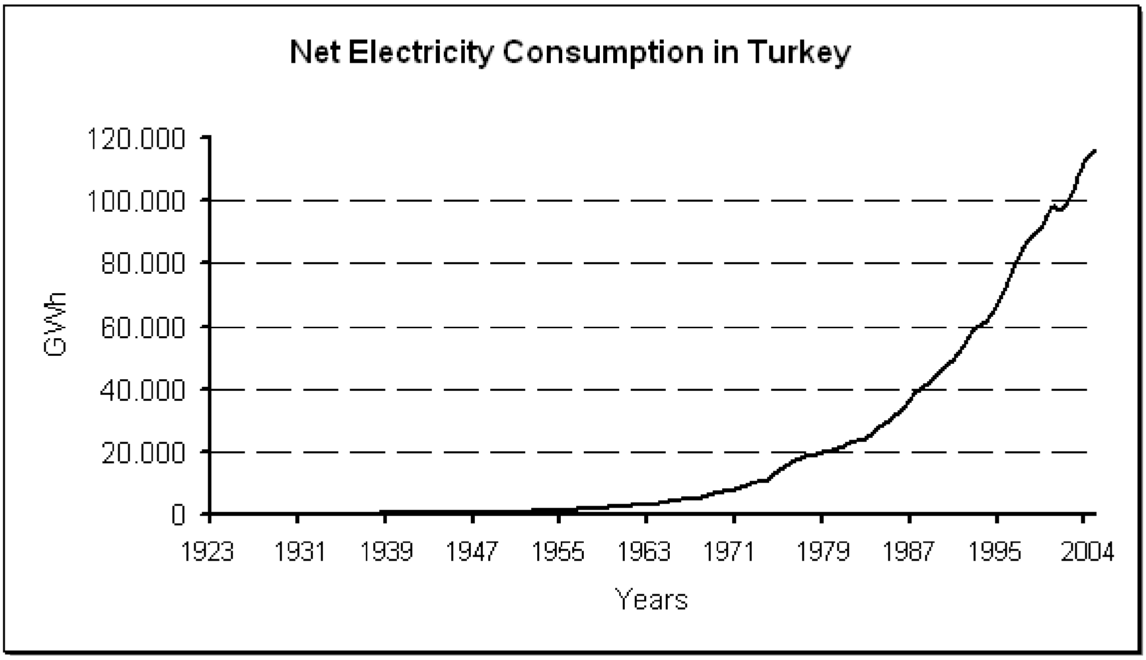
95% critical value for the Dickey-Fuller statistic = **-4.9387**

LL = Maximized log-likelihood AIC = Akaike Information Criterion

SBC = Schwarz Bayesian Criterion HQC = Hannan-Quinn Criterion

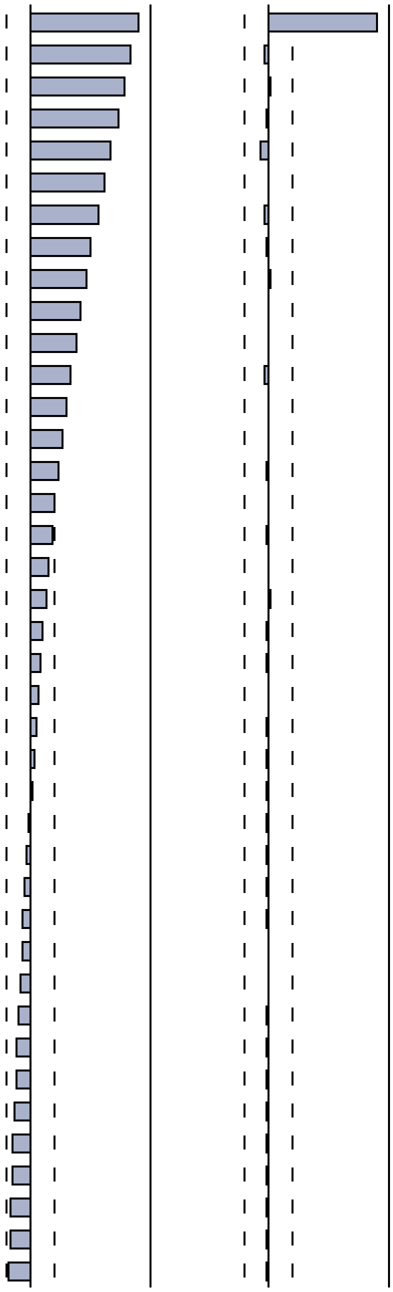
Appendix 6: Electricity Demand Forecasting for Turkey (2005-2015)

Appendix 6-A: Time series plot of Net Electricity Consumption in Turkey (1923-2004)



Appendix 6-B: The Correlogram of Turkish Electricity Consumption Data up to 40 lags

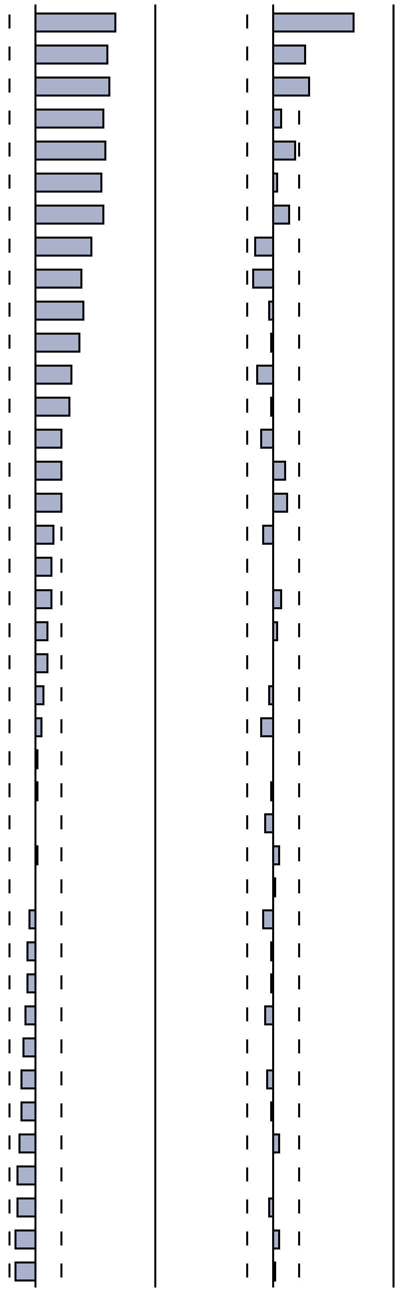
Sample: 1923 2004
Included observations: 82



Autocorrelation / Partial Correlation	Lag	AC	PAC	Q-Stat	Prob
	1	0.937	0.937	74.580	0.000
	2	0.873	-0.029	140.27	0.000
	3	0.816	0.013	198.37	0.000
	4	0.761	-0.013	249.54	0.000
	5	0.700	-0.079	293.38	0.000
	6	0.643	-0.003	330.83	0.000
	7	0.585	-0.041	362.30	0.000
	8	0.530	-0.014	388.49	0.000
	9	0.481	0.012	410.31	0.000
	10	0.436	0.004	428.52	0.000
	11	0.395	0.006	443.69	0.000
	12	0.354	-0.033	456.03	0.000
	13	0.316	-0.001	466.02	0.000
	14	0.281	-0.006	474.04	0.000
	15	0.247	-0.023	480.33	0.000
	16	0.215	-0.005	485.18	0.000
	17	0.185	-0.013	488.82	0.000
	18	0.157	-0.008	491.49	0.000
	19	0.133	0.008	493.41	0.000
	20	0.110	-0.012	494.75	0.000
	21	0.087	-0.011	495.61	0.000
	22	0.068	-0.002	496.14	0.000
	23	0.048	-0.024	496.40	0.000
	24	0.028	-0.013	496.49	0.000
	25	0.010	-0.014	496.51	0.000
	26	-0.009	-0.021	496.52	0.000
	27	-0.028	-0.019	496.61	0.000
	28	-0.047	-0.020	496.89	0.000
	29	-0.064	-0.009	497.43	0.000
	30	-0.079	-0.001	498.26	0.000
	31	-0.092	-0.002	499.41	0.000
	32	-0.105	-0.013	500.92	0.000
	33	-0.117	-0.014	502.85	0.000
	34	-0.128	-0.010	505.19	0.000
	35	-0.138	-0.013	507.98	0.000
	36	-0.148	-0.015	511.24	0.000
	37	-0.157	-0.011	514.99	0.000
	38	-0.165	-0.013	519.26	0.000
	39	-0.173	-0.013	524.07	0.000
	40	-0.181	-0.012	529.43	0.000

Appendix 6-C: The Correlogram of the First-Differenced Data up to 40 lags

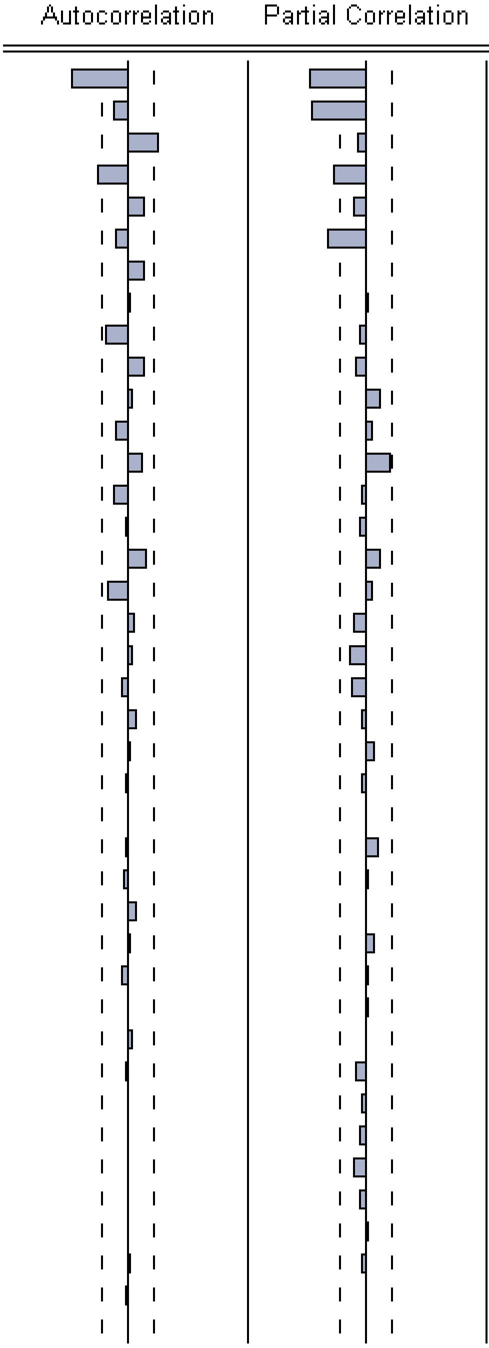
Sample: 1923 2004
Included observations: 81



Autocorrelation	Partial Correlation		AC	PAC	Q-Stat	Prob
		1	0.691	0.691	40.090	0.000
		2	0.623	0.280	73.170	0.000
		3	0.653	0.310	109.91	0.000
		4	0.592	0.072	140.50	0.000
		5	0.611	0.186	173.55	0.000
		6	0.580	0.038	203.76	0.000
		7	0.589	0.136	235.24	0.000
		8	0.495	-0.160	257.84	0.000
		9	0.403	-0.180	272.98	0.000
		10	0.421	-0.033	289.78	0.000
		11	0.390	-0.014	304.40	0.000
		12	0.311	-0.142	313.79	0.000
		13	0.298	-0.019	322.60	0.000
		14	0.235	-0.100	328.14	0.000
		15	0.231	0.104	333.56	0.000
		16	0.236	0.119	339.31	0.000
		17	0.149	-0.084	341.64	0.000
		18	0.147	0.006	343.95	0.000
		19	0.133	0.075	345.87	0.000
		20	0.106	0.037	347.12	0.000
		21	0.101	0.001	348.26	0.000
		22	0.079	-0.032	348.98	0.000
		23	0.045	-0.109	349.21	0.000
		24	0.022	-0.001	349.27	0.000
		25	0.008	-0.015	349.28	0.000
		26	0.008	-0.065	349.29	0.000
		27	0.022	0.057	349.35	0.000
		28	-0.007	0.014	349.35	0.000
		29	-0.053	-0.087	349.72	0.000
		30	-0.070	-0.015	350.37	0.000
		31	-0.073	-0.024	351.08	0.000
		32	-0.095	-0.066	352.31	0.000
		33	-0.108	0.007	353.94	0.000
		34	-0.119	-0.051	355.97	0.000
		35	-0.130	-0.010	358.45	0.000
		36	-0.143	0.056	361.51	0.000
		37	-0.153	0.001	365.09	0.000
		38	-0.160	-0.031	369.09	0.000
		39	-0.172	0.042	373.84	0.000
		40	-0.175	0.009	378.88	0.000

Appendix 6-D: The Correlogram of the Second-Differenced Data up to 40 lags

Sample: 1923 2004
Included observations: 80



	AC	PAC	Q-Stat	Prob
1	-0.481	-0.481	19.185	0.000
2	-0.122	-0.459	20.439	0.000
3	0.266	-0.067	26.449	0.000
4	-0.269	-0.279	32.683	0.000
5	0.141	-0.101	34.410	0.000
6	-0.104	-0.325	35.377	0.000
7	0.143	0.004	37.207	0.000
8	0.012	0.019	37.219	0.000
9	-0.181	-0.052	40.240	0.000
10	0.144	-0.097	42.179	0.000
11	0.034	0.123	42.289	0.000
12	-0.109	0.057	43.439	0.000
13	0.122	0.213	44.904	0.000
14	-0.122	-0.028	46.389	0.000
15	-0.013	-0.055	46.405	0.000
16	0.163	0.118	49.126	0.000
17	-0.170	0.054	52.134	0.000
18	0.050	-0.106	52.397	0.000
19	0.028	-0.138	52.483	0.000
20	-0.055	-0.116	52.811	0.000
21	0.063	-0.041	53.250	0.000
22	0.010	0.072	53.261	0.000
23	-0.021	-0.039	53.310	0.000
24	-0.003	0.008	53.311	0.001
25	-0.023	0.104	53.374	0.001
26	-0.030	0.009	53.484	0.001
27	0.060	0.002	53.924	0.002
28	0.017	0.080	53.961	0.002
29	-0.043	0.018	54.195	0.003
30	-0.006	0.011	54.200	0.004
31	0.031	0.003	54.329	0.006
32	-0.020	-0.092	54.385	0.008
33	0.001	-0.029	54.385	0.011
34	0.004	-0.057	54.387	0.015
35	0.000	-0.100	54.387	0.019
36	-0.003	-0.046	54.388	0.025
37	-0.005	0.010	54.392	0.032
38	0.011	-0.033	54.410	0.041
39	-0.017	0.003	54.455	0.051
40	0.008	-0.007	54.464	0.063

Appendix 6-E: The Output Table of ADF unit root test for the Second-Differenced Data

Null Hypothesis: D(E,2) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 2 (Fixed)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.459685	0.0001
Test critical values:	1% level	-4.081666	
	5% level	-3.469235	
	10% level	-3.161518	

*MacKinnon (1996) one-sided p-values.

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(E,3)
Method: Least Squares
Sample (adjusted): 1928 2004
Included observations: 77 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(E(-1),2)	-2.182197	0.399693	-5.459685	0.0000
D(E(-1),3)	0.429314	0.317061	1.354042	0.1800
D(E(-2),3)	-0.048718	0.170577	-0.285604	0.7760
C	-168.7739	324.1367	-0.520687	0.6042
@TREND(1923)	8.239787	6.739378	1.222633	0.2255

R-squared	0.804403	Mean dependent var	-52.04026
Adjusted R-squared	0.793536	S.D. dependent var	2867.817
S.E. of regression	1303.086	Akaike info criterion	17.24559
Sum squared resid	1.22E+08	Schwarz criterion	17.39778
Log likelihood	-658.9552	F-statistic	74.02595
Durbin-Watson stat	1.960384	Prob(F-statistic)	0.000000

Appendix 6-F: Estimation Output of OLS for Equation (23)

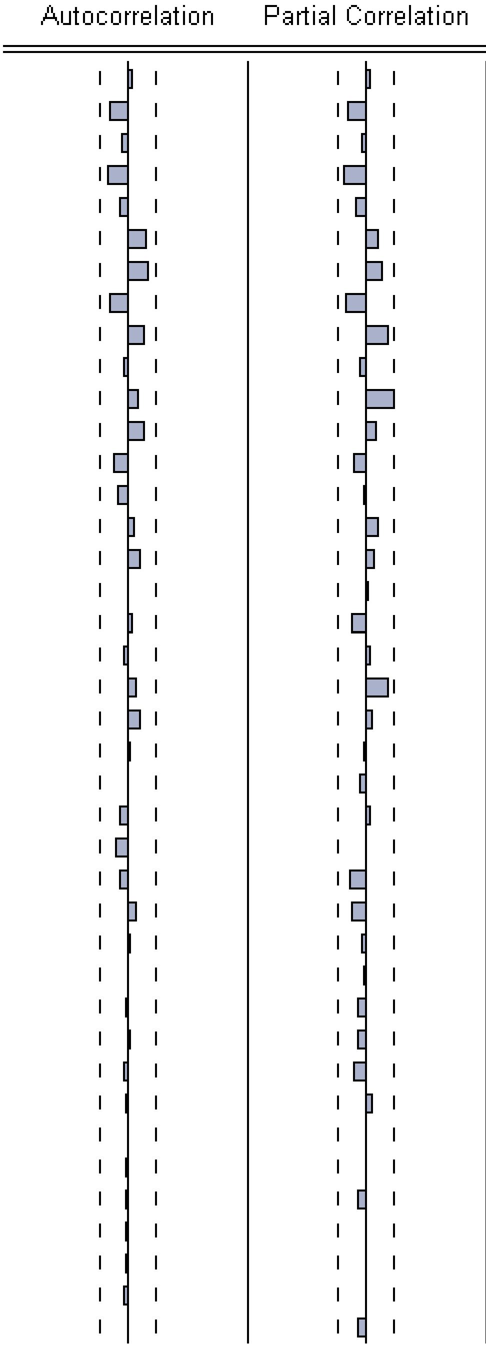
Dependent Variable: D2E
Method: Least Squares
Sample (adjusted): 1938 2004
Included observations: 67 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	275.9257	149.0168	1.851642	0.0689
D2E(-1)	-0.557877	0.103994	-5.364531	0.0000
D2E(-2)	-0.439390	0.109108	-4.027120	0.0002
D2E(-4)	-0.616152	0.157881	-3.902645	0.0002
D2E(-6)	-0.555630	0.213647	-2.600690	0.0117
D2E(-13)	0.537760	0.329528	1.631908	0.1079

R-squared	0.612053	Mean dependent var	70.80746
Adjusted R-squared	0.580254	S.D. dependent var	1812.079
S.E. of regression	1174.006	Akaike info criterion	17.05952
Sum squared resid	84075675	Schwarz criterion	17.25695
Log likelihood	-565.4938	F-statistic	19.24760
Durbin-Watson stat	1.868246	Prob(F-statistic)	0.000000

Appendix 6-G: The Correlogram of the Residuals from Equation (23)

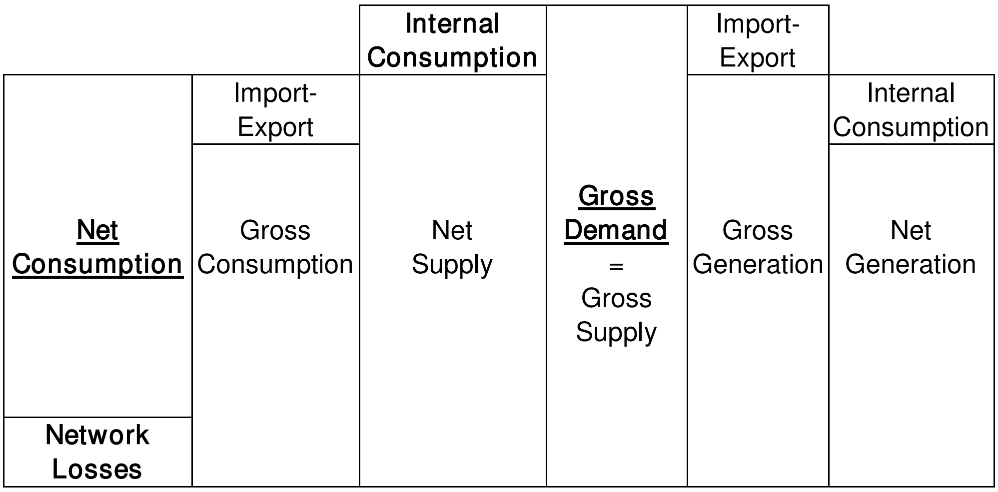
Sample: 1923 2004
Included observations: 67



	AC	PAC	Q-Stat	Prob
1	0.034	0.034	0.0827	0.774
2	-0.156	-0.157	1.8092	0.405
3	-0.047	-0.036	1.9683	0.579
4	-0.168	-0.195	4.0469	0.400
5	-0.076	-0.083	4.4761	0.483
6	0.154	0.101	6.2740	0.393
7	0.175	0.139	8.6420	0.279
8	-0.155	-0.171	10.536	0.229
9	0.132	0.194	11.918	0.218
10	-0.027	-0.048	11.975	0.287
11	0.097	0.249	12.750	0.310
12	0.143	0.086	14.464	0.272
13	-0.128	-0.105	15.866	0.256
14	-0.088	-0.009	16.542	0.281
15	0.051	0.114	16.770	0.333
16	0.108	0.073	17.826	0.334
17	-0.006	0.015	17.829	0.400
18	0.036	-0.121	17.950	0.459
19	-0.039	0.037	18.096	0.516
20	0.063	0.190	18.488	0.555
21	0.101	0.048	19.516	0.552
22	0.024	-0.009	19.574	0.610
23	0.002	-0.047	19.574	0.667
24	-0.066	0.025	20.039	0.695
25	-0.105	-0.008	21.262	0.678
26	-0.073	-0.148	21.867	0.696
27	0.070	-0.118	22.440	0.715
28	0.023	-0.036	22.502	0.758
29	-0.007	-0.019	22.508	0.799
30	-0.024	-0.068	22.583	0.832
31	0.013	-0.072	22.604	0.863
32	-0.026	-0.111	22.694	0.888
33	-0.010	0.048	22.708	0.911
34	-0.003	0.005	22.709	0.930
35	-0.018	-0.003	22.757	0.945
36	-0.010	-0.062	22.772	0.958
37	-0.022	0.005	22.850	0.967
38	-0.014	0.008	22.880	0.975
39	-0.025	-0.000	22.986	0.981
40	-0.006	-0.075	22.992	0.986

Appendix 6-H: The Process of Conversion of Official Electricity Gross Demand Projections into Net Electricity Consumption Figures

The relationship between various technical terms used to express electricity demand is shown below. Please note that network losses include both transmission and distribution losses; and internal consumption refers to electricity consumed by power plants for the purposes heating, pumping, traction, lighting and so on.



The table below shows the data on gross demand, internal consumption and network losses for the latest available 10-year period (i.e., 1994-2003); and, as can be seen in the table, during this period, internal consumption and network losses accounted for 22.3% of gross demand on average.

	Gross Demand *(GWh)* (a)	**Internal Consumption** *(GWh)* (b)	**Internal Cons. as a % of Gross Demand**	**Network Losses** *(GWh)* (c)	**Network Losses as a % of Gross Demand**	**Total** *(GWh)* (d=b+c)	**The Total as a % of Gross Demand**
1994	77,783.0	4,539.1	5.8	11,843.0	15.2	16,382.1	21.1
1995	85,551.5	4,388.8	5.1	13,768.8	16.1	18,157.6	21.2
1996	94,788.6	4,777.3	5.0	15,854.8	16.7	20,632.1	21.8
1997	105,517.1	5,050.2	4.8	18,581.9	17.6	23,632.1	22.4
1998	114,022.7	5,523.2	4.8	20,794.9	18.2	26,318.1	23.1
1999	118,484.9	5,738.0	4.8	21,545.0	18.2	27,283.0	23.0
2000	128,275.6	6,224.0	4.9	23,755.9	18.5	29,979.9	23.4
2001	126,871.3	6,472.6	5.1	23,328.7	18.4	29,801.3	23.5
2002	132,552.6	5,672.7	4.3	23,931.9	18.1	29,604.6	22.3
2003	141,150.9	5,332.2	3.8	24,052.7	17.0	29,384.9	20.8
		Annual Average:	*4.8*		*17.4*		***22.3***

Source: TEIAS (2005a,d)

Assuming that internal consumption and network losses will continue to account for 22.3% of gross demand on average during the period 2005-2012. The following table is prepared. In addition to calculated official net electricity consumption projections, the table also compares these projections with the forecasts based on ARIMA modelling.

	Official Projection of Gross Demand *(GWh)*	**Average Total Int. Cons. and Net. Losses as a % of Gross Demand**	**Official Projection of Net Cons.** *(GWh)* (e)	**Forecasted Net Electricity Cons. based on ARIMA Modelling** *(GWh)* (f)	**Difference** *(GWh)* (g=e-f)	**Difference as a % of forecasts based on ARIMA Modelling**
2005	168,262	22.3	130,739.6	130,204.9	534.7	0.4
2006	185,600	22.3	144,211.2	134,876.5	9,334.7	6.9
2007	204,150	22.3	158,624.6	142,091.6	16,533.0	11.6
2008	224,300	22.3	174,281.1	152,696.9	21,584.2	14.1
2009	246,150	22.3	191,258.6	153,897.4	37,361.2	24.3
2010	269,842	22.3	209,667.2	167,413.7	42,253.5	25.2
2011	295,800	22.3	229,836.6	170,957.3	58,879.3	34.4
2012	323,200	22.3	251,126.4	176,576.5	74,549.9	**42.2**