Cyprus Economic Policy Review, Vol.1, No.1, pp. 27-48 (2007) 1450-4561

Energy Policy in Cyprus: Outlook and Major Challenges

Theodoros Zachariadis*

Economics Research Centre, University of Cyprus

Abstract

This paper outlines major energy policy challenges that Cyprus is faced with. Main issues are securing the island's energy supply and limiting growth in greenhouse gas emissions. Results from econometric analyses show that energy use is income elastic and price inelastic, which indicates that energy consumption may continue to grow rapidly in the future in the absence of appropriate price signals and energy conservation measures. Based on these results, the paper argues that policymakers need to focus on three major topics: improving energy efficiency in buildings, controlling the growth of energy use in transport, and diversifying the power generation mix. Current progress is mixed: Although energy efficiency subsidies are useful, official estimates of energy savings achieved are optimistic, and a careful assessment is necessary. In transport, the introduction of reliable public transportation systems is an urgent priority. Plans to diversify the mix of power generation are well under way regarding the introduction of natural gas, but there are delays in the introduction of renewable sources, which also limit the degree of energy market liberalisation.

Keywords: elasticities, transportation, renewable energy, conservation, greenhouse gases.

1. Introduction

Energy policy aspects are becoming increasingly important in the European and international policy agenda. The recent upsurge in oil prices and temporary disruptions in the supply of natural gas from Russia to Europe have illustrated the vulnerability of European economies because of their growing dependence on energy imports and the fragmentation of European Union's energy markets. Moreover, concerns over global warming, mainly caused by anthropogenic greenhouse gas emissions that are closely related to the production and use of energy, underline the serious environmental implications of long-term energy strategies. In

---

* Address: Economics Research Centre, University of Cyprus P.O. Box 20537, 1678 Nicosia, Cyprus. E-mail: t.zachariadis@ucy.ac.cy.

response to these challenges, early in 2007 the European Commission published a series of documents addressing diverse aspects of energy and climate change policy. Major goals are to cut greenhouse gas emissions in the European Union (EU) by 20% in 2020 compared to 1990, regardless of whether other nations in the world undertake any similar action or not; to create a truly integrated internal energy market in the EU; to greatly improve energy efficiency up to 2020; and to increase the level of renewable energy in the EU's overall energy mix from less than 7% today to 20% by 2020. (European Commission 2007a, 2007b). EU leaders in their spring summit held in Brussels in March 2007 have approved these goals.

Because of its size and its isolated energy system, Cyprus cannot play a significant role in achieving the EU targets outlined above. However, compliance with these policy goals is not only necessary in view of the country's membership in the EU; it can also help the country fulfill its own policy priorities, namely to contain its ever increasing energy needs, diversify its dependence on energy imports and create a more competitive energy market. This paper will attempt to address some of the energy policy issues that are relevant to Cyprus, putting them in the European context. For this purpose, after a brief description of the current energy status in section 2, a brief account will be provided about the interaction between energy use, income, prices and weather conditions in Cyprus, based on recent econometric analysis and forecasts (section 3). Section 4 will outline and comment on the major policy issues that the island is faced with, and section 5 will conclude.

2. Current situation

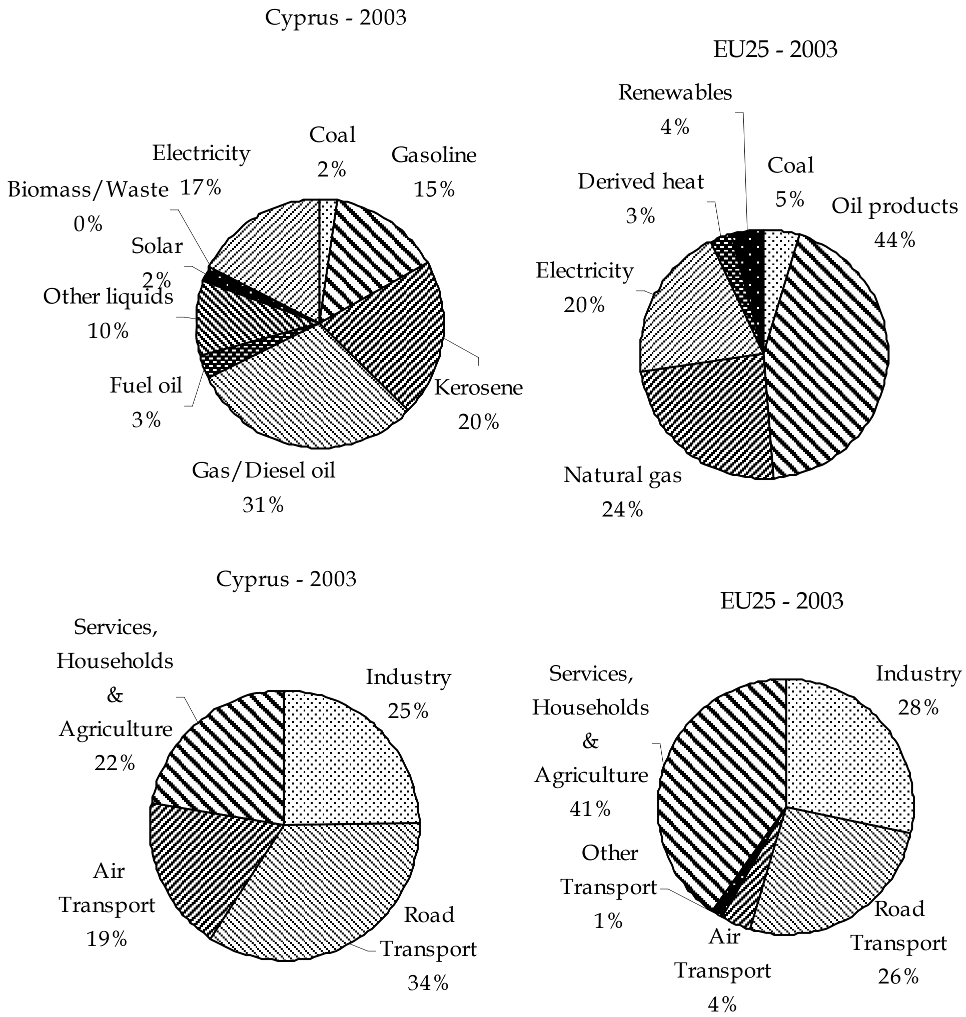
The basic characteristics of the Cypriot energy system have been described several times before (see e.g. Koroneos et al. 2005, Mirasgedis et al. 2004, Zervos et al. 2004). In short, the island possesses no indigenous energy resources apart from ample solar and some wind energy potential, and is highly dependent on imported petroleum products. Its power system is isolated, and power plants (with a total installed capacity of 988 MW in 2005) are mainly powered by fuel oil; from 2009/2010 onwards, new plants are scheduled to operate on natural gas too, which is to be transported to the island in liquefied form.

Cyprus has enjoyed sustained economic growth in the last three decades (averaging 5.8% and 3.1% per year over the last 30 and 10 years respectively) mainly due to tourist income and the development of financial services and despite the Turkish invasion in 1974. Its per capita GDP was close to 18 000 Euros in 2005, or 77% of the EU-25 average (89%

in purchasing power standards). Because of economic growth and as energy conservation was not a priority for authorities and citizens, total final energy consumption rose by about 4.5% per year in the 1975-2004 period, with signs of a slowdown since the mid-1990s (2.7% annual growth after 1995). Predictably, electricity consumption increased even faster (by 7.1% and 5.5% annually in the last 30 and 10 years respectively).

FIGURE 1

Final energy consumption in Cyprus and the whole European Union in 2003 by fuel and sector



Note: The very high difference in the shares of air transport between EU and Cyprus, which is present in both national and European statistical datasets, may be partially attributed to differences in statistical treatment of petroleum products for Cyprus.
Source: Eurostat.

Energy intensity, the amount of energy consumed per unit of GDP, is higher than that of any other Mediterranean EU country and has only recently shown some signs of receding (Eurostat 2006). Oil products currently account for more than 95% of primary energy demand, with coal and solar energy sharing the rest.

Table 1 displays some basic energy and environmental indicators in Cyprus and the EU. The intensity of both energy use and CO2 emissions in Cyprus has started decreasing recently, but is still considerably higher than in the EU. This should be attributed to a less efficient utilisation of energy in Cyprus, mainly because of the high share of road and air transport in total energy use, and to the very small penetration of low-carbon energy sources, i.e. renewable. Table 2 shows the same indicators for six European Mediterranean countries in year 2002: Cyprus exhibits the highest amount of energy use per unit of GDP and the highest CO2 emissions per capita. Again, these observations highlight the largely inefficient use of energy in Cyprus as well as the very high dependence on oil products that have relatively high carbon content and therefore give rise to high CO2 emissions.

TABLE 1

Basic energy and environmental indicators in Cyprus and the EU

		EU - 25		Cyprus	
Indicator	Unit	1990	2002	1990	2002
Energy intensity	toe / million Euros'95	246	209	330	280
CO_2 intensity	tonnes of CO_2 emissions / toe	2431	2236	3032	2831
Energy per capita	kg of oil equivalent	3524	3682	3143	3408
CO_2 per capita	kg of CO_2 emissions	8566	8233	9530	9646

Note: ‘toe’ denotes tonnes of oil equivalent.

The need for long-term energy analyses for Cyprus was mainly realised in the last 10-15 years, as a result of growing concerns about the security of energy supply and in view of the requirements for reporting and forecasting energy use and greenhouse gas emissions within the EU. Two recent studies in this context were a so called ‘Strategic Plan for the Limitation of Greenhouse Gas Emissions in Cyprus’ (Mirasgedis et al. 2004), conducted for the Cypriot Environment Service, and a White Paper for the exploitation of renewable energy and the rational use of energy in Cyprus (Zervos et al. 2004), a study that was commissioned by the Cypriot Energy Service. Those studies employed models that had been developed for other countries or regions, so that model parameters had not been derived from national data. Recognising this deficiency of earlier studies, the Economics Research Centre (ERC) of the University of Cyprus has recently carried out an analysis of national energy data through state-of-the-art econometric methods. This is described in more detail in the following section.

TABLE 2

Basic energy and environmental indicators in six Mediterranean countries in year 2002

Indicator	Unit	France	Greece	Italy	Malta	Spain	Cyprus
Energy intensity	toe / million Euros'95	187	258	184	263	229	280
CO_2 intensity	tonnes of CO_2 emissions / toe	1397	3152	2476	3124	2346	2831
Energy per capita	kg of oil equivalent	4269	2716	2991	2078	3203	3408
CO_2 per capita	kg of CO_2 emissions	5962	8559	7406	6493	7516	9646

3. Analysis of energy use and outlook into the future

3.1. Econometric analysis of historical data

This section presents some results from the first econometric study of energy consumption that has been conducted in Cyprus, based on time series analysis (Zachariadis 2006a). Time series analysed were those of residential, commercial, industrial and agricultural electricity use, gasoline consumption as well as the aggregate non-electricity and total energy consumption using annual data from 1960 to 2004. The dynamic interaction between the corresponding energy form and appropriate income, price and weather variables was examined through the application of widely used time series analysis techniques.[1]

[1] The techniques applied comprised unit root and co integration tests including an exogenous structural break in year 1974 (because of the war in Cyprus), Vector Error

Energy, economic and price data were taken from various publications of the Statistical Service of the Republic of Cyprus (CYSTAT 2005), and the analysis was as detailed as the available information allowed. Energy time series data and the corresponding economic and weather variables used in the regressions are summarised in the Appendix. Figures 2 to 5 show the evolution of the basic economic and energy variables.

Weather conditions may critically affect energy use, although not all energy studies account for this variable explicitly. In the case of Cyprus, it is both low temperatures (inducing energy use for heating) and high temperatures (causing air conditioner operation for cooling) that matter for energy analyses. Therefore, the appropriate climate variable is the sum of heating and cooling degree-days over each year.[2] The Meteorological Service of Cyprus recently computed this information for the first time in their history, and provided us with appropriate data.

Results show that a long-run equilibrium relationship between energy, income and prices exists for most energy uses. The long-term impact of income and prices on energy use is significant, with elasticities similar to those reported for other countries (above unity for income, less than 0.5 for prices in absolute terms). Weather fluctuations seem to be the most significant cause of short-term variation in electricity use (albeit with small elasticity values). Despite the quite small sample size, which poses limitations on the analysis, the evidence shows that results are meaningful and robust for residential, commercial and industrial electricity as well as gasoline consumption. This finding is important as it allows the corresponding income, price and weather elasticities to be used for forecasting purposes and policy analyses.

In this context, the temporal evolution of some of the estimated electricity consumption elasticities was also examined. Instead of relying solely on the estimates of electricity consumption models based on the whole sample period 1960–2004, the models were estimated again for a rolling 20-year period, i.e. starting with 1960–1979 and ending with 1985–2004. In this

---

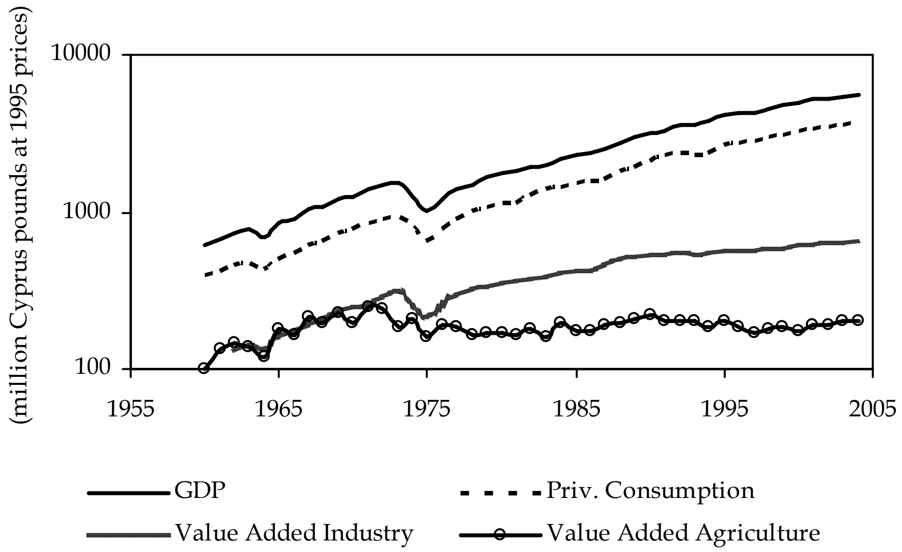
Correction (VEC) models, Granger causality tests and impulse response functions. Because of power and size problems associated with these methods in small samples, single-equation autoregressive distributed lag (ARDL) models were also employed for each energy variable.

[2] Heating (cooling) degree days are meant to measure the severity and duration of cold (hot) weather: the colder the weather in a given month or year the higher the heating degree day value. One degree-day expresses the need for heating (or cooling) during a day caused by an average daily temperature that is one degree lower (or higher) than a reference temperature.

way, despite eventual econometric problems caused by the small sample size, it is possible to explore potential structural changes that may have altered the response of energy use over the years. This rolling estimation procedure revealed that income, price and weather elasticities, both in the long and in the short term, have been increasing over time; for price elasticities, which have a negative sign, this means that they have been decreasing in absolute terms.

FIGURE 2

Evolution of GDP, final consumption expenditure and value added of selected sectors in Cyprus, 1960-2004

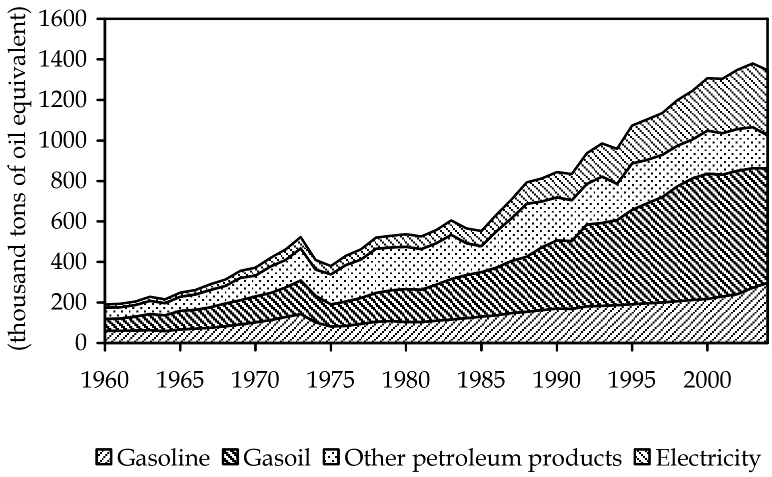


Note: The scale is logarithmic.
Source: Statistical Service of the Republic of Cyprus.

There are a number of reasons that can explain these trends. Firstly, rising incomes coupled with technological progress and falling real prices in electric and electronic equipment may lie behind the increasing income elasticity of electricity use. Secondly, as the electricity bill represents a small fraction of total expenses both for households and for enterprises in the tertiary sector, the increased ownership of electric and electronic appliances may have made electricity use more inelastic to price changes. Thirdly, for the reasons mentioned above, the use of electric heating and cooling appliances has been rising steadily over the years, thus making electricity consumption ever more dependent on weather conditions: since air conditioners and electric heaters exist in almost every household and every office, they will be operated whenever temperatures become too high or too low.

FIGURE 3

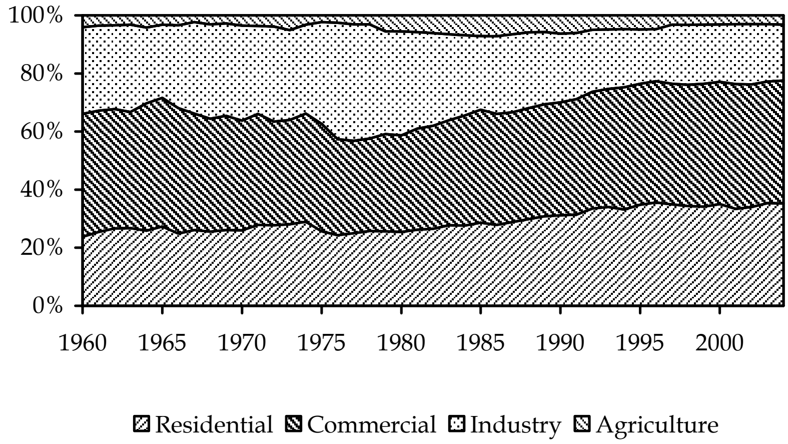
Evolution of final energy consumption of selected fuels in Cyprus, 1960-2004



Note: Other petroleum products do not include aviation fuel.
Source: Statistical Service of the Republic of Cyprus.

FIGURE 4

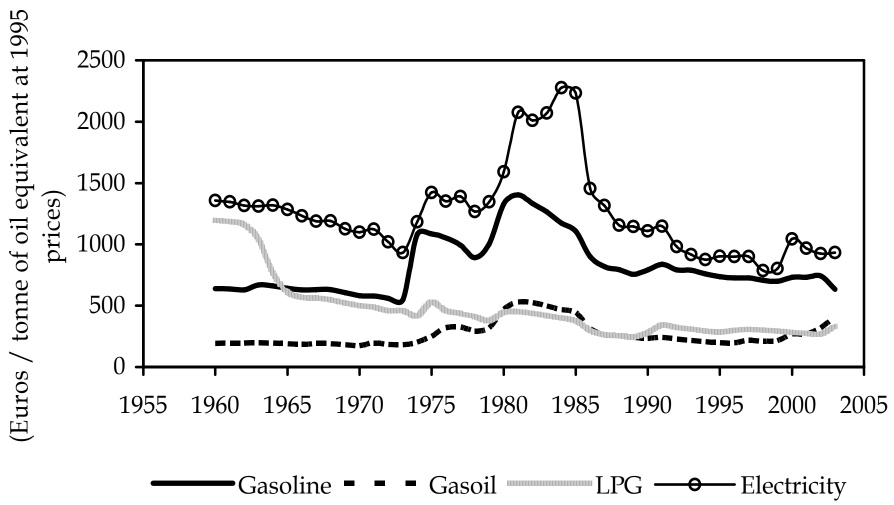
Sectoral shares of electricity consumption in Cyprus, 1960-2004



Source: Statistical Service of the Republic of Cyprus.

FIGURE 5

Evolution of real fuel prices in Cyprus, 1960-2003



Note: The price of heating and automotive gas oil was identical up to 2000 and has deviated very little since then. Electricity price is the sales-weighted average of all sectors.
Source: Statistical Service of the Republic of Cyprus.

In view of the increasing elasticity estimates over time, if one wants to perform forecasts for the future, it seems to be more appropriate to base these forecasts on elasticities estimated for the most recent period (1985–2004), which probably reflect better energy use patterns now and in the future. Table 3 displays the estimated elasticities for the most recent period; these ones were used for the electricity forecasts described in section 3.2.

TABLE 3

Income, price and weather elasticities that were applied for electricity consumption forecasts in Cyprus

	Short-term elasticities			Long-term elasticities		
Dependent variable	Income	Prices	Weather	Income	Prices	Weather
Residential electricity use	0.660	-0.094	0.361	1.561	-0.222	0.855
Industrial electricity use	0.120	-0.083	-	1.243	-0.857	-
Commercial electricity use	0.482	-0.067	0.145	1.287	-0.179	0.388

3.2. Outlook of electricity use up to 2030

It is evident from Figure 3 that, as in all developed countries, electricity is currently Cyprus' fastest growing energy form. Therefore, and since electricity data are the only ones available in some disaggregated form, a long-term forecast of electricity consumption in Cyprus up to the year 2030 was carried out, on the basis of the econometric analysis outlined above (Zachariadis 2006b). Electricity consumption in the residential, industrial, commercial and agricultural sectors was projected as a function of macroeconomic variables, electricity prices and weather conditions. To enable this, official macroeconomic forecasts were used along with three different assumptions on the evolution of crude oil prices, which have been taken from a recent analysis of the U.S. Energy Information Administration.

TABLE 4

Assumed annual growth rates of GDP and private consumption in Cyprus

	Past data		Forecast				
	1995-2000	2000-2005	2005-2010	2010-2015	2015-2020	2020-2025	2025-2030
Real GDP	3.8%	3.2%	4.2%	4.0%	3.6%	3.1%	2.8%
Real private consumption	4.2%	3.7%	3.9%	3.8%	3.5%	3.1%	2.8%

In order to proceed with the forecasts, some exogenous assumptions are necessary with regard to the future evolution of macroeconomic and price variables. As far as the macroeconomy is concerned, a 'business as usual' evolution was assumed, in line with short-term official forecasts[3] and long-term forecasts of the European Commission (2006a). Annual growth rates of real GDP and private consumption are shown in Table 4. As regards the evolution of the GDP share of major economic sectors, it was assumed that the share of industry will continue to decrease but at slow rates, thus reaching 9.5% of total GDP in 2030 compared to 11.9% in 2005. The share of the agricultural sector is also assumed to decrease further, while the shares of services and construction are assumed to grow moderately, reaching 79% and 9% of total GDP respectively (compared to the 2005 shares of 76.6% and 8.1% respectively).

[3] See the website of the Cypriot Ministry of Finance: http://www.mof.gov.cy.

As regards the assumed evolution of retail electricity prices, it was necessary to proceed in three steps: assume an evolution of international crude oil prices, determine the relationship between crude oil prices and those of fuel oil used in the power plants of Cyprus, and derive the effect of fuel oil cost on end-user electricity prices in the residential, commercial, industrial and agricultural sectors. For this purpose, and because of the large uncertainties associated with the future evolution of crude oil prices, three different assumptions were made on the evolution of oil prices, which have been taken from a recent analysis of the U.S. Energy Information Administration (EIA 2006). The three price scenarios are shown in Table 5.

TABLE 5

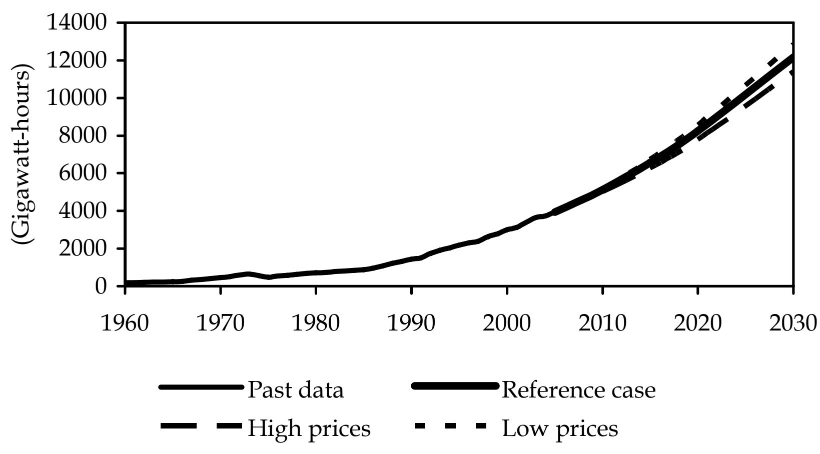
Assumed evolution of crude oil prices

	International crude oil price (US$ per barrel at 2004 prices)						
	2000	2005	2010	2015	2020	2025	2030
Reference case	32.9	54.5	47.3	47.8	50.7	54.1	57.0
High price scenario	32.9	54.5	62.7	76.3	85.1	90.3	95.7
Low price scenario	32.9	54.5	40.3	33.8	34.0	34.4	33.7

Source: United States Energy Information Administration.

FIGURE 6

Forecast of electricity use in Cyprus up to 2030, according to the three oil price scenarios



According to the results, illustrated in Figure 6, if past trends continue and no serious energy conservation policies are implemented, electricity use in Cyprus is expected to triple in the coming 25 years, with the residential and commercial sectors increasing their already high shares in total consumption. Although all power plants in Cyprus are currently oil fired, oil prices are projected to have a small influence, possibly changing electricity consumption by ±10% in the cases of high or low crude oil prices. This is mainly a result of low electricity price elasticities, despite the significant dependence of retail electricity prices on international oil prices

TABLE 6

Electricity use per capita and per GDP unit in selected developed economies (EIA 2005) and its projected evolution in Cyprus up to 2030 according to the reference case forecast shown in Figure 6

	Country	1980	1990	2000	2030
Electricity use per capita (kilowatt-hours)	Cyprus	1473	2536	3777	12808
	Australia	5550	7979	9509	
	Denmark	4330	5756	6064	
	Greece	2118	3070	4300	
	Italy	3014	3917	4909	
	Spain	2668	3434	4926	
	Sweden	10623	15134	15367	
	United States	9245	11373	12730	
Electricity use per unit of GDP (kilowatt-hours / thousand US$'2000)	Cyprus	281	293	322	476
	Australia	436	527	481	
	Denmark	206	235	204	
	Greece	264	347	414	
	Italy	231	242	263	
	Spain	308	305	357	
	Sweden	561	671	568	
	United States	406	399	366	

Table 6 presents some cross-country comparisons of electricity consumption and its probable evolution in Cyprus up to 2030. It is evident that electricity use per capita in Cyprus is currently among the lowest in developed countries, while electricity per unit of GDP currently lies around the average of developed nations. According to the forecasts presented in this paper, electricity consumption both per capita and per unit of GDP is projected to rise strongly in the future (except for the high oil price scenario, not shown in Table 6). Although per capita consumption is steadily increasing worldwide, consumption per GDP unit has stabilised or has even started declining in many developed economies (EIA 2005). In Cyprus, however, it is difficult to see any signs of stabilisation because of the lack of energy conservation measures and in view of prevailing weather conditions, which encourage the extensive use of electric cooling devices in the residential and commercial sectors. This means that, under 'business as usual' conditions, Cyprus will exhibit one of the highest electricity consumption figures per capita and per unit of GDP in the long term. This finding can give rise to several energy policy considerations, as will be discussed in the next section.

Finally, it is important to note that energy-related forecasts are not meant to serve as accurate predictions of the future but rather as answers to 'what if' questions. The main uncertainties associated with the projections presented here have to do with uncertain macroeconomic developments as well as with the still unknown impact on electricity prices from the introduction of natural gas in power generation and the planned liberalisation in the electricity sector of Cyprus. Still, forecasts can be of great use for long-term energy planning which aims at securing the supply of electricity in an island without any electricity interconnection with other countries.

4. Major policy challenges

As mentioned in the introductory section, the energy policy of Cyprus has to achieve the following primary goals:

- Reduce the very high dependence on imported energy, and diversify energy imports so as not to be completely dependent on petroleum products
- Comply with additional EU-wide commitments to liberalise energy markets and reduce greenhouse gas emissions.

Despite some trade-offs, these goals are complementary to a large extent. Moreover, the elasticity estimates reported in section 3.1 and the electricity forecasts presented in section 3.2 provide clear evidence that energy demand will continue to rise strongly in the future under 'business as usual' conditions. Taking also into account the sectoral shares of energy consumption as illustrated in Figures 1, 3 and 4, it becomes clear that the major areas that require particular attention by policy makers are:

- On the demand side, improving the energy efficiency of residential and commercial buildings and, to a lesser extent, industrial processes and improving the overall efficiency of the road transport sector.
- On the supply side, differentiating the power generation mix by including natural gas fired power plants and renewable sources in the energy system.

This section will elaborate on these policy priorities.

4.1. Energy efficiency: on the right track, but without an appropriate policy evaluation

Despite considerable advances in energy efficiency that have been realised during the last two decades, there is still much unexplored potential for further efficiency improvements, both in buildings and in industrial processes. Facing this fact, the European Commission adopted an Energy Efficiency Action Plan in fall 2006, aiming to reduce its primary energy use by 20% in 2020 (European Commission 2006b).

In line with EU commitments, the government of Cyprus adopted a few years ago specific measures to subsidise investments in energy efficient materials and processes for both households and firms. The subsidy scheme is declared to have been very successful and will therefore continue, at least for the next couple of years. Claiming 'successful implementation' of the scheme, the authorities mean that interested investors have indeed claimed funds that had been foreseen for this programme. However, to what extent these subsidies have indeed affected an increase in energy efficiency remains an open question.

As a rule, energy savings due to efficiency improvements are estimated in advance on the basis of engineering calculations; for example, an engineering study can assess how much a dwelling's heat losses will be reduced because of improved wall insulation or the installation of double glazed windows. Authorities usually adopt these calculations and assume that a specific investment yields exactly as many energy savings as predicted by the engineering analysis. However, this approach fails to account for the change in behaviour of consumers and producers when energy use becomes cheaper. In fact, both economic theory and empirical analysis worldwide provide evidence that energy savings are overestimated when they are based on engineering results only.

This discrepancy between pre-calculated and observed energy savings is expressed in energy economics with the term 'rebound effect' (see e.g. Berkhout et al. 2000). It is well known from economic theory that when the relative price of a good changes this causes an income effect and a substitution effect. In the case of energy efficiency improvements, energy use becomes cheaper, household energy expenditures decrease, and hence it is possible that consumers will consume more of that specific energy service because they have more income available (income effect) and because they may spend more for that energy service and less for other goods or services (substitution effect). As a result, energy consumption does decrease because of improved efficiency but not to the extent predicted by engineering analysis; income and substitution effects cancel some of the energy saving potential out.

It is not straightforward to assess the magnitude of this rebound effect. Empirical analyses around the world indicate that this may range between zero and 50%. This means that sometimes the total energy saving potential is fully utilised, while in other cases only half of the theoretical energy savings are attained. According to some studies, the rebound effect seems to be more pronounced in the case of energy use for space cooling purposes (Greening et al. 2000); this is particularly important for Cyprus, where a large fraction of energy use in the residential and commercial sector goes to space cooling. Moreover, there is evidence that energy savings are particularly low in low-income homes, where indoor temperatures are far from the desired ones. In such cases, an improvement in energy efficiency enables residents to live in more comfortable conditions paying the same energy bill, without lowering energy consumption (Milne and Boardman 2000).

In view of these considerations, it is not possible to evaluate the actual effectiveness of the recent Cyprus government's energy efficiency initiatives. For this, appropriate empirical analysis on an individual household basis would be required. Based on the international experience, it seems likely that real-world energy savings that have been achieved through these initiatives are 20–30% lower than those pre-calculated by the authorities. This remark does not mean to understate the importance of subsidies directed towards improving energy efficiency; it is, however, a reminder that the quantitative targets that have been set may not be fulfilled.

4.2. Transport: little progress is possible without promoting public transport and efficiency-based vehicle taxation

The share of transportation in total energy consumption and greenhouse gas (GHG) emissions is increasing, particularly in OECD countries, because of continuous growth in total vehicle kilometres travelled and stagnancy in automobile energy efficiency. This comes in sharp contrast to GHG mitigation achievements in other sectors like power generation and industrial processes. In the EU, for example, the transport sector almost completely cancels out other progress towards meeting the 8% GHG reduction target under the Kyoto protocol (European Environment Agency 2007). With the exception of bio fuels, which are regarded as CO2-neutral and whose production is gradually increasing and encouraged by European legislation, other fuel/engine combinations are still not mature for mass production and even commercially available hybrid powertrains are experiencing slow penetration rates. It therefore becomes imperative for European countries to succeed in improving the fuel economy of conventional gasoline- and diesel-fuelled passenger cars if they are to ensure progress in limiting GHG emissions and meeting their Kyoto commitments.

Many countries have imposed fuel economy standards in order to raise the fuel economy of new cars. Such a standard is usually expressed as the minimum sales-weighted average fuel economy for the new-car fleet entering the market in a given year. Mandatory fuel economy standards have been in force in the United States since 1978. Other countries followed later, and currently Australia, Canada, China, the EU, Japan, Switzerland, South Korea and Taiwan implement some type of fuel economy or CO2 standard. A second approach towards improving fuel economy is to increase fuel taxation in order to induce purchases of more efficient cars and discourage private car travel. A third complementary approach is to make vehicle taxation (including registration taxes and annual circulation taxes) depend on the fuel consumption or CO2 emissions of the car, thereby trying to induce the purchase of more fuel efficient cars.

Legislative initiatives both on CO2 emission standards and on CO2-based vehicle taxation are currently under discussion in Europe, while at the same time the number of national governments adopting a CO2-based vehicle taxation system –irrespective of EU-wide negotiations– is rising. In this context, the government of Cyprus has recently amended its vehicle taxation scheme; the new system foresees, among other things, some reduction in the car registration tax for vehicles with low CO2 emissions. However, for reasons explained in detail elsewhere, this system is unlikely to yield significant benefits (Zachariadis 2006c). Much stronger economic incentives are necessary for new car buyers, and such incentives should vary with car size in order to reward the most fuel-efficient cars in each car segment.

Besides measures that aim at encouraging the purchase of more efficient cars, a second major goal in transport policy is to contain the growth in car use. Higher incomes, changing lifestyles and the continuous sprawl of urban areas in Cyprus lead to an ever-higher number of vehicle kilometres travelled. Congestion problems during several hours of the day are now commonplace in the largest cities and give rise to serious economic losses. The major origin of this problem is the almost entire absence of public transport modes. Therefore, it would be particularly useful to conduct a systematic assessment of the externalities associated with private car use in Cyprus; this would demonstrate to policy makers that the lack of public transport has significant costs to the society, and is not an inevitable side effect of economic growth. If progress is to be made in improving the energy efficiency of transport, it will have to involve a very significant rise in the availability and use of public transport modes.

4.3. Market liberalisation and changes in power generation mix: progress is slow and timetables are unlikely to be met

As already mentioned, all power plants currently installed in Cyprus operate on fuel oil (and secondarily on diesel oil). This is expected to change considerably in the coming years, as a result of the introduction of natural gas and the construction of wind farms. A liquefied natural gas (LNG) terminal is scheduled to be operational by 2009/2010 in the area of Vasilikos. New plants operating on state-of-the-art combined cycle gas turbine (CCGT) technology, some owned by the Public Power Corporation of Cyprus (PPC) and at least one owned by private investors, will make use of the imported natural gas. The official aim is that by 2010 28% of all electricity will be produced by natural gas fired plants. However, due to significant delays in the decisions concerning the terms of gas supply and the construction of the necessary gas terminals, it is possible that natural gas will not enter the energy system before 2012.

As regards the exploitation of renewable energy sources for power generation, where the focus is on wind power, the official target for the year 2010 is to provide 6% of all electricity through renewables. Although the Regulatory Energy Authority of Cyprus (CERA) has already granted licenses for the operation of wind farms of about 600 MW total installed capacity (out of which only 6 MW to PPC and the rest to private investors)[4], it is questionable to what extent these farms will be operational in the coming years. Reasons for delays are administrative procedures as well as the opposition of local or governmental authorities to specific projects because of fear for adverse environmental impacts (noise, damage to ecosystems etc.).

There are also significant grants to households and enterprises to install photovoltaic (PV) panels, which utilise solar energy to produce electricity, which can then be sold to the PPC at a premium price. Up to now, the scheme seems to have been moderately successful. To increase penetration of solar energy in power generation, a greater engagement of the public sector is necessary through the installation of PV panels on a large number of governmental buildings. Moreover, incentives should be given to investors who can install large numbers of PV panels (e.g. with a capacity of several hundreds of kilowatts) and not only to individual households and firms who can only install small quantities of PV cells; no such incentives are in place yet.

Today, although in theory 35% of the electricity production market is open to competition, there is no privately owned power generation. In a recent assessment of energy policy aspects in European countries, Cyprus ranked second to last in terms of energy sector competitiveness (Röller et al. 2007). According to CERA, if all applications that have been currently submitted by private investors for the operation of new power plants are accepted, in the year 2010 almost 45% of total installed capacity will come from private plants and wind farms. To what extent this can yield benefits to the consumers –in terms of competitive retail electricity prices and improved customer service– remains an open question.

5. Conclusions

This paper has attempted to outline the major challenges that Cyprus faces with regard to its energy policy. These are mainly associated with the security of the island's energy supply and the containment of growth in greenhouse gas emissions. Econometric analysis shows that energy use is income elastic and price inelastic, which indicates that energy consumption may continue to grow fast in the future in the absence of

---

[4] Status as of February 2007. See the website of the Cyprus Regulatory Authority of Energy: www.cera.org.cy.

appropriate price signals and energy conservation measures. Electricity consumption in particular is expected to triple up to 2030, with obvious implications for the country's energy dependence, greenhouse gas emissions and requirements for new energy investments. Bearing in mind these results, it is evident that policy makers need to focus on three major topics: improving the energy efficiency of residential and commercial buildings and industrial processes, putting a halt on the rapid growth of energy use in transport, and diversifying the power generation mix. With regard to energy efficiency, the paper argued that official estimates of energy savings achieved through energy efficiency subsidies are most probably overestimated, and a more careful assessment is necessary. In the transport sector, no serious progress can be made without the introduction of a reliable public transportation system throughout Cyprus. As for plans to diversify the mix of power generation, these are well under way. The major plan, involving the introduction of natural gas in the Cypriot energy system before 2010, seems to be on track although delays up to 2012 are likely; penetration of renewable power generation through the installation of wind farms and solar photovoltaic panels still faces serious obstacles, thus making it very difficult to meet the official target of 6% renewable electricity production by 2010. Finally, the degree of energy market liberalisation depends largely on the rate of introduction of renewable energy investments – and this is still quite slow despite ambitious official plans. In any case, whether liberalisation can yield benefits to consumers remains an open question.

In summary, as everywhere in the world, ensuring a sustainable energy future requires serious commitment from policy makers with a visionary approach, who are willing to make well-informed decisions and to educate the public accordingly. This may be particularly difficult in Cyprus, where energy and environmental issues have never been high in the policy agenda.

Appendix

Energy data available for Cyprus and the corresponding economic and climate time series that were used in the econometric analysis

Energy consumption variables	Economic variables	Climate variable
Electricity, total	Real GDP	Cooling+heating degree-days
	Average weighted electricity price	
Electricity, residential	Real private consumption expenditure	Cooling+heating degree-days
	Residential electricity price	
Electricity, industry	Real value added of industry	-
	Industrial electricity price	
Electricity, commercial	Real value added of services	Cooling+heating degree-days
	Commercial electricity price	
Electricity, agriculture	Real value added of agriculture	-
	Agricultural electricity price	
Gasoline	Real GDP	-
	Gasoline price	
Total non-electricity final consumption	Real GDP	Cooling+heating degree-days
	Average weighted non-electricity price	
Total final energy consumption	Real GDP	Cooling+heating degree-days
	Average weighted energy price	

Acknowledgement

Most of the analyses outlined in this paper have been conducted in the framework of a Marie Curie Fellowship that I received from the European Commission. Some financial contribution of the Cyprus Research Promotion Foundation is also appreciated. The paper reflects my views only, and I am responsible for all errors or omissions.

References

Berkhout, P.H.G., Muskens, J.C. and Velthuijsen J.W. (2000) 'Defining the rebound effect', Energy Policy 28: 425-32.

CYSTAT (Statistical Service of the Republic of Cyprus) (2005), various economic, industrial and energy statistical publications.

EIA (US Department of Energy, Energy Information Administration) (2005) International Energy Annual 2003, Washington, DC. Also at http://www.eia.doe.gov/iea/.

EIA (US Department of Energy, Energy Information Administration) (2006) Annual Energy Outlook 2006, Report DOE/EIA-0383 (2006), Washington, DC. Also at http://www.eia.doe.gov/oiaf/aeo/index.html.

European Commission (2006a) 'The impact of ageing on public expenditure: projections for the EU25 Member States on pensions, health care, long-term care, education and unemployment transfers (2004-2050)', Report prepared by the Ageing Working Group of the Economic Policy Committee for the European Commission - DG ECFIN. Published in the 'European Economy' series, Special Report No. 1/2006, Brussels. Also at http://europa.eu.int/comm/economy_finance/epc/epc_publications_en.htm.

European Commission (2006b) 'Action Plan for Energy Efficiency: Realising the Potential', Document No. COM (2006) 545 final, Brussels, 19 October 2006. Also at http://ec.europa.eu/energy/action_plan_energy_efficiency/index_en.htm.

European Commission (2007a) 'An Energy Policy for Europe', Document No. COM (2007) 1 final, Brussels, 10 January 2007. Also at http://ec.europa.eu/energy/energy_policy/index_en.htm.

European Commission (2007b) 'Limiting Global Climate Change to 2 degrees Celsius - The way ahead for 2020 and beyond', Document No. COM (2007) 2 final, Brussels, 10 January 2007. Also at http://ec.europa.eu/environment/climat/pdf/com_2007_2_en.pdf.

European Environment Agency (2007) 'Transport and environment: on the way to a new common transport policy', EEA Report No. 1/2007, Copenhagen.

Eurostat (European Statistical Service) (2006) Economic and energy data available on the World Wide Web at http://europa.eu.int/newcronos.

Greening, L.A., Greene, D.L. and Difiglio, C. (2000) 'Energy efficiency and consumption - the rebound effect - a survey', Energy Policy 28: 389-401.

Milne, G. and Boardman, B. (2000) 'Making cold homes warmer: the effect of energy efficiency improvements in low-income homes', Energy Policy 28: 411-24.

Röller, L.-H., Delgado, J. and Friederiszick, H.W. (2007) 'Energy: Choices for Europe', Preliminary version, Bruegel Blueprint Series, Brussels.

Zachariadis T. (2006a) 'An empirical time series analysis of energy consumption in Cyprus', Economic Analysis Paper 01-06, Economics Research Centre, University of Cyprus. Also at http://www.erc.ucy.ac.cy/greek/publications.html.

Zachariadis T. (2006b) 'Long-term forecast of electricity consumption in Cyprus', Economic Policy Paper 09-06, Economics Research Centre, University of Cyprus - in Greek. Also at http://www.erc.ucy.ac.cy/greek/publications.html.

Zachariadis T. (2006c) 'Towards a new vehicle taxation system', Economic Policy Commentary No. 9, Economics Research Centre, University of Cyprus (in Greek). Also at http://www.erc.ucy.ac.cy/greek/announcements.html.