DEMAND FOR ENERGY AND THE REVENUE IMPACT OF CHANGES IN ENERGY PRICES

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DEMAND FOR ENERGY AND THE REVENUE IMPACT OF CHANGES IN ENERGY PRICES[1]

1. Introduction

The demand for energy[2] is expected to rise sharply as a country develops[3]. In 1971, the share of developing countries in the world energy consumption was only 15 percent, it increased to 27 percent in 1991, and it is expected to rise to 40 percent by the year 2010 (see Schneider (1994)). This rise in energy consumption is linked with industrialization and urbanization in these countries. Energy Intensity is, also, expected to rise initially with industrialization, then decline and ultimately settle down at a higher energy intensity ratio.

In Pakistan, the demand and supply, both, have expanded very rapidly (see Table 1). However, for different energy sources, the coefficient varies significantly (see Table 2).[4] For electricity, the energy coefficient is quite high and it may decline as efficiency in the use of electricity rises. The energy coefficient for natural gas is declining, which may be an indicator of improved efficiency in gas use as output grows. The tables also indicate that in

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[1] The author, Rehana Siddiqui, is Senior Research Economist at Pakistan Institute of Development Economics, Islamabad. She is extremely grateful to Mr. Zamir Ahmed and other members of the Energy Wing of Planning Division, for their help and extremely useful suggestions in the preparation of this report. However, the errors and omissions are sole responsibility of the author.

[2] Energy sector includes electricity, natural gas and petroleum products, including oil and coal. However, due to nonavailability of sufficient data on demand for coal, we can not analyse this component of energy, in detail.

[3] According to Ebinger (1981) there is little doubt that energy crises retards development efforts.

[4] According to Riaz (1984b) energy coefficient for U.K. is equal to 1.21. Energy coefficient is defined as growth of energy consumption divided by growth in output.

Pakistan the energy coefficient varied overtime and it was low, as expected, during the period of slow economic growth. Thus, the country should concentrate not only on the expansion of energy supply but also improve the efficiency in resource use. How efficiency in energy use can be achieved? Based on economic theory, prices can play an important role in this regard.

Table 1:Growth Rate of Energy Demand and Supply (1971-97)

	DEMAND				SUPPLY			
	1971-80	1980-90	1990-97	1971-97	1971-80	1980-90	1990-97	1971-97
Electricity(1)	8.64	10.77	5.81	8.68	8.28 (8.90)	7.79 (9.66)	9.37 (6.74)	8.61 (8.57)
Gas	9.35	6.88	4.36	6.95	9.60	6.73	4.93	7.13
Oil (2)	2.84	3.28	1.30	2.67	2.16 (2.93)	18.53 (-0.96)	1.23 (1.34)	8.14 (0.92)
Petroleum Products (2)	5.91	6.03	7.10	6.29	3.23 (18.08)	3.27 (11.09)	0.89 (12.61)	2.58 (13.71)

Source: Pakistan Economic Survey 1997-98

Notes:

(1) Supply growth rates for electricity are for installed capacity. The growth rates in parenthesis are for electricity generation.

(2) Demand for petroleum products is sum of production and imports of petroleum products. The growth rates for import of oil and petroleum are reported in parentheses.

Table 2:Energy Coefficients in Pakistan

	E1	E2	E3(a)	E3 (b)
1971-80	1.73	1.87	1.03	1.18
1980-90	2.03	1.30	1.73	1.14
1990-97	1.43	1.08	0.32	1.75
1971-97	1.62	1.30	0.50	1.18

Note: E1 = growth rate of electricity demand/growth rate of GDP (mp).
E2 = growth rate of demand for gas/growth rate of GDP (mp).
E3(a)= growth rate of demand for oil/growth rate of GDP (mp).
E3(b)= growth rate of demand for petroleum products/growth rate of GDP (mp).
GDP(mp)= Gross Domestic Product at market prices (1980/81 = 100).

The rise in prices can not only lead to increase in supply of energy it can also generate revenue for the government.[5],[6] Since it is difficult to increase the supply of electricity and natural gas in the short run, we can assume that supply is fixed. However, in the long run investment in expansion and exploration activities can lead to increase in supply. The increase in government resources can improve fiscal deficit and provide investible funds for the expansion of these public utilities. However, the impact on energy consumption could be energy conservation, which may be costly, or it can lead to competitive disadvantage in the short run. For example, Pintz (1986) argues that without information dissemination and sufficient resources for energy conservation, the policy of rise in energy prices can be counterproductive. Thus, it is important to examine the changes in energy demand in response to changes in prices, and economic conditions.

The aim of this study is to examine the revenue generating potential of the energy sector of Pakistan. For this purpose, we estimate energy demand functions, for each source of energy, by user groups, i.e., households, industry, commercial and other sectors. From these demand functions we estimate price (own and cross) elasticity and income elasticity to compute expected revenue in response to rise in price of energy. Disaggregation by energy sources and by user groups gives us detailed information regarding price and income elasticity.

[5] Government revenue in the category of development surcharge will increase.

[6] According to Riaz (1984a), present energy pricing structure does not provide incentives to improve efficiency. See also Helliwell and Cox (1979).

The study is divided in the following sections: In section 2, we briefly discuss the energy demand model and the methodology to compute revenue generating potential of the energy sector. The empirical results are discussed in section 3. Finally, section 4 concludes the study.

2. Model

A. Demand for Energy:

The use of energy by different economic groups is for different purposes. For example, household electricity demand is for consumption, the industrial and commercial sectors demand energy as input in the production. As mentioned earlier, the energy sector is disaggregated in two directions: First by source of energy, i.e., electricity, natural gas and petroleum products.[7] Second, by different user groups, i.e., households, industrial, commercial and others. For each component demand function is specified below:

i) Demand for Electricity:

[7] Petroleum products include: Motor Spirit, Furnace Oil, High Speed Diesel, light diesel oil and superior kerosene.

$$E^{d}_{Ht}=f(P^{e}_{Ht},P_{jHt},Y_{Pct},H_t,E^{d}_{Ht-1})$$

$$E^{d}_{It}=f(P^{e}_{It},P_{jit},Y_{Mt}I_t,E^{d}_{It-1})$$

$$E^{d}_{Ct}=f(P^{e}_{Ct},P_{jCt},Y_{At},C_t,E^{d}_{Ct-1})$$

$$E^{D}_{At}=f(P^{e}_{At},P_{jAt},Y_{Agt},,A_t,E^{d}_{t-1})$$

Electricity demand function is specified for households, industrial[8], commercial and agriculture sectors:

where $E^{D}_{Hb}, E^{d}_{It}, E^{d}_{CE}$ E^{D}_{At} are electricity demand, in period t, by households, industrial sector, commercial sector, and agriculture sector, respectively. $P^{e}_{Ht}, P^{e}_{It}, P^{e}_{Ct}$ P^{e}_{t} are electricity price for households, industrial user, commercial users and agriculture. P_{jHt}, P_{jIt},

P_{jct} and P_{jAt} are prices of related energy sources like natural gas and kerosene oil, furnace oil and others. The coefficient of these variables will help us to determine substitutability or complementarity among different energy sources. Y_{pct} is total output (gross domestic product-GDP), Y_{mt} is value added in the manufacturing sector, Y_{AGt} is the value added in the agriculture sector and Y_{AT} is total gross domestic product. H_t is the number of household consumers, I_t is number of industrial users, C_t is number of commercial users, and A_t is number of agriculture users. $E^d_{Ht-1}, E^d_{It-1}, E^d_{Ct-1} E^d_{At-1}$ are lagged values of the dependent variable. The own price effect, for each category of energy user, is expected to be negative, and the effect of income is expected to be positive. However, the effect of the prices of related goods can be positive or negative depending on the complementarity or substitutability between different sources of energy. The coefficient of lagged dependent variable, reflecting the lag adjustment in energy demand, is expected to be between zero and one. H_t, I_t and C_t will control for the rise in electricity demand due to increase in consumers.

ii) Demand for Natural Gas:

Natural gas has become the largest source of energy supply since 1980s, particularly in the power generation and as industrial fuel. The demand functions for this energy source are specified as:

$$G^D_{Ht} = f(P^G_{Ht}, P_{jHt}, Y_{Pct}, H_t, E^D_{Ht-1})$$

[8] In most studies industrial energy demand is estimated as an input demand function based on trans-log production/cost function (for details, see Nordhaus (1977), Burney (1990) and Pintz (1980)).

$$G_{It}^{D} = f(P_{It}^{G}, P_{jIt}, Y_{Mt}, I_{t}, G_{It-1}^{D})$$

$$G_{Ct}^{D} = f(P_{Ct}^{G}, P_{jct}, Y_{A}, C_{t}, G_{Ct-1}^{D})$$

$$G_{Ft}^{D} = f(P_{At}^{G}, P_{jt}, Y_{At}, G_{Ft-1}^{D})$$

$$G_{CEt}^{D} = f(P_{At}^{G}, P_{jt}, Y_{At}, G_{CEt-1}^{D})$$

where $G_{Ht-1}^{D}, G_{It}^{D}, G_{Ct}^{D}$ and G_{Ft}^{D} are gas demand by households, industrial sector commercial sector and fertilizer industry, respectively. $P_{Ht}^{G}, P_{It}^{G}, P_{Ct}^{G}$ and P_{At}^{G} are the gas price for each group of users. P_{jHt}, P_{jIt}, P_{jct} and P_{jt} are prices for related energy goods, like electricity price for households, industrial users, for commercial users and others. Y_{Pct}, Y_{Mt} and Y_{At} represent total output (GDP), value added in manufacturing and total output, respectively. H_t, I_t, C_t and A_t are number of users of natural gas in households, industries, commercial sector, and in agriculture sector, respectively. $G_{Ht-1}^{D}, G_{It-1}^{D}, \wedge G_{Ct-1}^{D}$, are the lagged dependent variables in each equation. The supply of this source of energy can be divided into three segments: wellhead producers, transmission pipelines and distribution. The discrepancy in prices charged by pipelines and distributors creates problems. In this study, own price of gas includes the subscribed price of natural gas and the gas development surcharge imposed by the government. Increase in gas development surcharge will raise government revenue. We

intend to include this aspect separately, as it will help us to examine the revenue generating potential of the government. As mentioned earlier, own price effect is expected to be negative, income effect is expected to be positive and cross price effects may be positive or negative[9].

(iii) Demand for Petroleum Products

Petroleum products include aviation fuel, HOBC, high speed diesel, light diesel oil, kerosene oil, furnace oil and gasoline (motor spirit). The analysis of demand for each petroleum product can be classified as the demand by different categories of users. For example, greater than 70 percent of the kerosene oil is consumed by the domestic users whereas greater than 60 percent of the furnace oil is used in the industrial sector. Therefore, we can say that demand for kerosene oil is mainly household demand for petroleum products and the demand for furnace oil is industrial demand for petroleum products. The demand functions for petroleum products are specified as:

$$K^{D}_{Ht} = f(P^{K}_{Ht} , P_{OHt} , Y_{Pc} , t, P_{op} , K^{D}_{Ht-1})$$

$$FO^{D}_{It} = f(P^{F}_{Ht} , P_{jFt} , Y_{Mt} , FO^{D}_{Ht-1})$$

$$HSD^{D}_{It} = f(P^{H}_{Tt}, P_{jHt}, Y_{Tt}, B, T, HSD^{D}_{Tt-1})$$

$$MSD^{D}_{T} = f(P^{M}_{Tt}, P_{jHt}, Y_{Tt}, Cars, NMV, MSD_{t-1})$$

[9] Prices of electricity and gas equipment may be another important variable affecting demand. However, due to

where K_H^D is demand for kerosene oil. P^k_{Ht} is price of kerosene oil. P_{oHjt} are price of related goods like gas and electricity faced by the household sector. Y_{PC} is total output (GDP), Pop. is population and K^D_{Ht-1} is lagged demand for kerosene oil.[10]

FO_{It}^D is demand for furnace oil (FO). Since approximately 60 to 75 percent of FO is demanded by industrial users, we include value-added generated in industrial sector as an explanatory variable. Other variables include price of furnace oil and prices of other related energy sources.

Similarly demand for high speed diesel oil (HSD) and motor spirit (MS) is mainly the energy demand by the transport sector. For example, the use of MS depends on the condition of the vehicles, average speed at roads, and rates of acceleration. Therefore, in addition to price, and value-added in transport sector, the number of buses (B), trucks (T), cars and number of other motor vehicles (NMV) are included in the analysis. The increase in price of MS may reduce consumption of MS and induce a change in the automobile usage pattern leading to increase in operating efficiency.

The demand analysis for the petroleum products differs from the demand analysis for electricity and natural gas in three respects:

(a) Price for petroleum products can be disaggregated between ex-factory price, sale price and development surcharge for different products. This disaggregation will help us to determine the responsiveness of petroleum products to changes in development surcharge resulting in direct revenue generation for the government.

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non-availability of complete data we cannot include this variable.

[10] Demand function for Light Diesel Oil is also estimated.

(b) The demand for petroleum products, unlike demand for electricity and gas, is significantly dependent on the import of petroleum products.

c) Pricing for petroleum products includes wellhead price, fixed rate of return to investors, marketing and distribution margins and taxes like custom/excise or development surcharges (DS). The development surcharges (DS) vary as the rate of return to the investor is linked with it. The investor is paid form DS if import parity price is low. This policy of fixed prices, assured profit margins and ad-hoc price revisions contain no incentives to minimize costs.[11]

B: Revenue Generation

As mentioned earlier our main interest in this study is to estimate potential of revenue generation in the energy sector. The revenue generation depends on the responsiveness of energy demand in response to changes in prices and in other factors. However, revenue generation from electricity is not revenue for the government. The surplus is kept for investment and expansion activities in WAPDA. However, it indirectly reduces the pressure on government funds as revenue shortfall in WAPDA is financed by the government.

For natural gas and petroleum products the coefficient of development surcharge, along with other factors, gives the potential for revenue generation for the government from these two energy sources. Thus, for these two energy sources, the expected government revenue is calculated on the basis of price elasticity of demand for each energy source. We

[11] Price variation among petroleum products, like low price of Kerosene oil and higher prices of HSD and MS allowed adulteration to increase the profit margin of the dealer.

also make alternative assumptions regarding price increases and increase in development surcharge.

3. Estimated Results:

A. Demand for Energy[a]

(i)Demand for Electricity:

For electricity, we have two major suppliers, i.e., WAPDA and KESC.[12] WAPDA supplies electricity for the whole country whereas KESC is responsible for electricity supply to Karachi and some neighboring areas. We add electricity demand data reported by these two sources and estimate electricity demand for different user groups. For domestic users of electricity income, electricity price, price of gas, price of petroleum product (kerosene oil), number of consumers, lagged electricity demand (lag), fuel adjustment surcharge, and time trend, are included as explanatory variables. The selected estimated equations are reported in Table-A2. The results show that for household electricity demand, the coefficient of GDP is positive but it is statistically insignificant, implying income effect on household demand is positive but negligible. However, for industrial and other productive sectors of the economy the income effect is almost proportionate. Own price effect is negative and statistically significant for all subgroups of energy users. This shows that increase in price reduces electricity demand (see table-A2) significantly, e.g., a 10 percent increase in price of

[12] a: All the equations are estimated in double-log form.

i) WAPDA-Water and Power Development Authority; KESC-Karachi Electric Supply Corporation.
ii) Electricity demand is measured in terms of GWH.
iii) The variables may be correlated, but estimation of when we tried to adjust the model, the results of the

electricity reduces electricity demand by 5 percent.[13] Interestingly, the own price effect is bigger (in absolute terms) for households as compared to other user groups. The impact of price of related goods, i.e., price of natural gas and price of kerosene oil are also included in the equation. The effect of changes in price of gas is negative and statistically insignificant but the change in price of kerosene oil has positive and statistically significant impact on demand for electricity. This shows that electricity and kerosene oil are substitutes for domestic energy users. A 10 percent increase in price of kerosene oil raises the demand for electricity by about 1.6 percent. The impact of a rise in number of consumers is highest and statistically significant. Increase in number of consumer can double the demand for electricity implying no economies of scale in the domestic use of electricity. The effect of changes in FAS (Fuel adjustment surcharge) is negligible. This shows that for domestic users, price of electricity, price of kerosene oil (substitute) and number of consumers are the major determinants of electricity demand.

For commercial group, as opposed to domestic consumers, level of economic activity is the most important variable. However, this price effect is negative but statistically insignificant. Changes in the number of consumers has significant and more than proportionate impact on electricity demand implying no economies of scale.

The agricultural demand for electricity increases as level of economic activity or value added in agriculture sector rises. Price effect is negligible. This is not surprising as electricity is provided at subsidized rates to the agriculture sector. Furthermore, electricity demand in the agriculture sector is lower relative to industrial or domestic demand.

For the industrial sector, all the coefficients have expected sign. The positive and

finally selected equations do not change significantly.

statistically significant output (value-added in manufacturing) elasticity is approximately equal to one implying proportionate increase in electricity demand as output increases. Price elasticity is negative and statistically significant. However, the numerical magnitude of the elasticity is quite small. A 10 percent increase in price reduces industrial electricity demand by 1 percent only. However, for industrial sector, the cross price effect of price of natural gas and price of furnace oil are not statistically significant. The impact of number of consumers is positive and statistically significant. However, the elasticity with respect to number of consumers is lower in this case as compared to elasticity for number of users in the domestic or commercial sector.

Similarly, at aggregate level, increase in GDP leads to more than proportionate increase in electricity demand. The price elasticity is negative and statistically significant. The elasticity with respect to number of consumers is positive but less than one. However, this coefficient is significantly lower than the coefficient for domestic consumers. This means that significant economies of scale may be prevailing in industrial and agriculture sectors. Concluding this section, we can say that at aggregate level, output, price and number of consumers are major determinants of electricity demand. However, time trend, FAS and cross price effects are not statistically significant, thus we drop these variables from the equation for aggregate electricity demand.

(ii): Demand for Natural Gas:[14]

Demand for gas is estimated, separately, for the following groups:

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[13] This supports Burney's (1990) conclusion that fuel is necessity for domestic users.

[14] Gas consumption is measured in MMCFT.

i) Domestic; ii) Commercial; iii) Industry; iv) Cement; v) Fertilizer; vi) Power and

vii) Aggregate.

A number of specifications are estimated and finally best equations are selected for detailed discussion (see Table A3). For domestic consumption of natural gas the income elasticity is quite small. The negative impact of changes in price is small but statistically significant. The negative cross price effect (of Kerosene oil) is quite high and significant. This confirms our earlier result that kerosene oil is substitute fuel for electricity in the household sector.

For commercial sector, demand for natural gas is affected significantly by changes in income, number of consumers and time trend. Overtime commercial consumption of gas has expanded very sharply, i.e., 11.0 percent per annum. For Industrial sector the demand for natural gas, as expected, rises as income increases. However, the negative impact of price change is not statistically significant. The price of electricity has positive and statistically significant coefficient but increase in price of petroleum products, like furnace oil, reduces gas consumption significantly. Therefore, electricity and gas may be (to some extent) substitutes whereas furnace oil is complementary fuel for the industrial sector. The results for demand for natural gas in cement industry are quite interesting. Unlike industrial sector, cement industry shows significant and almost proportional negative effect of increase in price of natural gas on gas consumption. Similarly fertilizer industry also responds negatively to change in prices but the impact of changes in price of furnace oil is statistically insignificant in the fertilizer industry. However, for power sector, price effect is

not statistically significant. Similarly, at aggregate level, income effect is positive and significant. A rise in price of kerosene oil increases demand for natural gas as both fuels are substitutes for each other. The trend reveals negligible decline in gas consumption over time in cement industry but a significantly rising trends in fertilizer industry and in power sector.

These results show that demand for natural gas increases as level of economic activity improves and declines as price of natural gas increases. However, the price of kerosene oil has positive impact on demand for natural gas. Similarly the demand for natural gas has changed significantly, for different sub-groups, over time. These results support Iqbal's (1983) conclusion of higher income elasticity and low price elasticity of demand for natural gas.

(iii):Demand for Petroleum Products:

The demand for petroleum products is disaggregated by products; i.e., kerosene oil (SK), furnace oil (FO), High Speed Diesel (HSD), Motor spirit (MS) and Light Diesel Oil (LDO). As mentioned earlier, this commodity disaggregation can be taken as disaggregation by user group also. For example, the demand for kerosene oil can be categorised as household demand for petroleum products and the demand for furnace oil can be categorised as industrial demand for petroleum products.

The estimated demand functions are reported in Table A4. Income elasticity of demand for kerosene oil is almost unity implying same proportionate increase in demand for kerosene oil as income goes up. Similarly, changes in economic activity affect demand for all petroleum products proportionately and significantly. The own price effect for each

petroleum product is negative and statistically significant. However, the cross price effect shows that high speed diesel oil can be substituted for motor spirit but the effect is not statistically significant.[15] The lagged effect is significant for domestic demand for kerosene oil only.

Concluding the results for energy demand we can say that income and price (own and cross) effects are significant and have expected signs. Since our objective is to determine how much revenue can be generated if the price of energy is increased, we conduct the exercise using the results of the estimated demand equations.

B: Revenue Generation:

Main objective of this study is to examine the revenue generation potential of the energy sector. Electricity is the most important source of energy. Since electricity does not generate revenue for the government directly, we do not include it as part of government revenue. However, surplus generated in this sub-sector provides resources for its modernization and expansion and it reduces the demand pressure for government funds. Therefore, we examine the surplus generated in each sector separately.

In order to examine the revenue generating potential of the energy sector, assuming no change in production cost of energy, we make following assumptions regarding the economic growth and price of each energy source.[16]

i. Output growth rate is either 0 or 5-percent; and

[15] For Motor spirit, we included number of vehicles as an explanatory variable but the coefficient was not statistically significant and it affected other coefficients, particularly the coefficient of GDP, adversely. Consequently, we decided to drop that variable. Thus, we can say that the coefficient of GDP gives not only the effect of changes in economic activity but also the effect of changes in number of vehicles. Sweeney (1979) also reports similar results.

ii. Prices of all energy sources change at the same rate.[17]

In case of electricity, the income elasticity is greater the one, and the magnitude of negative price elasticity is quite low (equaling 0.06). Thus, total revenue and consequently net revenue increases despite the decline in quantity demanded.[18],[19] Table-3 shows that net revenue almost doubles if price of electricity increases by 20 percent. This shows that due to price inelastic demand for electricity, net revenue (or investible resources) can be generated in the electricity sector. However, the amount of surplus will be significantly reduced if the cost of production increases and the electricity theft increases in response to increase in prices.

Revenue from electricity can increase substantially, if WAPDA and KESC can collect the accumulated arears equalling Rs. 11124.6 mln (in 1995). The data also show that growth rate of these accumulated arears, in 1990s, was about 25 percent p.a. which is high and efforts should be made to control it effectively.

Gas development surcharge is an important source of government revenue.[20] All the earlier assumptions are retained here. However, from `natural gas' government receives development surcharge as revenue. According to a `SNGPL' report almost 23-percent of the total sales revenue is paid as development surcharge (DS). Therefore, government revenue can increase if we increase DS on natural gas. We assume 10-percent, 15-percent and 20-

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[16] This assumption may not hold in the long run as the share of thermal power in total electricity supply is rising.

[17] This assumption is crucial in cases where cross price effects are significant.

[18] Electricity pricing is based on accounting approach, which takes into account all capital assets, depreciation and annual capacity related costs.

[19] The revenue generating potential of electricity may be affected by the rise in electricity theft in response to rise in electricity prices. However, due to non-availability of data it is difficult to quantify it.

[20] For gas producers price includes well-head price, rate of return on investment, but for consumers it also

percent increase in DS.[21]

Table-3 shows that lowest increase in surcharge revenue is equal to Rs.681.18 million, and the maximum increase is Rs.3509.95 million. This shows that if government wants to raise revenue by Rs.10-12 billion, the share of gas would be about 1/4 under the given assumptions. However, the number of gas consumers is increasing very rapidly, therefore, the potential for revenue generation from gas may be higher. However, the cost of gas from new well is also high which may have a dampening effect on gas demand and supply.

For the petroleum products, we analyze revenue generation from Kerosene oil (SK), Furnance oil (FO), motor spirit (MS), High speed diesel (HSD), and light diesel oil (LDO).[22]

***Table –3:*Revenue Generating Potential of Energy Sector (Rs.mln.)**

		A	B
Electricity (elasticity estimate are taken fromTable A.2)			
Increase in own Prices			
0	no change	9657.05	9657.05
i	10%	15056.14	16396.46
ii	15%	17737.86	19316.92
iii	20%	20405.69	22222.24
Natural Gas (elasticity estimates are taken from Table A3)			
a) increase in own prices			
0	no change	7174.561	7174.561
i	10%	7855.744	8201.319
ii	15%	8190.820	8551.135
iii	20%	8528.587	8903.760
a1: 10% increase in D.S			

includes taxes, transmission and distribution margin.

[21] Results for 15-percent increase in DS are not reported here.

[22] For petroleum products, price includes ex-refinery prices, rate of return on investment and various duties and taxes.

i.	10%	8641.318	9021.451
ii.	15%	9009.902	9406.249
iii.	20%	9381.446	9794.14

a2: 20% increase in DS

i	10%	9426.893	9841.583
ii.	15%	9828.985	10261.363
iii.	20%	10234.305	10684.513

Petroleum Products

a) Kerosene Oil [table-A4 (Kerosene oil eq. (1)]

a) increase in own price

0. no change	1282.34	1282.34
I . 10%	1375.00	1433.62
ii. 15%	1422.00	1482.62
iii. 20%	1467.83	1530.40

a1: 10% increase in D.S

I . 10%	1512.32	1576.79
Ii . 15%	1564.01	1630.69
iii. 20%	1614.42	1683.24

	A	B
a2: 20% increase in D.S.		
I . 10%	1650.24	1720.59
ii. 15%	1706.65	1779.41
iii. 20%	1761.65	1836.75

b. Furnance Oil [(table A4-Furnace oil eq.2)]

a) increase in own Prices

0. no change	4847.63	4847.63
i. 10 %	5000.71	5660.71
ii. 15%	5071.38	5740.72
iii. 20%	5143.74	5822.62

a1: 10% increase in D.S.

i. 10 %	5500.78	6226.79
ii. 15%	5578.52	6314.79
iii. 20%	5658.11	6404.88

a2: 20% increase in D.S.

i. 10%	6000.85	6792.86
ii. 15%	6085.66	6888.86
iii. 20%	6172.48	6987.14

c. Motor Spirit [(table A4 - Motor Spirit (eq.2)]

a) increase in prices

0. no change	10158.82	10158.82
i. 10%	11055.38	11665.29
ii. 15%	11499.26	12133.69
iii. 20%	11939.79	12598.00

a1: 10% increase in D.S.

i. 10%	12160.99	12831.90
ii. 15%	12649.26	13347.14
iii. 20%	13134.85	13858.43

a2: 20% increase in D.S.

i. 10%	13266.37	13998.26
ii. 15%	13799.02	14560.33
iii. 20%	14327.65	15118.10

	A	B

d). High Speed Diesel: [(table A4 -HSD (eq.2)]

a: increase in own prices

0. no change	7528.28	7528.28
i. 10%	8323.62	8924.03
ii. 15%	8722.36	9464.68
iii. 20%	9118.43	9776.17

a1: 10% increase in D.S.

i. 10%	9156.17	9816.64
ii. 15%	9594.79	10411.36

iii. 20%	10030.49	10754.01
a2: 20% increase in D.S.		
i. 10%	9618.82	10312.66
ii. 15%	10079.61	10937.44
iii. 20%	10537.32	11297.40
e) Light Diesel Oil (LDO) [(table-A4, LDO (eq.1)]		
a: increase in own prices		
0. no change	235.52	235.52
i. 10%	235.24	249.74
ii. 15%	235.20	250.55
iii. 20%	235.14	250.38
a1: 10% increase in D.S		
i. 10%	258.76	274.71
ii. 15%	258.82	275.60
iii. 20%	258.66	275.42
a2: 20% increase in D.S.		
i. 10%	282.29	299.69
ii. 15%	282.35	300.65
iii. 20%	282.17	300.46

Notes: equation numbers are based on the results reported in table A2, table A3 and table A4.
A: Option A assumes no change in GDP.
B: Option B: GDP-growth rate is 5%.
0: no change in prices.
i 10% increase in all prices.
ii 15% increase in all prices.
iii 20% increase in all prices.

Table-3 shows that maximum revenue can be generated from motor spirit, HSD, and furnace oil, where as the potential from LDO is, negligible. The contribution of each component depends on the share of DS in fixed sale price. The share of DS in price of motor spirit is about 49% of its fixed sale price. In case of LDO, this share is only 18 percent. The table shows that under the given assumptions minimum amount of revenue from surcharge on petroleum products could be Rs.1. 94 billion and maximum amount

could be Rs.11.5 billion. Another factor which can affect the revenue generation from this source is variation in import parity price (IPP) as lower sale price relative to IPP are compensated from revenue from development surcharge.

Therefore, based on the discussion in this section, we can say it may be difficult for the government to raise Rs. 10-12 billion revenue from energy sources like natural gas and petroleum products alone. However, if we include the net revenue generated from electricity then this target can be achieved. But another energy price increase may not be a desirable strategy as it will have strong implications for the inflationary pressures, on future economic growth of the country and on income distribution.

4. CONCLUSIONS

Main objective of the study is to analyze the determinants of energy demand and examine the revenue generating impact of changes in energy prices. Energy includes electricity, natural gas and petroleum products. The demand for each energy source is examined by user groups, i.e., households, commercial and industrial sector. In order to estimate the revenue generating potential we need information on own price elasticity, income elasticity and cross price elasticity of demand for energy.

The results show that, in most cases, income elasticity is positive and statistically significant. The own price elasticity is negative and statistically significant in most cases but the numerical magnitude of the price elasticity is low in most cases. This shows that

even large changes in prices have small impact on energy demand and consequently gross revenue may increase as price goes up. However, the potential to generate revenue may be limited as the increase in energy prices may not be desirable due to its impact on inflation, on income distribution, on external competitiveness, on environment, and on political and social conditions in the economy. The desirable aspect may be the employment expansion as a result of adoption of energy conservation strategy if energy becomes expensive (see Chisti and Mahmood (1991) and Kumar (1987)). For example, Chisti and Mahmood argue that energy and labor are substitute inputs in the production process. Thus, energy conservation, as result of rise in energy prices may have a favorable impact on employment. However, the energy conservation may not be feasible due to heavy investment costs and limited information regarding efficient technology.

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Table A-1: Trends in Energy Consumption in Pakistan

	1974-78	1980-81	1989-90	1993-94
A. Electricity (Unit=GWh)				
Domestic	1858	7647	11964	17739
Commercial	445	1106	1318	3011
Industrial	3482	8360	10532	11982
Agriculture	2125	5004	5742	7086
Total	9068	24121	32131	42715
B: Natural GAS (TOE)				
Domestic	415,079	1,407,276	1,929,582	2702418
Commercial	176,435	260,957	356,595	430635
Cement	610,393	186,966	238,379	203993
Fertilizer	1,325,703	2,111,497	2,715,033	2835079
Power	1,959,072	3,677,276	4,230,499	4206376
Industry	1,468,313	2,020,803	2,354,768	2582533
Total	5,954,995	9,665,007	11,825,862	12969418
C: Petroleum Products(Rs.mt) Sales (TOE))				
HOBC	12237	264439	143228	68445
SK	545357	1168556	627420	539109
HSD	1955806	4183718	5884283	6486643
LDO	193374	308630	325479	284271
FO	710150	3019131	4967544	6731208
MS	506333	877094	1103348	1267934
TOTAL	4405037	10230351	13492600	15846211

Source: Government of Pakistan, (1998), Pakistan Energy Yearbook, Ministry of Petroleum and Natural Resource, Islamabad, January.

Table –A2:Estimated Demand Equations for Electricity (GWH)-by Users

	DOMESTIC		COMMERCIAL	AGRICULTURE	INDUSTRY	AGGREGATE	
	(1)	(2)	(1)	(1)	(1)	(1)	(2)
Constant	-24.851 (3.14)	-19.727 (7.89)	-8.843 (3.18)	-17.151 (6.03)	31.34 (3.40)	-30.56 (1.39)	-13.11 (8.87)
GDP	0.199 (0.37)	0.270 (0.50)	0.445 (2.48)	1.942(b) (4.14)	1.24© (1.85)	1.31 (2.59)	1.64 (2.37)
Own Price	-0.526 (2.56)	-0.519 (3.12)	-0.06 (0.29)	-0.027 (0.22)	-0.095 (2.69)	-0.136 (2.21)	-0.16 (2.37)
Other Prices-Natural Gas	-0.042 (0.35)	-0.003 (0.001)	-	-	-0.068 (0.84)	-	-
-Petroleum Product	0.174(a) (2.84)	0.159(a) (2.74)	-	-	0.072(d) (0.69)	-	-
Number of Consumers	2.176 (8.06)	1.749 (4.45)	1.602 (1.93)	0.268 (0.48)	0.312 (3.62)	0.319 (2.19)	0.314 (2.23)
Fuel Adjustment surcharge	-0.071 (1.25)	-	-	-	-	-	-
Time trend	-	-	-	-	0.014 (3.63)	-0.09 (0.80)	-
R-Squ.	0.997	0.997	0.90	0.87	0.98	0.88	0.87
F	710.37	831`.27	321.0	140.43	321.93	169.08	131.18
Number of Observations	19	19	19	19	17	17	17

Note: rhe electricity demand includes demand for electricity generated by WAPDA and KESC

a = Price of petroleum mean price of kerosene oil.

b = Value-added in agriculture.

c = Value-added in manufacturing

d = Represents furnace oil consumption

GDP = Gross Domestic Product at constant factor cost (1980-81 = 100),
for industry and agriculture GDP represents value added in each sector, respectively.

P_i = (own) price of electricity by economic group.

P_j = price of other related products, e.g. gas and any petroleum product.

t-values are reported in parentheses.

Table-A3: Estimated Demand Equations for Natural Gas-by Users

	DOMESTIC	COMMERCIAL	INDUSTRY	CEMENT	FERTILIZER	POWER	AGGREGATE
Constant	25.57 (1.70)	241.41 (2.81)	3.486 (2.46)	-2.947 (0.07)	19.719 (2.06)	-44.916 (2.34)	0.553 (0.54)
GDP	0.011(a) (1.69)	1.388 (2.14)	0.138(b) (2.68)	0.793 (2.22)	-0.81© (1.13)	0.447 (2.79)	0.861 (9.30)
Own Price	-0.049 (1.69)	-0.067 (1.04)	-0.013 (0.24)	-0.96 (3.89)	-0.177 (1.95)	-0.272 (0.58)	-0.053 (1.91)
Other Prices-Petroleum Product	1.117 (3.81)	-	-0.154 (1.75)	0.083 (0.32)	0.105 (0.22)	0.0004 (1.84)	0.003 (4.16)
-Electricity	1.051 (1.14)	-	0.262 (1.83)	0.468 (2.99)	-	-	-
Number of Consumers	-	0.328 (6.12)	0.204 (2.57)	-	-	-	0.19 (7.72)
Time trend	0.067 (1.25)	0.11 (3.24)	-	0.025 (0.13)	0.048 (2.98)	-0.211 (2.23)	-
Lagged Dependent Var.	-	-	0.542 (3.65)	-	-	-	-
R-Squ.	0.815	0.88	0.891	0.90	0.80	0.78	0.80
F	843.49	182.05	244.67	38.63	12.26	33.17	88.16
Number of Observations	16	16	16	19	12	7	16

Notes: see notes in table 3 and table A2.

(a); GDP-per-capita, (b)-value added in manufacturing sector.

© Value added in agriculture sector.

Table- A4: Estimated Demand Equations for Different Petroleum Products

	KEROSENE OIL		FURNACE OIL		HIGH SPEED DIESEL		MOTOR SPIRIT		LIGHT DIESEL OIL	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Constant	-13.868 (5.73)	-6.245 (1.90)	-13.018 (8.88)	-14.34 (6.30)	-9.027 (8.31)	-10.274 (9.67)	-5.167 (2.63)	-5.775 (3.96)	-2.415 (1.28)	-12.934 (2.62)
GDP	0.901(a) (4.72)	1.253 (2.35)	1.455(b) (8.01)	2.53(b) (6.21)	1.313 (14.56)	1.393 (8.24)	0.864 (5.05)	1.074 (8.79)	1.256 (4.55)	2.045 (4.08)
Own Price	-0.082 (2.29)	-0.11 (0.85)	-0.592 (1.73)	-0.676 (2.25)	-0.16 (1.91)	-0.168 (1.51)	-0.277 (2.19)	-0.223 (1.74)	-1.005 (4.09)	-0.72 (2.84)
Other Prices-Electricity	-	-0.757 (1.97)	-0.205 (0.97)	-	-	-	-	-	-	-
-Petroleum Prod.	-	-	0.454© (1.96)	-	-	0.116(d) (0.56)	-	0.11© (1.40)	-	-
Lagged Dep. Variable	-	0.52 (2.48)	-	-	-	-	-	-	-	-
Number of Tractors	-	-	-	-	-	-	-	-	-	0.388 (2.27)
R-squ.	0.728	0.766	0.985	0.927	0.90	0.92	0.981	0.985	0.55	0.666
F	109.74	9.81	202.33	107.4	805.87	515.80	133.53	146.37	10.39	10.34
Number of Observations	19	16	16	19	19	19	19	19	19	19

Notes: see notes in table 3 and table A2.
(a): GDP-per capita. (b): value-added in Manufacturing sector. (c): price of high speed diesel oil.
(d): price of gasoline (motor spirit).

Abstract

Energy sector is considered an important source of revenue generation for the government. However, given the price elastic energy demand structure, the revenue generating potential of this sector may be limited. This study examines this issue by analyzing the demand for different sources of energy for domestic, commercial, industrial and other users. The results show that energy demand is, in general, price elastic. Similarly, the changes in income also affect energy demand significantly. This responsiveness of the energy demand to changes in prices (own and others) and to economic conditions in the country can affect the revenue generation from this sector. In Pakistan, given the existing economic conditions and the energy price structure, the actual revenue generation may be significantly lower then expected revenue. Furthermore, the rise in energy price may not be desirable due to its impact on inflation, income distribution, economic competitiveness, environment, and on other social conditions unless it leads to energy conservation in the country.