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# The Evaluation of Demand Function for Industrial Power Studied in Khuzestan

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## ABSTRACT

Energy plays an important role as consumption good to secure comfort and welfare for communities, it also acts asan input for production process in flourishing economy. Due to the importance of energy in economic equations, thehigh demand for it has long been considered by researchers and energy planners. If we assume economic activities as an index for welfare and consider sustainable growth as an objective, the concepts for energy demand for future discussions. Among the performed studies on energy demand, the power energy is one of the carriers which have been focused by researchers and most research has been conducted on domestic and industrial sectors compared with other sectors. Industrial consumption of electricity depends on industrial growth, the dimension of the industry sector, combinations and the amount of power consumption in variety of industries. We will deal with the demand for power in industrial sector in Khuzestan province through ECM Method.And finally the attractions for generation elasticity and estimate coefficients in methods ECM and OLS in both short-run and long-run will be offered.
**KEYWORDS:** Industrial Power Demand, Electricity Demand Function, Price Elasticity, ECM Method.

## 1-INTRODUCTION

Energy is considered one of the earliest needs in human life and its important role in the progress of nations is so noticeable that industrial development without employing a variety of energies is impossible. Making use of energy, which is considered to be among early needs for all economical activities, whether they are industrial, transportation, agricultural, services and social welfare for house holders, have long been parallel with the advancement of civilization and economic progress in each society and has always involved the consumption of energy. The important of energy issues, especially in the dimension of demand, has with studying quantative and qualities demands for energy based on variety of carriers of energy related to consuming groups. Studying quantitive demand of energy in different groups of consumers, such as household and industrial sectors has always been considered by researchers in such a way that by making a relationship between demand for energy (dependent variable) and economic and non–economic variables (descriptive variables) such as price, income and the like… has evaluated and assessed in the frame of a mathematical equation. Each from of energy is used to meet human goals in a special from. Electrical energy in different from plays an important part to mobilize economic activities, and nowadays, it can be considered as an index for economic growth as well as a criterion for welfare in economic development of countries. All of these advancements make the need for energy more evident.

Energy, like classic structures of production like land, capital, and work is one of the most fundamental factors in economic growth in every society and all members of society need it to improve standard of living, sustainable economic development and industrial activities involve making full use of variety of energies and changing them in different forms. If we consider national in came and the gross national product as an index for economic development, investigating the amount of national income of gross national product and consumption due to economic growth because of the close connection between consumption energy and economic growth in developed countries and developing countries, the increase in energy price will decrease the demand for energy in certain levels of economic activities.

Scarcity and high prices of energy will bring about important topics for future economic growth. Reactions to high priced of energy through economizing policies, change in technology and life style, especially industrial countries, will not only affect the standard of living in these countries, but it will also affect economic growth in these countries. Why the proportion of energy to products is different in different countries? Why is this proportion descending in certain countries while it is ascending in other countries, and fixed in others? The answer is that there exist considerable differences in life style in countries make for energy different; besides, attitudes and ways of life are not the same in different countries. No meaningful explanation can be offered for different consumption habits, and this is why we cannot anticipate charges in consumption through the charge of price for energy and gross national product in the sector of industry the demand for energy depends on the nature and method of product, especially different proportions of capital, labor force, and energy to react the charge in price all of these factors are utilized. The capability of work force substitution, capital and energy is a fixed factor in demand for energy industrial sector. In addition to these features for

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production the question is that, “Are demands for energy in industry and other factors appropriate to industrial production, or if the production growth are fixed, will there be any charge in the proportion of allocated expenses and will the substituted fuels be able to fix proportional prices?

## 2-MATERIALS AND METHODS

Among the variety of studies conducted on demand for energy, power energy is come of the carriers which has been focused by researchers, and the share of household and industrial sectors have been much more than other sectors. In the present research we will deal with the study of "Demand for electricity in industry sector in Khuzestan". Among the explanatory variables that are normally introduced in this case of Industrial Power Consumption, as well as company size, type of industrial sector and intensity of electricity in production for industrial electricity demand. All of researchers like Baker et al. (1989), Leth-Petersen (2002), Larsen and Nesbakken (2004),Filippini and Pachauri (2004), dealing with residential demand of electricity. For industrial electricity demand, the donations of Woodland (1993), Domsand Dunne (1995), Caloghirou et al. (1997),Christopoulos et al. (2000), and Bjørner et al. (2001), are remarkable. Labandeira, et al. (2009)tries to fill that void, estimating industrial electricity demand in a context of individual demand equations. Except some research, there is almost nothing about Iran industrial demand for electricity.

First, after studying the introduction and investigating literature related to power demand in industry in the world, based on the finding and data we will of suggest a suitable methodology as a model to interpret the results for Khuzestan.

### Methods

The demand for energy for production sectors is like a productive "input" based on the theory of "micro economy" taken from "production function". The production function from a special firm in a certain time is:

$$Q=F\ (K, L, M, E, S)$$

In which K, L, Mare representcapital, labor and non–energy factors and F and S are represent energy and other factors including charges in technology. An economic firm selects the maximum amount of profit by combining the required inputs with the minimum amount of cost for producing a certain amount of raw material by minimizing the cost function for production. Assume the demand for power as an input for production:

$$D_{EL}= D_{EL}\ (P_K, P_L, P_M\ P_{EL}, Q, S)$$

So the power demand in industry is a function of its price and the input price and production or added price and other factor (S). Assuming that an economical firm consumes power and other production factors, we assume that the production functions, the firm can be defined as follows:

$$Q=Q(H, EN)$$

Where EN defines the amount of consuming energy (EL) and other energies are (S) and (H) for production factor. Now assuming that the cost function of the firm is:

$$C=P_H H+P_S S+P_{EL} EL$$

The problem of optimization for the producer involves minimizing the cost function at a certain level of production, consequently by using "Lagrange function" we will get:

$$MinL = P_H H + P_S S + P_{EL} EL + \mu(\overline{Q} - Q(H, EN(EL, S))$$

Where $P_{EL}$ is the cost of power energy services, Ps is the price for substitute energy services; and $P_H$ is theprice of other inputs for production and $\mu$ is the function Lagrangian coefficient.For extension the model based on existing studies related to power demand, a modification model will be utilized.

Due to the fact that in long–run the real consumption and optimized model differ from each other, the modification model will be operated which has been altered into a logarithm form.

As it was mentioned, the long–run balance is obtained in this model based on "read quantities ($D_{EL}$) for proper power consumption ($D_{EL}$) and we will have:

$$\ln D_{EL.,t} - \ln D_{EL,t-1} = \lambda\left(\ln D_{EL,t-1} - \ln D_{EL,t-1}\right)$$

In this relationship $\lambda$ represents modification of velocity. After some modifications and solutions based on In $D_{EL,t}$ we will have:

$$\ln D_{EL,t} = \beta_\circ + \beta_1 \ln P_x + \beta_2 \ln P_s + \beta_3 \ln V_i + \beta_4 \ln D_{EL,t-1} + \beta_i \ln F_i$$

In this relationship $D_{EL}$ is the read demand for power, $P_x$ is the read price for power, $P_s$ is real price for substitute fuels, $V_i$ is additional value in industry and $D_{EL,t-1}$ is power consumption in each sector in previous period and $F_i$for other effective variables for power consumption.

**The Introduction of variables**

As in was explained in previous descriptive section on statistical inputs a fem of variables are under consideration, however, some of these variables have got some substitutes and a few others are used in a different way. All of these variables will be studied in logarithm forms.

***Table 1: the introduction of variables used in estimation of models***

| Variable Definition | Abbreviation |
|---|---|
| Industrial Power Consumption | CIND |
| Real IndustrialCapital | KRIND |
| Real Industrial Investment | IRIND |
| Industrial Labor | LIND |
| Industrial Clients | NIND |
| Real Industrial Revenue | YRIND |
| Real Industrial Add Value | VARIND |
| Real Industrial PowerPrice(PIND/CPI) | PRIND |
| Real add value per capita (VARIND/NIND) | PVARIND |
| Price Indices | CPI |
| Log(CIND) | LNCIND |
| Log(KRIND) | LNKRIND |
| Log(IRIND) | LNIRIND |
| Log(PRIND) | LNPRIND |
| Log(PVARIND) | LNPVARIND |

## 3-RESULTS

Estimation on demand for industrial power by making use of the annual inputs for the periods of 1975-2005 through the ordinary last squares (OLS) has already been performed. Different standards as model variables and combination of these variables considering economic literature made it possible to obtain many implications about demands for industrial power in Khuzestan province.

As we noticed in unit root test, all variables used in the constant models would "I(0)" consequently the best method for estimation of the equations is the same as OLS, which made it possible to perform estimation and consequently five linear models and eight logarithm models were obtained.The variables coefficients in different estimations were not likeliterature, but in all selected models the results of which have been reported the statistics implies the meaningfulness of the estimated parameters at the level of 95 percent.Through the estimation of the models it become evident that logarithm models are more suitable than linear models for this purpose and this notion has already been recognized in economic literature of Iran and the word as well as in methodology.

At this stage we will select a few acceptable models in order to use them for the estimation of short – run elasticity's through the use of the two methods, OLS and ECM.Convergence in sign of coefficients will be used to select there models considering economic literature and meaning full coefficients $R^2$ and D.W and a few of other tests. For the two variables which possess structural refraction the Proontest has been used.

Related to the variables without structural refraction or encountered with failure the "Proon Test" has not been performed.

***Table 2: The conclusions liner models on industrial power demands***

| **dependedvariable** | **CIND** | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| *PRIND*[*] | -9293 | -1565 | -2558 | -1240 | |
| *VARIND* | | | 0.86[**] | | 0.001 |
| *PVARIND* | | 1520 | | 1816 | 1516 |
| *IRIND* | 83 | 1.5 | | | |
| *CIND(-2)* | 0.61 | | | | |
| *(C)* | -141 | 168 | 191 | 176 | 154 |
| $R^2$ | 0.94 | 0.81 | 0.83 | 0.81 | 0.80 |
| *D.W* | 1.86 | 1.35 | 1.27 | 1.35 | 1.36 |

*-Independent variables as substitutes are used in models, this problem applies in capital and investment and also percapita added value and this procedure continues to the extent that making use of these variables seems to be permitable based on the literature of the issue to achieve on ideal model.

**- t for all variables in models ismeaningful at the level of 95%.

***Table 3: The conclusions logarithm models on industrial power demands***

| **dependedvariable** | **LNCIND**[**] | | | | |
|---|---|---|---|---|---|
| | Model 1 | Model 2 | Model 3 | Model 4 | Model 5 |
| *LNPRIND*[*] | 0.17 | 0.13 | -0.42 | -0.42 | -0.25 |
| *LNVARIND* | 0.33 | | | | |
| *LNPVARIND* | | | 0.67 | 0.61 | 0.44 |
| *LNKRIND* | | | 0.51 | 0.51 | 0.35 |
| *LNIRIND* | | -0.44 | | | |
| *LNYRIND* | | 0.43 | | | |
| (C) | 9.8 | 7.53 | 4.55 | 5 | 7.79 |
| $R^2$ | 0.85 | 0.90 | 0.94 | 0.89 | 0.91 |
| *D.W* | 2 | 1.66 | 1.86 | 1.94 | 1.75 |

*- t for all variables in models is meaningful at the level of 95%.

**-Only in case of LNCIND variable the Proon test is meaningful, most of variables lack the unit root and absolute value of calculating quantities of ADF more than critical quantities.

## 4- DISCUSSION

The logarithm models and non–logarithm models for estimated conclusions on demands for industrial power in Khuzestan were already offered. Most of them have made use of the price of industrial power and added value (as an income source) and investment as an effective factor for this demand. The statistic t for all variables in all equations was meaningful at the level of 95 percent.Approximately in all variables the level was meaning full out the value of 95%, except in a few cases the coefficients for variables followed economic literature. We will deed with the selection of suitable models through making use of criteria such as $R^2$ and D.W., and classic tests, then we will get on the use of short–run model through ECM method in such a way that we will achieve both a long–run model and a short–run model for calculation of price elasticity and income related to the demand for industrial power in Khuzestan province.

The results of criteria calculationshowed on estimation for selected model.Except D.W obtained from the tests mentioned above have the distribution of Chi square with smaller quantities which represents suitability of models proportionally. Certainly, among these tests, the test "LM" follows variables with stoppage in model and test of "white" following independent variables in the model along with an increase in variables through the advancement of degree of freedom in Chi-square distribution, acceptable limit is being developed.

It has been estimated non–logarithm models that two or three statistics of the "white test" are much more than critical quantities in Chi-square distribution and two or five statistics in "Jarque–Bera" test much more than this quantity and three quantities of "LM" test seem to be weak.

In models 3 and 5 the D.W encountered some difficulty.

The above–mentioned cases show that none of the above models cannot be considered an ideal model to calculate elasticity, because each and rejects classical assumptions in econometrics, more over in most of economic literature it has been mentioned that achieved models are of logarithm form and non – logarithm forms are rarely seen. Among logarithm models except in models $1^{th}$ and $8^{th}$ show that the statistics of "Jarque–Bera" are at high level, but in the rest of models the critical value of Chi-square distribution are at a lower level.

All logarithm models except 1 and 5 have been used to estimate a short–run model called, ECM, however, except model 4 which possesses dependent variables with stops and meaningful quality seems to be the most common model and it has also used descriptive variables to extract price elasticity and income in long–run. Model ECM based on the $4^{th}$ model for extraction of

price elasticity and income in short–run has also been utilized. The model is as follows:

$$Ln\ CIND = 5 - 0.42\ LnPRIND + 0.61LnPVARIND + 0.5057Ln\ KKIND$$

Based on this short–run model through ECM method we obtain:

$$DLn\ CIND = 0 - 0.074 - 0.2\ Ln\ PRIND\ (-1) + 0.3DLn\ VARIND(-1) + 0.03\ DLn\ IRIND(-1) - 0.4\ ECM$$

The best model of ECM has been achieved by long–run model which was a short–run model based on the 5th model of logarithm.A short–run model has been obtained through OLS method from the 3th logarithm which its long–run and short–run model is as follows; the long–run model through OLS method:

$$Ln\ CIND = 4.55 + 0.51\ Ln\ KIND - 0.42\ Ln\ PVARIND + 0.68\ Ln\ PVARIND$$

The short–run model by OLS method:

$$DLnCIND = 0.06 - 0.12\ DLn\ PRIND\ (-1) + 0.13\ DLn\ IRND\ (-1) + Ln\ PVARIND$$

The short–run models which have been achieved are selected from variety of models like long–run models; however, such a relationship was not obtained. Additional information about selected models is as follows:

***Table 4: long-run and short-run tests through OLS and ECM method:***

| **Tests** | OLS | | ECM | |
|---|---|---|---|---|
| | Long-Run | Short-Run | Long-Run | Short-Run |
| $R^2$ | 0.92 | 0.84 | 0.98 | 0.80 |
| D.W | 1.85 | 2 | 1.94 | 1.59 |
| Normality-t | 0.57 | 3.1 | 0.38 | 2.7 |
| LM-t | 0.68 | 3.1 | 0.014 | 1.4 |
| Arch-t | 0.58 | 0.14 | 0.61 | 4.2 |
| White-t | 9 | 8.7 | 6.1 | 6.2 |

The estimation of models for demands of power in Khuzestan industry has given acceptable result related to price elasticity, in come both in long–run and short–run through OLS and ECM methods offered in the below table.

***Table 5: Elasticity in prices and income on demand for power in Khuzestan industry***

| **Equations** | **Price Elasticity** | | **Income Elasticity** | |
|---|---|---|---|---|
| | **OLS** | **ECM** | **OLS** | **ECM** |
| Short-Run | -0.11 | -0.18 | 0.19 | 0.37 |
| Long-Run | -0.40 | -0.41 | 0.71 | 0.6 |

Based on the existing literature, elasticity for power demand to price is negative and in case an increase in price, the demand for electricity will decrease, which means that with a charge of about one per cent in price will be of about two per cent and in long–run it will be of about 4% in the demand for electricity (ECM method).

Besides, the elasticity in power demand is positive to the amount of income and in case of increase in income, the demand for electricity will increase, which means that with one per cent charge in came in average in short–run will be 3% and in long–run in will by 6% in power demand (ECM method). In OLS method, the elasticity for prices and in comes has already been calculated and reported. In a general summing up it can be claimed that the "absolute value" for long–run elasticity will be much more than those in the short–run.

## 5-Conclusions

In this research after an introduction can the economy of energy, the related literature about demand for industrial power in Iran and other countries were investigated them the methodology and theoretical principles of power demand was discussed. The estimation of function for power demand in Khuzestan industry was analyzed by making use of the time–series for 1975-2005 period through OLS and ECM, the elasticity of prices and income in both long–run and short–run were obtained. To study the stationary and non–stationary effect the time–series the generalized test method of ADF and Proon were employed. Most of the

variables were stationary and evaluation of dependent variable was also proved through the use of Proon method.In most of the models studied in Iran and the word the functions of demand have been originated from economic theory and in all of them the demand for power is recognized as a function of power prices and income. In most of these researches the elasticity of power price is a small figure (number) and it has been performed through the use of single equations.

In this research the estimate of models have been perform on the base literature of power demand using linear and logarithm models. The results obtained are concurrent with most of studies in this field and the logarithm models seemed to be more logical them than linear models.Elasticity of prices and incomes were obtained at a lower level based on single equations. The power energy to the prices and incomes in Khuzestan industries were without any elasticity which shows that power energy is a vital good for industries and the industrial organizations in Khuzestan show reaction to reduction or increase of the price.Moreover, power energy in these firms to the amount of income lacks any elasticity and attraction (certainly the proportion of price elasticity to income elasticity seems to be much more) and the situation might be due to the difficulties of statistic methods and the supportive role of government to the firms and structures of industries. The results of studied functions showed that the demand for industrial power is a function of the price of substitute fuels seem to be realistic, because physical possibilities and substitute technology of energies in our country as well as in Khuzestan is limited and seems to be in an impossible conditions.

The industry sector, especially in short–run period does not show any sensitivity to price fluctuations, because the charge of energy equipment to fit the immediate changes is impossible, it signifies the fact that if the price of furnace oil gets cheap in industry sector, the possibility of substitution of consumerequipment for fuel and electrical equipment is limited or impossible and it can be claimed that it is not economical.Due to these reasons, that is to say, lack of interest in industry sector in the process of sub situation of energies during the time of price fluctuation we can assume the demand for power in industry without any effect (neutral), compared with prices of other carriers.The demand of any society depends on an increase in the consumption of energy the demand of each of the above–mentioned sectors is a function of many independent variables which we dealt with them in this research related to the demand for energy in industry based on production and the price of energy.

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## REFERENCES

1. Arsenalt,E. Bernard, J. and Laplante, G.(1997).A Total Energy Demand of Quebec: Forecasting Properties,Energyconomics, vol.17,PP. 163-171.
2. Baker P, Blundell R, Micklewright, J. Modelling household energy expenditures using micro-data. Economic Journal 1989; 99; 720-738.
3. Bjørner T B, Togeby M, Jensen H H. Industrial companies’ demand for electricity: evidence from a micropanel. Energy Economics 2001; 23; 595-617.
4. Bentzen, J and Engstand, T. (1993). Short-and long-run lasticities in Energy Demand, Acointergration Approach, Energy Econimic, Jan, PP.9-16.
5. Bose,R.K and M.Shukla.(1999).Elasticity of Electricity Demand in India,Energy policy.Vol.22.
6. Caloghirou,Y.D and A.G moureslatos, and H.Thompson.(1997). Industrial Energy substitution During the 1980s in the Greek Economy,Energy Economics,Vol.19,No.4,PP.476-491.
7. Chang,H.S and yoHsing.(1991). The Demand for Residental Electricity: New Evidence on Time VaringElastisitie,Applied Economics.Vol.23.
8. Christopoulos,Dimitris.K.(2000).The Demand for Energy in Greek Manufacturing. Energy Economics.Vol.22.PP.569-589.
9. Eltong,M.N and Mohammad Hajeeh.(1998).the Sectoral Demand for Electricity in Kuwait.Opec Review.
10. Doms, M. E, Dunne T. (1995). Energy intensity, electricity consumption and advanced manufacturing-technology usage. Technological Forecasting and Social Change; 49; 297-310.

11. Filippini M, Pachauri S. Elasticities of electricity demand in urban Indian households. Energy Policy 2004;32; 429-436.
12. Labandeira, X. et. al (2009). Estimation of Elasticity Price of Electricity with Incomplete Information.
13. Labandeira X, Labeaga J M, Rodríguez, M. A residential energy demand system for Spain. Energy Journal 2006; 27; 87-112.
14. Larsen B M, Nesbakken R. Household electricity end-use consumption: results from econometric and engineering models. Energy Economics 2004; 26; 176-200.
15. Leth-Petersen S. Microeconometricmodelling of household energy use: testing for dependence between demand for electricity and natural gas. Energy Journal 2002; 23; 57-84.
16. Silk,J.I and F,Jouts.(1997).Short- and long-run Elasticities in U.S. Residential Electricity Demand,Energy Economics,Vol.19,PP.493-513.
17. Yi,Feng.(2000).Dynamic Energy Demand models: a Comparison,Energy Economics,Vol.22.PP.285-297.