THE ENERGY EFFICIENCY OF FIRMS IN ELECTRONICS INDUSTRY IN SLOVENIA: DO THEY PERFORM BETTER THAN AVERAGE MANUFACTURING FIRMS?

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Key words: Energy efficiency, electronic companies, Slovenian companies

Abstract: The article analyses the energy efficiency of Slovenian firms from the demand for energy perspective. Special emphasis is put on analyzing firms in electronics industry that manufacture electronics and small electrical devices, in comparison with other firms in manufacturing. The sample consists of 100 firms operating in different industries in the period of 2005-2007. The results show that Slovenian manufacturing firms are becoming more energy efficient indicating that possible energy efficient investment and innovations were made in the period under study. Moreover, firms operating in electronics industry exhibit above average energy efficiency in terms of energy per output and price elasticity of energy demand. Increasing energy-efficiency of consumption should become a goal of both firms and households. Firms need to restructure and invest in energy-efficient technologies, while households need to build energy-efficient houses and use energy-efficient house appliances. In the absence of a level playing field (e.g., global emissions trading or border adjustment taxes) we propose that regulatory and supportive policy instruments should be used much more extensively and actively than today.

Energijska učinkovitost podjetji v elektronski industriji v Sloveniji: Ali so ta podjetja boljša od povprečja v predelovalni industriji?

Kjučne besede: energijska učinkovitost, elektronika, slovenska podjetja

Izvleček: Članek analizira energijsko učinkovitost slovenskih podjetij z vidika povpraševanja po energiji. Poseben poudarek je na analizi podjetij, ki proizvajajo elektroniko in manjše električne naprave ter njihovi primerjavi s podjetji v predelovalni industriji. Vzorec sestavlja 100 podjetij, ki delujejo v različnih panogah predelovalne industrije v obdobju od leta 2005 do 2007. Rezultati prikazujejo, da postajajo slovenska podjetja energijsko bolj učinkovita, kar nakazuje, da so v preteklosti izvedla energetsko učinkovite investicije in inovacije. Podjetja, ki proizvajajo elektroniko izkazujejo nadpovprečno energetsko učinkovitost, če jo merimo v količini energije, porabljene na enoto proizvoda in cenovne elastičnosti povpraševanja po energiji. Povečevanje učinkovite rabe energije mora postati cilj tako podjetij kot gospodinjstev. Podjetja se morajo prestrukturirati in investirati v energetsko učinkovite tehnologije, medtem ko se morajo gospodinjstva v večji meri odločati za gradnjo energetsko učinkovitih hiš in uporabo učinkovitih gospodinjskih aparatov. V odsotnosti ukrepov ekonomske politike (kot na primer globalni sistem trgovanja z emisijami ali davčne izravnave med državami) predlagamo, da se uporabijo regulatorni in pomožni ukrepi za stimuliranje energetsko učinkovitega obnašanja.

1 Introduction

There is now a widespread consensus that man-made climate change is occurring, that it will continue into a foreseeable future, and that the climate change is a global externality /1/. The main GHGs emitted by human activity are carbon dioxide, (CO_2) contributing about 77% of total GHG emissions, followed by methane and nitrous oxide, each contributing about 14% and 8% respectively. A substantial part of GHG arises largely from the energy sector which, given its factors of internal dynamics, represents a special challenge. Due to a soaring demand, energy prices have continued to increase sharply. Moreover, given the continuous political instability and political interference in energy supply, energy markets have become more volatile. In order to avoid future energy crisis, the exposure to external factors must be decreased and the right incentives to consume less energy, to start consuming a renewable energy, and to improve energy efficiency should be developed.

In the past few years, the economic analysis of sustainable development gained new impetus by the merger of environmental economics and new (endogenous) growth theory, focusing on the issue of conditions under which sustainable growth within an endogenous growth model with environmental concern is feasible. Early economic growth models incorporating technical change as an exogenous factor /17/ attempt to explain the role of technical change for sustainable growth by "manna from heaven". A commonly found argument in standard growth theory literature is that technical change and factor substitution can effectively de-couple economic growth from the demand for resources and environmental services /6/. Energy efficiency, as part of the technical progress in neoclassical growth theory, is conventionally seen as a driver of economic growth. Depletion of finite energy and other resources and environmental degradation is not seen as a significant barrier to economic growth, since there will always be more abundant substitutes (either natural resources or human-made capital). In the 1990s, endogenous growth theorists have started to formally include concerns about environmental and resource factors limiting growth in standard growth models /2, 16/. Doing so, endogenous growth theory enables new insights about the relationships between resource scarcity, technical change, and economic growth, and hence constitutes a great leap forward compared to standard neoclassical growth theory. A further development of endogenous growth models to also account for rebound effects renders hope that in the future the relationship between economic growth, technical change and resource use (and eventually the size of various rebound effects on the macroeconomic level) can be better modeled and understood

Within the position of climate change paradigm in economic science the most important topic is to analyze environmental behavior, related to energy consumption at the macroeconomic and microeconomic levels. Industry accounts for about one-third of the energy used in Slovenia and is a major emitter of greenhouse gasses. Energy wastefulness in production is part of the socialist legacy of Central and Eastern European countries. In 1989, the energy consumption per unit of product in the Eastern bloc was four times greater than the average in the EU-15, whereas in 2000 it was twice as much. With 1.5 times as much energy per unit of output, Slovenia was the closest to the EU-15 average, while the worst was Lithuania which in 2000 still spent about five times as much energy per unit of output than the EU-15 average /9/. Data for 2006 show that Slovenia is still lagging behind the EU since it uses about 1.5 times more energy per unit of output than the EU. The question of energy efficiency is strongly associated with restructuring. Companies that achieved greater energy efficiency in the past are likely to invest more in capital goods that enable energy savings.

The literature shows many different barriers to energy efficiency such as inadequate pricing and lack of information. Internalising the environmental costs of energy would seem an evident solution to the first problem but it may be difficult to implement in a single country. In small open economy as the Slovene one, the basic industry is export oriented and sensitive to changes in its relative prices. In past years the introduction of emission trading system has contributed to significant energy price increase that spurred a new interest for energy efficiency in industry.

In the paper we summarize the energy efficiency of firms in Slovenian firms with special emphasis on electronics industry. The overall objective is to take stock of the current situation and discuss implications for future policy measures. Significant increase of energy prices since year 2000 considerably increased interest in energy efficiency and associated fields. The purpose of the article is to analyse energy consumption patterns in Slovenian companies and notably to establish whether their energy intensity is falling, especially among the largest users, with special emphasis on firms in electronics industry.

The paper contributes to the existing literature in at least three significant ways. First, the understanding about necessity of fulfilling environmental demands and efficient energy use is not yet developed in former socialist and communist economies. Therefore, the paper presents empirical microeconomic evidence on energy efficiency in the most developed former socialist economy, Slovenia. Second. From the microeconomic perspective it is urgent to scan the current situation and identify the factors that determine the energy demand at the firm level with respect to the profit maximizing behavior and imposed regulations. In this context we introduce dynamic components into the modeling of energy consumption because the effects of explicative factors are not totally instantaneous and lagged effects continue to act over more periods of time. Energy demand is derived demand on one hand since the needs expressed for the various energy sources result from the operation of a plant, and conditional demand on the other, a function of equipment stock. If we model the production decision at the firm level as profit maximizing behavior with respect to several factors of production including non-renewable factor - energy, we are able to identify energy demand and potential significance of particular factors that affect it. By our knowledge energy demand has not been studied in this context so far. Third, with special emphasis on electronics industry the paper brings new evidence and comparison of electronics with other manufacturing sectors within economy.

In the first part of the paper energy consumption data for Slovenia are presented, followed by a presentation of a model of energy efficiency. Third part introduces a theoretical and empirical framework, while in the fourth part the results are presented. Based on the findings, at the end some guidelines for the formulation of economic policy are suggested.

2 Energy efficiency in Slovenia

The efficiency of energy consumption at the level of a whole economy is monitored by the indicator of energy intensity calculated as the ratio between the amount of energy (expressed in kilograms of oil equivalent - kgoe) and gross domestic product expressed in constant prices of 1995. The indicator measures both energy consumption as well as overall efficiency.[1] Energy intensity (GJ per unit of GDP) and unit consumption ratio (GJ/t of product, GJ/Sq.m) in new EU member states are, despite clear progress during the last decade, still much higher than the average in Western Europe. For instance, energy intensity in the Czech Republic is 1.6 times higher. The comparison of energy efficiency in Slovenia and the EU shows that, despite this improvement, Slovenia still very much lags behind EU member states. Based on energy intensity data for the 1995 to 2006 period for the EU and Slovenia, it may be

1 Total energy spent is calculated as the sum of the following energy sources: coal, electricity, oil, natural gas and renewable energy sources. Sources are calculated as the equivalent of oil consumed.

concluded that the average energy consumption in both the Eurozone and the EU-27 is becoming increasingly efficient. According to Eurostat, in 2003 the European Union used energy more efficiently than the United States of America and less efficiently than Japan: an indicator of energy intensity for Japan amounted to 119 million kgoe/1000, in the EU-25 it amounted to 209 million kgoe/1000 and 313 kgoe/1000 million in the United States. With 128 kgoe/1000, Denmark had the lowest energy intensity in the European Union followed by Austria (151) and Germany (160). The least effective in its energy use were Estonia with 1208 kgoe/1000 million, Lithuania (1204) and Slovakia (937). In 2003 Slovenia spent 338 kgoe energy for EUR 1000 of generated GDP, which exceeds the average of both the EU-25 as well as the United States.In Slovenia, since 1995 energy intensity has on average decreased, with the exception of 1996 and 2001 when it rose slightly. In 2001 it amounted to 350 million kgoe/1000, and in 2003 to 338 kgoe/1000 million. In 2006 and 2007 the energy intensity again dropped significantly at both the primary level and with regard to final consumption[2]. Part of the decrease can be attributed to the growth of GDP, but another part can be attributed to the overall decrease in final energy consumption. In 2007 the share of electricity from renewable energy sources in total electricity generation amounted to 23 percent[3]. Based on statistical data it can be assumed that Slovenian energy consumers are becoming more energy efficient. The estimates of the economic potential for energy saving in Central Europe are estimated to exceed 20% of the total current final consumption. In South East Europe and CIS, this potential is even higher, in the range of 30-50%.

In year 2007 final energy consumption in Slovenia grew by five percent. The largest share is attributed to electricity (41 percent) followed by natural gas (36 percent), oil products (5 percent), renewable resources (5 percent), heat [4] (4 percent) and others as reported in figure 1.

The final consumption of energy is biggest in transport (29 percent), followed by manufacturing and construction (28 percent) and households that use a quarter of all energy consumed in Slovenia /15/. Comparing energy consumption by industry sectors we figure out that 93% of all consumption in 2006 and 95% in 2007 are in manufacturing.

When comparing the energy consumption by different manufacturing sectors we can see that manufacturing of basic metals and fabricated products accounts to 27 percent of all manufacturing consumption in 2007, manufacturing of other non-metal and mineral products 17 percent and manufacturing of textile and textile products to almost 15 percent. Manufacturing of electronics and electrical devices contributed less than 3 percent of all energy consumption in total manufacturing in 2007.

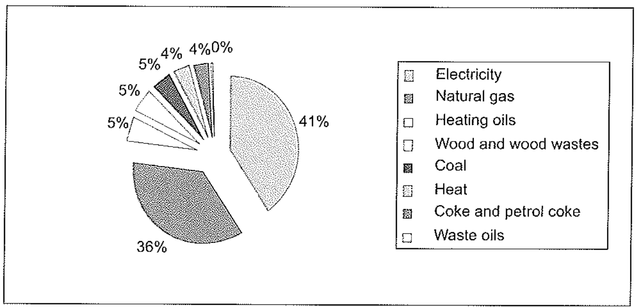

Fig. 1: Energy consumption of fuels, electricity and heat in manufacturing sector in Slovenia, 2007 Source: SI-STAT database, Statistical Office of Slovenia.

The energy consumptions by all manufacturing as well as electronics industry show upward trends in the period of 2003 - 2007 as reported by figure 2. However, when interpreting figure 2 we have to be careful as energy consumption is correlated with production. Therefore, the energy increase captures two effects: increase in total production in the industry and potential energy inefficiencies in production-

The prices of all sources of energy have shown sharp increase especially after year 2000. The prices of natural gas increased by almost 100 percent in the period of 2000-2007 for the smallest industry users while increased by 244 percent for the biggest ones. The prices of electrical energy increased from 0,145 EUR/kWh in 2000 to 0,195 in 2009 for the small consumers and from 0,050 to 0,094 EUR/kWh for the biggest ones.

A comparison of energy prices in Slovenia with those in other EU member states shows that the price of electricity for households in Slovenia is 25 percent lower than the average price in the European Union. In the Czech Republic, Malta, Poland, Estonia, Greece, Latvia and Lithuania the prices of electricity for households are below the Slovenian ones. The highest price is found in Denmark. In Slovenia the price of natural gas for households that use gas for heating is about the same as the average price in

2 In 2006 we reported a decrease in energy intensity (by 5 percent for the primary level and 4 percent for the final level). This trend was also present in 2007 when energy intensity on the primary level again dropped by 5 percent and by 7 percent for final level of consumption (Source: Statistical Office of Slovenia).

3 The biggest share of energy was produced by hydroelectric power stations - producers by main activity (89 percent), followed by small hydroelectric power plants (5 percent) and hydroelectric power plant self-producers. (2 percent), while the remaining electrical energy from renewable resources was produced from wood, wooden waste and bone meal (2 percent) and photovoltaic, deposited gas, gas from treatment plants, other biogas and formalin gas (2 percent).

4 Heated sanitary water meant for remote heating purposes.

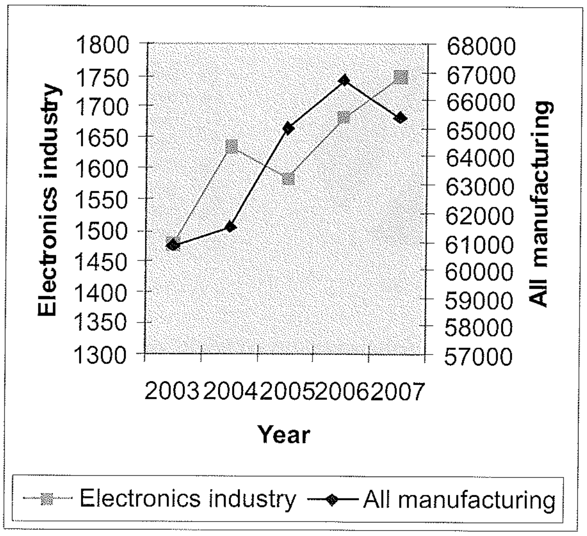

Fig. 2: Energy consumption by manufacturing and electronics in Slovenia in 2007 (measured in TJ) Source: SI-STAT database, Statistical Office of Slovenia.

the European Union. In the European Union the maximum price of natural gas for households has been recorded in Denmark and Sweden and the lowest in Estonia and Latvia /15/.

3 Model of energy efficiency

A model of energy efficiency can be derived from neoclassical factor demand. It is similar to the models used in the empirical studies by /20/, /3/ and /4/ to study the investment behaviour of firms. Based on similar models, also / 8/ studied the factor demand of Slovenian companies in the 1996-2000 period.

Neoclassical factor demand is based on the assumption that a company in any period of time maximises the value of shareholders' assets[5]. The company operates in competitive markets and demands three types of production factors: capital ($K = (K_1, K_2, \ldots, K_E, K_N)$), which offers productive services in several periods of time, work ($L = (L_1, L_2, \ldots L_R)$) that is according to economic theory a variable production factor, as well as production factors purchased and entirely spent in the current manufacturing process ($M = (M_1, M_2, \ldots M_S)$). In the context of capital goods, more energy-efficient capital goods (K_E) are an important part because after the investment period they allow lower energy intensity and consequently significant cost savings. Therefore, the enterprise encounters the problem of the maximisation of shareholders' value, which can be illustrated as follows:

$$V_t(s_{t-1}) = \max_{K,L,I,M}\{\Pi_t(s_t, M_t, I_t, H_t) + \beta_{t+1}E_t[\,V_{t+1}(s_t)\,]\} \quad (1),$$

with V_t being the maximised value of the company at time t Π_t (.) is a profit function in time t, $s_t = (L_t, K_t)'$ is a vector of labour stock and capital at the end of time period t. H_t measures the gross employment rate of workers and I_t the permanent investment in the capital stock, while investment in energy-efficient capital goods are an important part. E_t indicates the expected value, $\beta_{t+1} = 1/(1+\theta_{t+1})$ the discount factor, where θ_{t+1} is the nominal required rate of return between t and t + 1. The company in each period t invests in various types of capital goods I, even in energy-efficient ones. The amount of capital operating in the company at any time can be defined as the sum of capital goods in the past period and the current investment period (I_t).

The profit function can be expressed as:

$$\Pi_t(K_t, L_t, M_t, I_t, H_t) = p_t{*}Y_t(K_t, L_t, M_t) - p^I_t I_t - w_t L_t - p^M_t M_t\,, \quad (2)$$

where $Y_t(K_t, L_t, M_t)$ represents a company's total product, p_t the price of the company's product, $p^I_t = (p^1_t, \ldots, p^N_t)$ is the price vector for each type of capital good, $w_t = (w^1_t, \ldots, w^R_t)$ is the wages vector for each type of work, $p^M_t = (p^{M,1}_t, \ldots, p^{M,S}_t)$ is the factors vector of material production prices.

Based on a static model of the factor demand the reduced demand for labour and capital goods can be derived. Assuming the CES form of production function and a constant coefficient of demand elasticity for the finished product (η^D), and if the company has no impact on establishment of the final price, then the optimal amount of capital is:

$$K_t = \alpha^\sigma_K Y_t\left(\frac{p^I_t}{p_t(1-\frac{1}{\eta_D})}\right)^{-\sigma} \quad (3)$$

The optimal amount of capital may represent a long-term equilibrium level of the employment of capital. Using logs, we can rewrite (3) as follows:

$$k_t = \mu_K + y_t - \sigma(p_I - p)_t\,, \quad (3a)$$

where k_t denotes the logarithm of the volume of capital goods, y_t is the logarithm of the total product, $(p_I-p)_t$ is the costs of the capital production factor in the production process, and μ_K is constant.

The energy-efficient type of capital is one of the types of capital in which the company invests. Therefore, equation (3a) provides the framework for an empirical model that we now examine.

4 Sample description and empirical model

The population of companies targeted in this research was made up of all companies registered in Slovenia, operat-

5 It is assumed that shareholders are risk-neutral, companies do not issue debt security and do not pay taxes.

ing in the manufacturing industry and which had more than 50 employees in 2007. According to AJPES' data there were 434 such enterprises. The data were collected through a questionnaire which was distributed via ordinary mail and e-mail from July to September 2008. The questionnaires were addressed to presidents of companies or executive directors[6]. The data gathered were supplemented with financial information from the balance sheets and income statements of companies (AJPES database).

On average, companies in the sample[7] had 251 employees at the end of 2005. Two years later, the number of employees had on average risen to 265. The average total revenues in 2005 were EUR 24.8 million and EUR 35.4 million two years later. The volume of total assets in 2005 amounted to an average of EUR 8.78 million and EUR 10.6 million two years later. Firms in electronics industry included in the sample were, on average, bigger than the average sampled firms. They reported 345 employees in 2005 and 353 in 2007. The average total revenues in 2005 were EUR 37.3 million and EUR 47.2 million two years later. The labour productivity in the electronics industry in the period of 2005-2007 was at 98 percent of average value.

Companies in the sample spent an average of 8.5 million kilowatt-hours of electricity in 2005 (0.5 kilowatt-hour for EUR 1 of revenue), 1.16 million cubic meters of gas and 46,000 tonnes of fossil fuels, where only 24 companies used gas and 60 companies fossil fuels. The consumption of electricity increased and was 10 million kilowatt-hours in 2007, while gas consumption dropped to 1.12 million tonnes, along with the consumption of fossil fuels to 43,000 tonnes. The observed trend is positive in terms of cost efficiency (electricity is the cheapest energy). Greater efficiency can also be detected in the consumption of electricity for every euro created. On average in 2005, firms spent 0.5 of a kilowatt-hour of electricity per EUR 1 of revenue, in 2006 0.42 kilowatt-hour and in 2007 only 0.37 kilowatt-hour, representing a 26-percent reduction over 2005. A company can primarily achieve such savings by investing in new energy-efficient technology and to a smaller extent by raising the prices of its finished products[8].

The real costs of energy used by an average company in 2005 amounted to EUR 651,000 and EUR 876,000 two years later. When comparing the cost of energy to generated revenues, we see that the share fell slightly from EUR 0.028 (cost of energy) per generated EUR 1 of revenue in 2005 to 0.026 in 2007 (Table 1).

An analysis of the average consumption of electricity per EUR 1 of revenue by industry reveals that this share declined on average in all sectors, with the most obvious reduction seen in the chemical and rubber industry (from 0.48 kilowatt-hour per EUR 1 of revenue in 2005 to 0.34 kilowatt-hour per EUR 1 of revenue in 2007), and the smallest reduction in the production of food and drinks (from 0.17 kilowatt-hour per EUR 1 of revenue in 2005 to 0.16 kilowatt-hour per EUR 1 of revenue in 2007). Electronics sector exhibits the lowest average consumption of electricity by revenue. However, a comparison of energy costs with revenue generated by different industries shows that the share slightly rose in the industry of wood processing, paper production and publishing (from EUR 0.030 of energy costs per EUR 1 of generated revenue in 2005 to 0.035 in 2007) and in the industry of machinery, appliances and vehicles production (from EUR 0.016 of energy costs per EUR 1 of generated revenue in 2005 to 0.017 in 2007). The share remained unchanged during the observed period in the production of textiles, apparel and leather (EUR 0.036 of energy costs per EUR 1 of generated revenue), while it slightly decreased in all other sectors including electronics (Table 1).

The empirical model of the desired volume of energy-saving capital is derived from equation (3a) as:

$$k^{E}{}_{it} = \beta_0 + \beta_1 y_{it} + \beta_2 (p^i - p)_{it} + v_{it} \qquad (4)$$

where β_1 represents the elasticity of the use of energy-saving capital according to the company's sales, β_2 is the elasticity of capital according to the cost of usage, i indicates companies and t the time period (year). Since companies have difficulties assessing the level of energy-saving capital in the production process, instead of the volume of capital we used a "proxy" variable which measures the consumption of electricity in companies in given years, while the costs of usage are measured as the real costs of energy for electricity consumed at the company level.

5 Results

Based on a regression analysis of the model (4), estimates of elasticity over the years were obtained (Table 2). The

6 According to /7/ 39.5 percent of the questionnaires were completed by presidents of the company or executive directors. 35.4 percent of the questionnaires were completed by middle management (e.g. directors of business units), in 25.2 percent of the companies respondents to the questionnaire were other groups of employees (e.g. representatives of the management responsible for protecting the environment, or heads of various other business units). Of the 434 companies that were suitable for research, the questionnaires were collected from 153 companies, representing a 35.3-percent response rate.

7 Companies included in the sample were only those that stated information on energy consumption in the examined period (2005-2007).

8 The sample mainly includes companies which have a larger part of their sales in foreign markets, where they act as niche suppliers.

Table 1: Average values of electricity consumption, energy costs, consumption of electricity per revenues created and energy costs per revenue created by industry

Industry	Year	No. of firms	Average consumption of electricity (in kilowatt hours)	Average costs of energy (in EUR)	Average consumption of electricity per revenues created (in kilowatt hours per EUR)	Average energy costs per revenue created
Industry 1 (manufacturing of food, beverages and tobacco)	2005	12	4,179,736	532,736	0.17	0.034
	2006	12	4,437,948	602,135	0.17	0.034
	2007	12	4,564,269	666,534	0.16	0.032
Industry 2 (manufacturing of textile and textile products)	2005	8	5,588,478	483,686	0.35	0.036
	2006	8	5,537,949	521,170	0.32	0.036
	2007	8	5,140,179	586,870	0.28	0.036
Industry 3 (manufacturing of wood and wood products)	2005	9	50,195,608	126,917	2.5	0.030
	2006	9	62,059,460	154,417	2.5	0.033
	2007	9	63,452,348	180,695	2.3	0.035
Industry 4 (Manufacturing of chemicals and rubber)	2005	16	4,414,245	655,860	0.48	0.038
	2006	16	4,815,720	691,528	0.44	0.028
	2007	16	4,975,775	811,537	0.34	0.029
Industry 5 (manufacturing of electronics and electrical devices)	**2005**	**14**	**3,158,328**	**365,228**	**0.12**	**0.015**
	2006	**14**	**3,362,148**	**408,574**	**0.10**	**0.014**
	2007	**14**	**3,509,351**	**479,464**	**0.09**	**0.014**
Industry 6 (manufacturing of machinery and equipment)	2005	25	4,280,374	432,849	0.13	0.016
	2006	25	4,555,109	519,027	0.11	0.017
	2007	25	4,717,132	584,338	0.096	0.017
Industry 7 (manufacturing of basic metals and fabricated metal products)	2005	16	5,148,617	1,704,450	0.31	0.039
	2006	16	4,984,370	2,225,614	0.27	0.039
	2007	16	5,640,602	2,439,610	0.24	0.036
Sample (all companies)	**2005**	**100**	**8,508,568**	**651,039**	**0.50**	**0.028**
	2006	**100**	**9,738,433**	**781,547**	**0.42**	**0.027**
	2007	**100**	**10,038,850**	**876,589**	**0.37**	**0.026**

Source: Own calculations based on the survey questionnaires and the AJPES database

results show that, on average, 1 percent growth in sales recorded by the sample companies led to 0.88 percent growth in electricity consumption in the period from 2005 to 2007. A comparison by years indicates that the elasticity of consumption relative to total sales declined throughout the whole period, indicating that the manufacturing process is becoming more efficient in terms of electricity consumption[9]. When looking at prices we see that the demand for electricity is almost constantly elastic - an increase in energy prices by 1 percent leads to a reduction of consumption on average by 0.93 percent with unchanged sales. A comparison over the years suggests that companies are becoming increasingly sensitive to the price of electricity, which is leading to increasing the absolute value of the coefficient of the price elasticity of demand.

A comparison of energy efficiency by industry, reported in Table 3, shows that the highest electricity consumption per unit of revenue generated was used in industry 4 (chemical and rubber) and 7 (production of metals and fabricated metal products), where the increase in revenue for each percent increases the energy consumption by more than 1 percent. This is followed by the industries of the production of food, beverages and tobacco (industry 1), manufacturing of wood and wood products (industry 3), production of electronics and electrical devices (industry 5) and production of machinery and equipment (industry 6). It is interesting that in the case of the production of textiles and textile products (industry 2) there is no distinct connection between the product and energy consumption, even though it has an extremely high coefficient of the price elasticity of demand for electricity.

A comparison of industries by the size of the coefficient of the price elasticity of demand shows that industry 2 (production of textiles and textile products) is the most sensitive to electricity price changes, whereas the least sensitive to price changes is industry 4 (chemical products), which on average consumes 10 times more electricity than the rest of the industries. Obviously, this industry is primarily related to the use of technology which does not allow for significant savings if the price of electricity rises. A price-elastic demand for energy during the observed period is also seen in industry 5 (production of electronics and electrical devices) and 7 (production of metals and fabricated metal products). In the other industries the demand is constantly elastic.

9 This conclusion is derived from the assumption that the prices of finished products in the analysed companies remained unchanged in real terms. Given that the sample companies operate mainly in foreign markets as niche suppliers, it can be concluded that during the observed period there were no major changes regarding prices.

Table 2: Estimates of regression coefficients of model 4 for the period from 2005 to 2007

Model (4)	Year			
	2005 OLS method	2006 OLS method	2007 OLS method	2005-2007 XT on groups' averages
y_{it}	0.893*** (0.075)	0.889*** (0.075)	0.866*** (0.070)	0.885*** (0.072)
$(p^{i}-p)_{it}$	-0.931*** (0.042)	-0.911*** (0.041)	-0.941*** (0.041)	-0.935*** (0.040)
Constant	-2.099* (1.241)	-2.056 (1.252)	-1.722 (1.77)	-2.005* (1.196)
Adjusted R^2	0.854	0.860	0.870	0.864
Number of observations	100	100	100	100

Note: the standard error is shown in brackets

*** Coefficient is significant with a level of risk of less than 1 percent

** Coefficient is significant with a level of risk of less than 5 percent and more than 1 percent

* Coefficient is significant with a level of risk of less than 10 and more than 5 percent

Source: Own calculations based on the survey questionnaires and AJPES database

A comparison of effective electric power consumption by industry and by years shows that efficiency in the observed period only grew in industry 6 (production of machinery, appliances and vehicles)[10]. In the other industries there are no significant changes. It should be noted that these results could be significantly affected by the lower number of observations in certain years and certain industries.

6. Conclusions

Strict environmental regulations could stimulate innovations and advancement of sustainable technologies by which companies by itself find out that the final effect is often a process which does not only pollute less but also lowers costs and raises quality /14/. The survey presents the energy efficiency in Slovenian firms. We can conclude that, on average, Slovene firms became more energy efficient in the period under study in terms of decreasing ratio of energy consumed per unit of output and energy costs. Therefore we can conclude that firms most likely invested in advanced technology that enabled energy efficient production. Some industries, also electronics industry, performed significantly better comparing to others. However, the changes are not big, especially when compared to the extent to which Slovenian industrial companies are lagging behind their counterparts in more developed countries. There are still significant reserves. An important task for businesses is that they must invest in the introduction of energy-efficient practices and related technologies, yet it is also a significant task of the government. The government should therefore create appropriate incentives, promote the benefits of these technologies to businesses and provide support. Based on the paper we can highlight some possibilities of regulations for purposes of stimulating progress and innovation in technologies aligned with the sustainable development paradigm /13/.

The International Energy Agency stressed the need to encourage investment to boost the efficiency of energy consumption. The current subsidy scheme should be revised, while precise standards for measuring energy efficiency should be determined and benefits at the company level

Table 3: Estimates of regression coefficients of model 4 after sectors for the period from 2005 to 2007

Model (4)OLS method	Industry						
	Industry 1 (manufacturing of food, beverages and tobacco)	Industry 2 (manufacturing of textiles and textile products)	Industry 3 (manufacturing of wood and wood products)	Industry 4 (manufacturing of chemical products)	**Industry 5 (manufacturing of electronics and electrical devices)**	Industry 6 (manufacturing of machinery and equipment)	Industry 7 (manufacturing of metals and fabricated metal products)
y_{it}	0.837*** (0.068)	0.319 (0.252)	0.763*** (0.225)	1.257*** (0.103)	**0.759*** (0.085)**	0.849*** (0.061)	1.096*** (0.103)
$(p^{i}-p)_{it}$	-0.972*** (0.051)	-1.241*** (0.109)	-0.942*** (0.064)	-0.733*** (0.045)	**-1.067*** (0.042)**	-0.933*** (0.035)	-1.018*** (0.164)
Constant	-0.851* (1.101)	-6.790 (4.032)	-0.027 (3.380)	-7.785*** (1.715)	**-0.445 (1.471)**	-1.671 (1.027)	-5.191*** (1.741)
Adjusted R^2	0.953	0.891	0.944	0.889	**0.943**	0.921	0.741
Number of observations	36	24	27	48	**42**	75	48

Note: the standard error is shown in brackets

*** Coefficient is significant with a level of risk of less than 1 percent

** Coefficient is significant with a level of risk of less than 5 percent and more than 1 percent

** Coefficient is significant with a level of risk of less than 10 and more than 5 percent*

Source: Own calculations based on the survey questionnaires and AJPES database

10 These results are not specifically shown in the article in the form of a table and are available from the authors.

resulting from reduced energy consumption should be represented. Since the biggest problems with such investments are adequate resources (also due to the uncertainty and long periods of reimbursement), creating the appropriate funding schemes should be considered.

Another of the proposed measures is the creation of minimum energy-efficient standards for machines, which are the most important consumers of energy. Some 10 percent of all energy could be saved by ensuring the greater efficiency of power consumption involved in such mechanisation.

Tapping the energy-saving potential of electricity is an opportunity custom-made for today, as the issues of a sustainable energy future and a clean and safe environment become more urgent. In addition to addressing these needs, electro technologies offer a host of non- energy benefits, including improved manufacturing precision and control, enhanced product quality, increased worker productivity, and reduced environmental impacts. While efficient electro technologies are used throughout industry today, the potential for broader application remains, as does the potential for greater energy-efficient processes.

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Prispelo (Arrived): 17.09.2008 Sprejeto (Accepted): 15.12.2008