MONITORING COSTS WITH ELECTRICITY PRODUCTION FROM RENEWABLE SOURCES BY MEANS OF ECONOMETRIC TOOLS

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Abstract. *This paper presents the need for capitalization of electricity production from renewable sources, as an alternative for the future, and the need to know and trace costs generated by this type of production. The paper follows three main objectives: to present general aspects of the theme in literature, to determine the extent to which our country has complied with the specifications on the promotion of renewable energy sources under the Official Journal of the European Union, and to use to econometric tools for tracking and forecasting costs with electricity production from renewable sources. The statistical assumptions and results obtained from the study will be presented and validated. The study will be made at SC Hidroelectra SA (Corporation), a strategic hydropower producer from our country. Personal contribution is reflected in the investigation of a segment of unexploited energy production and in the presentation of appropriate conclusions drawn from the case study on the importance of exploiting the hydropower potential of our country and ensuring operational control of costs in the production of hydropower.*

Keywords*: renewable energy, hydropower potential, energy costs, econometric model.*

JEL Classification*: C5; Q2; Q4.*

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AMIS AND BACKGROUND

The objective of this paper is to present the need to exploit renewable energy sources in electricity production and monitor costs generated by this type of production. After a brief introduction in the field of the energy sector, the paper indicates the important role that accounting plays in providing information which is useful to managers in this sector, using modern tools to treat type cost information.

The paper is organized into six parts. The first part deals with the relationship between energy and environment. The second part discusses the problem of electricity in the European context, while the subsequent one refers to the current situation of the energy sector in Romania. The fourth part of the article brings to the foreground a solution to the global issue of energy, that is the use of renewable sources in the production processes. The fifth part emphasizes the role of accounting in the process of monitoring costs with energy production, and the last part proposes, following a case study, a dynamic econometric model of nonlinear regression as a useful tool of analysis and prediction of produced energy costs for the producing entities.

DISCUSSION

RELATIONSHIP BETWEEN ELECTRICITY AND ENVIRONMENT

The concern for environment is not recent, but unfortunately environmental issues are addressed in different ways, without a unified ecological vision. Interaction of a variety of economic, social, political, environmental and ecological factors had a major influence on the environment balance, generating changes in life conditions and conditions of economic and social development of mankind.

Electricity is a form of energy indispensable to any field of activity and a strategic factor that has generated a number of major concerns worldwide. It was always a vital component and a cost factor for economic development and progress of the society.

Meeting the needs of the present, without compromising the ability of future generations to meet their own needs, requires viable solutions and adoption of appropriate environmental policies. The key element of sustainable development is reconciliation between development and environment quality.

The concept of environmental protection includes, in addition to the issues of pollution, saving energy and resources. Saving energy is really a challenge at an individual level, as well as at national economy level. Energy is an essential product, with high economic, social, political and strategic value. Meeting the energy needs, both now and on medium and long term, adequately priced on the modern market economy and a decent standard of living, in terms of quality, food safety, but especially with respect to the principles of sustainable development is the general objective of any strategy implemented in the energy sector in Europe.

ELECTRICITY PROBLEM IN THE EUROPEAN CONTEXT

After the crisis, forecasts indicate an economic growth that will generate an increased consumption of energy. In the light of these developments, it is estimated that the total energy demand for 2030 will be 50% higher than in 2003, and the demand for oil will be 46% higher. Other equally gloomy forecasts relate to global oil reserves that could be maintained at the current consumption up to the year 2040, as also natural gas reserves would ensure maximum consumption by the year 2070, while world reserves of coal are provided for the next 200 years. These statistics increasingly encourage the orientation towards exploitation of renewable energy sources.

The energy sector is, at the EU level, a major economic and geopolitical factor. The EU is the second energy market in the world. To ensure energy sustainability, competitiveness and security in the European energy strategy project called European Strategy for Sustainable, Competitive and Secure Energy, main strands of EU are specified, the first being the diversity of energy sources. Although the European Union has sought to reduce energy consumption and promote renewable energy sources, the results are visible only in some states.

In recent years, the European Union has seriously concerned about the development of a set of measures that correspond to the concept of sustainable development and ensure energy security with competitive and "clean" energy.

These measures covered all energy sources, from fossil fuels to nuclear and renewable energy. Thus, the most ambitious energy policy project was created, the "Energy - Climate Change" Package, adopted by the European Parliament in December 2008 and published in the Official Journal of the European Union in June 2009. With this measure package, the EU establishes up to 2020, the reference year in the European vision, a set of objectives known as "20-20-20 objectives", namely: reducing greenhouse gas emissions at least 20% below the 1990 levels, increasing to 20% the share represented by renewable energy sources in the total energy consumption, the 20% reduction of primary energy consumption from estimated levels by increasing measures of energy efficiency[1]. The energy legislative package aimed mainly at developing renewable energy sources and reducing greenhouse gas emissions.

THE CURRENT SITUATION OF THE ENERGY SECTOR IN ROMANIA

Romania, a member of the European Union, is in a difficult position. Since energy is the main contributor to environmental pollution and climate change, our country must meet a dual demand: on the one hand, the high standards of the EU on energy and its impact on the environment and, on the other hand, the correction of the deficiencies in energy sector.

Currently, a developed economy cannot be conceived without an efficient energy sector. Romania is a country with a long tradition in the energy industry, with experience both in energy and thermal production industry and in oil and gas industry. It has a wide, but quantitatively reduced range of primary energy resources: oil, natural gas, coal, uranium, and an important capitalized potential of renewable resource[2].

Beyond this fact, the lack of investment in the sector, stiff willingness for privatization, area restriction and underperforming mines closure, the type of financing practiced by state, predominantly in the form of grants, but also political indifference to the problems of the sector, have contributed to the poor state of the energy sector in our country.

ENERGY PRODUCTION FROM RENEWABLE SOURCES, AN ALTERNATIVE FOR THE FUTURE OF ROMANIA

Renewable sources have an important energy potential, and ensure unlimited use. Capitalization of renewable energy sources is based on three important premises: *accessibility*, *availability* and *acceptability*.

The main renewable or unconventional energy sources are: solar radiation energy (solar energy), water power hydraulic energy, wave energy, geothermal energy, wind energy, the energy contained in the wood and other plant material (biomass).

Romania has a significant potential of renewable energy resources. With the exception of hydro potential, used approximately 50%, and biomass for individual heating, this renewable energy potential is virtually unused in our country.

Using renewable resources helps for: energy security, by limiting dependence on imported or primary energy resources and sustainable development, by reducing the impact of the energy sector on the environment. The energy Strategy of Romania for 2007-2020 structures the national potential of RES as follows:

Table 1. National potential of renewable sources

Source	Annual potential	Aplication
Solar energy	60 PJ 1.2 TWh	Thermal energy Electrictricity
Wind energy (theoretical potential)	23 TWh	Electricity
Hydroenergy of which below 10 MW	36 TWh 3.6 TWh	Electricity
Biomass and biogas	318 PJ	Thermal energy Electricity
Geothermal energy	7 PJ	Thermal energy

The share of renewable energy sources, by source type in total primary resource consumption in Romania is as follows:

Table 2. The share of renewable energy sources in total primary resource consumption

Renewable energy source	Year 2000 (tep)	Year 2010 (thousand tep)	Yearl 2015 (tep)
Solar energy	-	7.50	17.0
Wind energy	-	27.00	86.10
Hydropower	1,272	1,565.20	1,608.20
Biomass energy	2,772	3,347.30	3,802.00
Geothermal energy	-	17.50	23.90
Total	4,044	4,946.00	5,537.20
RES share in total consumption of primary energy resources (%)	10.01	11.00	11.20

In Romania, the share of RES in total primary energy resource consumption in 2000 was 10.01%, then in 2010 it was about 11%, following in 2015 to reach 11.2%. In our country, an important role in promoting the use of renewable energy sources was held by the Strategy for Capitalization of Renewable Energy Sources in Romania, approved by the Government Decision 1535/2003 published in the Official Gazette No. 17 of 7 January 2004. Under the Directive 2009/28/EC on the promotion of renewable energy sources, the share of electricity produced from renewable sources (RES-E) in national consumption of electricity, national overall target for the share of renewable energy sources in gross final energy consumption since 2020 is 24%, while other EU countries register shares as follows: Greece 18%, Italy 17%, Bulgaria 16%, Austria 34%, Sweden 49%[3]. Romania still has a long way to fulfill the European standards, given that our country is estimated to reach only half of the required level in 2015.

THE ROLE OF ACCOUNTING IN THE MONITORING COSTS PROCESS

Environmental protection is one of the current concerns of modern entities, and their role in achieving it tends to be more pronounced. In order to develop such a capability, it is necessary for the entity to develop a system of environmental management with accounting playing a key role.

The financial impact of environmental destruction is far from negligible, and the entities shall disclose information about policies, objectives and implemented environmental programs, expenditures in this field, environmental risks. In this context, evaluating the actions taken by entities for environmental protection is an initiative that should be encouraged. Accounting is the main source of information that allows estimating an entity's value and, therefore, it is necessary to reflect the environmental issues that may have significant financial consequences[4].

Accounting is an old invention still evolving[5], an information system that enables the production and dissemination of information for decision making. Accounting is a specific information system, due to its multiple valences, among which, the following may be mentioned : providing real, comparable, synthetic and analytical information for analysis of various aspects which economic phenomena can take; communicating information from the place of disclosure to its use; amplifying the control function on economic phenomena; increasing forecast role etc.[6]

Although cost information type has a particular importance for managers in the decision making, many entities in the energy sector ignore the use of this component in accounting. Most costs affect the image of the entity, its performance, quality of products; therefore the use of management accounting can be decisive for the entities' survival. It refers to processes and management techniques designed to increase organizations' value to achieve efficient use of resources in a dynamic and competitive environment[7]. Management accounting quantifies and reports financial and non-financial information that helps managers to make decisions that will enable an organization to achieve its goals. Managers use management accounting information to choose, communicate and implement strategies[8].

MONITORING COSTS IN ELECTRICITY PRODUCTION THROUGH ECONOMETRIC TOOLS

The subject of costs is the ratio formed between the costs incurred by an enterprise in a certain period, on the one hand, and economic process that generated those costs, on the other hand[9], but studying them without being followed by analysis, tracking and forecasting is irrelevant to the entity.

Studying the behavior of costs in the energy sector is to know the dynamics and laws that they follow. Knowledge allows modeling and improving decisions by performing forecasting calculations, showing possible outcomes of different choices considered.

One of the most effective tools for forecasting costs is provided by econometric modeling. Econometrics is a subject of knowledge of the development mechanisms of economic processes, described by statistical series data, by using quantitative methods of statistical or mathematical nature[10].

The main tool used by econometrics to study economic phenomena is the model, and its building is called modeling. At the econometric level, the model is a simplified and formalized description of a phenomenon as equations in which variables are economic values[11].

Practical use of this tool for analysis and forecasting of cost development was made within SC Hidroelectra SA Corporation, a company for which we used, based on the data collected in three consecutive financial years, the construction of a dynamic econometric model based on non-linear regression.

The main hypothesis formulated was to find a representative econometric model and its validation for use in the next three financial years to forecast energy costs.

It should be noted that the definition of the model was achieved through a complex process of selection and measurement of the variables analyzed in the studied company, which led to the model shape. The case study was conducted in a company producing electricity, but the developed econometric model is applicable to other areas. This econometric model was not built exclusively for the production of electricity. The econometric model is not the one applicable to renewable energy, but this is a simple quantitative research tool one resorts to in the decision making process, or not. The output type does not influence the shape of the built model, but the pattern is generated from analyzing the series underlying the model, and the series was composed from existing data in a real life entity in the studied periods. As a result of the application of selection techniques, such as those based on the analysis of connection intensity, the initially existing variables in the model were selected.

For reasons of space limitation assigned to this study, I will use a summary of steps taken to build the model, indicating that it may be detailed in a future research:

Step 1: Setting time series components

Statistical observation allowed the recording of the values studied in each statistical unit. The statistical series obtained from data systematization was of chronological type, following the repeated observation of the phenomenon over time.

The initial phase of construction of a dynamic econometric model at S.C. Hidroelectra S.A. was based on a complex process of collection, observation and selection of data required for time series construction. The variable analyzed in time series is denoted by y, and it is represented by the total expenditure incurred for the work performed, and corresponds to reference time.

The level of indicator y appears as a result of the action of several key, cyclic, seasonal, incidental factors. The key factors are those which act continuously and determine the most important component of that time series, called trend. Cyclical factors are also important, but only act regularly on the studied phenomenon, causing fluctuations around the trend. The cyclical component can be highlighted for periods longer than a year. Similarly, seasonal factors also act regularly on trends, in periods shorter than a year. Incidental factors act randomly, causing small fluctuations around the trend.

Extracting the data required for establishing the time series has been done on the basis of *Statements of Expenditure* made by SC Hidroelectra SA, over three calendar years, i.e. 2010, 2011 and 2012 (Table 3), expressed in lei, resulting in the following time series:

Table 3. Time series components

	Jan	Feb	Mar	Apr	May	June
1	4870226	7634964	6478645	7040592	8175084	1204232
2	5828203	6229365	6212149	5808290	5204150	5156107
3	5379183	5676083	6095722	6074908	5495007	5782277
	July	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1	7103518	6412382	5279845	5359485	5762485	8120759
2	6792566	6378456	5184189	5162352	5248221	8118892
3	6601088	7466130	7690484	8006718	5837110	6990759

Step 2: Deseasonalisation time series

In the study of a phenomenon, in order to make predictions based on existing data in series of this time type, it is critical that, from these data, the main part to be detached, i.e. the trend. The essence of building an econometric model lies in finding this trend, determining the parameters and then making predictions. Since both the seasonal and the cyclical component lead to oscillations around the trend, the trend component will only be highlighted by removing the seasonal and cyclical component. In other words, deseasonalization and decyclization of the series are necessary. This is a link in mathematical reasoning, it is not an option, and it is a stage precisely defined by econometric literature.

Deseasonalization time series involves the *moving average method*. After applying these *moving averages,* a time series from which the seasonal component is removed will be obtained. Since the number of seasons in our case is even (*h = 12*) the general formula for calculating moving averages, which led to obtaining deseasonal series (Table 4) is:

$$y_t{}' = \frac{y_{t-p+0,5} + y_{t-p+1,5} + \ldots + y_{t-0,5} + y_{t+0,5} + \ldots + y_{t+p+0,5}}{h}$$

Table 4. Deseasonalized values of time series

	Jan	Feb	Mar	Apr	May	June
1	-	-	-	-	-	-
2	6026772	6012402	6007003	5994803	5965161,6	5943656
3	5941010	5978351	6128100	6351044	6494096,5	6471628
	July	**Aug**	**Sept**	**Oct**	**Nov**	**Dec**
1	6160100	6141450	6071779	6009329	5834194	5875067
2	5924869	5883107	5855202	5861460	5884688	5922898
3	-	-	-	-	-	-

The essence of building an econometric model lies in determining and quantifying the trend. Later, as the phenomenon presents though seasonal factors, such as hydropower production, the regular values will be corrected by the influence of seasonal factors. The intensity of these factors is numerically highlighted by the seasonal factors. For reasons of size of the conducted case study, calculation and interpretation of these seasonal factors were not included in the present study, but for clarity, we elaborate this calculation.

The calculation of the coefficients of seasonality is presented as follows:

$$K_{17} = \frac{y_{17}}{y'_{17}}.100 = \frac{7{,}103.518}{6{,}160.100} \cdot 100 = 115.31\% \qquad K_{27} = \frac{y_{27}}{y'_{27}}.100 = \frac{6{,}792.566}{5{,}924.869} \cdot 100 = 114.65\%$$

$$K_{18} = \frac{y_{18}}{y'_{18}}.100 = \frac{6{,}412.382}{6{,}141.450} \cdot 100 = 104.41\% \qquad K_{28} = \frac{y_{28}}{y'_{28}}.100 = \frac{6{,}378.456}{5{,}883.107} \cdot 100 = 108.42\%$$

$$K_{19} = \frac{y_{19}}{y'_{19}}.100 = \frac{5{,}279.845}{6{,}071.779} \cdot 100 = 86.96\% \qquad K_{29} = \frac{y_{29}}{y'_{29}}.100 = \frac{5{,}184.189}{5{,}855.202} \cdot 100 = 88.54\%$$

$$K_{1.10} = \frac{y_{1.10}}{y'_{1.10}}.100 = \frac{5{,}359.485}{6{,}009.329} \cdot 100 = 89.19\% \qquad K_{2.10} = \frac{y_{2.10}}{y'_{2.10}}.100 = \frac{5{,}162.352}{5{,}861.460} \cdot 100 = 88.07\%$$

$$K_{1.11} = \frac{y_{1.11}}{y'_{1.11}}.100 = \frac{5{,}762.485}{5{,}834.194} \cdot 100 = 98.77\% \qquad K_{2.11} = \frac{y_{2.11}}{y'_{2.11}}.100 = \frac{5{,}248.221}{5{,}884.688} \cdot 100 = 89.18\%$$

$$K_{1.12} = \frac{y_{1.12}}{y'_{1.12}}.100 = \frac{8{,}120.759}{5{,}875.067} \cdot 100 = 138.22\% \qquad K_{2.12} = \frac{y_{2.12}}{y'_{2.12}}.100 = \frac{8{,}118.892}{5{,}922.898} \cdot 100 = 137.07\%$$

$$K_{21} = \frac{y_{21}}{y'_{21}}.100 = \frac{5{,}828.203}{6{,}026.772} \cdot 100 = 96.71\% \qquad K_{31} = \frac{y_{31}}{y'_{31}}.100 = \frac{5{,}379.183}{5{,}941.010} \cdot 100 = 90.54\%$$

$$K_{22} = \frac{y_{22}}{y'_{22}}.100 = \frac{6{,}229.365}{6{,}012.402} \cdot 100 = 103.61\% \qquad K_{32} = \frac{y_{32}}{y'_{32}}.100 = \frac{5{,}676.083}{5{,}978.351} \cdot 100 = 94.94\%$$

$$K_{23} = \frac{y_{23}}{y'_{23}}.100 = \frac{6{,}212.149}{6{,}007.003} \cdot 100 = 103.42\% \qquad K_{33} = \frac{y_{33}}{y'_{33}}.100 = \frac{6{,}095.722}{6{,}128.100} \cdot 100 = 99.47\%$$

$$K_{24} = \frac{y_{24}}{y'_{24}}.100 = \frac{7{,}040.592}{5{,}994.803} \cdot 100 = 117.44\% \qquad K_{34} = \frac{y_{34}}{y'_{34}}.100 = \frac{6{,}074.908}{6{,}351.044} \cdot 100 = 95.65\%$$

$$K_{25} = \frac{y_{25}}{y'_{25}}.100 = \frac{5{,}204.150}{5{,}965.162} \cdot 100 = 87.24\% \qquad K_{35} = \frac{y_{35}}{y'_{35}}.100 = \frac{5{,}495.007}{6{,}494.096} \cdot 100 = 84.62\%$$

$$K_{26} = \frac{y_{26}}{y'_{26}}.100 = \frac{5{,}156.107}{5{,}943.656} \cdot 100 = 86.75\% \qquad K_{36} = \frac{y_{36}}{y'_{36}}.100 = \frac{5{,}782.277}{6{,}471.628} \cdot 100 = 89.35\%$$

Their calculation must be completed with the determination of ***average seasonal factors***, these being used in making predictions. Based on the 24 factors previously determined, expressed as a percentage, there will be calculated 12 average seasonal factors, which will also be expressed as a percentage and will be compared to 100%, as follows:

$$\overline{K_1} = \frac{K_{21} + K_{31}}{2} = \frac{96.71 + 90.54}{2} = 93.63 < 100$$

$$\overline{K_2} = \frac{K_{22} + K_{32}}{2} = \frac{103.61 + 94.94}{2} = 99.28 < 100$$

$$\overline{K_3} = \frac{K_{23} + K_{33}}{2} = \frac{103.42 + 99.47}{2} = 101.45 > 100$$

$$\overline{K_4} = \frac{K_{24} + K_{34}}{2} = \frac{117.44 + 95.65}{2} = 106.55 > 100$$

$$\overline{K_5} = \frac{K_{25} + K_{35}}{2} = \frac{87.24 + 84.62}{2} = 85.93 < 100$$

$$\overline{K_6} = \frac{K_{26} + K_{36}}{2} = \frac{86.75 + 89.35}{2} = 88.05 < 100$$

$$\overline{K_7} = \frac{K_{17} + K_{27}}{2} = \frac{115.31 + 114.65}{2} = 114.98 > 100$$

$$\overline{K_8} = \frac{K_{18} + K_{28}}{2} = \frac{104.41 + 108.42}{2} = 106.42 > 100$$

$$\overline{K_9} = \frac{K_{19} + K_{29}}{2} = \frac{86.96 + 88.54}{2} = 87.75 < 100$$

$$\overline{K_{10}} = \frac{K_{1.10} + K_{2.10}}{2} = \frac{89.19 + 88.07}{2} = 88.63 < 100$$

$$\overline{K_{11}} = \frac{K_{1.11} + K_{2.11}}{2} = \frac{98.77 + 89.18}{2} = 93.97 < 100$$

$$\overline{K_{12}} = \frac{K_{1.12} + K_{2.12}}{2} = \frac{138.22 + 137.07}{2} = 137.65 > 100$$

After determining these results, we conclude that, during the seasons when the average of seasonal factors is less than 100%, namely *January, February, May, June, September, October and November*, there was a *decrease* in the expenses incurred by the activity performed at S.C. Hidroelectra S.A., following that the activity performed during the seasons with an average seasonal factor of over 100%, namely *March, April, July, August and December* lead to an increase in expenditure.

Step 3: Determining the trend of the econometric model

The mathematical shape of the regression model resulted from the strip shape on which frequencies were placed in the correlation table in the case study carried out, and their placing mostly resembles a parable. Also, to establish the regression curve, the empirical regression curve is analyzed, i.e. the polygonal line joining the points of the statistical cloud. In practice, it does not generally happen that the waveform points to be exactly on a line, parabola, hyperbola, but only to approach one of them as much at the expense of the others. Therefore, it will be chosen as the most possible trend line that curve to which the absolute differences correspond or at least are close to. The curve which best approximates the empirical regression curve will be sought.

Following this analysis, one or more assumptions about the mathematical shape of the link between the two variables may be formulated. For the processed data from SC Hidroelectra SA, a non-linear regression econometric model of parabolic type was obtained. The parabolic model cannot be removed, it resulted by econometric calculation from the performed analysis. In these circumstances, the determination of the parameters of the regression equation can be achieved by giving the model a linear shape by applying a smoothing technique. Direct application of the method of least squares can result in achieving non-linear equation systems in relation to the estimators of the model parameters, whose solution is difficult and more often does not lead to the effective expression. For these reasons, linearization was considered.

Effective determination of parameters for the case when the trend line is a parabola is reduced to achieving a substitution and bringing the model to determine the parameters of a linear regression model, as follows:

$$\overline{Y}(X_1) = a_0 + a_1 X_1 + a_2 X_1^2$$

To reduce to the linear case, we make the following substitution:

$$X_1 = X_1 \qquad X_2 = X_1^2$$

and we obtain:

$$\overline{Y}(X_1, X_2) = a_0 + a_1 X_1 + a_2 X_2 ,$$

that is, a multiple linear connection.

Subsequently, the data are presented as time series, and the existence of time in the model specification led us to the conclusion that we are dealing with a dynamic model as well.

For SC Hydroelectric S.A. Sebeş, after analyzing the time chart, one can notice a *parabolic trend* of the time chart points, a tendency that takes the following general form:

$$T(t) = a + bt + ct^2$$

The trend T (t) is that continuous line towards which the deviations of the waveform points are insignificant. To determine whether it is linear or nonlinear (parabolic) we question the choice of the function type that best represents the series waveform. To determine the trend we first ensure that there is no seasonal and cyclical component and then we apply the following mechanism: setting the possible trend lines and deducting the probable trend line: numerical determination of the probable trend line.[12]

Step 4: Numerical determination of the model underlying trend

There are two ways to determine the parameters of the trend, the shortest way will be presented further. *This method* leads to faster results: three different columns will be built, one for the 24 deseasonalized values of the variable Y, one for X_1, that is representing time points and one for X_2, i.e. the square root of the analyzed time points (X_1^2).

Subsequently, by applying the LINEST function, information on parabolic function parameters will be obtained in a space consisting of 5 rows and 3 columns. The three parameters are:

Coefficient of X^2(a2)	**Coefficient of X(a1)**	**Constant (a0)**
3226.410864	-71685,62697	6268101.83
484.691217	12481.46547	67721.0365
0.717368007	101500.0965	#N/A
26.65078359	21	#N/A
5.49127E+11	2.16348E+11	#N/A

The *nonlinear dynamic econometric regression model* will take the following form in the case of SC Hidroelectra S.A.:

$$\overline{Y}(X_1) = 6{,}268{,}102 - 71{,}686X_1 + 3{,}226X_1^2$$

After determining the trend and the parameters forming the function underlying the econometric model, we can determine the seasonal and cyclical component. If within the analyzed size we encounter the action of long-term factors, seasonal and random factors, namely: $y(t) = T(t) + S(t) + \varepsilon(t)$, a way of determining the seasonal component is that of moving average.

The seasonal component relative to a period is determined by calculating the average differences for all years, between the observed values of that period and the values calculated as moving average. Also, if we know the trend, subtracting from the observed values the values resulting from the trend, seasonal component values are obtained under the assumption that random factors are insignificant.

Cyclical factors most often occur during an economic approach. In an economic cycle, the following periods can be distinguished: expansion, crisis, recession, recovery. To determine the cyclical component, we can proceed as in the seasonal component, using $C(t) = y(t) - T(t) - S(t)$.

Step 5: Making predictions based on the econometric model

The main purpose of building one econometric model is the opportunity it offers to make predictions that enjoy mathematical accuracy. Based on the dynamic model previously formulated, we make a prediction of the cost of energy produced for the next 24 seasons, from the last non-estimated season in the matrix of deseasonized values. These results will then be corrected by adjusting them by the seasonality coefficients determined in step 2, thus eliminating the main factor influencing the production costs of SC Hidroelectra S.A., namely seasonality. A forecast for the future value of a quantity *y* involves appropriately extrapolating the trend and correcting it, taking into account the action of the seasonal and cyclical factors affecting ***SC Hidroelectra S.A***. In the case of a parabola arc, of the following type:

$T(t) = a + bt + ct^2$, that is

$T(t) = 6{,}268{,}102 - 71{,}686t + 3{,}226t^2$, extrapolating the value *y* at the moment $(t + k)$:

- for the season *t* = 48 (***June 2015***) the forecasting value of the costs is the following:

T(48) = $6{,}268{,}102 - 71{,}686 * 48 + 3{,}226 * 48^2$ = 6,268,102 – 3,440,910.24 + 7,433,648.64 = ***1,260,840.4 lei***

Increasing costs over the time horizon considered was not caused by the option for an inappropriate econometric parabolic model, but by the factors acting systematically and consistently on costs (production volume, green certificates, restrictions imposed by the European Union, the elimination of subsidies, etc.). Seasonal factors are also manifest, but the difficulty lies in finding a way to quantify them, and adjusting the results achieved under their influence.

Relevant to the management is the use of a cost monitoring tool to measure the impact of these factors along with others which are manifest, this possibility being offered by a dynamic econometric parabolic model, but initially, when determining the trend of the phenomenon, their influence is eliminated, when deseasonalization occurs. The projections took into account the influence of seasonal factors, subsequently achieving the deseasonalization of predicted values which, for space reasons, was not attached.

Step 6: Analysis of the model representativeness

To determine representativeness of the chosen nonlinear regression model, a ***test of representativeness*** is applied, which in turn requires the completion of several steps:

1. Formulating hypotheses (basic and alternative):

- basic hypothesis (the model is not representative): $H_0 : \widetilde{R}_{012} = 0$,

- alternative hypothesis (the model is representative): $H_1 : \widetilde{R}_{012} \neq 0$.

2. Determination of the value of $\widetilde{R}_{012}$ (correlation coefficient) at the sample level.

Correlation coefficient calculation using the known information on the sample, further extended to the population level, involves the use of variation and co-variation matrix built for SC Hidroelectra S.A., namely:

$$M^{(3)} = \begin{pmatrix} m_{00} & m_{01} & m_2 \\ m_{10} & m_{11} & m_{12} \\ m_{20} & m_{21} & m_{22} \end{pmatrix} = \begin{pmatrix} 31{,}894{,}844{,}297.74 & 430{,}035.12 & 16{,}646{,}247.07 \\ 430{,}035.12 & 47.92 & 1{,}197.88 \\ 16{,}646{,}247.07 & 1{,}197.88 & 31{,}773.78 \end{pmatrix}$$

Based on the data collected on the volume sample *24* on seasonally deseasonalized variable *y*, the correlation ratio estimator will be obtained, as follows:

$$\widetilde{R}_{012} = 0{,}8466062798 = 0{,}84$$

3. Statistical test F is applied on a random value:

$$F = \frac{\widetilde{R}_{012}^{\ 2} / (n - p)}{\left(1 - \widetilde{R}_{012}^{\ 2}\right)}$$

which follows the Fisher law of probability, with $\nu_1 = 1$

$\nu_2 = n - p = 24 - 3 = 21$

degrees of freedom.

4. Based on risk and significance level of $\alpha = 0.05$

It is determined from the table of the Fisher law, corresponding to $\nu_1 = 1$ and $\nu_2 = 21$ degrees of freedom, a chart value $Ft_{\alpha,\nu_1,\nu_2} = 2.080$ (Table of Student-Fisher Law) and the area for accepting the hypothesis will be $\lfloor 0, Ft_{\alpha,\nu_1,\nu_2} \rfloor = \lfloor 0;2.080 \rfloor$.

5. Based on the data from the sample, a particular value of the variable can be determined:

$$F_{calc} = \frac{\widetilde{R}_{012}{}^2 / (n-p)}{\left(1 - \widetilde{R}_{012}{}^2\right)} = \frac{0.84^2 / (24-3)}{\left(1 - 0.84^2\right)} = \frac{0,7056 * 21}{0,2944} = \frac{14,8176}{0,2944} = 50.33$$

6. Decision making:

It is noticed that $F_{calc} \notin \lfloor 0, F_{\alpha,\nu_1,\nu_2} \rfloor$, that is 50.33 $\notin$ $\lfloor 0;2,080 \rfloor$, therefore we reject the null hypothesis and accept the alternative hypothesis $\widetilde{R}_{012} \neq 0$, ***the model is representative and appropriate to data***, and *y* is explained quite well by a parabolic model on *t*, with a significance level $\alpha \leq 5\%$.

Step 7: Validation of the econometric model and establishment of confidence intervals for the coefficients of nonlinear regression function

The determination of dynamic nonlinear regression model also implied the determination of the parameters which define it.

$$\overline{Y}(X_1) = a_0 + a_1 X_1 + a_2 X_1^2$$
$$\overline{Y}(X_1) = 6.268.102 - 71.686 X_1 + 3.226 X_1^2$$

To these coefficients determined in step 4, the ***Test T of the model coefficients significance*** can be applied and confidence interval for each parameter will be drawn.

After applying ***Test T***, the following confidence interval for a_0 is obtained:

$$P\left(\hat{a}_0 - t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_0)} \le a_0 \le \hat{a}_0 + t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_0)} \right) = 1-\alpha$$

$$P(6{,}268{,}102 - 2.518 * 67{,}721.04 \le a_0 \le 6{,}268{,}102 + 2{,}518 * 67{,}721.04) = 0.95$$

$$P(6{,}268{,}102 - 170{,}521.58 \le a_0 \le 6{,}268{,}102 + 170{,}521.58) = 0.95$$

$$P(6{,}097{,}580.42 \le a_0 \le 6{,}438{,}623.58) = 0.95$$

As we can see, the value obtained at a sample level for a_0 was ***6,26,102***, value placed with a probability of 95% within the confidence interval formulated for a_0.

After applying ***Test T***, the following ***confidence interval*** for $\hat{a}_1$ is obtained***:***

$$P\left(\hat{a}_1 - t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_1)} \le a_1 \le \hat{a}_1 + t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_1)} \right) = 1-\alpha$$

$$P(-71{,}685.62 - 2{,}518 * 12{,}481.47 \le a_1 \le -71{,}685.62 + 2{,}518 * 12{,}481.47) = 0.95$$

$$P(-71{,}685.62 - 31{,}428.34 \le a_1 \le -71{,}685.62 + 31{,}428.34) = 0.95$$

$$P(-103{,}113.96 \le a_1 \le -40{,}257.28) = 0.95$$

As we can see, the value obtained at a sample level for $\hat{a}_1$ was ***-71,685.63***, placed with a probability of 95% within the confidence interval formulated for a_1.

After applying ***Test T***, the following ***confidence interval*** for a_2 is obtained***:***

$$P\left(\hat{a}_2 - t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_2)} \le a_2 \le \hat{a}_2 + t_{\alpha/2,n-p}\sqrt{\hat{V}(\hat{a}_2)} \right) = 1-\alpha$$

$$P(3{,}226.41 - 2.518 * 484.69 \le a_2 \le 3{,}226.41 + 2.518 * 484.69) = 0.95$$

$$P(3{,}226.41 - 1{,}220.45 \le a_2 \le 3{,}226.41 + 1{,}220.45) = 0.95$$

$$P(2{,}005.96 \le a_2 \le 4{,}446.86) = 0.95$$

As we can see, the value obtained at a sample level for a_2 was ***3.226***, placed with a probability of 95% within the confidence interval formulated for a_2.

RESULTS AND DISCUSSION

Econometric modeling limits for S.C. Hidroelectra S.A. can be summarized as follows:

- ✓ Data ordered chronologically, similar to those of S.C. Hidroelectra S.A. during the analysed period, cease to be a result of random drawings, which is one of the causes of regression result frailty for a long time, when time series are used as input.
- ✓ Time evolutionary processes are not addressed from causes to effects, but are only limited to examining the effects of temporal sequence, what reduces the area of conducting the analysis on somewhat passive, but not unimportant, findings.
- ✓ Econometrics is primarily concerned with causal relations and evolution study in time, which provides a series of quantifiable issues for S.C. Hidroelectra S.A. (obtaining optimum values, scheduling activities, interaction effects, etc.) to remain, for the most part or entirely, outside econometric representations.
- ✓ Econometric model formulated for S.C. Hidroelectra S.A. expresses only the main coordinates of the analysed economic process, referring to an important variable expressed in a little "stylized" form in relation to other variables (e.g. the achieved production). A residual area, which can be considered as a proportion, being the additional size of the correlation coefficient, remains outside knowledge.
- ✓ The main sources of error, more or less random, such as human behavior, form only tangentially the object of quantifications, which gives forecasts and simulations strictly limited to measurable aspects, some uncertainty in acceptance.
- ✓ Knowledge of evolutionary veering moments, medium and long term forecasts, measuring the combined effect of several causes that define a situation for S.C. Hidroelectra S.A. will remain elements in relation to which the analysis of time series models can be improved.

CONCLUSION

The cost is related to the entire production and management. In the energy sector in Romania, the production cost is seen as a qualitative and economic indicator occupying a central position in the system of indicators characterizing the activity of an entity, being used in assessing the economic efficiency so that business results correspond to social needs and allocated resources are consumed by the demands required by the market.

Building a dynamic econometric model, of nonlinear regression, allows a company to make predictions about the evolution of variables of utmost importance for a normal activity. For example, we performed the calculation of model parameters using the data collected from S.C. Hidroelectra S.A. Economic processes developed within S.C. Hidroelectra S.A. are characterized by the fact that they are caused by a number of factors with a direct or indirect action, which, in a given configuration, lead to partially predictable results. These factors, in turn, are determined by certain fundamental causes which, suffering changes, will trigger similar developments among several variables.

The differenciation of direct causes from the apparent ones is the main problem for today's econometrician. However, economic phenomenon within S.C. Hidroelectra S.A. is characterized by a partially random development, difficult to predict with certainty, and by a series of minor, accidental causes, which remain outside knowledge, and which outlines a number of limitations in the formulation and application of econometric models.

Building a dynamic econometric model based on time series, for S.C. Hidroelectra S.A. was determined by the reason that the variable analyzed within this company, the costs of the work done, is affected to such an overwhelming extent by ***seasonality***, or the predictions based on time series are among the best performing in these circumstances of conducting an activity.

Seasonality is a factor of influence which particularly occurs in expenditures made in the energy sector, especially in the production of hydropower due to droughts, freeze/thaw, especially seasonal phenomena. Seasonality measurement possibilities are deviations from the average incumbent systematically and quantifiable as real by resorting to econometric modeling. This oscillation around a reference level was observed in the analyzed period of time at S.C. Hidroelectra S.A. and motivated the construction of a dynamic econometric model, which is based on a parabolic trend, able to help that entity management to achieve development scenarios for expenditure level, removing the component of seasonal influence.

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