

Prognosis of Hydro Power Plant Energy Indicator by Using the Least Squares Method

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რეზიუმე

ჰიდროსადგურის ენერგეტიკული ინდიკატორის პროგნოზირება უმცირეს კვადრატთა მეთოდის გამოყენებით

ნაშრომში სტატისტიკურ ინფორმაციაზე დაყრდნობით გამოთვლილია ხადორი ჰესის ძირითადი საშუალებების ფონდამოგების კოეფიციენტი 2009-2013 წლებისთვის. ჭფონდამოგების მაჩვენებლის 2014-2018 წლების პროგნოზისთვის გამოყენებულია უმცირეს კვადრატთა მეთოდი. საბოლოოდ, გამოვლენილია ტრენდის ხაზი და გრაფიკულად გამოსახულია პროგნოზული მაჩვენებლები.

საკვანძო სიტყვები: უმცირეს კვადრატთა მეთოდი, პროგნოზირება, ენერგეტიკული ინდიკატორები.

Summary

In this paper is calculated Khadiri HPP energy indicator called „Coefficient of Turnover Fixed Assets” based on statistical information during 2009 -2013 years. To determine Coefficient of Turnover fixed assets of Khadiri HPP in future 2014-2018 years, we use Least Squares Method. Finally is revealed trend line and graphically shown prognoses indicators.

Key Words: Least Squares Method, Prognosis, Energy Indicators.

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Khadori HPP is a seasonally regulated hydro power plant and is located in Akhmeta region at the tributary of rivers Alazani and Samkhuristskhali. Khadori HPP was put into operation is 2004. It is in a private possession.

The installed capacity of the plant is 24 MW. Average annual capacity is 100 million kWh. Fixed assets are 5 mln GEL, retail price is set by Georgian National Energy and Water Regulatory Commission (GNERC) 0,875 GEL/kWh plus 20% Value Added Tax (VAT), sum would be 0,105 GEL/kWh. Production value in 2009 is (100 mln kWh*0,105GEL/kWh) 10,5 mln GEL. Production value during 2009-2013 is shown in table 1.

We calculated Coefficient of Turnover fixed assets=Production, GEL/Fixed Assets, GEL.

Table 1.

Years	2009	2010	2011	2012	2013
Production, mln GEL	10,5	24	13,8	40,8	34,6
Fixed assets, mln GEL	5	5,1	5,3	5,2	5,1
Coefficient of Turnover Fixed Assets	2	5	3	8	7

To determine Coefficient of Turnover fixed assets in future 2014-2018 years, we use Least Squares Method. The equation of least square line is:

$$Y=ax+b$$

Where (a) and (b) are the values.

We must calculate following steps:

Step1: Count the number of values: n.

Step 2: Find xy, x².

Step 3: Find Σx, Σy, Σxy, Σx².

Step 4: We use the least squares regression line equations to find the value of (a) and (b):

After that equation system has following image:

$$\begin{cases} \sum y = a \sum x + nb \\ \sum xy = a \sum x^2 + b \sum x \end{cases} \quad (1)$$

We can find trend line values:

$$\tilde{y}=ax+b \quad (2)$$

Where

$\tilde{y}$ is trend line value;

x is data points;

(a) and (b) are the values.

Deviation from real (y) value

$$\sum (y - \tilde{y}) = 0 \quad (3)$$

We must fit a least square line to the following data from table 1. Also find trend values.

Table 2.

Year	2009	2010	2011	2012	2013
X	1	2	3	4	5
Y	2	5	3	8	7

I step: n=5

II step and III step are represented in table 3.

Table 3.

n	x	y	xy	x ²	$\tilde{y}=ax+b$	y- $\tilde{y}$
1	1	2	2	1	2.4	-0.4
2	2	5	10	4	3.7	1.3
3	3	3	9	9	5.0	-2
4	4	8	32	16	6.3	1.7
5	5	7	35	25	7.6	-0.6
5	$\Sigma 15$	$\Sigma 25$	$\Sigma 88$	$\Sigma 55$	Trend Value	$\Sigma (y-\tilde{y})=0$

IV Step: solve this equation system:

$$\begin{cases} 25 = 15a + 5b \\ 88 = 55a + 15b \end{cases} \quad (4)$$

(5)

Calculate (b) from (4)

$$b = \frac{25-15a}{5} \quad (6)$$

Insert (b) in (5)

$$88 = 55a + 15 * \frac{25-15a}{5}$$

Divide 15 on 5:

$$88 = 55a + (3*25) - (3*15a)$$

$$88 = 55a + 75 - 45a$$

$$88 - 75 = 55a - 45a$$

$$13 = 10a$$

$$a = 13/10$$

$$a = 1,3$$

Determined (a) insert in (6) and calculate (b):

$$b = \frac{25-15(1,3)}{5}$$

$$= \frac{25-19,5}{5}$$

$$= \frac{5,5}{5} =$$

$$= 1,1$$

$$a = 1,3; \quad b = 1,1$$

The equation of least square line (Trend Value) has following image:

$$\tilde{y} = 1,3x + 1,1(7)$$

For the trend values, put the value of (x) in equation (7):

$$\tilde{y}_1 = 1,3(1) + 1,1 = 2,4 \text{ and so on from table 3.}$$

Deviation from real (y1) value in year 2009 will be:

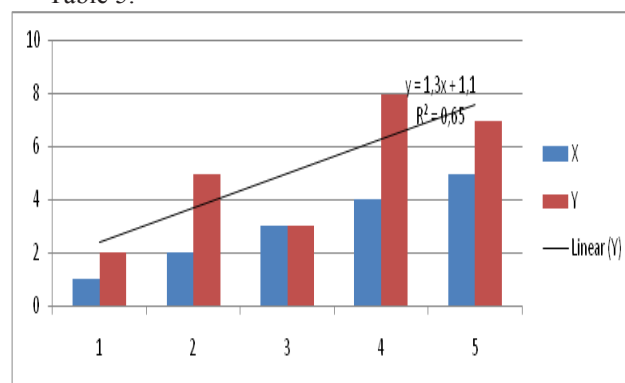
$$y - \tilde{y} = 2 - 2,4 = -0,4$$

Table 4.

n	year	Trend Line Value $\tilde{y}=ax+b$
6	2014	$\tilde{y}_6 = 1,3(6) + 1,1 = 8,9$
7	2015	$\tilde{y}_7 = 1,3(7) + 1,1 = 10,2$
8	2016	$\tilde{y}_8 = 1,3(8) + 1,1 = 11,5$
9	2017	$\tilde{y}_9 = 1,3(9) + 1,1 = 12,8$
10	2018	$\tilde{y}_{10} = 1,3(10) + 1,1 = 14,1$

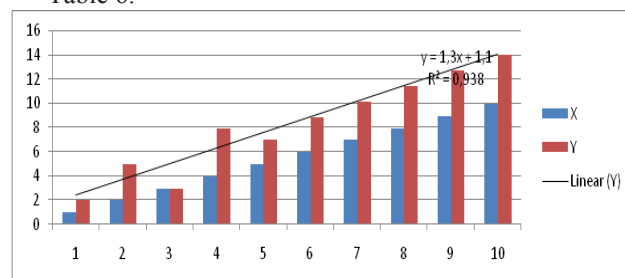
Solution with Excel: Insert>column>add trendline>correlation>OK.

Table 5.



We draw graph of prognoses coefficients during 2014-2018 years.

Table 6.



Finally is revealed trend line and graphically shown prognoses indicators of Khadori HPP in future 2014-2018 years.

Used Literature:

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