

Analysis of the Time Series of the Global Renewable Energy Project Investment at the Sectoral Level

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Abstract: Now almost all the global economic systems consume the energy from the two conceptually different sources - the renewable and non-renewable ones. The analysis carried out in this study has shown, that the share of the renewable energy sources is constantly mounting, which is caused by many reasons: the need for ensuring the energy, environmental, economic safety, the global markets penetration, especially in the developing countries, conservation of the native energy resource stocks for the next generations, increase in the feedstock consumption for the non-energy fuel utilization.

Key words: Investment • Project investment • Renewable energy • Solar energy • Wind energy
• Small-scale hydroenergy • Geothermal energy • Bioenergy • Global aspect

INTRODUCTION

Today the energy conservation issue becomes one of the crucial ones in every field of the human activity. Hence the consideration of the most effective ways to conserve energy, one of which is the renewable energy utilization, becomes urgent. The renewable energy is the energy from the sources, which are inexhaustible in the human terms. The main principle of the renewable energy utilization is to capture it from ongoing natural processes and to supply it for technical use. These sources are: sunshine, wind, rain, tides and the geothermal heat, which are naturally renewed [1].

The project investment is used in a considerable part of the renewable energy projects and contemplates financing a particular investment project, the funds source to recover the investments is the cash flow, generated by this project only.

Methods: The following methods have been used to carry out the renewable energy investment analysis: the sector analysis, the method of the time series design using the chain and base indexes of the growth and accession rates and the average indexes of the time series [2, 3, 4]. The sector analysis allows analysing the renewable energy investment dynamics for each of the renewable energy sources under consideration and finding the most developing of it. The time series analysis allows tracing

the absolute and relative index variation over the period under consideration. The use of the above-noted interrelated methods allows comprehensively reviewing the analysed issue and obtaining conceptually new results when investigating the trends in the renewable energy investment.

Body: The data have been inflation-adjusted to carry out more precise analysis of the renewable energy investment [5]. The OECD-average inflation rate has been used when correcting the indexes. It has been done to get the comparable indexes and to obtain consistent results of the conducted research when further analysing.

The sector analysis of the renewable energy investment is based on the Table 1 data.

As shown on the Table 1, in 2012 the total renewable energy investments were 290.84 bln USD, 167.08 bln USD (57.45%) of which were the solar energy investment, 95.56 bln USD (32.85%) were the wind energy investment, 9.28 bln USD (3.19%) were the small-scale hydroenergy investment, 5.95 bln USD (2.04%) – were the biofuel investment, 2.50 bln USD (0.85%) – were the geothermal energy investment.

According to the Bloomberg data, in 2012 only 6.5% of the world energy was generated using different renewable energy technologies. However this index value exceeds the value in 2011, when the energy was generated only 5.7% of its total amount. It is shown on the Fig. 1.

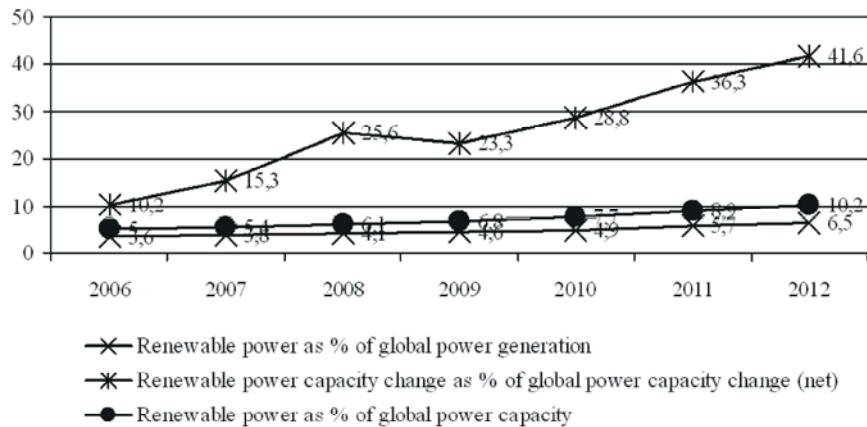


Fig. 1: Share of the Renewable Energy in the Total World Energy in 2004-2012, % [6, 7, 8, 9, 10]

Table 1: Inflation-Adjusted Renewable Energy Project Investment at the Sectoral Level in 2004-2012, Bln USD [6, 7, 8, 9, 10]

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2004	39.60	14.40	12.30	3.70	1.50	1.40	6.3
2005	66.25	26.11	16.79	9.11	4.71	0.92	8.4
2006	105.00	34.02	23.21	27.41	5.67	1.47	12.7
2007	157.10	61.76	42.07	30.34	6.35	1.94	13.8
2008	188.27	76.96	65.29	21.25	7.82	1.98	14.3
2009	191.41	83.87	70.90	12.06	6.03	3.07	13.5
2010	259.69	79.10	114.19	10.52	5.14	4.00	13.9
2011	323.92	103.68	183.55	9.64	7.55	4.30	13.2
2012	290.84	95.56	167.08	5.95	9.28	2.50	8.9

Table 2: Overall Chain Accession of the Renewable Energy Project Investment at the Sectoral Level over 2005-2012, Bln USD

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2005	26.65	11.71	4.49	5.41	3.21	-0.48	6.30
2006	38.75	7.91	6.41	18.29	0.96	0.55	8.60
2007	52.10	27.74	18.87	2.94	0.68	0.47	13.34
2008	31.18	15.20	23.22	-9.09	1.47	0.05	14.85
2009	3.14	6.91	5.61	-9.19	-1.79	1.09	15.74
2010	68.28	-4.77	43.29	-1.55	-0.89	0.93	15.36
2011	64.23	24.58	69.37	-0.88	2.40	0.30	15.89
2012	-33.08	-8.12	-16.48	-3.69	1.74	-1.80	15.33

When analysing the time series according to the applicable way to compare the performance indexes could be calculated using the permanent and variable comparison bases. When designing the time series upon the overall chain accession of the renewable energy investment amount (Table 2) we receive the following data.

The overall chain accession of the renewable energy investment remained positive over a period of 2005-2011, however it was - 33,08 bln USD in 2012. In 2010 and 2011 the overall accession was considerable increased as compared with the indexes prior to the crisis. The maximum overall accession is observed in the wind and solar sectors of the renewable energy sectors. The solar energy investment was reduced by 8.12 bln USD in 2012

alone, the overall wind energy accession was negative in 2010 and 2012. The overall chain accession of the biofuel energy investment has shown negative values since 2008. After the considerable reduction of the small-scale hydroenergy investment in 2009 and 2010, in 2011 and 2012 the overall accession of this sector showed its maximum values of 2.40 and 1.74 bln USD respectively over the past 7 years.

The overall base accession of the renewable energy investment is represented in the Table 3.

When analysing the Table 3 data we came to a conclusion that the overall base accession of the renewable energy investment had been 251.24 bln USD by 2012. The maximum value compared with the other sectors has the solar energy, although up to 2009 the overall base

Table 3: Overall Base Accession of the Renewable Energy Project Investment at the Sectoral Level over 2005-2012, Bln USD

	Grand Total	Wind Energy	Solar Energy	Biofuels.	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2005	26.65	11.71	4.49	5.41	3.21	-0.48	2.30
2006	65.40	19.62	10.91	23.71	4.17	0.07	4.73
2007	117.50	47.36	29.77	26.64	4.85	0.54	1.51
2008	148.67	62.56	52.99	17.55	6.32	0.58	0.90
2009	151.81	69.47	58.60	8.36	4.53	1.67	-0.38
2010	220.09	64.70	101.89	6.82	3.64	2.60	0.52
2011	284.32	89.28	171.25	5.94	6.05	2.90	-0.56
2012	251.24	81.16	154.78	2.25	7.78	1.10	-4.73

Table 4: Chain Rate of the Renewable Energy Project Investment Growth at the Sectoral Level over 2005-2012, Times

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2005	1.67	1.81	1.37	2.46	3.14	0.66	2.30
2006	1.58	1.30	1.38	3.01	1.20	1.60	7.04
2007	1.50	1.82	1.81	1.11	1.12	1.32	8.55
2008	1.20	1.25	1.55	0.70	1.23	1.02	9.44
2009	1.02	1.09	1.09	0.57	0.77	1.55	9.06
2010	1.36	0.94	1.61	0.87	0.85	1.30	9.59
2011	1.25	1.31	1.61	0.92	1.47	1.07	9.03
2012	0.90	0.92	0.91	0.62	1.23	0.58	4.29

Table 5: Base Rate of the Renewable Energy Project Investment Growth at the Sectoral Level over 2005-2012, Times

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2004	1.00	1.00	1.00	1.00	1.00	1.00	1.37
2005	1.67	1.81	1.37	2.46	3.14	0.66	1.55
2006	2.65	2.36	1.89	7.41	3.78	1.05	1.11
2007	3.97	4.29	3.42	8.20	4.23	1.38	1.06
2008	4.75	5.34	5.31	5.74	5.21	1.42	0.98
2009	4.83	5.82	5.76	3.26	4.02	2.19	1.03
2010	6.56	5.49	9.28	2.84	3.43	2.86	0.96
2011	8.18	7.20	14.92	2.60	5.03	3.07	0.69
2012	7.34	6.64	13.58	1.61	6.19	1.79	1.37

accession of the wind energy investment exceeded. The overall base accession of the biofuel investment showed its maximum value of 26.64 bln USD in 2007, but by 2012 it reduced to the minimum one of 2.25 bln USD. In the small-scale hydroenergy sector the maximum overall base accession of 6.32 bln USD was in 2008. In the geothermal renewable energy the overall base accession had been increasing since 2005 and in 2012 was 2.9 bln USD.

The data of the chain investment growth rate over the period of interest are represented in the Table 4.

Over a period of 2005-2011 the overall chain rate of the renewable energy investment growth varied from 1.02 to 1.67 times, in 2012 it reduced by 0.9 times. Thus, in 2005-2011 the renewable energy investments increased as compared with the previous year and in 2012 it reduced by 10% as compared with 2011.

The base rate of the renewable energy investment growth, represented in the Table 5, was increasing from 2004 till 2011 and showed the maximum value of 8.18 times in the latter year.

In 2012 the index reduced by 7.34 times. At the same time the recession was observed in all fields, but the small-scale hydroenergy, where in 2011-2012 the base growth rate increased from 5.03 to 6.19 times. According to the results of the whole observed period the maximum base growth rate of 13.58 times has been presented in the solar energy.

The results of investigating the chain rate of the renewable energy project investment accession at the sectoral level over 2005-2012 are represented in the Table 6.

As the Table 6 shows the chain rate of the renewable energy investment accession has generally remained above zero for all the years of the observed period, except for 2012. At the same time far different performance was observed in various sectors. Only in 2005-2007 the positive value of the chain accession rate was simultaneously observed in all the sectors. Over the whole observed period the maximum accession rate of 214.03% was in the small-scale hydroenergy sector in 2005.

Table 6: Chain Rate of the Renewable Energy Project Investment Accession at the Sectoral Level over 2005-2012, %

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2005	67.31	81.33	36.53	146.31	214.03	-34.17	1.00
2006	58.48	30.28	38.18	200.70	20.37	59.51	1.37
2007	49.62	81.55	81.30	10.72	11.96	31.76	2.12
2008	19.84	24.61	55.19	-29.97	23.13	2.32	2.36
2009	1.67	8.98	8.59	-43.23	-22.84	55.04	2.50
2010	35.67	-5.69	61.06	-12.83	-14.72	30.20	2.44
2011	24.73	31.08	60.75	-8.36	46.72	7.38	2.52
2012	-10.21	-7.83	-8.98	-38.25	23.00	-41.83	2.43

Table 7: Base Rate of the Renewable Energy Project Investment Accession at the Sectoral Level over 2005-2012, %

	Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
2004	-	-	-	-	-	-	36.53
2005	67.31	81.33	36.53	146.31	214.03	-34.17	55.03
2006	165.15	136.25	88.66	640.68	278.00	5.00	11.35
2007	296.71	328.91	242.05	720.09	323.23	38.34	6.03
2008	375.43	434.44	430.81	474.31	421.14	41.56	-2.42
2009	383.36	482.43	476.40	226.02	302.09	119.47	3.42
2010	555.78	449.28	828.34	184.21	242.90	185.75	-3.54
2011	717.98	619.98	1392.31	160.44	403.10	206.84	-30.89
2012	634.43	563.59	1258.34	60.81	518.80	78.50	36.53

Table 8: Average Values of the Time Series of the Renewable Energy Investment at the Sectoral Level over 2004-2012, Bln USD

Grand Total	Wind Energy	Solar Energy	Biofuels	Small-Scale Hydroenergy	Geothermal Energy	Any Other
Average Series Value						
180.23	63.94	77.26	14.44	6.01	2.40	12.89
Average Overall Accession						
31.40	10.14	19.35	0.28	0.97	0.14	0.54
Average Growth Rate						
1.28	1.27	1.39	1.06	1.26	1.08	1.07
Average Accession Rate %						
28.31	26.69	38.56	6.12	25.59	7.51	6.71

The results of investigating the base rate of the renewable energy project investment accession at the sectoral level over 2005-2012 are represented in the Table 7.

As the Table 7 shows, over the period of interest the renewable energy project investment had increased by 634.43%, including the solar one - by 1258.34 %. The minimum accession was observed when financing the biofuel production (60.81%) and the geothermal energy generation (78.50%).

Resuming the conducted research let's consider the average time series values at the sectoral level over the analysed period, represented in the Table 8.

The average annual investment value for all the countries and sectors was 180.23 bln USD. The one for the wind energy - was 63.94 bln USD. The average value for the solar energy was the maximum one of 77.26 bln USD of the sectors. The small-scale hydroenergy index was 6.01 bln USD, the geothermal energy one - was 2.40 bln USD.

The maximum index of the average series value is in Europe compared with the other world regions, where it is 73.66 bln USD. It is followed by the USA (33 bln USD) and China (32.73 bln USD), ASOC (except for China and India) - 16.32 bln USD. In Brazil the average series value is 7.38 bln USD, in America (except for the USA and Brazil) - it is 6.76 bln USD. In India this index is 6.86 bln USD.

The average overall accession of the renewable energy project investment over the period of interest was 31.40 bln USD, the average growth rate – was 1.28 times, accordingly, the average accession rate – was 28.31 %.

CONCLUSIONS

As the represented data show, now the most investors' attention is paid to the solar energy. This field of the renewable energy showed the maximum accession upon both absolute and relative base indexes over the analysed period of 2004-2012.

The primary prerequisites for the increase in the investment amounts in 2011 were the considerable growth just in the solar energy investment and the energy policy shift in the USA. Before 2011 the wind energy had dominated in the sector aspect, after 2011 - the solar one did it, which investment amounts exceeded twice the wind energy investment amounts, demonstrated the increase of 52 % and reached 147 bln USD. This increase resulted from the "1000 roofs" program implementation in Germany and Italy, the micromodules installation on the roofs of the houses in almost all the countries of the world, including China and Great Britain, financing the megaprojects on capturing energy from the solar energy in Spain and the USA.

In 2011 the solar energy investment boom was followed by the negative impact on the equipment manufacturers in this sector. Along with the fall in the share prices this fact was caused by rapidly falling prices of the solar modules due to the increase in the production scales, the increase of the share of the Chinese manufacturers' cheap equipment, the reduction of the state support scope, in addition, by 2012 the global solar energy market had been tapped in practice and had no real opportunities to grow. Almost 50% fall in the solar module prices during 2011 promoted the demand, especially on the modules, installed on the roofs of the houses and it adversely affected the financial results of many equipment manufacturers. At the end of 2011 the "solar" module cost was approximately 1.0 \$ per 1 Watt (76% of the 2008 level).

The second aspect of the increase in the renewable energy investment amounts in 2011 was the burst of the political interest, a temporary one at least, in the renewable energy in the USA. Although the USA ranks second after China in the investment amount, this country has demonstrated the increase in such investment amount by 57% (51 bln USD). For the comparison, the renewable energy investment in China increased by 17 %, in Germany - by 12 % and reached the level of 52 and 31 bln USD respectively. Such state of thing is due to the fact that in 2011 the implementation period and, accordingly, the period of financing the three federal programs of the renewable energy support expired.

Over the last years the thermal and solar energy has been considerably developed in many developing countries. The large projects start appearing there, for example, in Morocco a solar thermal station at the cost of 1.2 bln USD has been announced to be constructed near the city of Ouarzazate. Crowdsourcing started to play a prominent role in investing the small European and USA solar stations.

While in 2012 the investment relation between the developed and developing countries continued to shift towards the developing ones, in such sectors as the wind energy, small hydropower plants and geothermal energy, the developing countries have been already ahead of the developed ones according to the investment amounts. In particular, the developing countries have invested 45.3 bln USD in the wind energy, while the developed ones - only 35 bln USD.

As to the overall trends in the renewable energy investment, different sectors demonstrate the same performance and the environmental exposure.

REFERENCES

1. Krutova, I., 2012. Assessment of Renewable Energy Source Utilization in the Global Energy System. *Economic Issues*, 6: 34-40.
2. Anderson, T., 1976. *The Statistical Analysis of Time Series*. Mir, pp: 755.
3. Box, G. and G. Jenkins, 1974. *Time Series Analysis. Forecasting and control*. Mir, pp: 408.
4. Otnes, R. and L. Enochson, 1982. *Applied Time Series Analysis*. Mir, pp: 428.
5. Statistics. Date Views 11th October 2013 www.oecd.org.
6. Global Trends in Renewable Energy Investment 2012. Date Views 11th October 2013 www.oecd.org.
7. Global Trends in Renewable Energy Investment 2011. Date Views 11th October 2013 www.oecd.org.
8. Global Trends in Renewable Energy Investment 2010. Date Views 11th October 2013 www.oecd.org.
9. Global Trends in Renewable Energy Investment 2009. Date Views 11th October 2013 www.oecd.org.
10. Global Trends in Renewable Energy Investment 2008. Date Views 11th October 2013 www.oecd.org.