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PARADOX OF ALTERNATIVE ENERGY CONSUMPTION: LEAN OR PROFLIGACY?

Abstract: *Consumption of alternative energy resources is conventionally considered as an implement of lean management, main target of which is use of renewable (in terms of exhaustibility) energy resources. However, when it comes to actual consumption of alternative energy resources, the contradiction is arisen between «providence», the caused need of economy of non-renewable energy resources and rational environmental management and «providence» which is caused by cost reduction of energy consumption. What is the factual providence, how substantial is the dilemma between environmental friendliness and cost effectiveness in matters of energy savings, what is the significance of alternative energy consumption in countries with different economic types, what should balanced solution in energy mentioned issues are contemplated in current article.*

Keywords: *Lean production, Renewable energy sources, Industry consumption, CO2 emissions, «green» activity*

1. Introduction

Amplification of lean economy tendencies in economic agents performance, from domestic household to large industrial entities, is in considerable point explained by the growth of confirmed crisis occurrences, which have diverse origin. For instance, there are economic instability and limitation of financial resources, which require cost optimization and reduction of production expenses. Furthermore, problems of natural environment deterioration and decumulation of natural resource potential, which is considered as factor of production, determine the necessity of preserving the resources and rational use of nature.

In other words, lean economic activity is objectively becoming indispensable in current economic conditions and constrains business entities to alter and reorganize the manufacturing process taking into account affecting factors and in accordance with purposes and requirements of parsimony.

In scientific literature there are multitude of descriptive characteristics of lean production. Nevertheless, with sufficient harmony, intelligibility and rationality of the classical principles of providence, in practice of economic management there are certain situations occur which do not allow to ensure the fulfillment of all lean management requirements.

In this regard, the issue of selecting priorities in terms of providence is relevant. In order to substantiate this hypothesis and determine possible directions of rational economic activity in the event of mentioned contradictions, the use of alternative energy sources as an element of lean management is considered.

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2. Lean production as a system of postulates and requirements

Lean production is described in the literature from different positions. From one point it is assumed that «lean is a business management practice aiming to deliver greater value for customers with fewer resources», implying that «wide range of lean activities, including operational, logistical and maintenance improvements, applied both locally, and throughout the value chain» (David and Found, 2016).

Otherwise in a narrow sense, lean management is sometimes considered only in terms of organizational and logistic component of production and is construed as « leanness' can be conceptualized in terms of a quest for structural flexibility involving restructuring, downsizing and outsourcing» (Neumann et al., 2012).

One of the common approaches, which is remarkable for systematic conception of lean production, is classic construct of providence originated from the Toyota Production System (TPS). Current concept is based on the diminution of activities and operations in the production system that do not create added value. «The TPS system seeks to manage operations easily and efficiently, making optimal use of resources. The result is a manufacturing system capable of meeting the quality requirements and customer delivery at less cost (Samuel et al., 2013).

In continuance of this construct, deduced by Toyota in another version, the attention is focused on space and time aspect, on acceleration of production processes and lean management is considered not only as «optimizing of transactions», but the «accelerated production of links, as the acceluction regime» (Bounfour 2016).

Another thing worth being mentioned is that optimization of production activities according to the classical theory, the foundations of which are laid down in the TPS, is based on the reduction of losses.

In classical philosophy of lean production are considered in context of even types of waste (over-production, waiting time, transportation, processing, inventory, motion and scrap) in manufacturing or any type of business (Gao and Low, 2014).

However, in opinion of analysts, current enumeration concentrates on the process and ignores the significance of the human resource or social aspect, which points on it imperfection. While production system is to identify was completely. Researchers added one more waste: waste of unused employee creativity, which resulted in losing time, ideas, skills, improvements, and learning opportunities by not engaging or listening to employees. That is the reason why lean production, according to the proponents of this concept, should be defined as «an integrated socio-technical system, whose main objective is to eliminate waste by concurrently reducing or minimizing supplier, customer, and internal variability» (Gao and Low, 2014).

Moreover, there is an opinion that in current list comprises not self-arising types of losses, but ones which cause each other. «Observing the seven causes of waste, one can easily deduce that overproduction is the independent cause of further six other dependent causes that are sources of waste by themselves» (Tsigkas, 2013).

Supporting parties of this approach fairly allege that it is necessary to «add more energy consumption in production than necessary as a form of waste to the list… Savings achieved through energy conservation exclusively address the decrease in the cost of energy consumed» (Tsigkas, 2013).

Despite the variety of characteristics of lean manufacturing, its basic essence unchanged and aims to reduce losses, the value of which allows to consider reduction of production costs. Thus, we presume that main hallmark of lean production is the fulfillment of production economy requirement.

Nonetheless, on debates about what production is considered to be economical, there is also a point of view, according to which the requirement of environmental friendliness in modern industries is equivalent to the criterion of profitability and closely correlates with it.

This point of view is confirmed by studies and these researches studies underline the strong coherences and interdependencies between lean and green (L&G) manufacturing activities (Bergmiller, 2006).

Both perspectives share similar basics with eliminating waste as a major aspect. The results of studies even reveal that the existence of green manufacturing initiatives actually foster the implementation of lean management in companies and specifically supports to improve cost performance (Herrmann et al., 2008).

However, economic efficiency of the «green activity» of enterprises is justified in this case either through the theory of externalities, meaning that savings are achieved by emissions reduction, diminution of environmental fines and payments, or by energy savings of traditional energy sources.

Another position claims that use of certain types of environmental-friendly processes, technologies, in economic activity, contradicts the criterion of economy: «although Green concerns are recognized as important, they are still perceived as costly and unrelated to Lean in the majority of companies» (David and Found, 2016).

For example, use of renewable energy as one of the options of «green activity» in the context of the L&G system can be so costly that the costs for them are not compensated by the absence of fines and payments.

As a consequence, such paradox as the contradiction between efficiency and environmental friendliness arises in situations alike, and therefore it is necessary to find out what the right choice should be.

3. Use of alternative energy - conformity to the system of values of lean

In order to perceive the depth of emerging contradiction it is important to understand: how use of renewable sources in general might be considered in the context of lean production.

Use of renewable energy is the cornerstone of the philosophy of sustainable development. This is due to the fact that, «the transformation of the energy system is a pre-requisite for climate change mitigation. Access to clean, affordable energy is a fundamental requirement for sustainable development…Low-carbon energy system holds the potential to deliver multiple co-benefits in the areas of health, environmental integrity and energy security (Hansen et al., 2012).

In the context of sustainability « it means, making use of natural resources without destroying them, without exceeding its resilience, without excluding the possibility of their use by future generations» (Alves et al.,2016).

It has been a short while since the theory of sustainability and lean production were considered as interconnected. As a connecting link, issues of waste reduction are considered foremost, including reduction of carbon dioxide emissions, directly promoted to the sustainable growth. Obviously, within the values of lean production, carbon emissions are coming up with the type of wastes that do not create added value and can be significantly reduced to low levels with lean management.

Carbon Emissions occur in production processes when fossil fuels are used. In order to understand the scale of influence of this factor in the context of well-known seven-waste system, we will highlight the energy component in the list of environmental factors (Table 1), proposed in the article «An environmental perspective on Lean Production» (Herrmann et al., 2008).

Table 1. Energy component in the list of factors that environmental impacts

Waste Type	Energy environmental impacts	Consciences
Overproduction	More energy consumed in making the unnecessary products	More CO2 emissions
Inventory	More energy used to heat, cool and light inventory space	
Transportation and Motion	More energy use for transport	
Defects	Energy consumed in making the defective products	
Over processing	Unnecessary processing increases wastes, energy use	
Waiting	Wasted energy from heating, cooling and lighting during production downtime	

Apparently, when renewable energy sources are used, the problem of CO2 emissions ceases to exist not only as a result of reduction of waste in the context of the movement of the production system to the principles of lean production, but also in the system of basic production costs of the enterprise related to energy consumption.

Thus, renewable energy consumption meets the requirements of lean production waste reduction and can be characterized as rational and generating benefits.

Thus, renewable energy consumption meets the requirements of lean production waste reduction and can be characterized as rational and generating benefits. However, with possible savings on emissions-related payments, the issue of the correlation between the cost of alternative energy sources and the basic energy consumption option, considered as the total cost of traditional energy resources and payments for emissions associated with their use, arises, as noted above.

In further consideration the scale and trends of alternative energy use in industrial production in economies of various types are described in order to understand the factors that determine the choice of economic entities in favor of economically advantageous traditional or «green» energy consumption options.

4. Status and trends of alternative energy consumption in the manufacturing sector by types of national economies

The World Bank data confirm that the share of renewable energy consumption in percentage of final energy consumption has a general tendency of small growth and has increased from 17,9% to 18,9% in period from 2000 to 2014 (with a slight decrease in 2004 and 2007) (Figure 1). At the same time, experts note that «new energy sources (primarily solar and wind power) became the engine of the rapid growth of renewable energy sources (RES) in the last 25 years - their share increased from 1,5% in 1990 to 6,3% in 2014 and is expected to overtake with hydropower share in 2030, reaching 16,3% (Khokhlov, 2017).

If it is considered that share of renewable energy consumption in percentage of total final energy consumption for groups of countries distinguished by GNI per capita, then there can be significant differentiation between high-income countries, characterized as developed countries and middle- and low-income countries

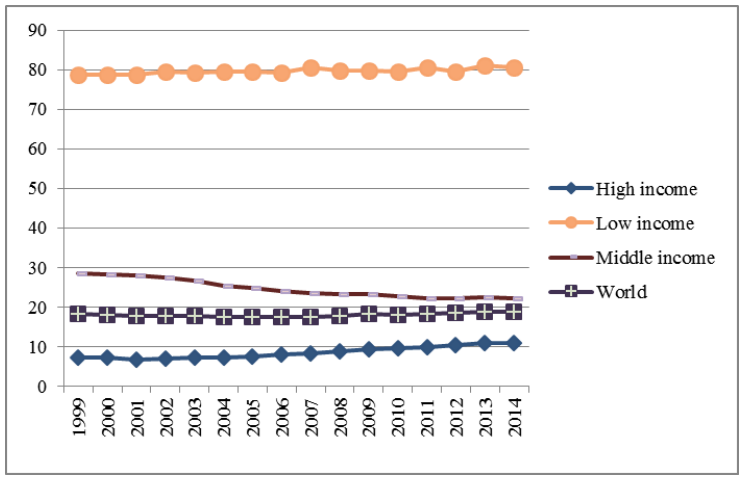

Figure 1. Renewable energy consumption (% of total final energy consumption), adopted from data world bank (World Bank, 2017)

Significant share of renewable energy consumption in percentages of total final energy consumption in low-income countries is conditioned by the prevalence of solid biofuel use in households and small businesses of agricultural sector, which simultaneously determined global structure of the sectoral consumption of renewable energy (Figure 2) (International Energy Agency, 2016; International Energy Agency, 2017).

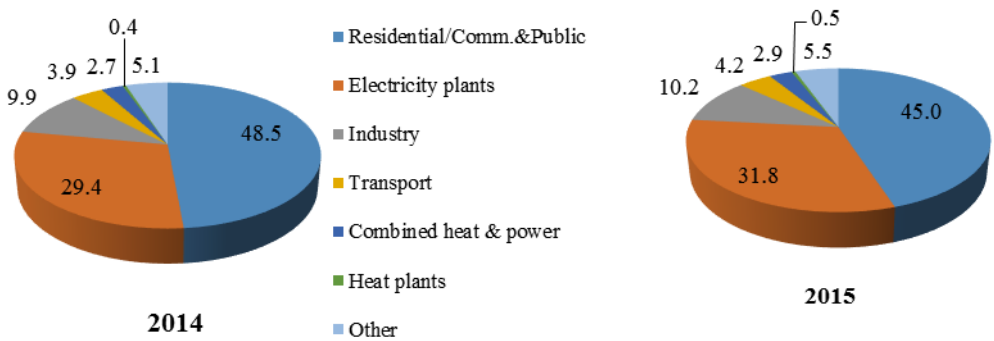

Figure 2. World sectoral consumption of renewable

According to data in 2014, about 48.5% of renewable energy sources around the world have been used in residential, commercial and public service sectors. However, in 2015, the share of this indicator has reduced to 45%, due to increase in the share of RES used in transport (from 3.9 to 4.2%), industry (from 9.9 to 10.2%), and the development of thermal and Electricity (in total from 32.5 to 35.2%).

Considering use of renewable energy sources in the manufacturing sector, it should be noted that despite an increase in the aggregate consumption of renewables, the trends in industrial consumption in the country context are ambiguous.

For example, in developed countries, with a promotional scheme for renewable energy (Paschke, 2017) , patulous incentive mechanism for producers and industrial

consumers of renewable energy (including a well-known system of green certificates, the installation of mandatory quotas for the production, supply or consumption of renewable energy, the provision of bonuses, incentives, compensation, differentiated tariff policy for the released and consumed energy) there is a constant growth in number of companies of manufacturing sector, using in production process electric and thermal energy from renewable resources (Klochkov et al., 2017).

There are examples of two applications of solar thermal systems in the dairy industry in Greece; Bio-isoprene has been successfully produced by the Danish company Genencor, one of the leaders in the production of enzymes for second generation biofuels. Owing to pure technology, the Sumitomo Rubber Industries for Dunlop have managed to reduce the fossil content in the Enasave tyre to only 3%. In addition, Demonstration plants have been successfully running under several research projects, including the IEA Solar Heating and Cooling (SHC) programme, and the Mediterranean food and agricultural industry applications of solar cooling technologies (MEDISCO) (Renewable Energy, 2010).

When attention is spread beyond production confines, examples of successful implementation of renewable energy can be also found.

A good example is the single largest private employer in the United States, the retailing giant, Walmart. This company set an ambitious target 'to produce zero waste, to be supplied with 100% renewable energy and to sell sustainable products (Lee and Vachon, 2016).

Successful experience in the use of RES in large industrial companies in developed world countries is determined by the sufficient financial and technological potential for the purchase or installation in production sector of renewable energy generators (Gazizulina et al., 2017). Nonetheless, discussions about singlestable and intensive growth dynamics in the use of RES in the industrial sector of developed countries are precocious and this fact is proved by the country statistical indicators (Table 2).

Table 2. Indicators of industry and total consumption of RE in high-income countries *

Country	Industry consumption TJ ,%						Total RE Consumption, TJ		
	2013		2014		2015		2013	2014	2015
Australia	158738	53	148270	50	153917	52	298452	294897	296824
Belgium	47652	42	52393	44	56975	45	114451	120148	127373
Canada	991905	51	643098	40	625217	39	1939343	1615016	1584351
Germany	309361	30	350455	32	368 680	31	1034315	1085922	1182178

* adopted from data IRENA (International Renewable, 2017)

So if in 2013-2015 in Belgium, absolute and relative indicators evidence that there was an increase in consumption of renewable energy in industry, then in Canada there are reverse trends in reduction of these indicators. The same situation was observed in 2104 in Australia, despite a significant share of industrial consumption of RES (more than 50% of total consumption of RES). In Germany, in 2015, share of industrial consumption of renewable energy declined slightly, although at the same time there was an increase in physical volumes of consumption of RES.

If we consider in the same period examples of low-income countries, then the level of consumption of renewable energy in general and in industry in particular is much lower. (Table 3).

Table 3. Indicators of industrial and total consumption of RE in low-income countries

Country	Industry consumption TJ ,%						Total RE Consumption, TJ		
	2013		2014		2015		2013	2014	2015
Kenia	-	-	23232	8	25424	9	-	291033	293669
Zambia	46414	17	46254	17	47733	17	274666	279922	282423
Pakistan	142703	27	152355	28	36617	8	534367	548814	439937
Afganistan	-	-	0	0	0	0	-	24670	24767

- нет данных

* adopted from data IRENA (International Renewable, 2017)

If in African countries: Zambia and Kenya, the situation either does not change or changes slightly for the better; in Pakistan there is a sharp decline in industrial consumption of RES (from 152355 TJ in 2014 to 36617 TJ in 2015). In Afghanistan, in the total absence of industrial use, RES are 90% used by household sector and 10% by services sector.

Considered examples, with some degree of conventionality, evidence that influence of countries financial well-being and do not fully explain issues of using renewable energy in industrial production since there are many other factors, circumstances and conditions.

If we talk about possible impact of the competitiveness factor of fossil energy sources and RES (Table 4), then the situation here is also not clear. Obviously, with sufficient volumes of fossil resources in Russia and Norway, share of industrial renewable energy consumption is approximately 38-40% in the same range, whereas in the UAE this indicator is critically small (2% in 2015).

Table 4. Indicators of industry and total consumption of RE of oil and gas producing countries

Country	Industry consumption, TJ ,%						Total RE Consumption, TJ		
	2013		2014		2015		2013	2014	2015
Russia	218635	38	208377	36	257112	42	569 742	586 955	607 089
United Arab Emirates	36,1	5	104	2	114	2	954	4628	5598
Norway	167388	38	166456	39	169269	39	443688	425157	435172

* adopted from data IRENA (International Renewable, 2017)

But, this factor can not beestimated reliably, since a number of other factors operate simultaneously, which can either strengthen or compensate each other.

Among other factors, it is important to emphasize the effect of CO2 emissions, which are mainly generated by thermal power plants working for industrial enterprises. If the indicator of CO2 per capita in the above-mentioned countries is considered, it is obvious that this indicator is higher in countries where the scale of industrial production is significant: in Australia, Canada, Russia, Germany and Belgium (Figure 3).

At the same time in Australia and Canada in the dynamics of 2000 - 2013 there are tendencies of endurant emission reduction, while in Russia the level of CO2 per capita is steadily growing.

Obviously, concern about emissions is one of the most significant factors that determine scale of industrial consumption of RES. However, as in the case of the described

factors (availability of sufficient financial capacity, mechanism of incitement for manufacturer and industrial consumers of renewable energy and of renewable fuel resources) unidirectional effect of a single factor does not allow to objectively evaluate the tendency of industrial consumption of renewable energy.

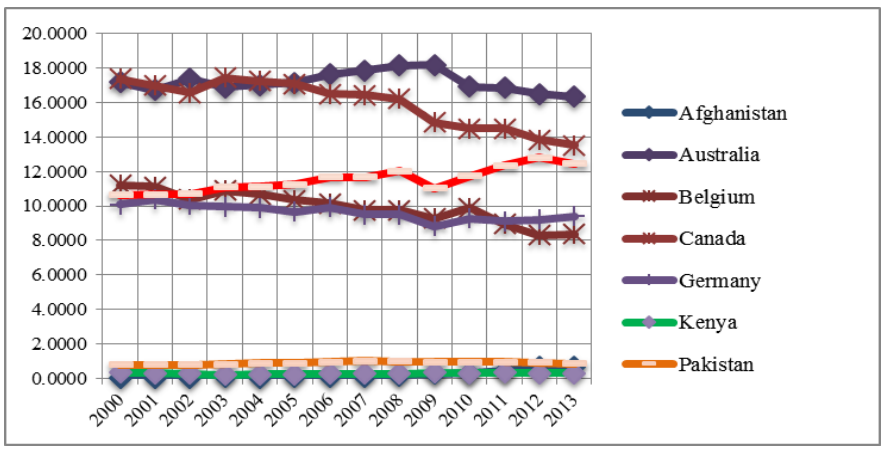

Figure 3. CO2 emissions (metric tons per capita), adopted from data world bank (World Bank, 2017)

The range of factors determining the level and trends in use of renewable energy in industrial production is quite wide. Among the most important factors, experts also refer to framework of legislative acts, including tariff policy pursued in the country, which stimulates not only industrial consumption of renewable energy, but, above all, the production of RES (to ensure supply of renewable energy on the market).

For example, in the EU countries, the tariff policy, among other things, includes incentive measures such as (Electronic Journal, 2011): quotas for energy companies to generate electricity from RES in the amount of 2-15% of electricity sales, mandatory to purchase at a 20-year fixed price of electricity from owners (In Germany at a price of 0.57 Euro / kWh at a power of less than 30 kW, in Spain 0.4 Euro / kWh at a power of less than 5 kW, in Austria 0.6 euro / kWh at a power of less than 20 kW, in Luxembourg 0.5 Euro / kWh, in France - 0.295 euro / kWh at a capacity of up to 450 kW); Freedom of choice for consumers of electricity generated by renewable energy, the power company from which electricity will be p urchased; grants for the installation of generators for RES (not more than 40-75% of the cost of the generator, low lending rates and tax incentives for entities that finance the cost of purchasing and operating equipment using RES and number of other measures.

At the same time, the improvement of tools for regulatory promotion of producing and using of renewable energy is continued, despite the complexity of the tasks of legislative regulation in this field.

For example in Germany, programm Energiewende took place in the development of energy concept, adopted by the German government in September 2010. It outlines Germany's energy policy orientation until 2050 and specifies measures for development of renewable energy, development of the networks and energy efficiency (Paschke, 2017).

EEG 2014, with its changes on volume control and direct marketing, introduced significant changes to the promotion regime of renewable energy. It is the first amendment that provides for a volume

control of eligible electricity from renewable sources. The Act also includes mechanisms that ought to reduce promotion costs of electricity from renewable sources in terms of cost efficiency. The volume control is carried out in such a way, that an expansion target is determined for the share of consumption of every climate neutral energy source for certain periods of time. This ought to make actual implementation more specific and predictable (Paschke, 2017).

Similar tools are used in some developing countries. Thus, in Thailand, in a framework of implementation of the Alternative Energy Development Plan (AEDP), regulatory instruments include: reduction or complete exemption from customs duties on imported equipment and machines operating at expense of alternative energy; Tax preferences for enterprises producing RES or using energy-saving technologies (usually based on alternative energy consumption); Subsidizing for producers of alternative energy at certain prices depending on the source of RES: biomass: 4,24-5,34 THB / kWh; Biogas: 3.76-5.34 THB / kWh; MSW: 5.08-6.34 THB / kWh; Wind: 6.06 THB / kWh; Water: 4.90 THB / kWh; Of the sun: 5.66-6.85 THB / kWh. Grants and targeted financial support instruments in Thailand are used through special funds ENCON Fund and ESCO Revolving Fund, created to encourage private investment in projects in the field of renewable energy and energy efficiency (Sathienyanon, 2015; Esco Revolving Funds, 2017)

Examples of the implementation of effective instruments of the state energy policy in field of production and use of renewable energy canbe found in developing countries such as China and India, they have surpassed the US at the top of the latest Renewable energy country attractiveness index (RECAI). In China, the National Energy Administration (NEA) announced in January 2017 that it will spend US$363 b developing renewable power capacity by 2020. This investment will see renewables account for half of all new generating capacity. China also plans to launch a pilot tradable green certificate program in July 2017 for project operators to prove they have generated clean power and sell to consumers (Ernst, 2017).

Moreover, in India, in recent years, significant progress has been made in area of production and use of RES, owing the Government's program to build 175GW in renewable energy generation by 2022 and to have renewable energy account for 40% of installed capacity by 2040. The country has added more than 10GW of solar capacity in the last three years – starting from a low base of 2.6GW in 2014 (The economic times, 2017).

Important factor forced develop renewable such, as energy of solar and wind was nuclear disaster at Fukushima. Following the accident, some countries reviewed their nuclear-energy policies, driven in part by public opinion. Germany, which relies on nuclear power for 23% of its electricity needs, immediately shutdown seven of its older reactors and reaffirmed that it would abandon all nuclear power plants by 2022, while Switzerland also decided to abandon nuclear power by 2034. In Italy, a referendum turned down a government plan to construct new nuclear power plants (Hayashi and Hughes, 2013).

Thus, the propagation of solar and wind energy and others of the same is also considered as a way to reduce dangerous nuclear generation and for some countries it is also an opportunity to reduce the dependence on imported fossil fuels, reducing vulnerability to changeable world prices for gas and coal.

In general, in the context of assessment of the scale of production and industrial use of RES in developed and developing countries, one could note the overall positive direction and the desire to develop the production and consumption (including industrial) of the energy generated by renewable energy sources.

However, as practice has shown, there are also some negative aspects related to the

competitiveness of RES based on which there is an opinion that «green» energy is too expensive in comparison with the conventional one, and it develops only due to state support. A high share of debt financing in RES projects (up to 80%) can lead to bankruptcy of companies or to the need to allocate government support funds»(Khokhlov, 2017).

Certain facts partly confirm this point of view: so in Germany in July of 2014 the bankruptcy was announced by Prokon windmill manufacturer (Reuters News Agency, 2014), in april of 2017 the same happened to the manufacturer of solar installations and equipment Sun Edison (Kary and Eckhouse, 2017), in may of 2017 - solar panel manufacturer - Solarworld. In April of 2017 US manufacturer of solar panels Suniva also announced being a bankrupt. Among the reasons of bankruptcy of mentioned companies researchers define problem of saturation of some segments of the RES market. In fact, according to forecasts in 2017 number of solar batteries will grow only by 1.3% against 35% in 2016. In addition, decrement of subsidies provided by European governments to companies working with renewable energy sources and the availability of cheaper Chinese counterparts (Rozhdestvenskaya, 2017).

Current examples do not indicate mass trends in production of renewable energy, however, in a number of cases they demonstrate a critical level of efficiency of renewable energygeneration, production of which, without subsidizing, will lead to rise in the cost of tariffs and will accordingly limit the possibilities for broad industrial consumption.

Obviously, the problem of expanding the use of renewable energy, including in the framework of industrial consumption, is rather complicated, andlist of influencing factors whose influence is multidirectional is far from exhaustive.

In this regard, the search for opportunities of RES use in manufacturing sector lies in the plane of clear impact factors identification and assessment of the extent of influence on a particular national economy, taking into account its potential and characteristics.

5. Balanced decisions based on an assessment of the factors and conditions which are existing in national economy

Based on the analysis of technological possibilities of using various types of renewable energy in different branches of industrial production, in 2010 UNIDO specialists predicted a steady increase in the «green» activity of enterprises by 2050. For example, use of the biomass potential for process heat in industry by 2050 was estimated in the following proportions: in chemical and petrochemical - 37%, in non-metallic minerals -25%, paper, pulp and printing -18%, wood and wood products - 10%, food and tobacco - 4%, iron and still - 4%. Similarly, for the solar thermal potential for the process of heat inindustry in the 2050 the sectoral breakdown is estimated as follows: food and tobacco - 46%, machinery -20%, mining and quarrying -16%, textile and leather -13%, transport equipment -5% (Renewable Energy, 2017).

For the first case, it is important that the potential for biomass use in the national economy is largely determined by the availability of biomass resources, created mainly in the agricultural sector, in the second case, effective use of solar energy is possible in countries with stable solar radiation. Similar examples can be cited and considered for energy of wind, tides, etc.

In other words, presence of natural conditions in a particular country contributes to the formation of the minimum necessary level of costs for the production of renewable energy sources of the appropriate type, and, consequently, creates the potential for large-scale generation and use of RES,

including industries (Glukhov, et al., 2015). Their inadequacy, in turn, does not mean impossibility of generating renewable energy in a particular country, but in this case their competitiveness can be ensured only by instruments of state financial support.

Another country parameter, the accounting of which is important for determining the need for additional or alternative power supply, is technical base of industry, the potential and the dynamics of its development. In countries with outdated technical base and used technologies, in the absence of developed infrastructure and communications, use of renewable energy becomes a priori impossible, whereas on the contrary, in countries with progressive technical potential, the characteristics of the equipment and technology used allow to use of various types of energy, including RES.

In the first case, the situation may also be aggravated by the negative state of the atmosphere, which in the opinion of researchers (Safina and Lebedeva, 2016) is the result of the use of «dirty» production technologies, the lack of environmental constraints, the lack of economic incentives for environmental conservation activities.

In this case, balancing factors are instruments of financial state regulation of a wide range of actions, from tax preferences to subsidizing environmental programs of enterprises that involve use of renewable energy sources.

In the absence of the possibility of using financial tools, favorable institutional conditions, the creation of systems for encouraging the implementation of environmental requirements and certification, confirming the generation of a certain amount of energy based on RES, can be a prerequisite for stimulating the green activity of enterprises (Glukhov, et al., 2016).

In this regard, it is rightly noted (Charles et al., 2014):

- Countries must set objectives and develop consistent, durable, and clear national policies to manage the complexity of large-scale renewable energy integration;
- A high level of renewable penetration presents unique challenges, but is manageable through a coordinated system-wide approach;
- Solutions must be tailored to local conditions and include monitoring mechanisms.

All the parameters, factors and conditions considered are in fact a definite field, the clearness of which allows the subjects of the national economy, including the production sector, to determine their own capabilities and priorities in business (the social and ecological orientation of which, as is known, attracts consumers and can bring also commercial benefits thereby).

Thus, a reliable assessment of all existing factors and conditions operating in the national economy will allow the subjects of industrial production to determine their own strategic guidelines and to find a compromise solution in the contradictory issues of maximizing profits and the need to reduce long-term environmental consequences.

6. Conclusion

Use of alternative energy sources in industrial production lies in the plane of lean production issues, which is manifested in the reduction of CO2 emissions at all stages of energy consumption and waste reduction during the production cycle. Actual choice between renewable and non-renewable sources is determined with large extent by resolving the contradictions between economic and environmental performance criteria of business.

An assessment of the scale of industrial consumption of renewable energy shows the contradictory trends observed in different countries. The action of a wide range of factors and conditions, from climatic to

institutional ones, determines the specifics, possibilities and prospects of energy generation from RES and its subsequent consumption in each nationally taken national economy. An accurate and objective analysis of these factors allows the companies in the manufacturing sector to determine the most optimal variant of energy consumption, both in terms of achieving economic goals and reducing the negative environmental consequences of the business conduction effectiveness.

References:

Alves, A., Moreira, F., Abreu, F., & Colombo, C. (2016). Sustainability, Lean and Eco-Efficiency Symbioses. In M. Peris-Ortiz, J. Ferreira, L. Farinha, N. Fernandes (Eds) Multiple *Helix Ecosystems for Sustainable Competitiveness. Innovation, Technology, and Knowledge Management.* Cham: Springer.

Bergmiller, G. G. (2006). *Lean Manufacturers Transcendence to Green Manufacturing: Lean Manufacturers Transcendence to Green Manufacturing.* USA: University of South Florida.

Bounfour, A. (2016). *Digital Futures, Digital Transformation: From Lean Production to Acceluction (Progress in IS)*. Springer.

David, S. M. C., & Found, P. (2016). An Implementation Model for Lean and Green. In A. Chiarini, P. Found, N. Rich (Eds) *Understanding the Lean Enterprise. Measuring Operations Performance*. Switzerland: Springer.

Ernst & Young Global Limited. (2017). *Renewable energy country attractiveness index.* Retrieved from: http://www.ey.com/Publication/vwLUAssets/EY-RECAI-49-May-2017-index-at-a-glance/$FILE/EY-RECAI-49-May-2017-index-at-a-glance.pdf

Ernst & Young Global Limited. (2017).*Press release*. Retrieved from: http://www.ey.com/gl/en/newsroom/news-releases/news-ey-china-and-india-overtake-us-at-top-of-renewable-energy-attractiveness-index

Esco Revolving Funds. *Energy for Environment Foundation.* Retrieved from: http://www.efe.or.th/escofund.php?task=8

Gao, S., & Low, S. P. (2014). *Lean Construction Management*. Springer, Singapore.

Gazizulina, A., Eskina, E., Vasilieva, I., & Valeeva, O. (2017). The Reasons for the Increase in Self-Organization in Companies. *International Journal of Reliability, Quality and Safety Engineering*, *24*(6), 1740002 (11 pages). DOI: 10.1142/S0218539317400022.

Glukhov, V. V., Ilin, I. V., & Levina, A. I. (2015). Project Management Team Structure for Internet Providing Companies. In: Balandin S., Andreev S., Koucheryavy Y. (Eds) *ruSMART 2015: Internet of Things, Smart Spaces, and Next Generation Networks and Systems*. Lecture Notes in Computer Science, 9247. Cham: Springer.

Glukhov, V., Turichin, G., Klimova-Korsmik, O., Zemlyakov, E., & Babkin, K. (2016). Quality management of metal products prepared by high-speed direct laser deposition technology. *Key Engineering Materials*, *684*, 461-467.

Hansen, G., Jakob, M., & Kadner S. (2012). Sustainable Development as a Cornerstone of a Future Energy System. In O. Edenhofer, J. Wallacher, H. Lotze-Campe, M. Reder, B. Knopf, J. Müller (Eds) *Climate Change, Justice and Sustainability*. Dordrecht: Springer.

Hayashi, M., & Hughes, L. (2013). The Fukushima nuclear accident and its effect on global energy security. *Energy Policy*, *59*, 102-111.

Herrmann, C., Thiede, S., Stehr, J., & Bergmann, L. (2008). An environmental perspective on Lean Production. In M. Mitsuishi, K. Ueda, F. Kimura (Eds) *Manufacturing Systems and Technologies for the New Frontier*. London: Springer.

International Energy Agency. *Key Renewables Trends. Excerpt from Renewables information* (2016 edition). Retrieved from: www.iea.org/statistics/topics/renewables/

International Energy Agency. *Key Renewables Trends. Excerpt from Renewables information* (2017 edition). Retrieved from: http://www.iea.org/publications/freepublications/publication/renewables-information--2017-edition

International Renewable Energy Agency (IRENA). *Renewable Energy Balances. Final Renewable Energy Consumption.* Retrieved from: http://resourceirena.irena.org/gateway/dashboard/?topic=18&subTopic=47

Kary, T., & Eckhouse, B. (2017). *Sun Edison Sees Life Post-Bankruptcy, Creditors Contest Value.* Retrieved from: https://www.bloomberg.com/news/articles/2017-03-29/sunedison-sees-life-after-bankruptcy-creditors-question-value

Khokhlov, A. (2017). *Renewable energy sources: a new revolution or another bubble. Forbes*. Retrieved from: http://www.forbes.ru/biznes/343591-vozobnovlyaemye-istochniki-energii-novaya-revolyuciya-ili-ocherednoy-puzyr

Klochkov, Y., Papic, L., & Butkevich, R. (2017). Development of the Standardization System in an Organization. *International Journal of Reliability, Quality and Safety Engineering*, *24*, (6). DOI: 10.1142/S0218539317400046.

Lee, K. H., & Vachon S. (2016). The Carbon Economy: A Brave New World? In: *Business Value and Sustainability*. London: Palgrave Macmillan.

Neumann, C., Kohlhuber, S., & Hanusch S. (2012). Lean Production in Austrian Industrial Companies: An Empirical Investigation. In H. Jodlbauer, J. Olhager, R. Schonberger (Eds) *Modelling Value. Contributions to Management Science.* Physica-Verlag HD, pp 275-289.

Paschke, M. (2017). Legal Challenges of the New Energy Policy in Germany. *Zapiski Gornogo instituta*, *226*, 487-496. DOI: 10.25515/PMI.2017.4.487 p.487

Reuters News Agency (2014). *German wind park group Prokon warns insolvency possible*. Retrieved from: http://www.reuters.com/article/prokon-insolvency-idUSL6N0KL0AP20140111

Rozhdestvenskaya, Y. (2017). *How European solar cell manufacturers lost to the Chinese*. Retrieved from: https://www.kommersant.ru/doc/3296887

Safina, E., & Lebedeva, O. (2016). Improvement of economic tools of promoting and inspiring environmental activities in the mining industry. *Mining Journal*, *2227*(6), 67-73

Sathienyanon, P. (2015). *Alternative Energy Development Plan 2015-2036 (AEDP 2015)*. Retrieved from: http://thailand.ahk.de/fileadmin/ahk_thailand/Projects/Biogas_Presentation/AEDP-Biogas-GT-_08-06-15.pdf

The economic times. (2017). *India ranked second in renewable energy attractiveness index*. Retrieved from: http://economictimes.indiatimes.com/articleshow/58698180.cms?utm_source=contentofinterest&utm_medium=text&utm_campaign=cppst

Tsigkas, A. C. (2013). Basic Principles of Lean Production. In: *The Lean Enterprise*. Springer Texts in Business and Economics. Berlin, Heidelberg: Springer.

UNIDO. *Renewable Energy in Industrial Applications. An assessment of the 2050 potential* (2010). p.60. Retrieved from: https://www.unido.org/fileadmin/user_media/Services/Energy_and_Climate_Change/Energy_Efficiency/Renewables_%20Industrial_%20Applications.pdf

World bank. Renewable energy consumption (% of total final energy consumption). Retrieved from: http://data.worldbank.org/indicator/EG.FEC.RNEW.ZS?view=chart

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