RESEARCH PAPER

Energy demands and the world's population growth as challenges for the knowledge economy

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Abstract
The aim of this paper is to analyze the near future challenges regarding energy demands and the world population growth that knowledge economy faces as a new economic paradigm.
Knowledge based economy uses far less quantity of labor, capital, energy and raw materials, compared to the conventional economy and accomplishes better results in economic sense. Products into which knowledge is built in are more sophisticated, more functional, more durable, more useful, "intelligent", they are environmentally friendly and above all, they use far less energy than products produced in the conventional economy.
Hence, this economic paradigm will be able to deal much better with global challenges such as: world population growth and within this regard: the growth of the urban population, increased food requirements, increased demands for clean water sources, management of soil fertility and the satisfaction of the energy demands in the following period.
Key Words: *knowledge economy, conventional economy, energy, poverty, new technologies*

Introduction

The period after the oil crisis is to be considered as the beginning of the non-industrial form of production. It is not a phenomenon that can be exclusively related to industrial production, but to the appearance of completely new characteristics of production and reproduction in general and in the society as a whole. Unlike industrial production, which rests on capital, labor and the land, non-industrial production rests primarily on information, knowledge, innovation and individual creativity as the necessary factors for productivity and organization of production. In this way, the new form of production and new technologies are free from the inflexibility of conventional factors of production that allows them to cope with the upcoming challenges in the world, especially from the aspect of world population growth.

The essence of the knowledge economy

The knowledge economy is a new economic paradigm in which knowledge plays a dominant role in creating the wealth of a country. Today, knowledge is of strategic importance to countries and businesses around the world, and the theories according to which countries possess competitive ability based on relatively cheap factors of production such as raw materials, energy sources or cheap labor force are not valid in the case of many countries. The example of Japan or Israel illustrates how it is possible to develop a competitive advantage by applying knowledge

and in conditions of expensive energy, lack of raw materials, expensive labor force, lack of fertile agricultural soils etc. The knowledge economy uses the same factors of production as the conventional economy, but in a much less quantity and, most importantly: it gives them added value, applying and incorporating additional knowledge in them. So, the knowledge economy uses far less labor, capital, energy and raw materials, and achieves better effects in an economic sense, thanks to the built-in additional knowledge in the product. This new concept is manifested in a whole range of characteristics such as design, usefulness, functionality, durability as well as knowledge incorporated in the good or service. Products into which knowledge is built in are more durable, more functional, more useful, more intelligent, they are ecological and use far less energy in comparison with the products that originate from the production in conventional economy.

Conventional economy

The conventional economy had its own expansion time in the period when the society functioned on the basis of massive exploitation of relatively low-cost energy inputs, such as oil, coal and gas. Oil crisis in the 1970s and the inflation rise in the developed countries in the 1990s, caused by oil market disruptions, has shown the whole illusion of the paradigm for economic development based exclusively on mass production. The conventional economy has produced certain market conditions that in the long run had become the main reason for its gradual decline, taking into consideration the fact for irrational and almost absurd way of usage of the basic production factors such as labor, capital and other resources (energy, raw materials etc.). Also, this type of economy produced many negative phenomena such as oil crisis, unemployment, inflation. It created a mass of consumers that purchase products for whose production a large amount of energy was irresponsible used. This economy supported a senseless and irresponsible behavior of economic entities in the exploitation of natural resources at the expense of irreversible pollution and destruction of the human environment.

All its major "successes" and results were only the consequence of the oppressive exploitation of fossil fuels (coal, oil and gas), and far less were the result of human intelligence, innovation, creativity, organization and major scientific discoveries. The illusion of the "success" of such an economy lasted exactly till the first major oil crisis. The conventional economy based its economic paradigm on economies of scale and massive exploitation of energy, mass consumption of material goods and the accumulation of material wealth.

Summarized, the characteristics of the knowledge economy can be presented in the following way: sustainable economic growth, innovation and advancement, design, usefulness, functionality, product durability, knowledge built in the product, new product quality, education, environmental approach in production. All of this, in the long run, should cause positive economic and non-economic effects (sustainability of the economic growth, mobility, etc.). On the other hand, the sublimated characteristics of the conventional economy would be: mass consumption, economies of scale, "dirty" technologies, spending large quantities of energy, industrialization of agriculture, welfare state, etc. Here, in the long run, would be caused negative economic and non-economic effects such as: environmental pollution, macroeconomic distortions, market instability etc. (Figure).

In this context, a good plastic example that very accurately explains the essential difference between the knowledge economy and the conventional economy, as well as their characteristics, is as follows: Both, coal and knowledge, contribute to the output of an economy. But when a certain amount of coal, for example a ton, is used as a fuel, this amount of coal is forever used and can't be used again. A new amount of coal needs to be processed, causing costs in the form of salaries for miners, depreciation of machines, etc., in order to obtain the second tone of coal and to continue its use as an energy input in the

industry. On the other hand, once created knowledge, can be used again and again, without fear that it will be wasted and without any additional cost for its creation (1)

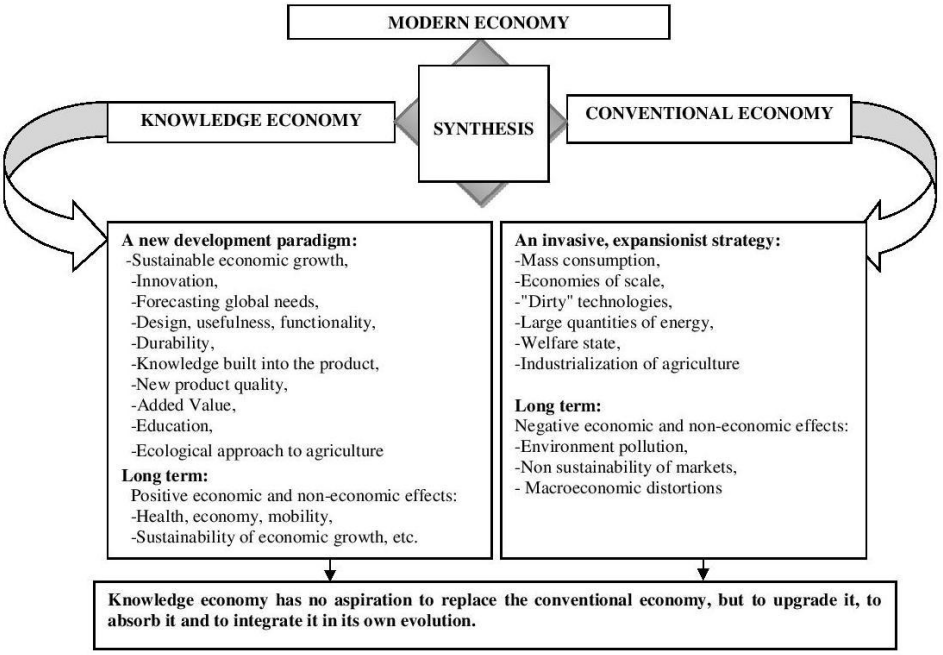

Figure 1. Basic dichotomy of the modern economy

The role of energy in the knowledge economy

For any production, it is necessary to use a certain amount of energy. Energy can be divided into two major groups: renewable and non-renewable energy. In recent decades, non-renewable energy sources have been very intensively used. For these reasons, some studies alarm the world that in near future these sources will be exploited and if new ones are not discovered, the economic development will come to an end.

Since the Industrial revolution, global energy consumption has been growing rapidly, especially on fossil fuels. In the forthcoming period (by 2030), over 80% of the required energy will be generated from fossil fuels (oil, gas, coal), nuclear energy will participate with 5,5%, hydropower and "new renewable sources" with 1%, while traditional (or non-commercial) energy sources with 13,5%. (*Adapted according to International Energy Agency (IEA), World Energy Outlook, Paris, 2005, pp. 80)*

Energy is deeply involved in the economic, social and environmental dimensions of human development. The energy itself is not sufficient for creating economic growth, but it is necessary for the development of the economic activities with which growth is achieved. Economic growth always leads to increased energy consumption, especially in the early stages of development. In doing so, economic analyses show the great importance that energy plays for the economic growth in modern economies based on knowledge. During the era of the conventional economy, much more energy per product unit was used, which was reflected in its price. Unlike conventional economy products, the knowledge economy products use intelligent solutions, use information and knowledge, and use much less energy per product unit for their production. At the same time, the coefficient of utility becomes several times bigger with each new solution and innovation. Spending less energy and material resources has, also, a multiplier effect in general.

Furthermore, the contribution of energy to the economic growth of a country can be more accurately assessed if the energy is incorporated in the standard Cobb-Douglas production function (the production function here is characterized with constant rate of returns). In this case, the production function would receive the following form:

$$Y_t = A_t(K_t)^{\alpha}(L_t)^{\beta}(E_t)^{1-\alpha-\beta}$$

Where:

Y is output,
K is capital,
L is labor,
E is primary energy consumption,
A is the total factor productivity *(TPF)*,
t is time, and
α and β are numbers between 0 and 1, that represent the proportional participation of the factors of production in the output creation.

Research on these contributions has shown that the combinations of capital, labor and energy have contributed more to the economic growth than to productivity.

The energy intensity of an economy is a measure of the annual energy demand for the production of one unit of economic output. Reduced energy intensity means less quantity of energy required to produce the same output, which is related to energy efficiency. The energy consumption in the period from 1970 to 2000 doubled. By 2030, it should be expected a further duplication of consumption, which will occur mainly in developing countries. Otherwise, there is no energy deficit, and in that context, it should be mentioned that the solar energy that comes to Earth is 100 times greater than the one needed to meet all human needs. The problem that occurs is how that energy can be accumulated and stored in order to be used later when needs will arise. This requires very large capital investments, but at this point, there is no possibility for greater commercialization in the usage of this type of energy.

Table 1**.** Contribution of the factors of production and the total factor productivity to GDP growth, 1980-2001

Country	Average annual growth of real GDP (%)	Contribution of the factors of production and the total factor productivity (TFP) to the growth of the real GDP (% of GDP growth)			
		Energy	Labor	Capital	TPF
Brazil	2,4	77	20	11	-8
China	9,6	13	7	26	54
India	5,6	15	22	19	44
Indonesia	5,1	19	34	12	35
Korea	7,2	50	11	16	23
Mexico	2,2	30	60	6	4
Turkey	3,7	71	17	15	-3
USA	3,2	11	24	18	47

Source: International Energy Agency (IEA), (2004): World Energy Outlook, Paris, pp. 333.

Atomic energy is also a source of energy, which is increasingly used in modern economies and it complements deficits from other fuels. This type of energy also requires considerable resources for its production, as in order to ensure controlled atomization, high technology is needed with several protective ramparts, sure security and permanent control. This means increased price per unit of energy. If all these technologies and security protocols are not applied, there may be a nuclear disaster with uncontrolled radiation and pollution of the human environment (The consequences of the nuclear accident in Chernobyl (then the USSR, today's Ukraine), which happened in 1986, are felt today as well. The accident in Fukushima, Japan, as a result of the earthquake and tsunami, has raised the world's leaders and opened the issue of nuclear power plant safety and the possible consequences of radioactivity).Despite this, many countries in the world have built

atomic power plants. Also, large armies use this energy for military purposes: they build ships, aircraft carriers and submarines that are on atomic energy. Very large funds are spent on their maintenance, but even greater costs arise after these capacities have passed their service life. These costs for dismantling and purification of all parts of the equipment, as well as for the storage of nuclear waste, are estimated at 50% of the initial investment to be built.

Global challenges in the knowledge economy from the aspect of the world population growth

The most serious challenges to the process of creating a global knowledge-based economy will be its ability to accelerate the growth of the world economy, to reduce the absolute poverty in the world and to provide environmental sustainability. Today, more than 3 billion people worldwide live with less than 2,5 US dollars a day and more than 1,3 billion people live in extreme poverty with less than US$ 1,25 per day. According to UNICEF, 22.000 children die each day due to poverty. More than 805 million people in the world do not have enough food to eat and more than 750 million people have a shortage of clean drinking water. It has been estimated that 842.000 people die every year from diarrhea (*https://www.dosomething.org/us/facts/11-facts-about-global-poverty*). For comparison, about 1.735 billion US$ are spent on weapons world vide (or 247 US$ per capita). This amount represents 2,5% of the world GDP (*Unković Milorad, Kordić Ninela, (2014): Međunarodna ekonomija, Univerzitet Singidunum, Beograd)*. In the following period, as a result of the growing world population and accelerated urbanization, it is estimated that food demand will increase by 35% and the demand for water by 40%.(*US National Intelligence Council, (2012): Global Trends 2030: Alternative Worlds, US Government Printing Office, Washington, D.C.)* The population growth in the world is estimated to reach the 8,5 billion inhabitants by 2030, of which, the urban population is expected to reach 60% or over 5 billion people (United Nations, Department of Economic and Social Affairs, (2017): World Population Prospects: The 2017 Revision, New York: United Nations, pp. 1) However, these forecasts are rather uncertain. For example, in 1780, when the population of Western Europe was already greater than 100 million and that of North America barely 3 million, no one could have guessed the magnitude of the change that lay ahead. By 2010, the population of Western Europe was just above 410 million, while the North American population had increased to 350 million. According to UN projections, the catch-up process will be complete by 2050, at which time the Western European population will have grown to around 430 million, compared with 450 million for North America.

Table 2. World Population Forecast (2020-2050)

Year	Population	Yearly (%) Change	Yearly Change	Median Age	Fertility Rate	Density (P/km²)	Urban Population (%)	Urban Population
2020	7.795.482.309	1,09%	82.494.698	31	2,47	52	55,6%	4.338.014.924
2025	8.185.613.757	0,98%	78.026.290	32	2,43	55	57,5%	4.705.773.576
2030	8.551.198.644	0,88%	73.116.977	33	2,39	57	59,2%	5.058.158.460
2035	8.892.701.940	0,79%	68.300.659	34	2,35	60	60,7%	5.394.234.712
2040	9.210.337.004	0,70%	63.527.013	35	2,31	62	62,1%	5.715.413.029
2045	9.504.209.572	0,63%	58.774.514	35	2,27	64	63,5%	6.030.924.065
2050	9.771.822.753	0,56%	53.522.636	36	2,24	66	64,9%	6.338.611.492

Source: http://worldometers.info/world-population.

What explains this reversal? Not just the flow of immigrants to the New World but also the markedly higher fertility rate there compared with old Europe. The gap persists to this day, even among groups that came originally from Europe, and the reasons for it remain largely a mystery to demographers. One thing is sure: the higher fertility rate in North America is not due to more generous family policies, since such policies are virtually nonexistent there. When it comes to decisions as complex as those related to fertility, no psychological or cultural explanation can be ruled out in advance, and anything is possible. Indeed, US demographic growth has been declining steadily, and current trends could be reversed if immigration into the European Union continues to increase, or fertility increases, or the European life expectancy widens the gap with the United States. United Nations forecasts are not certainties (Piketty Thomas, (2014)

On the other hand, modern economies are increasingly open, showing tendency to attract more foreign investments. The more open economies also show tendency to be more innovative due to increased trade in intellectual capital: information, ideas and technologies (*Vinay Bhargava (edited by), (2006)*

The openness of the national economies has spurred the process of deepening the global reallocation of production processes, not only on final products, but also on intermediary products. Companies relate activities in foreign countries through outsourcing mechanisms that are realized through contracts for the production of parts with foreign suppliers and off shoring that is accomplished by moving production abroad through the establishment of a subsidiary. Offshore is usually performed in China and is more commonly linked to production, while outsourcing in India and it is more often associated with services. For example, the value of all services that are done in India for foreign companies (outsourcing), is about 150 billion dollars a year*http://www.economictimes.indiatimes.com/tech/ites/indias-technology-vendors-paddling-shaky-* In addition to this, is the fact that due to the new technologies, a large percentage of the population, especially in the world's most populated countries, China and India, succeeded to abandon the poverty vicious cycle. Also, new technologies that are characteristic of the knowledge economy (primarily information and communication technologies) enable improvement of education in the poor and rural communities, they promote the production of food, hydro-melioration systems, etc., which improves the living conditions of millions of people in the world. In this way, the negative consequences of the world population growth in the future can be drastically reduced.

Conclusion

With the end of the golden era of industrialization and the massive consumption of industrial products, as well as the emergence of energy crises and the persistent threats from environmental disasters, there was a need to consider the possibility of changing the economic paradigm on the basis of which the development was based. Conventional economy and the knowledge economy represent two conceptually different approaches for assessing fundamental human values. The conventional economy still exists thanks to the mass consumption of material goods, which are indispensable for human survival. Unlike the industrial production which rests on capital, labor and raw materials, non-industrial production rests primarily on knowledge, information, innovation and individual creativity as the necessary factors for general productivity and organization of production. Information and knowledge "can't be dressed or eaten", but the very production of products becomes much more efficient, more diverse, cheaper, more ecological and consumes far less energy. In addition to this, new knowledge-based technologies can facilitate and enable the poverty abandonment for many people in the world, especially in developing countries.

References

1. Baumol J. Wiliam, Blinder S. Alan,

(2003): ECONOMICS-Principles and policy, Thomson, South-western.

2. International Energy Agency (IEA), (2005): World Energy Outlook, Paris.

3. Piketty Thomas, (2014): Capital in the Twenty-First Century, Harvard University Press.

4. United Nations, Department of Economic and Social Affairs, (2017): World Population Prospects: The 2017 Revision, New York: United Nations.

5**. Unković Milorad, Kordić Ninela, (2014**): Međunarodna ekonomija, Univerzitet Singidunum, Beograd.

6. US National Intelligence Council, (2012): Global Trends 2030: Alternative Worlds, US Government Printing Office, Washington, D.C., December.

7. Vinay Bhargava (edited by), (2006): Global Issues for Global Citizens, World Bank, Washington, DC.

8.https://www.dosomething.org/us/facts/11-facts-about-global-poverty,

9.http://www.economictimes.indiatimes.com /tech/ites/indias-technology-vendors-paddling-shaky-boats/articleshow/56543653.cms.

10.http://worldometers.info.