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# NEW CLASSIFICATION OF RENEWABLE ENERGY SOURCES IN THE DEVELOPMENT OF TECHNOLOGY IN ARCHITECTURE FOR A SUSTAINABLE SOCIETY

# NOWA KLASYFIKACJA ODNAWIALNYCH ŹRÓDEŁ ENERGII W ROZWOJU TECHNOLOGICZNYM W ARCHITEKTURZE DLA ZRÓWNOWAŻONEGO SPOŁECZEŃSTWA

A b s t r a c t

The transformation to a sustainable society. The transformation of the energy market. The social value of $CO_2$ emissions. Change of the value system in society. The dominant production technology of the capital of nature with simultaneous restoration of ecosystems. Division and economic quantification of renewable energy sources as a production technology of capital provided to man by nature. Predictable and unpredictable renewable energy sources. Renewable energy sources generated in economic human activity as a secondary product. Development of technology in architecture for a sustainable society.

*Keywords*: *renewable energy sources*, *sustainable society*, *$CO_2$ emissions*, *energy market*

S t r e s z c z e n i e

Transformacja do społeczeństwa zrównoważonego. Transformacja rynku energii. Społeczne znaczenie emisji $CO_2$. Zmiana społecznego systemu wartości. Dominująca technologia produkcyjna bazująca na kapitale przyrody z jednoczesnym przywróceniem ekosystemów. Podział i ilościowa ocena ekonomiczna odnawialnych źródeł energii jako technologia produkcji kapitału dostarczanego człowiekowi przez naturę. Przewidywalne i nieprzewidywalne odnawialne źródła energii. Odnawialne źródła energii generowane w działalności gospodarczej człowieka jako produkty wtórne. Rozwój technologii w architekturze dla zrównoważonego społeczeństwa.

*Słowa kluczowe*: *odnawialne źródła energii*, *społeczeństwo zrównoważone*, *emisja $CO_2$*, *rynek energii*

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## 1. Introduction

The economic activity of man leads to the creation of two fundamental economics-based utility values: energy as a product required by the market and $CO_2$ emissions as a parallel undesirable product.

While fossil fuels facilitated the rise of the standard of living on the planet and the biocapacity of the Earth has been able to assimilate the resulting greenhouse gases, no violation of the balance between energy sources and the economic activity of man or production of emissions from it has been recorded.

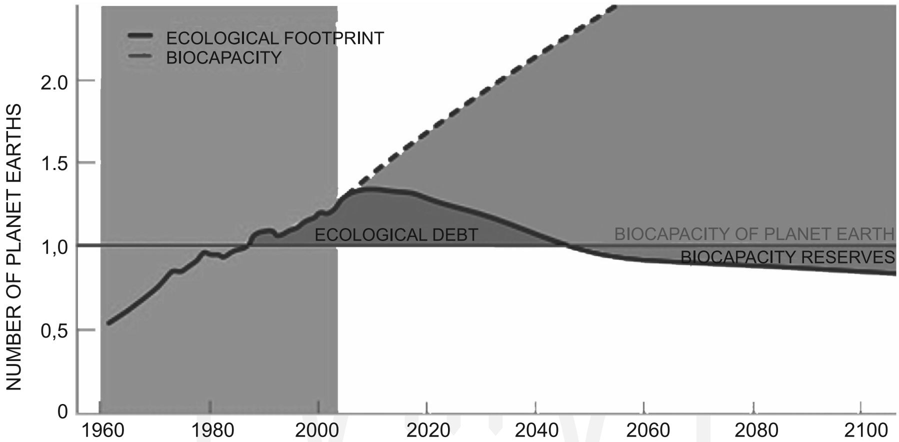


Fig. 1. Graph of renewal of function of the Earth's biocapacity [4]

Around the 1980s, the economic system representing the activities of man (industry, transportation, human dwellings) rose above the production value of the Earth's biocapacity – Fig.1. Man crossed the limit set by nature. Man has started to produce ecological debt on the planet. Currently, the ecological load exceeds the absorption ability of the planet's ecological systems approximately 30% [4].

## 2. Transition to Sustainability by Changing the Value System of Economic Models in Society

The crisis of fossil fuels in the 70s, related to their high level of usage; the crisis of ecological systems of nature in the second half of the 80s, resulting in the problem of climate changes; and the crisis of financial markets as a culmination of economic processes starting in early 1995 and with their peak in 2008 in the USA and in 2010 in the EU, have become the catalyst for a global social movement. This results in a long-term, irreversible transition process, accompanied by the disintegration of the old and the establishment of a new value system [3].

It is about transition to a sustainable society in terms of the reassessment of priorities in social investments, leading to the transformation of the energy sector and to the change of the organization of the energy market from a combined market of fossil fuels and renewable energy sources to a market comprising only renewable energy sources; the transformation of the materials sector, with the focus on ecologically clean materials and their composites; and the transformation of the whole economy towards low-energy and low-emission technologies and to the manufacture of ecologically clean products [2].

Renewable energy sources (Fig. 2) perform two significant functions in a synergy effect: they represent a new capital provided to man by nature and simultaneously significantly reduce greenhouse emissions, therefore restoring the assimilation capacity of the planet [2]. In this context, the conditioning factor of the combined energy market is the social value of $CO_2$ emissions. This represents the additional costs which society must pay to reduce emissions.

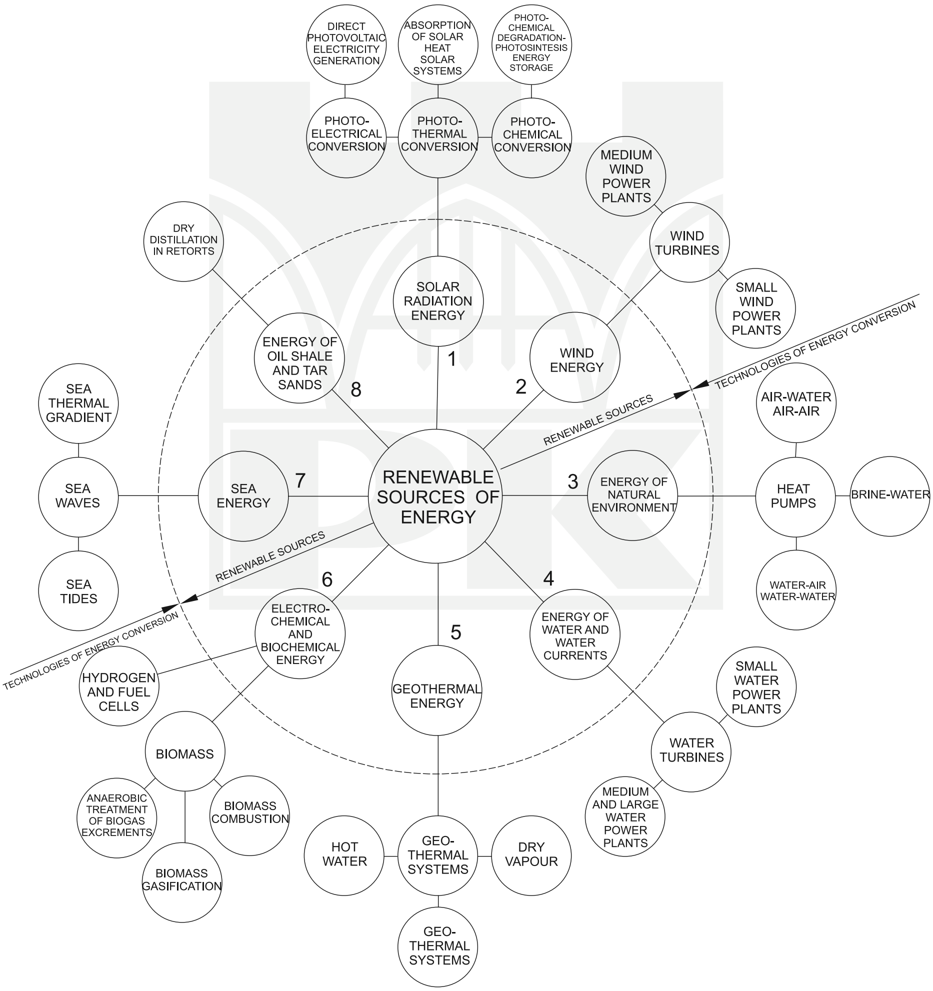


Fig. 2. Renewable energy sources – production technology of the capital provided to man by nature

Oneway to describe the acceptance of the change of value system would be to say that until now it was man who set the quantitative physical parameters e.g. in the technology of architecture for a construction or building and nature was obliged to ensure concentrated energy for these parameters. The new value system means that man must first evaluate how much energy is available in a given locality to be utilized for his economic activity, and in what form. It is only within the limits set by nature that man can subsequently define parameters, e.g. in the technology of architecture of a particular construction or building.

From the existing system, “man first and nature second”, the value system is transformed to a new one in which nature first sets the limits of individual parameters, and man then accepts these parameters in his economic activities [2]. This way, it is possible to practically illustrate the change of value system in general. If man imagined that he, with the help of modern technology, subordinates nature, nature now shows us that he was mistaken.

However, in order to change the value system it is necessary to change people´s way of thinking. It is necessary to give up the prioritization of the interests of the individual and look for a solution where the interests of society are at one with the interests of the individual. Unifying the interests of society and the individual represents one of the fundamental criteria of a proper solution to any social problem.

In the suggested transition of society and the change of value system, as has been shown, it is necessary to accept that nature sets the terms of creating and maintaining the new required balance between natural capital and the economic activity of man [5].

History has shown that in the economy of society there have always existed dominant production technologies which, in a given long-term period (on average 50 years), provided above-standard added value and facilitated the fundamental development of society (Fig. 3). It is a reasonable assumption that environmental technologies and renewable energy sources in their various forms will become the next such dominant production technology.

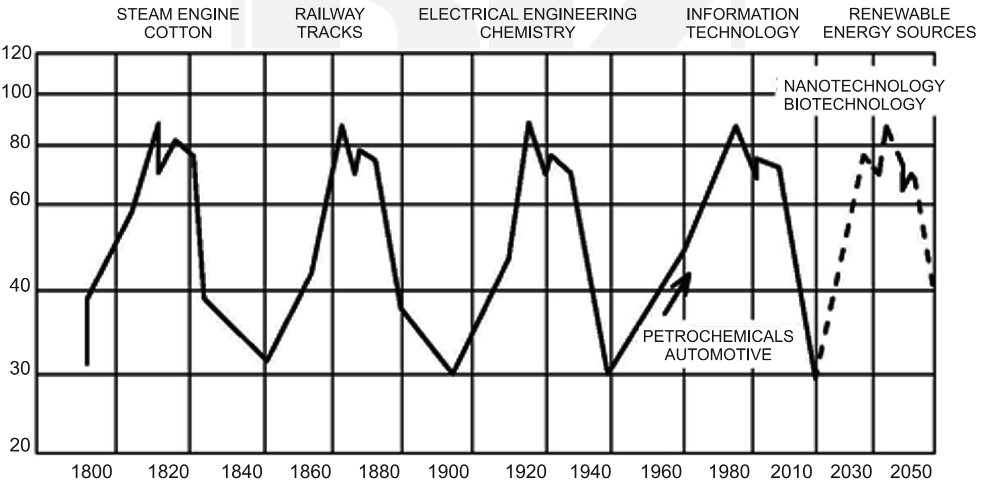


Fig. 3. Kondratiev cycles

## 3. Economic Quantification of Renewable Energy Sources as a Dominant Production Technology of Capital Provided to Man by Nature

Mankind faces the necessity of broadening the energy base for society on the basis of renewable energy sources. A renewable energy source is capable of renewing its energy output by natural processes in the ecosystems of nature. The renewal of the energy output of the source can take time, which is a very important consideration in relation to its utilizability in the economic activity of man in real time. If we take the term renewable energy source out of context, either in terms of the time taken for its renewal or its utilizability in real time in the economic activity of man, it is easy to come to incorrect conclusions [2].

Renewable energy sources may be divided into four groups, depending on the economic base (Fig. 4):

1. Renewable sources where natural ecosystems provide the necessary energy output continuously with a constant intensity in real time relative to the economic activity of man. We call them predictable renewable energy sources (Fig. 4). After repayment of the initial investments into the technology of energy conversion done in situ (such as a heat pump, etc.), they do not require any additional economic costs. Utilization of these energy sources is without any associated production of $CO_2$ emissions. These include geothermal, hydrothermal and aerothermal energy from the natural environment (ground, water and air), energy from water gradients of natural lakes and reservoirs, energy from rivers, sea gradients, geothermal hot water and dry steam, and electrochemical energy (hydrogen fuel cells) (Fig. 4).
2. Renewable sources where natural ecosystems provide energy output discontinuously, with variable intensity and not entirely in real time relative to the economic activity of man. We call them unpredictable renewable energy sources (Fig. 4). After repayment of the initial investments into the technology for energy conversion done in situ, e.g. photovoltaic cells, wind turbines etc., they require economic costs in the form of additional technologies enabling the conversion of the characteristics of this energy from unpredictable energy to that of standard quality, suitable for economic utilization in real time relative to the economic activity of man (e.g. problem of energy storage etc.). Utilization of these energy sources is without any associated production of $CO_2$ emissions. These include solar energy, wind energy, and energy from sea dynamics (waves and tide) (Fig. 4).
3. Renewable sources where natural ecosystems provide the energy output created as a result of a long term natural process (e.g. growth of wood) (Fig. 4).
4. Renewable energy sources created in the economic activity of man as a secondary product. These sources provide energy output with a phase delay, but effectively in real time relative to the economic activity of man, and therefore may be classified as predictable renewable energy sources (Fig. 4). They have their economic significance only the primary economic activity of man of which they are by-products is economically viable in and of itself. The change of the status of renewable energy sources created as a secondary product of the economic activity of man to a primary economic activity can cause a lot of economic losses which rise with the price of human labour and the availability of additional production technologies which cannot be expected to create above-standard

economic added value. With all of the energy sources in this group, the energy is generated by combustion, a secondary effect of which is the production of $CO_2$ emissions. Their production of $CO_2$ per unit of energy is high (e.g. biomass is comparable to black coal). These include wood mass, oil shale, tar sands, biomass, biogas, and landfill gas from sewage treatment plants (Fig. 4).

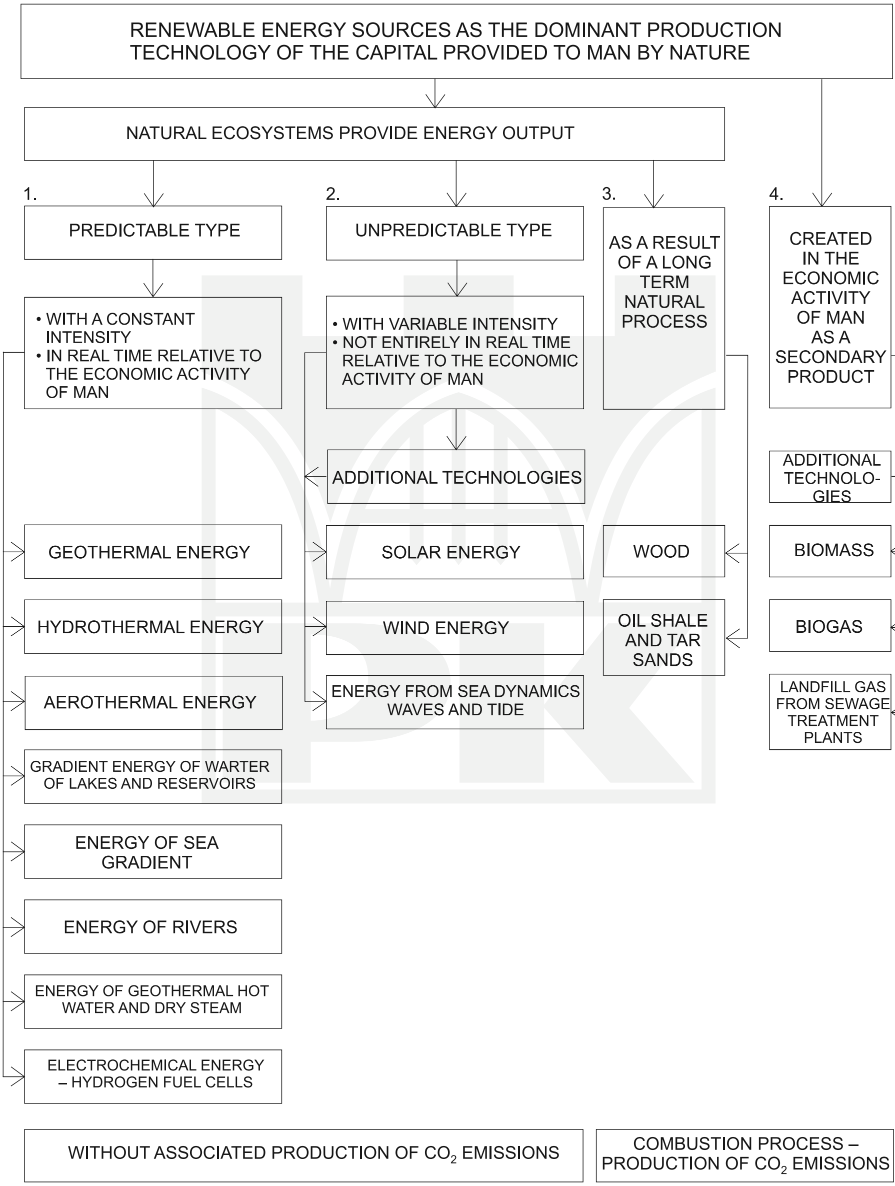


Fig. 4. Division and classification of renewable energy sources in terms of economic base

## 4. Development of Technology in Architecture in the Transition to Sustainability

Local renewable energy sources and the transformation of buildings in accordance with the development of technology in architecture enable us to reshape existing knowledge to incorporate new knowledge and to create new working models for the energy efficiency of human settlements on their basis. This way, renewable energy sources as the dominant production technology of natural capital with simultaneous renewal of ecosystems become the conditioning factor in changes to the principal concept of energy quantification of buildings.

A part of the transformation, as has been shown, must not only be a new arrangement of relationships in society, including the arrangement of human settlements, but also the whole range of parameters especially in the technology of architecture expressed by the technological transformation of the building itself. This becomes a place for the collection of renewable sources and conversion of energy in situ as a part of the transformation of the organization of the energy market. Buildings cease to be only consumers of energy, and are technologically transformed to become part of the complex system of conversion and distribution of energy [1]. They become a part of energy distribution networks. And just in the interaction with these distribution networks, a new quantification of the physical-energy demand of buildings is outlined, expressed by the term zero-energy building in relation to the distribution networks (Net-Zero-Energy Building), nearly-zero-energy building in relation to the distribution networks (nearly-Net-Zero-Energy Building) or plus-energy building, supplying energy to the distribution networks (Net-Plus-Energy Building) [6, 7].

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## References

[1] Syed A., *Advanced Building Technologies for Sustainability*, John Wiley & Sons, Inc., Hoboken, New Jersey 2012.
[2] Bielek B., Híreš J., Lukášik D., Bielek M., *Development of Technology in Architecture for Sustainable Society*, Nakladateľstvo STU, Bratislava 2012.
[3] Zelený M., *Human Systems Management Integrating Knowledge Management and Systems*, World Scientific Publishing Co. Plc. Ltd., Singapore 2008.
[4] Cambridge University, *Global Climate Change Impacts in the United States*, Cambridge University Press, New York 2009.
[5] Constanza R., Cemberland J., Darly H., Goodland R., Nogaard R., *An Introduction to Ecological Economics*, CRC Press LLC, St. Lucie Press Bold Raton, Florida 1997.
[6] Sartori I., Napolitano A., Woss K., *Net Zero Energy Buildings: A Consistent Definition Framework*, Energy and Buildings, Elsevier 2012.
[7] Marszal A.J., Heiselberg P., Bourrelle E., Mussall K., Woss K., Sartori I., Napolitano A., *Zero Energy Building – A Review of Definitions and Calculation Methodologies*, Energy and Buildings, Elsevier 2011.