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INTEGRATED SPATIAL AND ENERGY PLANNING – IMPORTANCE OF A PROBLEM FOR CONTEMPORARY ARCHITECTS AND URBAN PLANNERS WITH FOCUS ON ENVIRONMENTAL FACTORS

Keywords: energy, spatial planning, energy-efficient structures.

ZINTEGROWANE PLANOWANIE PRZESTRZENNE I ENERGETYCZNE – ZNACZENIE PROBLEMU DLA WSPÓŁCZESNYCH ARCHITEKTÓW I URBANISTÓW Z UWAGI NA CZYNNIKI ŚRODOWISKOWE

Słowa kluczowe: energia, planowanie przestrzenne, zabudowa energooszczędna.

Introduction

Growing population in the cities along with legislation requirements imply turning to energy efficient modes of building and more restrictive energy performances.

Poland as a member of European Union is obliged to follow certain international regulations and standards concerning building energy performance. First of them is the "Energy Performance of Buildings Directive" from 2010[1]. In this document it is required, that by 2018 all new public buildings must be nearly zero-energy and by the end of 2020 all new buildings must be nearly zero-energy.

The term nearly zero-energy building characterizes a building that has a very high energy performance. The required nearly zero or low amount of energy should by mostly covered by renewable energy sources, including energy from renewable sources produced on-site or nearby.

Certainly, several factors determining the need of contemporary designers to turn to energy-saving buildings can be distinguished. The mentioned factors are closely related to the issues of sustainable development. As one of the main principles, environmental actions are specially highlighted, including the need to prevent climate change – so called climate action.

Many controversies and contradictory opinions have arisen around climate change, sometimes misinterpreting them as the main and only reason for the necessity of turning to low-energy building standards. This article is summarizing and presenting the main approaches towards the controversial topic

[1] *Directive 2010/31/EU on the energy performance of buildings,* European Parliament and the European Council, 19 May 2010.

of climate change, as well as further environmental and non-environmental arguments in favor of turning to energy-efficient construction.

As a research method in this paper, literature review was used, which allowed to refer to varying arguments and current research results, compilations and analyzes. Due to the volume of data, information on ecological footprint and biological capacity are considered mostly in the context of Poland.

1. Climate change and climate protection

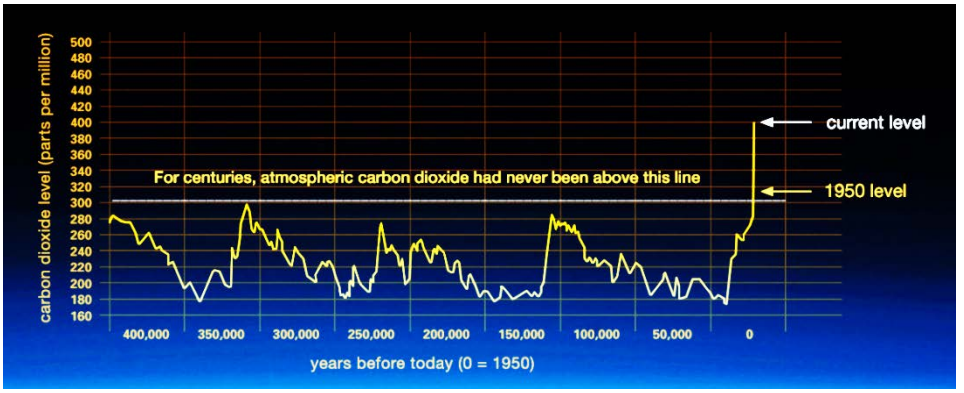
Global climate change and its consequences are becoming today's most pressing issue, especially in terms of extreme weather events. Despite numerous international investigations, the exact mechanism of their occurrence is ambiguous and accordingly, universal climate change adaptation strategies have not yet been developed.

Numerous investigations conducted by NASA[2] and other organizations of International Climate Change Panel confirm the flux of our climate[3]. The scientists claim that since the 1950s the changes in the climate are extraordinary. The mean temperatures have risen what is visible in the atmosphere, ocean levels and melting glaciers. The changes of atmospheric levels of CO_2 are visible on figure 1.

[2] Schmidt G. A., Arndt D., *Annual Global Analysis of temperatures for 2016, NOAA/NASA* January 2017.

[3] Field, C.B., Barros V.R., Dokken D.J., Mach K.J., Mastrandrea M.D., Bilir T.E., Chatterjee M., Ebi K.L., Estrada Y.O., Genova R.C., Girma B., Kissel E.S., Levy A.N., S. MacCracken, Mastrandrea P.R., White L.L., *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summaries, Frequently Asked Questions, and Cross-Chapter Boxes. A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* IPCC, 2014, World Meteorological Organization, Geneva, Switzerland, pages: 1–32.

Figure 1. Graph from NASA, providing evidence that atmospheric levels of CO_2 have increased since the Industrial Revolution. The graph is based on the comparison of atmospheric samples contained in ice cores and more recent direct measurements.



Source: NASA[4]

Given the complexity of climate no confident prediction about future global mean temperature or its impact can be made[5]. Also, in terms of climate change and anthropogenic influence there are many often contradictory theories arising. We can distinguish three main groups of people dealing with the climate change problems: the scientists form IPCC (International Panel of Climate Change, organized by United Nations), the second group consisting of scientists called skeptics and the third group-politicians, environmentalists and media. According to scientists from IPCC, climate change is due to burning fossil fuels like oil, coal and natural gas[6]. Because of that the emission of CO_2 is arising and may dangerously heat the planet. They also support the view on anthropogenic influence of climate change[7].

As stated by sceptic group of scientists -there are many reasons why the climate changes – sun, clouds, oceans and myriad of other inputs. None of them is fully understood and there is no evidence that CO_2 emissions caused by human are the dominant factor in climate change. One of them is American atmospheric physicist known for his work in the dynamics of the middle atmosphere, retired professor from Massachusetts University of Technology, who regularly confirms his thesis on research articles and scientific books[8] , [9].

[4] https://climate.nasa.gov/evidence/ Access [08.02.2018]
[5] Ibid.
[6] Ibid.
[7] Ibid.
[8] Lindzen R., Choi Y.-S., *On the Observational Determination of Climate Sensitivity and Its Implications,* The Korean Meteorological Society and Springer 2011.

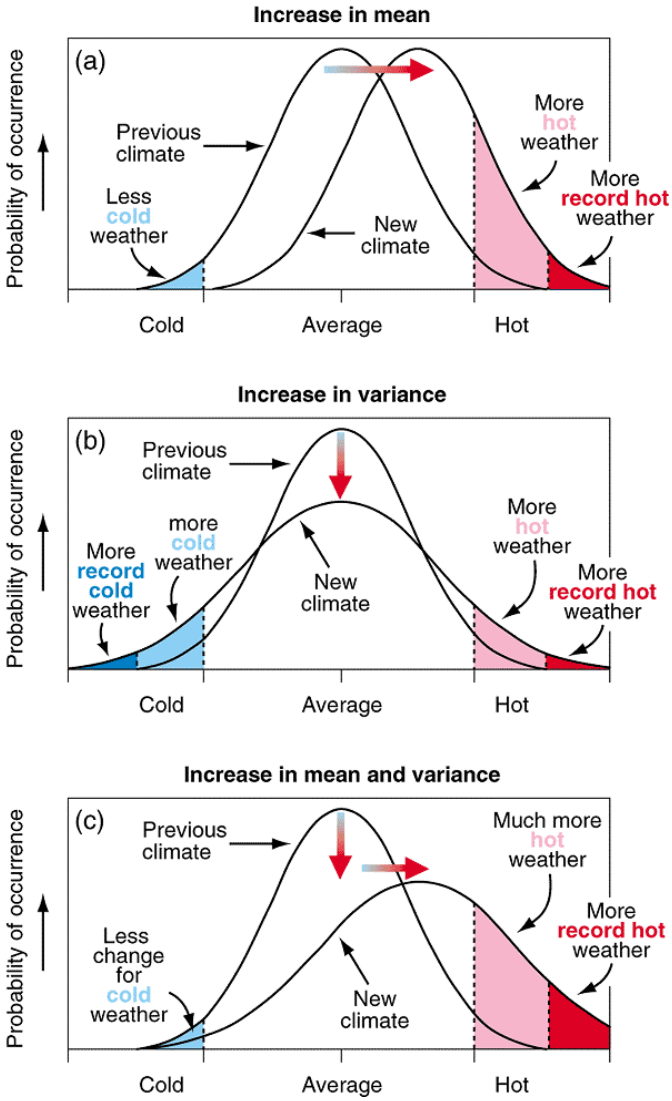
For the third group, global warming alarmism provides the things they most desire – for politicians it is money and power, for environmentalists it is money for their organizations and confirmation of their near religious devotion to the idea that man is destructive force acting upon nature.

Independent from the fact if human factor plays the role in climate change or not, some facts are undoubtful play significant role in terms of extreme weather events and climate hazards.

The fact is that climate has been always changing. CO_2 is a greenhouse gas without which life on earth is not possible, but increased concentration of it to atmosphere should lead to warming. Atmospheric levels of CO_2 have been increasing since the middle ice-age. By 1800-2000 global mean temperature has increased slightly and erratically by 1°C*. However only since 1960s has man's greenhouse emissions been sufficient to play a role[10]. Possible fluxes of climate are to be observed on Figure 2.

[9] Lindzen R., *Global warming and the irrelevance of science,* The Global Warming Policy Foundation, 2016.
[10] Lindzen R., Choi Y.-S., Op. cit.

Figure 2. Schematic presenting possible changes in climate and the effect on extreme temperatures. Possible climate changes and their influence are to be observed in the diagrams. When for a normal distribution of temperature: a) the mean temperature increases (i.e. longer summer growing season); b) the variance increases (i.e. extreme precipitation and droughts); c) both the mean and variance increase.



Source: Intergovernmental Panel on Climate Change.[11]

[11] Intergovernmental Panel on Climate Change 2001. Climate Change 2001: The Scientific Basis. IPCC Third Assessment Report. Cambridge Univ. Press, https://www.ipcc.ch/ipccreports/tar/wg1/fig2-32.htm, Access [08.02.2018]

If considered potential climate changes, three different results can be expected. When for a normal distribution of temperature, the mean temperature increases it can lead to longer seasons (without transitional seasons), for example longer summer growing season and longer winter season almost without existence of autumn and spring. In the situation when the variance increases extreme weather events can grow i.e. extreme precipitation and droughts. There is also a possibility of growth both the mean and variance increase what can result in both in prolonging the seasons without transitional seasons and increase in extreme weather events[12].

2. Environmental pollution and greenhouse gasses emissions

Regardless of the constant fluxes of climate another fact is that greenhouse gas emissions are projected to rise constantly if our policies will not turn to renewable energy.

Global energy-related carbon dioxide emissions (CO_2) have been rising constantly since 1975, from 16 Gt, till over 30 Gt in 2015. Throughout those years they only had three periods when they stopped off, what was stopped by second oil shock around 1979, dissolution of Soviet Union in 1991 and global economic downturn in 2010. Luckily, since 2015 It tends to stay flat for the second year in a row, from at the level lower than 35Gt according to analysis of preliminary data for 2015 released by the International Energy Agency (IEA)[13]. Global energy-related CO_2 emissions are presented on figure 3.

The preliminary data of IEA informs that the reason for such decoupling can be found in electricity generated by renewables (with wind alone producing over 50 percent of new electricity generation). At the same time the global economy grew continuously by over three percent, which creates an evidence that economic growth and emissions can be independent and is a great hope for future development.

[12] *Aktiv für mehr Behaglichkeit: Das Passivhaus*, Passivhaus Institut Austria, 2016
[13] Footprint Network, [Access 19.01.2018]
https://www.footprintnetwork.org/content/documents/ecological_footprint_nations/index.html

Figure 3. Global energy-related CO_2 emissions, presented by International Energy Agency.

Source: International Energy Agency[14]

3. Biocapacity and ecological footprint

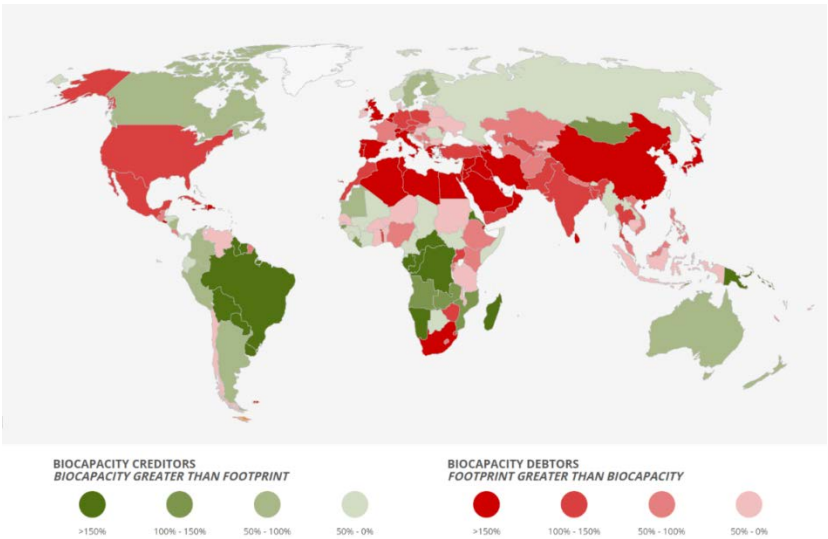
Regardless of the constant fluxes of climate another fact is that greenhouse gas emissions are projected to rise constantly if our policies will not turn to renewable energy.

The increase on economic globalization and growing population poses greater resources consumption and fossil fuel emissions. The ecosystem which is provided by society in terms of these resources and absorption can in numerous cases no longer be sustained. To solve this problem a holistic approach is required to avoid situation where pressure is just being shifted from one part of the biosphere to another[15].

Ecological Footprint enables measuring the ecological assets which are required by a given population for production and consumption of natural resources and simultaneously for absorption of waste, especially carbon emissions under current technology[16]. On the world map below (figure 4) we can observe the occurrence of ecological deficit or reserve. An ecological deficit arises when the Ecological Footprint of a population is higher than the biocapacity of the area available to that population. In terms of Poland (figures 5 and 6) there is a visible tendency to use up more resources than the Earth can reproduce.

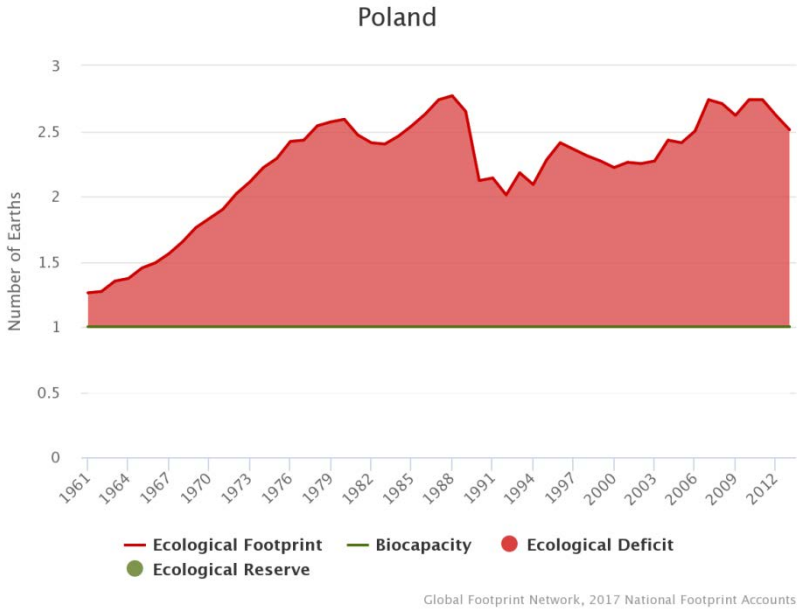
[14] https://www.iea.org/newsroom/news/2016/march/decoupling-of-global-emissions-and-economic-growth-confirmed.html , Access [08.02.2018]
[15]Goldfinger S., Poblete P., *The Ecological Wealth of Nations*, Footprint Network 2005.
[16] Ibidem.

Figure 4. World map presenting ecological deficit or reserve.



Source: Footprint Network[17].

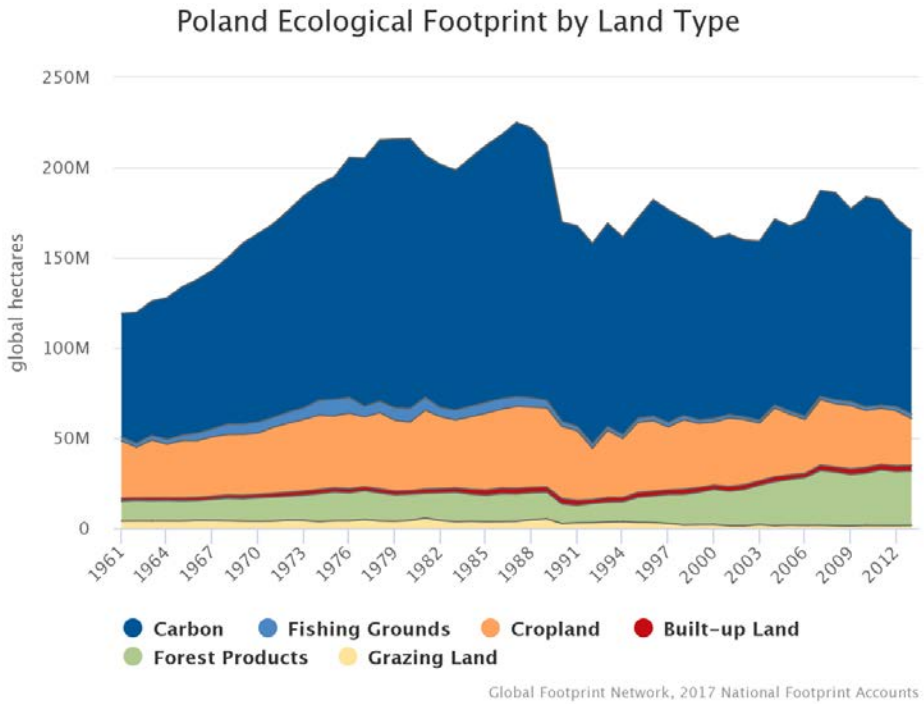
Figure 5. Ecological footprint of Poland till 2013.



Source: Footprint Network[18].

[17] https://www.footprintnetwork.org/content/documents/ecological_footprint_nations/index.html , Access [08.02.2018]

Figure 6. Poland ecological footprint by land type.



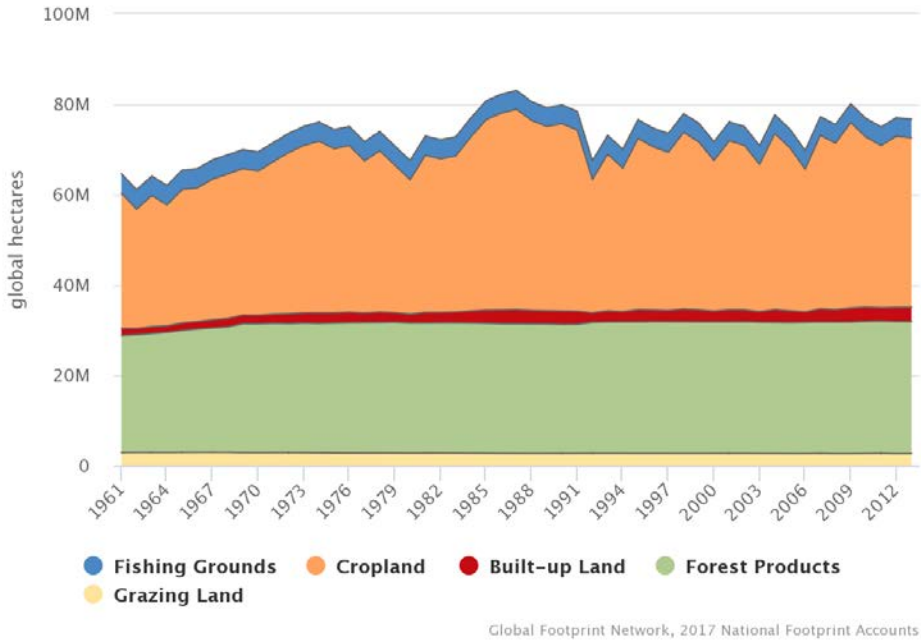
Source: Footprint Network[19].

Biocapacity has a function of supply side, as it represents the productivity of its ecological assets given current management practices. Together with Ecological Footprint they are measure in standard units called global hectares (gha) representing either a hectare of forest, cropland, grazing land or fishing grounds with world average productivity[20].

The fact is that during constant grows of economies, populations, the demand of resources as well as the size of the planet and its capacities remains the same. For this reason, there is a threat that with not paying attention to this fact and using much than the Earth is able to regenerate we may come to a blind spot.

[18] http://data.footprintnetwork.org/#/countryTrends?type=earth&cn=173, Access [08.02.2018].
[19] http://data.footprintnetwork.org/#/analyzeTrends?type=EFCtot&cn=173, Access [08.02.2018].
[20] Goldfinger S., Poblete P., op. cit.

Figure 7. Poland, Biocapacity by land type.

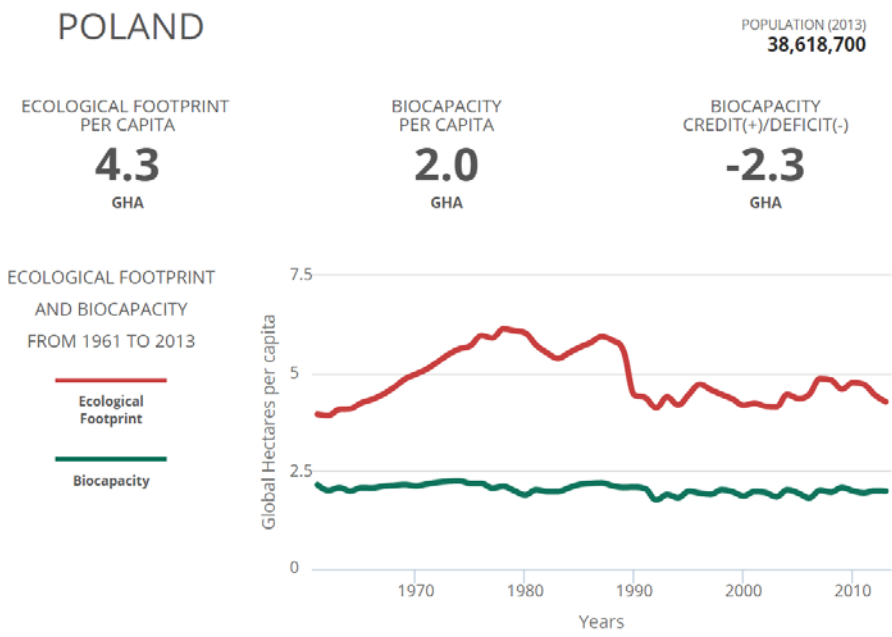


Source: Footprint Network[21].

The situation is also alarming in Poland (figure 7,8), because, according to investigations from Footprint Network, the level of ecological footprint is higher than the level of biocapacity. It means that currently we are using approximately 150 percent of environment what is more than the region's ecosystems can renew and leads to running an ecological deficit.[22]

[21] http://data.footprintnetwork.org/#/analyzeTrends?type=BCtot&cn=173, Access [08.02.2018].
[22] Op. cit. Footprint Network.

Figure 8. Ecological footprint and biocapacity in Poland from 1961 to 2013.



Sources: National Footprint Accounts 2017 (Data Year 2013); World Development Indicators, The World Bank (2016); U.N. Food and Agriculture Organization.[23]

4. Economic aspects – energy demand and costs prognosis

Considering spatial and urban growth aspects, it is also important to look at prospected demand and supply as well as at the costs of energy.

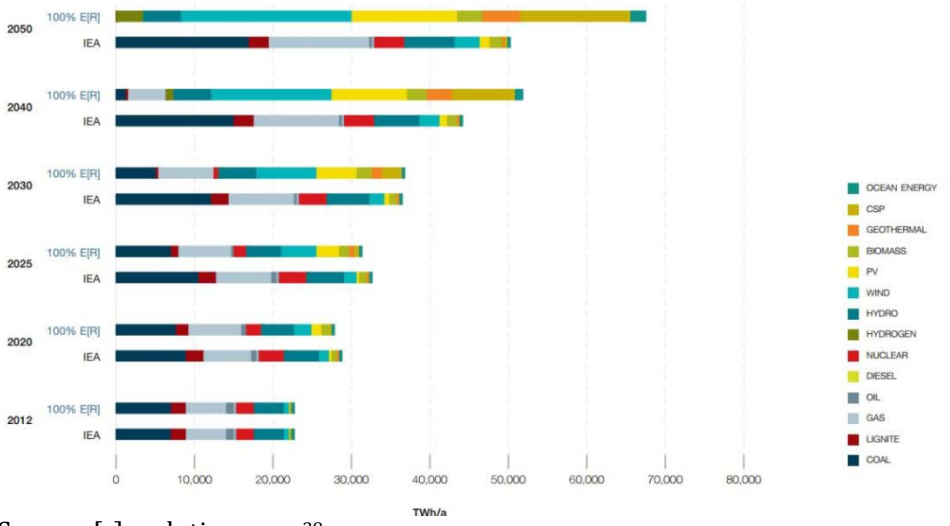
Due to economic growth and improvement of living standards, global energy demand continues to grow as well. If both population and gross domestic product, together with improvements in energy intensity will grow, there is a forecasted peak energy demand for 2020, which will remain at that level for ten years. By 2050 overall demand is expected to decrease below current levels. It will reach about 453,000 PJ/a – which is 15 percent below current global primary energy demand.[24]

Despite the rapid changes in emissions landscape, fossil fuels are still delivering 81.2% of the world's primary energy supply. Therefore, bringing down emissions before 2020 is one of the necessary steps.

[23] https://www.footprintnetwork.org/content/documents/ecological_footprint_nations/ecological.html, Access [08.02.2018].
[24] Teske S., Mills J., Loeffelbein T., Kaiser M., op. cit.

The environmental goods and services amount nowadays US$1 trillion per year in the international trade, which is around five percent of whole trade. By 2020 the trade in low-carbon and energy-efficient technologies is projected to reach US$2.2 trillion, which is three times more than the current level.[25] Emerging and developing economies will constitute 40 percent of this market, whereas their suppliers will come from all over the world. In order not to exceed the rise more than two Celsius degrees the mean temperature by emission of CO_2, the humankind is not allowed to produce more than 1000 Gt of CO_2 from right now.[26] If we stay at current level in terms of production and emissions, whole carbon budget is projected to be used by 2040[27].

Figure 9. World development of electricity generation under the IEA "Current policies" and the energy.



Source: [r]evolution case [28].

5. Energy efficiency in buildings and built structures

Built structures, as the consumers of 40 percent of total world energy need new approach. Thanks to combination of energy efficiency and renewable energy

[25] The 2016 New Climate Economy Report, The Sustainable Infrastructure Imperative – Financing for Better Growth and Development, World Resources Institute, 2016.

[26] Field, C.B., Barros V.R., Dokken D.J., Mach K.J., Mastrandrea M.D., Bilir T.E., Chatterjee M., Ebi K.L., Estrada Y.O., Genova R.C., Girma B., Kissel E.S., Levy A.N., S. MacCracken, Mastrandrea P.R., White L.L., op. cit.

[27] Teske S., Mills J., Loeffelbein T., Kaiser M., op.cit.

[28] http://m.greenpeace.org/international/Global/international/publications/climate/2015/Energy-Revolution-2015-Summary.pdf Access [08.02.2018]

technologies we can achieve a stabilization of CO_2 emissions by 2020 and constantly reduce them towards nearly zero CO_2 emissions in 2050 [29].

We can distinguish numerous ideas and standards helping in reaching those ambitious goals-energy efficient, passive house standards, or other certification building standards in terms of energy. For instance, a typical passive house can save up energy couple of times in comparison to a standard house. Moreover, its cost pays off after couple of years and the house starts to bring financial gains in terms of significantly lower energy savings in comparison to traditional building. Implementation of such energy saving objects can be undoubtedly beneficial both in economic and ecological terms[30]. All of them encourage to invest into energetically optimized structures. As a holistic approach is specially needed in terms of energy, energetical goals should be realized also in bigger scale – from local to regional, national and super national.

However, a holistic approach is definitely needed in terms of energy, therefore energetical goals should be realized also in bigger scale – super national, national, regional as well as local.

6. Socio-economic development

Turning into low carbon future as well as integrated spatial and energy design may not be the easiest task and may require significant investment. Major part of the investment which is needed in low-carbon infrastructure is possible to realize through existing structures and mechanisms, with the help of effective policy, regulation and market signals. Significant action will be needed for energy efficiency improvement – from businesses, land owners, farmers and households. The task of governments will be a proper expansion and enhancement of infrastructure productivity and seeking to influence the direction of private finance[31]. Probably, creating efficient finance structures or attracting finance is more complex and may require dedicated policy for some investments. This in effect can create new working places in renewable energy sector and trigger economic development.

Conclusions

The coming decades could both a time of great progress and growth, as we have the technological, financial and human resources to improve quality of life around the world. That is why contemporary cities should be seen rather as a source of solutions our world is facing nowadays.

On the other side rapid urbanization and urban development can lead to increased energy and resources demand as well as environmental pollution.

[29] Teske S., Mills J., Loeffelbein T., Kaiser M., op. cit.
[30] Passivhaus Institut Austria, op. cit.
[31] World Resources Institute, op. cit.

As the resources are limited, new ways of attitude towards pollution and energy and technological upgrade need to be developed. In terms of broadcasting the knowledge, technology and reducing its prices, the aspects of international cooperation and globalization may be helpful. Renewable sources of energy used in greater scale are potential solution towards climate change and sustainable approach in our era of constant changes and development. Their application needs further reflection considered in building complexes and international level.

Integrated spatial and energy planning tackle not only the issues concerned with sheer planning or energy. It influences the social factors as well, and if properly applied may increase the quality of lives and economic development.

The importance of integrated spatial and energy planning cannot be underestimated. While planning process, not only the environmental factors and their changeability need to be seriously taken into consideration, but also the social and economic ones. Although, there are numerous strategies being developed and implemented, problems bound with integrated spatial and energy planning need further investigation and profound insight which in each case should be treated individually. Nowadays we have sufficient knowledge and technological experience, all the factors needed to meet balanced, sustainable spatial and energy planning. What we still need is raising of awareness and social attitude towards more sustainable future including integrated spatial and energy planning.

References

1. *Aktiv für mehr Behaglichkeit: Das Passivhaus*, Passivhaus Institut Austria, 2016.
2. Albritton D. L., Barker T., Bashmakov I. A., Canziani O., Christ R., Cubasch U., Davidson O., Habiba Gitay, Griggs D., Halsnaes K., Houghton J., House J., Kundzewicz Z., Lal M., Leary N., Magadza C., McCarthy J.J., Mitchell J.F.B., Moreira J.R., Munasinghe M., Noble I., Pachauri R., Pittock B., Prather M., Richels R.G., Robinson J.B., Sathaye J., Schneider S., Scholes R., Stocker T., Sundararaman N., Swart R., Taniguchi T., Zhou D., *Intergovernmental Panel on Climate Change. 2001. Climate Change 2001: The Scientific Basis. IPCC Third Assessment Report.* Cambridge Univ. Press, pg. 881, 2001.
3. C*limate Action in Megacities,* C40 Cities Baseline and Opportunities, C40 Cities and Arup, Vol. 3.0., 2015.
4. *Directive 2010/31/EU on the energy performance of buildings,* European Parliament and the European Council, 19 May 2010.
5. Field, C.B., Barros V.R., Dokken D.J., Mach K.J., Mastrandrea M.D., Bilir T.E., Chatterjee M., Ebi K.L., Estrada Y.O., Genova R.C., Girma B., Kissel E.S., Levy

A.N., S. MacCracken, Mastrandrea P.R., White L.L., *Climate Change 2014: Impacts, Adaptation, and Vulnerability. Summaries, Frequently Asked Questions, and Cross-Chapter Boxes. A Contribution of Working Group II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change,* IPCC, 2014, World Meteorological Organization, Geneva, Switzerland, pages: 1–32.

6. Goldfinger S., Poblete P.*, The Ecological Wealth of Nations*, Footprint Network 2005.
7. Lindzen R., Choi Y.-S., *On the Observational Determination of Climate Sensitivity and Its Implications,* The Korean Meteorological Society and Springer 2011.
8. Lindzen R., *Global warming and the irrelevance of science,* The Global Warming Policy Foundation, 2016.
9. *New Urban Agenda*, United Nations-Habitat, 2017.
10. *OECD Environmental Outlook to 2050: The Consequences of Inaction*, OECD 2012.
11. *Paris Climate Change Conference - November 2015, Adoption of the Paris Agreement*, United Nations, Framework Convention on Climate Change, 12 December 2015.
12. Schmidt G. A., Arndt D., *Annual Global Analysis of temperatures for 2016, NOAA/NASA,* January 2017
13. Stoeglehner G., Neugebarer G., Erker S., *Integrated Spatial and Energy Planning,* 2016.
14. Teske S., Mills J., Loeffelbein T., Kaiser M., *Energy [r]evolution a sustainable world energy outlook 2015*, report 5th edition 2015, world energy scenario, 2015.
15. The 2016 New Climate Economy Report, The Sustainable Infrastructure Imperative – Financing for Better Growth and Development, World Resources Institute, 2016.
16. *World Urbanization Prospects: The 2014 Revision, Highlights (ST/ESA/SER.A/352),* Department of Economic and Social Affairs, United Nations, EEA, 2014.

Internet Webpages:

17. Footprint Network, [Access 19.01.2018] https://www.footprintnetwork.org/content/documents/ecological_footprint_nations/index.html
18. International Energy Agency, https://www.iea.org/newsroom/news/2016/march/decoupling-of-global-emissions-and-economic-growth-confirmed.html [Access 19.01.2018].

Streszczenie

Oprócz przestrzegania podstawowych kwestii związanych ze zrównoważonym rozwojem, w najbliższych latach planiści zobowiązani będą także do spełniania bardziej rygorystycznych norm związanych z efektywnością energetyczną. W Polsce, przełomowym rokiem okaże się 2021, kiedy wchodzi w życie unijna dyrektywa dotycząca efektywności energetycznej budynków. W tej kwestii ogromne znaczenie mają nie tylko charakterystyki pojedynczych obiektów, co całe ich kompleksy i całościowe podejście do planowania – uwzględniające także otoczenie i odwołujące się do skali urbanistycznej.

Celem tego artykułu jest przybliżenie głównych przyczyn przemawiających za zwróceniem się do zintegrowanego planowania energetycznego i przestrzennego. Wyjaśniono w nim kontrowersyjne kwestie związane ze spekulowanymi zmianami klimatycznymi oraz ich potencjalnym związkiem z sektorem budownictwa. Oprócz tego, w artykule przedstawiono argumenty odwołujące się do czynników ekologicznych, a także podstawowych kwestii związanych z ewolucją terenów zurbanizowanych i czynników socjoekonomicznych.

Summary

Along with respecting basic sustainable development goals, planners will also be obliged to meet more stringent provisions related to energy efficiency in the coming years. In Poland, a crucial year will be 2021, when the EU directive on the energy efficiency of buildings comes into force. In this matter, not only the characteristics of individual objects are of great importance, but their whole complexes and the overall approach to planning - considering the surroundings and referring to the urban scale.

The purpose of this article is to indicate the main reasons for turning to integrated energy and spatial planning. It also explains the controversial issues related to speculated climate change and their potential relationship with the construction sector. In addition, the article presents arguments referring to ecological factors as well as basic issues related to the evolution of urban areas and socio-economic factors.

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