sciendo

INTERNATIONAL CONFERENCE enviBUILD BUILDINGS AND ENVIRONMENT 2019 7th November, Slovak University of Technology, Bratislava

STU SvF

AGRO-BUILDING CLUSTERS FOR SOLUTION CRITICAL CHALLENGES OF SUSTAINABLE DEVELOPMENT

Maryna Babenko[1], Tetiana Nikiforova[2], Vitalii Spyrydonenkov[3], Oleksandr Savytskyi[4], Sergey Andrukh[5], Michael Schmidt[6]

Department of research, SHEI PSACEA, Faculty of Civil Engineering, Chernyshevsky 24A, Dnipro, Ukraine,

[1] Email: babenko.maryna@yahoo.com

[2] Email: nikiforova_t@pgasa.dp.ua

[3] Email: sva.stroitelp@gmail.com

[4] Email: san.stroitelp@gmail.com

[5] Department of Architecture and Engineering Survey, SNAU, Kondrat`eva, 160, Sumy, Ukraine
sl_a@ukr.net

[6] Department of Enviromental Management, BTU-Cottbus-Senftenberg, Cottbus, Germany
michael.schmidt@b-tu.de

ABSTRACT

The overarching purpose of the Sustainable Development Goals (SDGs) for the year 2030 is to end poverty, protect the planet and ensure prosperity for all. A major role in addressing these problems are the agricultural and construction sectors of the economy that provide basic human needs. However, at present, the agricultural sector not only provides food, but is one of the largest supplier of waste. Buildings and communal services are one of the most energy-intensive sectors of the world economy. A new sustainable development paradigm is based on the provisions of the circular economy. A circular economy is an economic system of closed loops in which raw materials, components and products lose their value as little as possible, renewable energy sources are used and systems thinking is at the core. In this article we will explain this definition in more detail. The organizational form of the creation of new formations can be agrarian and building clusters (ABCs). Cluster is completely self-sufficient that can power and feed itself with closed internal cycle of material and energy flows and the external supply of products and surplus energy to other consumers. ABC will use local organic (wood, straw, hemp) and inorganic (clay, soil, loam, sandy loam) materials for the construction of cheap Zero Energy Buildings (ZEB) or energy-positive homes, existing green technologies such as renewable energy sources, energy storage, organic food production, water management and waste-to-resource systems. In the frame of the presented study the autonomy of the building unit for ABS has been analyzed for the condition of Dnipro region, Ukraine.

INTRODUCTION

Today, we have developed a number of pilot projects in Ukraine for the rehabilitation of existing and development of new self-sufficient agrarian and building clusters. The aim of these projects is the creation

https://doi.org/10.2478/9788395669699-001

demo facilities for high tech events as a showcase for further distribution, measurement and monitoring of environmental parameters, the built environment and human capacity. ABCs have not only environmental and financial value, but also social value, by solving the housing problem, reducing of the rural depopulation, contributing the return of city residents into the rural areas. The overarching purpose of the Sustainable Development Goals (SDGs) for the year 2030 is to end poverty, protect the planet and ensure prosperity for all. The World Economic Forum [1] has singled out 10 key global challenges that require cooperation from the governments, private sector, civil society, science and education sector. The most important ones are the following: agriculture and food security, economic growth and social inclusion, preventing illness and preserving the health of populations. A major role in addressing these problems are the agricultural and construction sectors of the economy that provide basic human needs (Maslow) [2]. A new sustainable development paradigm is based on the provisions of the green economy, circular economy, Blue Economy. The green economy is defined as economy that aims at reducing environmental risks and ecological scarcities, and that aims for sustainable development without degrading the environment [3]. A green economy is based on six main sectors: renewable energy, green buildings, sustainable transport, water management, waste management, land management [4]. The circular economy is an economy that is producing no waste and pollution. A circular economy is an economic system aimed at eliminating waste and the continual use of resources. Circular systems employ recycling, reuse, remanufacturing and refurbishment to create a closed system, minimizing the use of resource input and the creation of waste (Fig. 1)[5].

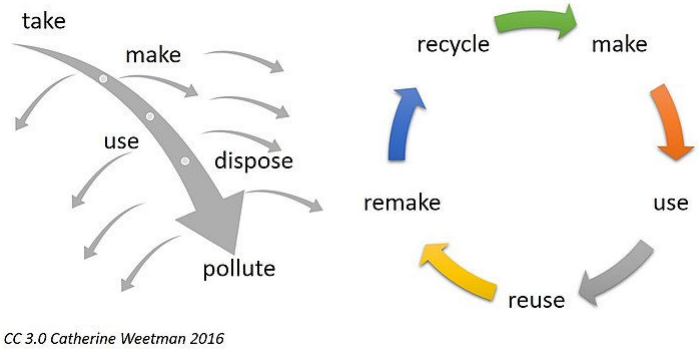

Fig.1. Linear versus circular economy [6].

Blue Economy is where the best for health and the environment is cheapest and the necessities for life are free thanks to a local system of production and consumption that works with what you have [7]. Blue Economy is ZERI's philosophy in action. Zero Emissions Research and Initiatives (ZERI) is a global network of creative minds, seeking solutions to the ever increasing problems of the world [8]. The main direction of the nearest time it is necessary to consider the sustainable development of rural areas through reconstruction of both existing and creation of new types of individual farms and communities. The organizational form of the creation of new formations can be agrarian and building clusters (ABCs) with high-tech agrarian socio-eco-complexes. A business cluster is a geographic concentration of interconnected businesses, suppliers, and associated institutions in a particular field. Clusters are considered to increase the productivity with which companies can compete, nationally and globally [9]. Cluster is completely self-sufficient that can power and feed itself with closed internal cycle of material and energy flows and the external supply of products and surplus energy to other consumers.

Ukraine is primarily an agricultural state. Its formation occurred under the influence of the processes that passed in the villages. Nowadays Ukrainian government has a difficult task to revive the village which is the center of national traditions' preservation such as: honoring the family and established relations between generations, which have a significant influence on the formation of the Ukrainian mentality.

Nowadays agricultural sector is one of the most important parts of Ukrainian economy. Today more than 14 million people are employed in the agricultural sector, and only 620,000 of them are working in the large

farms – agro-holding companies. The core components of the government's policy are support for micro and small scale enterprises (MSEs) and integrated housing development. Extremely important factor for the agricultural sphere is not only increase in production rates but also the development of rural social infrastructure, thus we are faced with the necessity for a governmentally funded program to ensure affordable housing in the regions [10]. The development a scientifically sound model of strategic and spatial planning at the regional levels, which should be based on the main principles of sustainable development: improving economic performance and energy efficiency, social orientation, environmental friendliness, preservation of cultural heritage is an important and actual task. Decision of this task was a general goal of this research. The formation of ABCs and their integration into the existing system of settlement was proposed on the base of global tendency of sustainable development. The concept of ABCs is developed on the basis of globalization trends' analysis and awareness of Ukraine's role in the global labor division. Other notions taken in to account are the principles of sustainable development, the features of modern post-industrial information society ('knowledge society'), the formation of «national idea», the modern technologies of natural farming, the study of international experience of ecovillages' existence, the innovative energy-efficient construction and information technology implementation. It is also very important to consider the historical relationship both to the ancient agricultural Tripoli culture that was present on the Ukrainian lands and existence of the Cossack 'Zimovniki' and the hamlet of farms.

The village is a place of the most natural living conditions for human. Because land provides with the feed and the physical work which can make the body healthy and cultivate positive living traits (perseverance, focus, optimism), of course it requires the creation of appropriate social conditions. Combination of environmental building technologies with modern bio-agricultural technologies can solve socioeconomic problems of the modern village - to provide affordable quality housing, safe and useful work with green technologies for land, in tourism and in scientific spheres; to create a new attractive youth ideology of cultural heritage restoration and cultivation of healthy life and modern thinking according to global trends in sustainable development.Fig.2 [11]

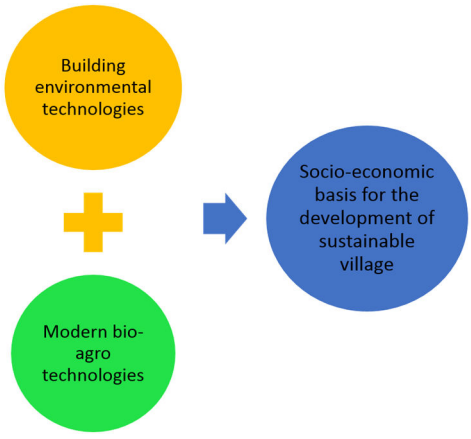

Fig.2. Theoretical basis for effective countryside development

MAIN MATERIALS

Extremely important for the agrarian sector of the economy is not only the growth of production volumes, but also the development of rural social infrastructure: housing, roads, kindergartens, schools, medical institutions, shops, processing enterprises, cultural establishments. In a market economy, large agroholdings are not interested in this; therefore, a state program for the development of rural areas is needed.

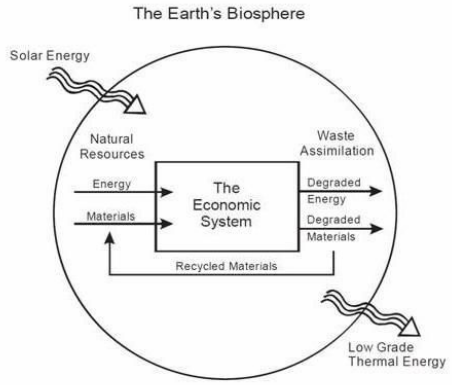

Fig. 2. Diagram of natural resource flows [10].

ABC will use local organic (wood, straw, hemp) and inorganic (clay, soil, loam, sandy loam) materials for the construction of cheap Zero Energy Buildings (ZEB) or energy-positive homes, existing green technologies such as renewable energy sources, energy storage, organic food production, water management and waste-to-resource systems. The next step in the development of construction for ABC is buildings that are designed according to the concept of "Three Zeros". The principle of “three zeros” (Triple Zero) - zero energy consumption, zero harmful emissions, zero waste - from 2021 will become mandatory in Europe for all construction projects. This, in particular, is required by the EU Directive on the energy efficiency of buildings.

Residential buildings with the characteristics described above are required to ensure the functioning of the ABC. For the normal functioning of the house and the provision of comfortable living conditions for the living in it, it is necessary to expend thermal and electric energy for the following functions: cooking and storage; heating (cooling) of air in the house to ensure comfortable living conditions for people; supply of cold water to the house and sewerage; heating of water for heating and hot water supply; functioning of household appliances; the functioning of the auxiliary objects of the manor (economic block, greenhouse, etc.); work of tools and devices of management.

Within presented study the possible autonomous effective building operation has been analyzed. The analyze has been proceeded in the context of the proposed solution implementation in ABC as the building unite of the cluster. The following groups of electricity consumers were taken into account: basic regular consumers (refrigerator, kitchen stove, TV, inverter, charge controller, laptop, cold water pump, electric kettle, air recuperator, lighting lamps), auxiliary regular consumers (electric oven, washing machine, iron, vacuum cleaner, kitchen extractor), irregular consumers (cutting machine, electric drill, welding machine, plant crusher, lawn mower, pump greenhouses). The results of such an analysis are given in Table 1.

Table 1. Estimated average electric power consumption by periods, kWh

Month												
1	2	3	4	5	6	7	8	9	10	11	12	1-12
305	283	340	343	328	316	325	327	361	312	279	286	3805

As stated in [12] the main article of energy consumption is heating. The statistical data a power consumption in private building which is located in Dnipro Ukraine are given in Table 2. The conversion of gas combustion heat into electrical energy was performed according to the ratio: 1000 cubic meters of natural gas is equal to 3305 kWh electricity [13].

Table 2. Average power consumption by periods, kWh

Year		Month												
		12	1	2	3	4	5	6	7	8	9	10	11	1-12
2013	Electric, kWh	270	276	178	242	250	173	173	131	131	150	253	210	2437
	Gas, m³ El., kWh	632 2088	733 2422	425 1404	559 1847	16 535	22 72	22 72	17 56	18 59	100 330	304 1005	327 1081	3321 10976
	total	2358	2698	1582				245	187	190				13413
2014	Electric, kWh	250	233	270	160	231	157	188	235	209	178	150	219	2480
	Gas, m³ El., kWh	575 1900	579 1914	698 2307	225 744	195 644	21 69	32 106	34 112	20 66	24 79	144 476	385 1272	2932 9690
	total	2150	2147	2577				294	347	275				12170
2015	Electric, kWh	172	236	220	251	180	185	205	60	225	176	210	226	2346
	Gas, m³ El., kWh	371 1226	492 1626	389 1286	237 783	90 297	30 99	27 89	1 3	30 99	22 73	200 661	232 767	2121 7010
	total	1398	1862	1506				294	63	324				9356
Aver-age total	Electric, kWh	1969	2236	1888				278	199	263				11646
Aver-age	Electric, kWh	2031						247						

The next stage of research was devoted to the selection of solar power plant parameters that satisfied the annual energy requirement for the building under review. Type of installation – pitched roof, module type – single crystal, azimuth -0, tilt angle -30. Preliminary calculation of the generation of electricity using a solar power plant is easy to perform due to the Solar power calculator [14].

The calculation results are shown in the table 3. The results show that solar power plants with a capacity of more than 10 kW meet the annual energy requirement for the analyzed house.

Table 3. Year consumption and generation of electrical energy, kWh

Parameter	Power of photomodules, kW Area, sq. m		
	5 27	10 55	15 82
annual output	6152	12303	18455
consumption	11646	11646	11646
difference	-5494	+657	+6809

CONCLUSIONS

1. The basic principles of development of ABCs are: ecological, technological, business and social activity of the inhabitants, the comprehensive development of individual.
2. Strengthen sustainable economic development and lead to job creation, particularly in agriculture regions. In this context, the resettlement of much of the urban population into ABCs is an effective solution.
3. Combination of environmental building technologies with modern bio-agricultural technologies can solve socioeconomic problems of the modern village - to provide affordable quality housing, safe and useful work with green technologies for land, in tourism and in scientific spheres; to create a new attractive youth ideology of cultural heritage restoration and cultivation of healthy life and modern thinking according to global trends in sustainable development
4. The results of the studies show that in the Central European zone of Ukraine, where Dnipro is located, it is possible to provide an autonomous power supply for a low-rise residential building.

REFERENCES

[1] World Economics Forum [https://en.wikipedia.org/wiki/World_Economic_Forum]
[2] Maslow hierarchy of needs [https://en.wikipedia.org/wiki/Maslow%27s_hierarchy_of_needs]
[3]Green Economy [https://en.wikipedia.org/wiki/Green_economy]
[4] "How do you define the 'green' economy?" MNN - Mother Nature Network. 2009-01-09. Retrieved 2013-11-09.
[5] Circular Economy [https://en.wikipedia.org/wiki/Circular_economy]
[6] Linear versus circular [https://commons.wikimedia.org/wiki/File:Linear_versus_circular.jpg]
[7] Blue home [https://web.archive.org/web/20131006095609/http://www.theblueeconomy.org/blue/Home.html]
[8] ZERI project [http://www.zeri.org/what-is-zeri.html]
[9] Business cluster [https://en.wikipedia.org/wiki/Business_cluster]
[10] Аграрні соціоекокомплекси в Україні/ Савицький М.В., Ніколаєнко С.М., Бендерський Ю.Б., Бабенко М.М., Бондаренко О.І.// Д:ДВНЗ ПДАБА, 2014. – 103 с.
[11] Development of countryside by the building of agrarian socio-eco-comlexes. M Babenko, M Savytskyi - Litteris et Artibus, 2015
[12] Energy technologies area [http://eetd.lbl.gov/newsletter/nl29/]
[13] Ukraine horticulture business development project
[https://uhbdp.org/images/uhbdp/pdf/library_sabo/odynyci_kilkosti_ teploty_ta_potuzhnosti.pdf]
[14] Solar power calculator [https://rentechno.ua/en/solar-calc.html]