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Implementation Of Green Building Project Within The Example Of Techno-Eco-Park, Rostov-On-Don

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Abstract

This article performs an analytical overview of "green" standards system development and the green building in Russia and abroad. According to the example of the Southern Regional Techno-Eco-park in Rostov-on-Don the possibilities of green building, renewable energy sources use and "green" technologies in the Southern Federal District are shown. The developed project will be the first innovative platform in the South of Russia for the study and practical application of environmentally friendly construction technologies and the operation of buildings in order to create a comfortable urban environment.

Techno-Eco-park will include the objects of existing buildings and newly constructed academic buildings, research laboratories, the pilot plants for building materials production, a hostel for university staff, business centers, exhibition centers and sports facilities. The project provides the creation of intelligent energy resources management system within the Techno-Eco-park territory, the construction of new and the reconstruction of existing facilities in accordance with the requirements of the "green" standards, which corresponds to the priority trends of Russian Federation technological development.

The article provides an overview of the draft of the sustainable development decisions for a development area, architecture, the energy supply system, the measures for saving water and energy.

The technical, economic and social substantiation of the project implementation effectiveness is presented.

Key words: green building, energy saving, ecological building standards, renewable energy sources, Smart Grid.

1. INTRODUCTION

The modern development of many Russian cities is faced with the need for a number of tasks solution to create a comfortable sustainable urban environment, such as: the expansion of pedestrian areas, recreational areas, the unloading transport hubs, the collection and disposal of waste, the construction and reconstruction of buildings according to power efficient and other standards [1]. To solve them it is advisable to apply the concept of "green" building. In modern sense the "green" building is not only the practice of building construction and operation that reduces the consumption of energy and material resources throughout its life cycle, but also, in some sense, it is a new philosophy of creating a comfortable internal (buildings) and external (city) environment [2].

The development of "green" building meets the objectives of Russian state housing policy to create a comfortable environment for the period up to 2020. Besides, the relevance of "green" standards in Russian construction is conditioned by the following factors:

- the development of design, construction and operation process;
- the application of the best environmental and energy-efficient technologies, equipment and materials;
- the extension of buildings service period;
- the reduction of current repairs frequency and operating costs;
- the provision of more comfortable working conditions, accommodation, leisure activities, and thus the growth of labor productivity and the increase of life expectancy.

2. SYSTEM OF STANDARDS AND GREEN BUILDING PRACTICES IN RUSSIA AND ABROAD

The system of green building standards abroad had a long stage of development: the systems of national standards were developed (in Switzerland - Minergie, in Germany - German Sustainable Building Certification, in Japan - Comprehensive Assessment System for Building Environmental Efficiency et al.). There are international rating assessment system of "Green Buildings" (BREEAM and LEED). There is an active implementation of the developed standards in the practice of construction and operation of buildings [3, 4].

In Russia, the national system of green building standards is in the process of its formation and development (Fig. 1).

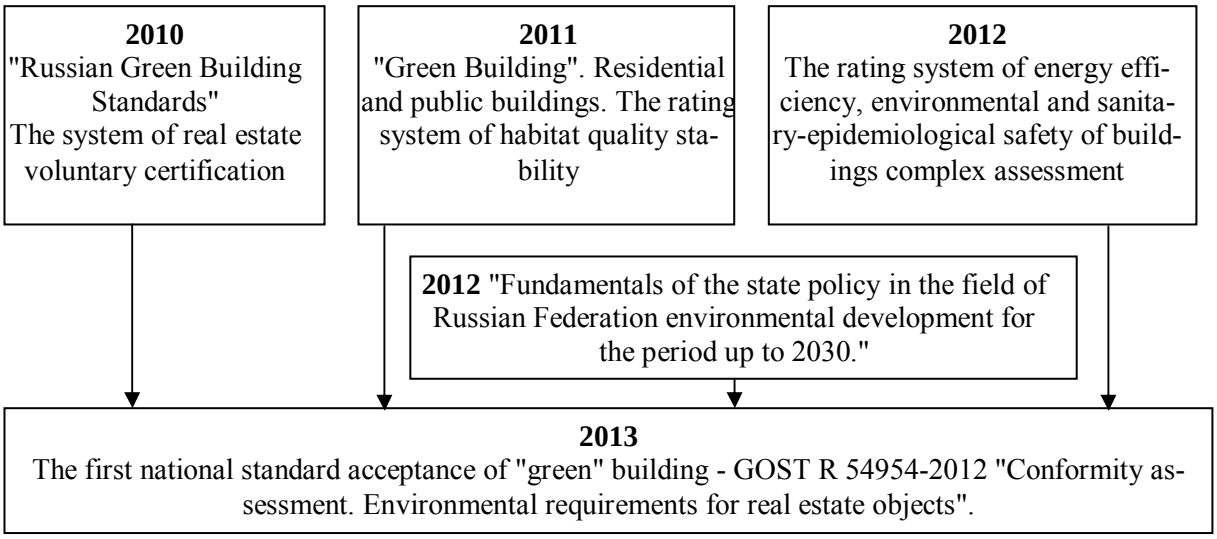


Fig. (1) – Main stages of "green" building standards development in Russia

The systems of green building assessment adopted in Russia and abroad, have a number of common features, such as the use of point evaluation system, the provision of higher importance for criteria that are important from the environmental protection point of view and energy-saving strategy. The differences are within the applicable criteria, the number of points assigned, the system of graduation. The significant feature of "green" building standards is their continuous improvement based on scientific, technical advances and political changes. It ensures the ~~necessary~~ modernization development vector necessary for our country.

Russia is far behind the other countries in respect of "green" building volumes. The most popular introduction trend of "green" technologies in our country is the commercial real estate sector (Fig. 2).

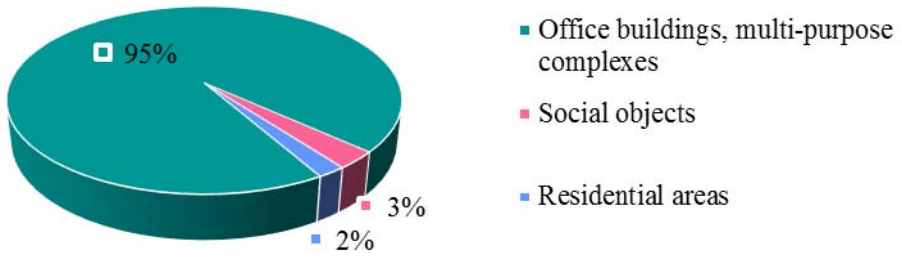


Fig. (2) – The structure of "green" building market in Russia

BREEAM and LEED certificates are provided for a number of class A business centers in Moscow and St. Petersburg, the Olympic facilities in Sochi (Ice Palace

"Bolshoy" and the train station "Olympic Park" have the environmental certificate «Very Good» of BREEAM standard) [5, 6]. Most of the "green" objects in Russia are at the design stage. These are, for example, the sports facilities for the FIFA World Cup, the buildings on the territory of New Moscow and "Moscow City", the innovation city Skolkovo et al. [7].

After the analysis of "green" construction development features abroad, we revealed the following possible areas of its stimulation in Russia:

l) the simplification of documentation approval procedure for the design and construction of "green" buildings;
2) the obtaining land use rights for the "green" building on favorable terms;
3) the simplification of certification procedure and the confirmation of equipment and materials conformity used for "green" construction;
4) the construction of housing according to any government programs taking into account the requirements of "green" standards;
5) the introduction of the life cycle contract during the construction of buildings, which provides the follow-up maintenance, repair and the disposal of delivered goods during the service period [8].

The implementation of these measures in terms of active governmental support will ensure the sustained growth of green building throughout our country.

3. THE CONCEPT OF SOUTHERN REGIONAL TECHNO-ECO-PARK RSUCE

Rostov region has a great potential for green building development. This is a fast developing area with a developed industry of construction materials production, rich in renewable energy sources (RES), which needs to solve the housing problem and create a comfortable living environment for citizens.

In order to support the innovative development of the construction industry taking into account the modern demands for the green building in Rostov-on-Don city the project of the Southern Regional Construction Techno-Eco-park at Rostov State University of Civil Engineering (RSUCE) was developed. RSUCE Techno-Eco-park is the system of educational, scientific and industrial complexes located in the city of Rostov-on-Don with a total area of 14 hectares, consisting of existing and newly designed objects in accordance with the provisions of the "green" standards system including exhibition centers, dormitories for scientific employees, business centers, laboratory, sports buildings and other objects (Fig. 3).

Fig. (3) – 3D model of RSUCE Techno-Eco-park

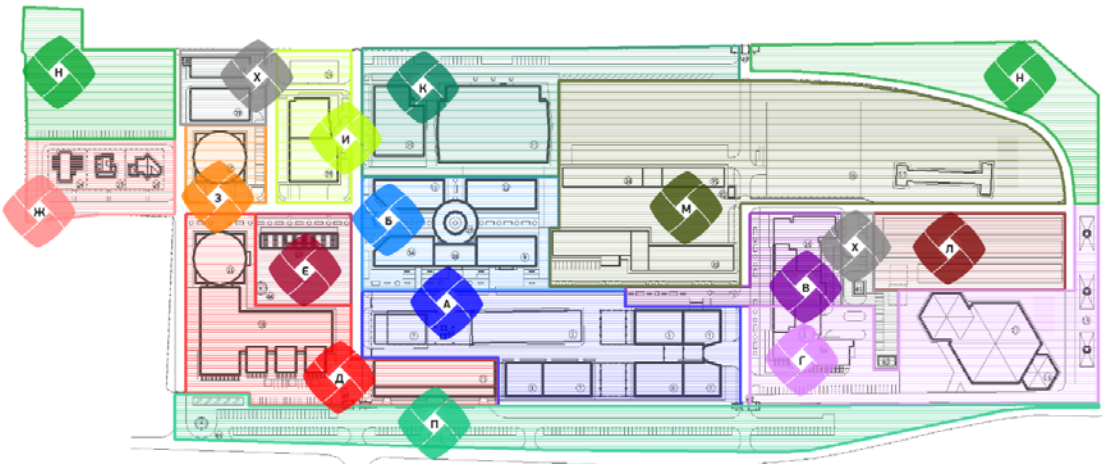
The purpose of Techno-Eco-park building is the creation of a pilot site for the development and implementation of innovations in the field of design, construction and operation of buildings; the creation of educational and research platform that provides the preparation of highly trained engineers for the construction industry in the region, the carrying out of research and development work, its commercialization on the basis of the territory development.

The accounting within the project of "green" standards requirements, the use of alternative energy sources, as well as the creation and the planned pilot operation of intellectual energy management systems of the territory Smart Grid, corresponds to priority areas of Russian Federation equipment and technology development.

4. THE PLANNING OF TECHNO-ECO-PARK TERRITORY DEVELOPMENT

The area planned for RSUCE Techno-Eco-park development is partially mastered. The project used the method of area zoning by dividing it into 15 clusters, each of which has a basic set of infrastructure for autonomous life (Fig. 4).

The built up area has the access to public transport, connecting the area with other parts of the city. When you enter the Techno-Eco-park territory the parking for private vehicles will be provided. The driving along the site in a private car will be limited. Cycling and public electric cars will be used for the movement along the territory. This will expand the pedestrian areas, will reduce the paved areas and the air pollution.

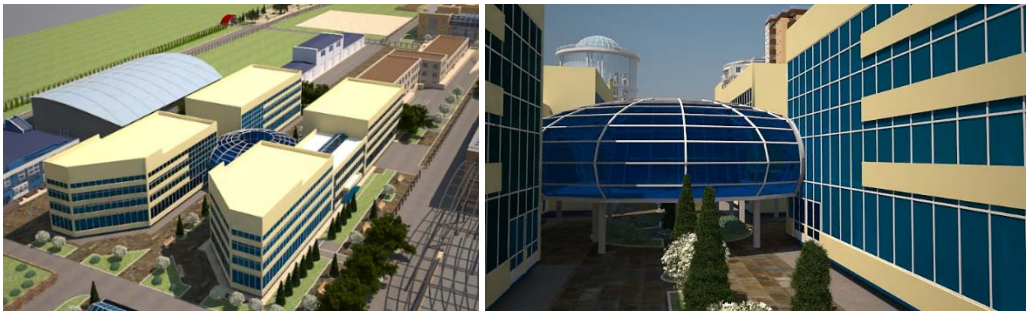


А. Innovation and production area
Б. Training and production area
В. Training zone
Г. Scientific zone
Д. Exhibition area
Е. Innovative exhibition space for urban construction equipment and technologies
Ж. Research and experimental testing ground for low-rise housing
З. Business zone
И. Social infrastructure zone
К. Sports zone
Л. Stadium for Emergency Rescue Service
М. The training ground of the military department
Н. Recreational area
Х. Economic zone
П. Developed surrounding area

Fig. (4) – RSUCE Techno-Eco-park zoning scheme

The project has developed a detailed plan of land development and the construction works performance. In order to prevent the soil erosion special drainage ditches will be dug out preventing the leakage of contaminated water from the area territory. The sedimentary ponds were developed for the stormwater treatment during the period of construction. The fertile layer will be saved and re-used for landscaping.

In zone A the administration and experimental facilities for the production of building materials, structures and products are located (Fig. 5). The project provides the modernization of 2 existing industrial buildings with the area of 1605.5 m^2, and the construction of new ones according to the framework scheme (10 756.9 m^2).



Training and production facility (zone Б)

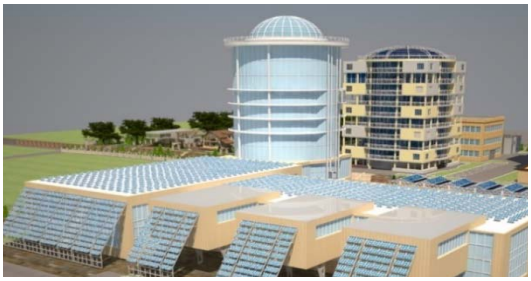
Administrative and domestic buildings (zone А)

Fig. (5) – Techno-Eco-park projected objects

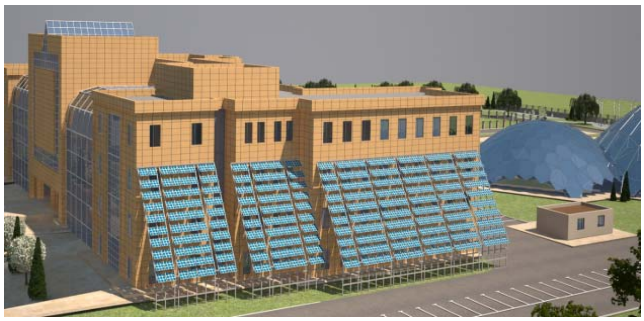
Zone Б will include the centers of engineering personnel teaching and training for construction industry (Fig. 5).

The training area В is presented by a 6-storey academic building with the total area of 13 057.2 square meters. The scientific zone Г within the area of 11 541.4 square meters will hold wind turbines. The construction of the center and laboratory building with the total area of 3564 square meters for the study of alternative energy sources use is also provided. The exploited roofs and special stands will have solar panels (3930 m²) and the solar panels (2,740 m²) at the location nearby.

The building of pavilion and exhibition area (3940.5 square meters), the parking for motor vehicles is planned for the zone Д and Е. Zone Ж is the area of experimental construction for 3-storey low-rise buildings with a high-class of thermal protection, architectural solutions corresponding to the requirements of "green" building standards (Fig. 6).



Office facility in an exhibition centre



6-storey training facility in the scientific zone

Business centre

Examples of low rise cottage projects

Fig. (6) – Techno-Eco-park projected objects

It is planned to build a 10-storey multifunctional business center with the area of 8744.9 square meters in the zone 3. For the stays of graduate students and university staff two residential high-rise buildings with the area of 18850.8 square meters (Zone И) will be built. The external walling hostel structures will be faced according to innovative wall cladding system that provides insulation properties, water and air barrier ~~and a drainage panel~~. This will allow to save on heating and air conditioning of facilities.

The building of a swimming-pools and an ice rink is planned in the sports zone K. Both facilities are actively involved in the energy provision system as energy accumulators. The area M has a military department polygon. The following objects are related to it: academic buildings, military equipment garages, workshops, a shooting range are the part of an existing development.

In order preserve the natural landscape, and recreational development in the north-eastern and north-western part of the Techno-Eco-park the recreation area of 13808.1 square meters is located. The area includes: open-air cafes, small decorative forms, green fencing of the area. Zone X incorporates the objects for household purposes. The construction of a new boiler and administrative buildings is planned on its territory.

5. WATER CONSUMPTION EFFICIENCY BY TECHNO-ECO-PARK OBJECTS

The buildings with a pentroof will have the system of collection, the accumulation of rainwater and its reuse for technical purposes. It is also planned to create a system for the collection and infiltration of stormwater with the possibility of peak flow adjustment followed by a slow release of water in order to avoid a sharp rise of water level in the drainage system within the Techno-Eco-park territory.

The Techno-Eco-park buildings under construction will be equipped with water flow limiters that allow to decrease an excess consumption caused by a high blood pressure, as well as by automatic (electronic) valves to regulate the flow of water depending on the actual needs. These activities will provide the saving of water, and in case of hot water - the saving of energy.

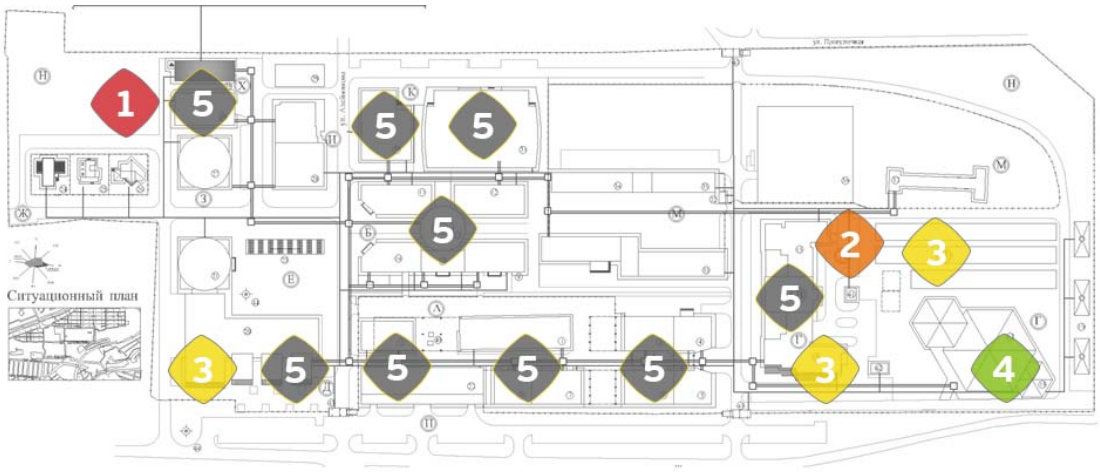
6. THE POWER SUPPLY SYSTEM FOR TECHNO-ECO-PARK

The need of Techno-Eco-park objects for resources supply:

- electrical load - 8.8 MW;
- heat load of 18 MW for hot water supply system (HWS) - 1.4 MW;
- load for air conditioning and making ice - 4.2 MW;
- the load for ventilation system - 1.5 MW.

In order to provide a sustainable and reliable energy supply for Techno-Eco-park facilities based on the needs of the territory, the LLC NPP "Don Technologies" together with RSUCE developed the system of power supply, consisting of the following sources:

- ✓ mini heat and power plant (HPP) - the main source of energy;
- ✓ transformer substation and integrated switchgear;
- ✓ solar photoelectric power plant;
- ✓ wind power plant;
- ✓ heat pumps (high power heat pumps are the part of a mini HPP and heat pumps, distributed by separate Techno-Eco-park objects);
- ✓ solar heliostation (distributed by separate station objects, combined in a single system of heating, cooling and HWS);
- ✓ accumulators of electric and thermal energy as a part of a mini HS and heat pump systems, distributed by objects (Fig. 7) [9].



1 - mini HS; 2 - transformer substation; 3 - solar station; 4 - wind turbines; 5 - heat pumps

Fig. (7) – Techno-Eco-park power supply system composition

The planned share of renewable energy sources in the overall balance of electricity production makes up to 20%, and the thermal energy planned share production makes up to 50% [10]. The solar station will be a distributed system consisting of a main unit (the cascade module, integrated in the architecture of its facilities with the capacity of 100-150 kW) and individual elements of 3-20 kW, distributed along the roofs of industrial park objects, based on the capabilities of their placement.

The structure of a wind power plant will include 3 stations with the capacity of 500-1000 kW each. The mast height may reach 50-70 m, the axis of rotation is horizontal and in a direction of the wind. The energy produced by solar photoelectric energy and wind power plants will be transferred to its own local network of the park energy supply.

7. SMART ENERGY SUPPLY CONTROL SYSTEM

In order to manage the energy supply and consumption of Techno-Eco-park objects under the uneven power generation of RES, the change of objects number which may both consume and generate energy, it is appropriate to create a smart, self-regulating system – Smart Grid and its organization in the form of Smart-space.

This system includes:

- the sources of energy supply;
- a single point of dispatch (Fig.8), which monitors the production, transport, distribution and consumption of heat and electricity, and also provides:
  - the maintenance and management of the indoor environment;
  - the control of street and house lighting systems, fire alarm system, backup power supply and the engineering systems of a building;
- the system of unified resource management in geoinformation environment with the presentation of an engineering infrastructure scheme which provides:
  - the monitoring and the indication of object status;
  - an alarm system;
  - an automatic response to external changes in accordance with predetermined criteria and the remote process management;
- data transfer system via fiber-optic lines, telephone and dispatch communication network between objects (IP-telephony technology). Hardware and software system - ECSS-10 will serve as a data management center.

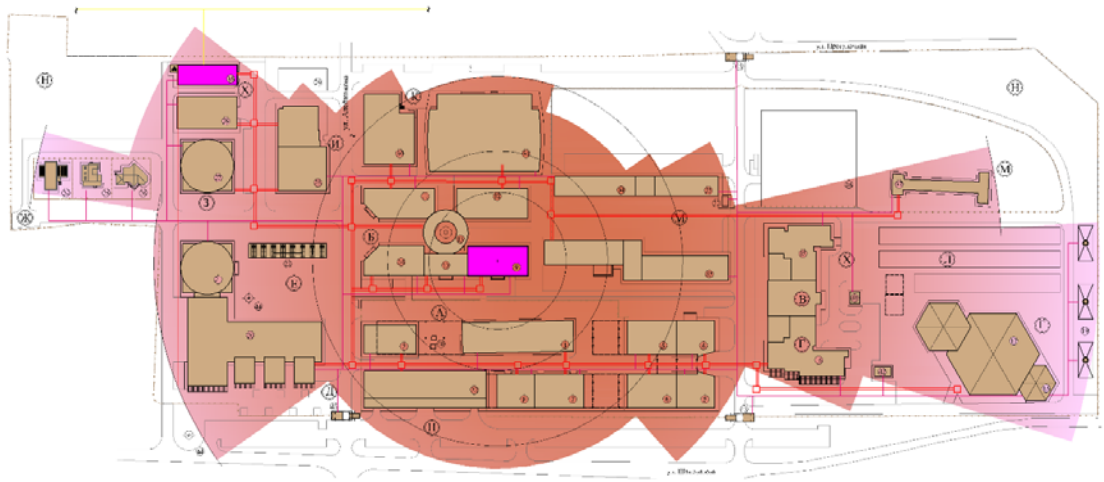


Fig. (8) – The scheme of power supply system management from the Control Center

The Smart-space developed within the Techno-Eco-park territory will provide: the increase of power equipment use ratio, the reduction of operating costs, comfortable accommodation terms for customers.

8. RESOURCE SAVING SOLUTIONS FOR TECHNO-ECO-PARK OBJECTS

The priority task of the project is the reduction of energy consumption for Techno-Eco-park objects. This reduction is achieved by:

- ✓ the building thermal protection upgrade (installation of two chamber insulating glass unit with a reflective coating and low heat-conducting argon, the thermal insulation of external walling) [11];
- ✓ automatic control of heat supply for heating;
- ✓ mandatory use of supply and exhaust ventilation with heat recovery and air conditioning systems;
- ✓ "solar" walls design use for a ventilation system incoming air heating;
- ✓ the use of alternative, renewable energy sources of soils, sun and wind for heat pump, photo-electric and wind power plants;
- ✓ the creation of an automated control system with the engineering systems of buildings.

In training zones Б and В, for example, the heat pump will be applied for heating, working from the energy of exhaust ventilation air and low-grade heat of the soil surface layers. The foundation piles with monolithic pipelines will serve as heat exchangers. This zone also includes:

- ✓ indirect solar heating by internal walls accumulating heat;
- ✓ the use of buffer tanks as heat accumulators and winter gardens in the system of a building microclimate provision (low inertia air conditioning system of a building).

In the sports area К the water heating in a swimming pool during summer period (April-October) will be provided by a solar heat pump device with solar absorbers during winter period and a heat pump device operating at low potential energy on cloudy days.

9. TECHNICAL AND ECONOMIC ASSESSMENT (TEA) OF RSUCE TECHNO-ECO-PARK PROJECT IMPLEMENTATION

The project implementation form is a public-private partnership. The sources of funding: federal (17%), regional (20%) and private investment (63%).

The TEA of Techno-Eco-park project construction effectiveness:

1. The net present value (NPV) of the whole project as a whole makes 7000,0 mln. RUB.
2. Profitability Index (PI) > 1 (PI = 1,18), therefore, the project may be considered as a cost-effective.
3. The internal rate of return (IRR) makes 12%, which exceeds the discount rate. Therefore, the project is considered to be an effective one.
4. The discounted payback period (DPP) of an innovation project makes 15-20 years.

10. CONCLUSION

The performed TEA of the project proved the effectiveness of its implementation from an economic point of view. The resulting economic benefits from the project implementation due to the use of "green" standards:

- ✓ the decrease of operating costs and attraction of a public attention to the project that will contribute to the fast return on rental space.

Benefits for environment and society:

- ✓ resource saving and the reduction of adverse effects on natural ecosystems;
- ✓ activization of innovative solutions search that minimize the impact on the environment, and the creation of conditions for the development of a comfortable urban environment;
- ✓ provision of high quality construction, RSUCE Techno-Eco-park building maintenance;
- ✓ the development of public demand for new knowledge and technologies in the field of renewable energy;
- ✓ the creation of new jobs in the production and operational sectors.

The implementation of the project concerning the creation of the Southern regional architectural RSUCE Techno-Eco-park will provide a significant breakthrough in the application of modern technology, green building materials, will create an experimental platform for smart building management systems testing in the city of Rostov-on-Don and the Rostov region.

CONFLICT OF INTEREST

The author confirms that the information presented in the article is based on the analysis of Russian and foreign author study results concerning the issues of green building. This info does not contain any conflict of interest.

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