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USE OF ENERGY SAVING TECHNOLOGIES IN GREENHOUSE COMPLEXES (ON THE EXAMPLE OF THE DIPLOMA PROJECT)

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Abstract: The article covers a topical issue for the operation of greenhouses and greenhouse complexes - measures to reduce maintenance costs. Greenhouse complexes are unique constructions according to spatial and spatial, architectural-planning and engineering-constructive decisions; modern greenhouses are characterized by an individual approach to design, it increases the cost of individually designed structures, the manufacture of unique components, climate support systems, etc. That is why modern greenhouses require high costs for their design, construction and operation; This factor is one of the levers that hinders the development of greenhouses in Ukraine, so the related issue is the use of energy efficient means for the autonomy of the building in matters of self-sufficiency (energy, heat, irrigation water, etc.), which in turn contributes to savings.

The author of the article proposes to analyze and adjust and introduce measures of energy efficient technologies on the example of a diploma project for a Bachelor's degree, on the topic - «Scientific and exhibition pavilion with a greenhouse in Odesa». Among the issues covered by the author, possible ways of energy saving were identified: at the urban level; at the level of the master plan; and at the master plan level. The analysis of the project was carried out, in accordance with these ways, in several stages: analysis of the organization of the master plan and directions of the facade (identified areas to be closed from cold winds or make additional landscaping; also identified facades that need sun protection); analysis of the coating material and its replacement by pain is energy efficient; scheme of installation of solar panels and installation (or dismantling) of sun protection lamellas; and the layout of energy-efficient technologies as small architectural forms. To illustrate these provisions, the article is equipped with comprehensive diagrams and drawings.

The problems discussed in the article give impetus to the renewal of the technological base of botanical gardens and greenhouses of Ukraine, in a way that is commercially viable and in the future will help create a sustainable environmentally active position.

Keywords: Greenhouse complex; ecological architecture; energy efficient technologies; energy saving; provision of greenhouses.

Formulation of the problem. Greenhouse complexes are unique constructions according to spatial and spatial, architectural-planning and engineering-constructive decisions; modern greenhouses, which have been designed since the twentieth century, have no analogues. Functional and typological characteristics affect the appearance of buildings, the need for large amounts of sunlight causes large glass surfaces up to 70% and sometimes 100%. The difficulty is to ensure sun protection and energy conservation without violating the architectural and ideological plan. That is why modern greenhouses require high costs for their construction and maintenance; This factor is one of the levers that hinders the development of greenhouses in Ukraine, so the related issue is the use of energy efficient means for the autonomy of the building in matters of self-sufficiency (energy, heat, irrigation water, etc.), which in turn contributes to savings.

Purpose of the article: analyze the application of energy efficient technologies in greenhouses and greenhouse complexes, on the example of the bachelor's degree project of the greenhouse

Objective of the article:

1. Consider advanced energy-saving devices to ensure energy independence.
2. Investigate the world experience in the use of energy-saving technologies.
3. Analyze the diploma project to identify possible ways of energy saving at the urban, object and master plan levels.

Statement of the main research material. The development of greenhouse complexes is an integral part of the modern direction of «eco construction». The purpose of «green» construction is the use of architectural solutions that improve the quality of the environment and the ecological condition of the planet, which can provide such a structure as a greenhouse [1]. One of the most important functions of greenhouses is to keep rare exotic plants, whose native climate does not coincide with the climate of the greenhouse location. Therefore, the functional filling of cultivation facilities requires complex engineering equipment that provides the necessary parameters of the microclimate, such as temperature, relative humidity, air exchange, etc., all these characteristics create a microclimate as close as possible to natural. In order to maintain the greenhouse was possible and less expensive, you need to take into account many urban factors that affect the creation of a microclimate inside [10].

Consider measures to prevent heat consumption and heat supply, which describes in his textbook on the architecture of greenhouses and hothouses Novikova NV the problem of costs for providing cultivation facilities with heating, under conditions of constant growth of energy costs, is most relevant. Heating 1 m2 of greenhouse in the winter, without the use of energy-saving measures, is about twice as expensive as heating residential buildings, and when applying a set of energy-saving measures, heat loss is reduced by almost 36%.

Analysis of world practice shows possible ways of energy saving, which allowed us to identify three major groups of ways to save energy [1, 4]:

1. At the urban level:

- Locate near energy facilities. Formation of greenhouse complexes on the basis of non-traditional energy sources (solar, wind, geothermal, biofuels) allows energy savings of up to 100%;
- Choice of building types depending on the climate of the region;
- Construction of one-slope structures on natural and artificial southern slopes with a slope of 30o increases the level of illumination by 1.2 - 1.5 times (which in turn reduces the cost of lighting);
- Location of greenhouses in difficult areas, sanitary zones of industrial enterprises, which will save on land fees.

2. At the level of the master plan:

- Properly chosen orientation of the building, taking into account sufficient insolation, aeration and other conditions to create a comfortable microclimate, saves up to 25% of energy;
- Adhere to the latitudinal orientation of greenhouses built in the southern and central regions, helps to save energy on heating;
- The device of a flat roof in greenhouses located in the southern areas helps to save about 50% of energy for heating;
- Choosing the most optimal type of building by blocking buildings;
- Installation of drainage systems on the territory of the complex, will ensure the collection of atmospheric water into tanks and use for irrigation.

3. At the object level:

- Changing the configuration of the roof and the structural scheme of buildings in order to increase illumination, as well as reduce heat loss through translucent enclosing structures;
- Thermal insulation of all "cold bridges", stage, plinth, adjacent blocks, etc.;

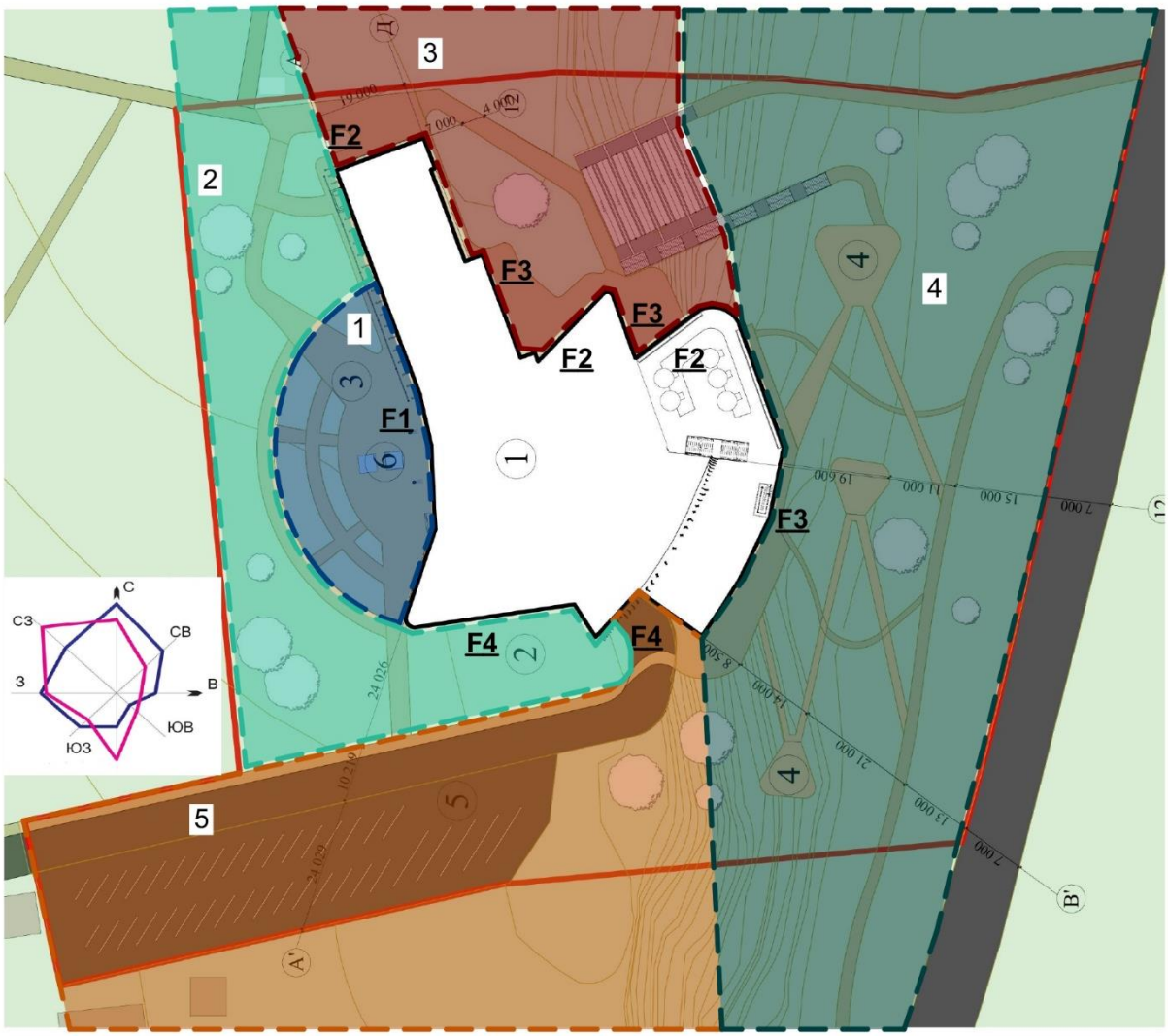
- Enlargement of objects by blocking horizontally and vertically, the use of compact spatial planning compositions, reducing the area of open surfaces and the volume of the heating part of the building;
- Using the effect of a thermal mirror (film inside the glass) allows to achieve savings of 70 - 80% [3];
- Development of new engineering and structural schemes of greenhouses with the use of non-traditional energy resources (solar systems, windmills, heat exchangers);
- Abandonment of elements that shade the building (extra frames of fine-section glazing, which reduces the area of light transmission), the use of large glass can increase the level of illumination by 10-15%;
- Use of solar panels (greenhouses that use solar energy for heating). The sun's rays heat the air inside the greenhouse, directing it to a kind of solar collector. And continue to spread in the right direction. Such a scheme is rational to use for greenhouses of small size [1];
- Selection of the correct glass. Today there is a large selection of energy efficient glass coatings on the market [9];
- Use of louver systems and individual sun protection measures (for example, MANEZH - Ukrainian developer, which includes a section of sun protection with its products, especially for winter gardens and greenhouses) [5, 6];
- Application of innovative coating technology - Texlon, based on ethylene-techrofluoroethylene (ETFE-polymer). This unique material allows you to cover large spaces (facades and roofs of buildings), and has high energy efficiency of light transmission and heat loss [7, 8].

In the course of the study it was decided to analyze the application of energy efficiency measures, provided that the greenhouse is already built and at this stage needs adjustment to implement energy-saving technologies, as the number of decent greenhouses in Ukraine is high and the introduction of modern technologies in operation. The diploma project for the Bachelor's degree of the author of the article is selected for the analysis. In the process of creating a diploma project - a research and exhibition pavilion with a greenhouse in Odesa - the author relied on the textbook Novikova NV «Architecture of greenhouses and hothouses» [1]; DBN B.2.2-2-95 «Buildings and structures. Greenhouses and hotbeds» [2], and analysis of world experience in the design and restoration of modern greenhouse buildings.

The section of the coastal zone of the city of Odesa, on the slope between the French Boulevard and the Arcadia Road (parallel to the Health Route), on the territory of the existing botanical garden, was chosen for the projected object. The project was created to restore interest in the botanical garden and greenhouses in them; update the functional content for the manifestation of multifunctionality and reveal the relevance and value of buildings of this typology.

According to the functional purpose, the center contains three large groups - exhibition (greenhouse), consists of four exhibition and greenhouse halls (hall «Tropics», temperate climate hall, desert hall and a hall for temporary exhibitions); scientific and educational - houses the Department of Botany with lecture and practical classrooms and research laboratories; the latter - tourist - houses an observation tower, cafes and specialty shops.

The analysis of the selected site for the project showed (Fig. 1) that the location in the structure of the city is typical for this typology; landing on the master plan corresponds to most of the points to ensure energy efficiency (compact shape of the object, orientation around the world, the use of sloping roofs to get more sunlight, choosing a site with difficult conditions), see the diagram (Fig. 1).



F1 - Facade oriented to C, overheating is possible; the facade is therefore protected by landscaping and watering was arranged in front of the main facade;

F2 -based from the analysis of the facade, it is clear that this is one of the most shaded facades, but thanks to the glazing on the roof, the room gets a lot of necessary lighting. Located in the NW direction needs landscaping protection from hypothermia

F3 - PnS orientation of the facade involves the possible placement of solar panels on aluminum lamella sun protection panels - Alumil M5600 Solar Protection

F4 - the facade is oriented to the south, so overheating is possible, you need sun protection. Alumil M5600 Solar Protection aluminum panels are used for sun protection. Also, solar panels are installed on them.

1 Additional flooding of the territory with dry fountains in front of the main entrance from C (F1);

2 The area in front of the main entrance to the greenhouse complex is free from construction. The area is well ventilated, with sufficiently dense landscaping, which promotes aeration and sun protection from the C (F1) winds;

3 Protection against dangerous winter wind Mon (F3), Mon (F2) landscaping, if landscaping is not enough, install additional protective screens against dangerous winds;

4 The area with the location of the descent, summer expansion of the cafe area, well ventilated, which contributes to the aeration of the area from the favorable winter and summer Mon (F3) and NW (F2) winds;

5 Area with parking spaces, overheating is possible, as it is the south side (F4), so the installation of solar panels on the roof of the parking lot is envisaged;

Site boundaries

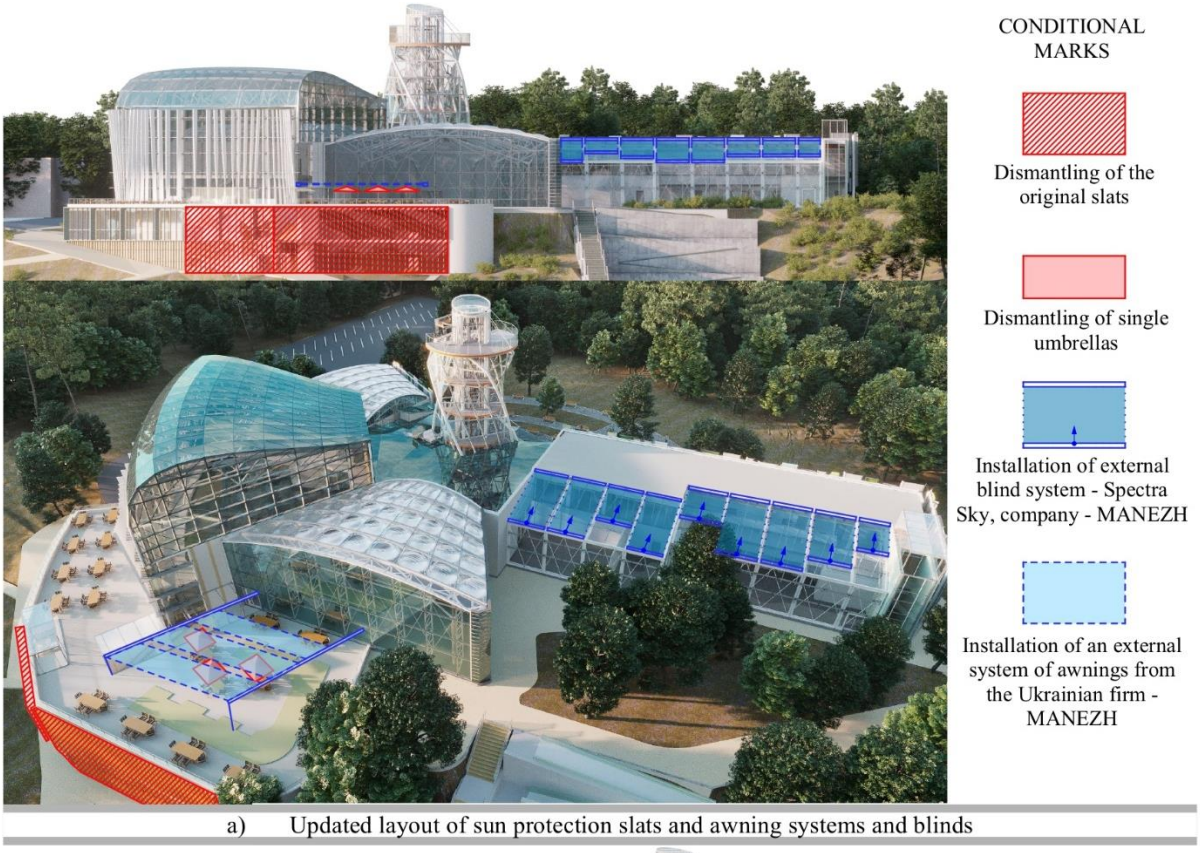
Fig. 1. Analysis of the organization of the master plan and directions of the facade

Fig. 2. Scheme of energy-efficient Texlon coating

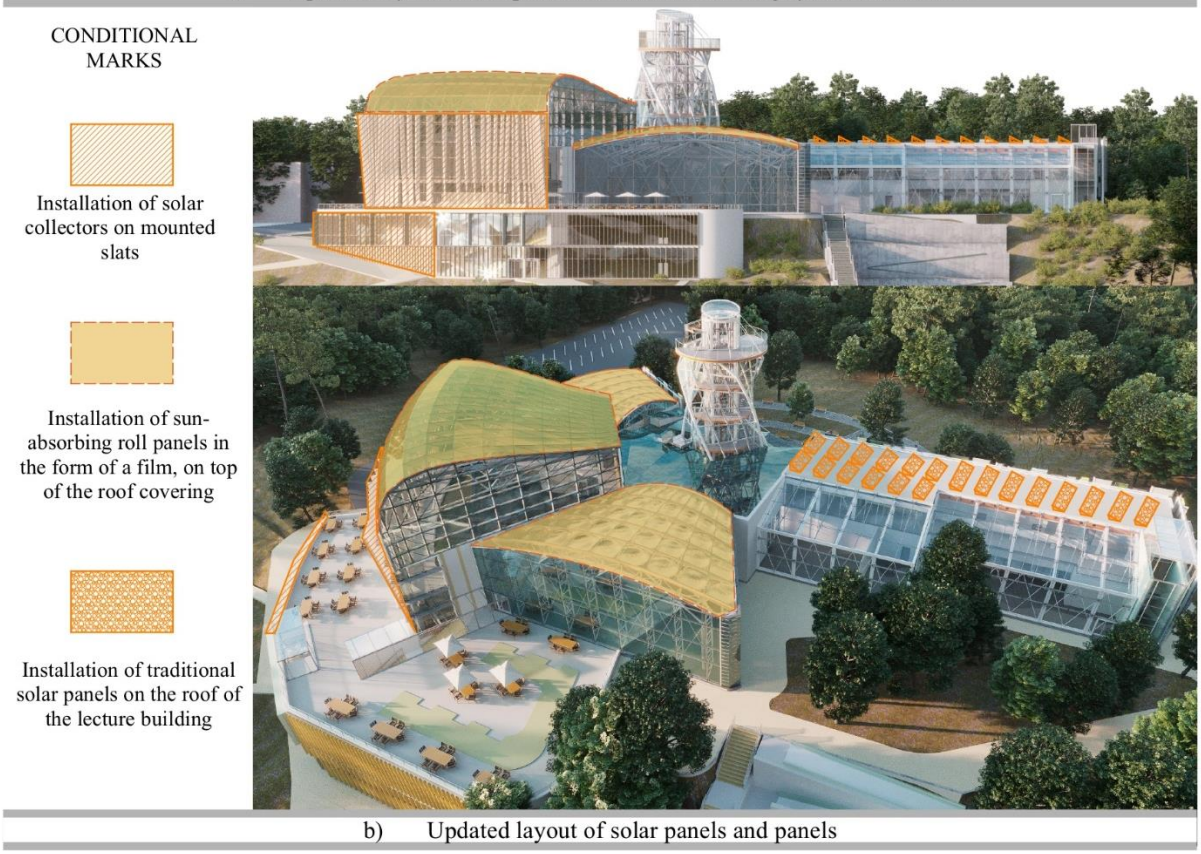
After the analysis, the glass coating of the upper glazing is proposed to be replaced by a coating of high energy efficiency - ETFE (ethylene tetrafluoroethylene, ethylene tetrafluoroethylene) [7,8], using Texlon technology. Innovative material, which is a transparent membrane, with a number of the following characteristics that make it the most effective material for covering greenhouse structures:

- the maximum transparency of the material is 94%, and the transparency in the ultraviolet range
- more than 90%, which allows to achieve a high level of natural light of the object;
- resistance of the material to ultraviolet radiation in natural conditions, which is actually durable, is more than 100 years;
- Texlon system can be recycled, many components are made from recycled materials;
- low-flammability, non-flammable material, does not spread the flame on the surface;
- approved for use in areas with a high probability of severe hurricanes, due to the elasticity of the shell and light weight (3 kg/m^2);
- has a sufficient degree of hail resistance due to high tensile strength (>500% before rupture) and can withstand snow loads over 200 kg/m^2.

Another important advantage is the overwhelming lightness, compared to glass, which allows you to make the metal frame thinner; it increases the area of worldview and the use of less metal (reducing the cost of construction).



a) Updated layout of sun protection slats and awning systems and blinds



b) Updated layout of solar panels and panels

Fig. 3. a, b: Scheme of updating the installation of sun protection slats and solar panels

Based on the analysis of the three-dimensional structure of the greenhouse complex (Fig. 3), it was decided to dismantle the sun protection slats from part of the facade 3, as overheating

does not occur; to dismantle single umbrellas on the summer expansion of the cafe on the roof, instead of them, to install external awning systems of a larger area, the company MANEZH [6], - Ukrainian manufacturer; to organize the installation of an external blind system - Spectra Sky, also the company MANEZH [5]. The scheme of analysis of possible placement of solar panels revealed the most successful types and places of installation of devices: installation of solar collectors on lamella blades is planned on the facade of the main greenhouse and on the facade of the restaurant with a south-eastern orientation; installation of sun-absorbing rolled panels in the form of a film, on top of the roof covering; installation of traditional solar panels on the roof of the research and lecture block of the greenhouse complex.

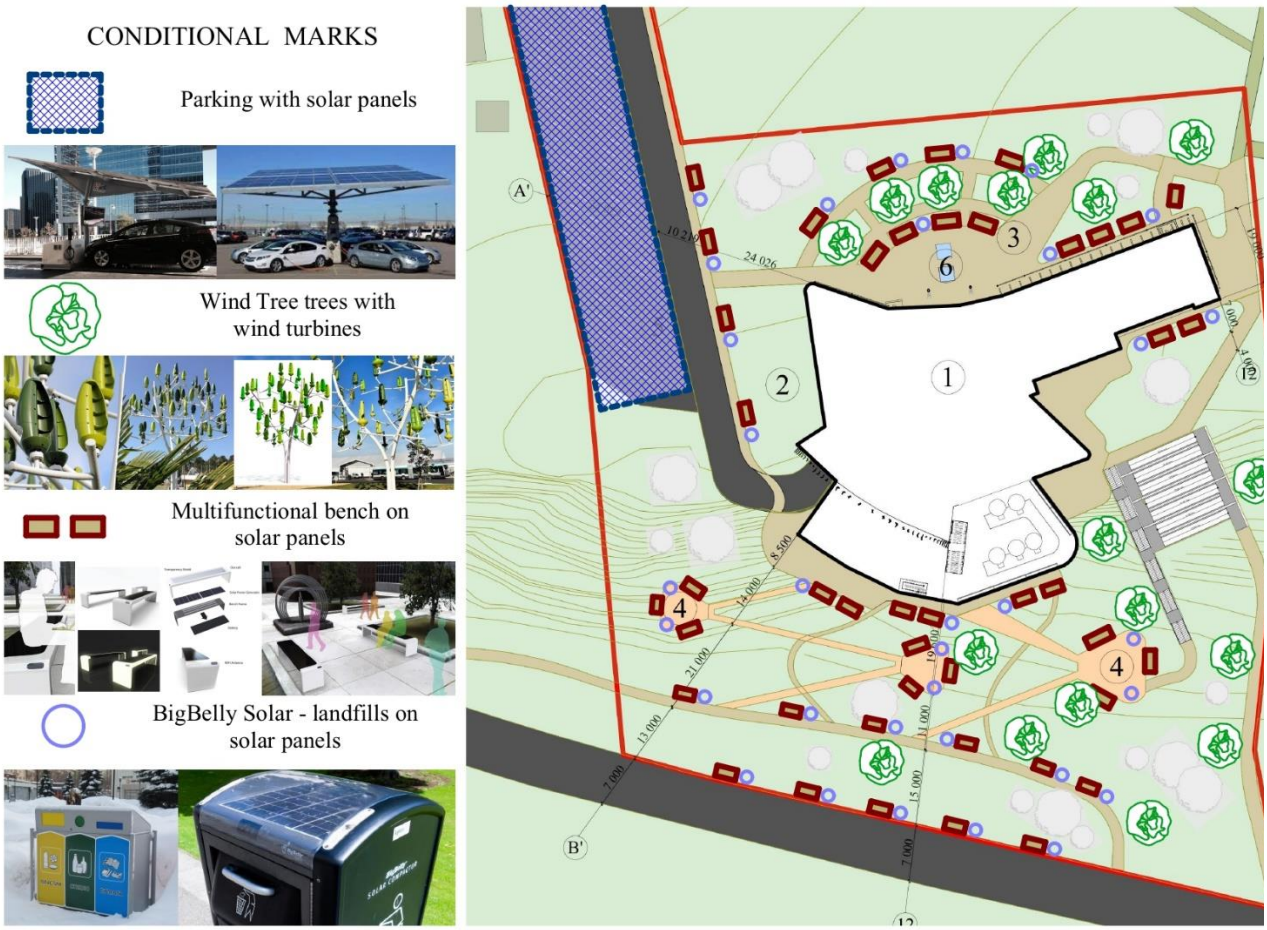


Fig. 4. Scheme of placement on the master plan of energy efficient facilities

The analysis of the diploma project provides a scheme of placement on the master plan of energy efficient means as small architectural forms; this item includes:

BigBelly Solar is a solar-powered garbage container that holds about 7 times more household waste than standard 110-liter bags. The ballot box is charged with the help of a solar battery installed on its roof, has a special call sensor on the wi-fi utility service, when it's time to take out the garbage [12].

Solar Inside - a multifunctional bench equipped with solar panels, in the evening the bench begins to glow, «shifting» the responsibilities of lanterns, in addition, it provides Wi-Fi access. Create such benches from recycled plastic and aluminum [13,14].

Conclusions. Based on the submitted material, it can be concluded that greenhouses and hothouse complexes are commercially expensive structures and the issue of operating savings is relevant. On the example of the diploma project, the author demonstrated ways to optimize and install energy-saving technologies in a hypothetically built greenhouse after commissioning, as in

Ukraine there are enough greenhouses to which these updates can be applied. Energy efficiency pathways can be implemented at three levels: the urban level, the master plan level and the object level. For greenhouses already put into operation, the level of the master plan and the object level is partially suitable. Thanks to the schemes, which can be clearly traced the author's opinion, the article is designed for a wide range of readers.

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ВИКОРИСТАННЯ ЕНЕРГОСБЕРІГАЮЧИХ ТЕХНОЛОГІЙ В ОРАНЖЕРЕЙНИХ КОМПЛЕКСАХ. НА ПРИКЛАДІ ДИПЛОМНОГО ПРОЕКТУ НАУКОВО-ВИСТАВКОВОГО ПАВІЛЬЙОНУ З ОРАНЖЕРЕЄЮ В М. ОДЕСА

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Анотація: У статті освітлюється актуальна тема для експлуатації оранжерей та оранжерейних комплексів – заходи, які забезпечують скорочення витрат на утримання споруди. Оранжерейні комплекси унікальні споруди за просторово-об'ємними, архітектурно-планувальними та інженерно-конструктивними рішеннями; сучасні оранжереї вирізняються особливістю індивідуального підходу до проектування, це сприяє збільшенню витрат на індивідуально розроблені конструкції, виготовлення унікальних вузлів, систем кліматичного забезпечення і т. д. Саме тому сучасні оранжереї потребують великих витрат на їх проектування, будування та експлуатацію; цей фактор являється одним із важелів, який гальмує розвиток оранжерейних споруд в Україні.

Автором статті запропоновано на прикладі дипломного проекту на ступінь Бакалавра, на тему – «Науково-виставкового павільйону з оранжереєю в м. Одеса», провести аналіз та скорегувати і ввести заходи енергоефективних технологій. Серед, освітлених автором питань, були визначені можливі шляхи енергозбереження: на містобудівному рівні; на рівні генерального плану; та на рівні генерального плану. Аналіз проекту проводився, відповідно до цих шляхів, у декілька етапів: аналіз організації генерального плану та орієнтації фасаду (були виявлені території які треба закрити від холодного вітру, або зробити додаткове озеленення, обводнення; також, виявлені фасади на яких необхідний сонцезахист); аналіз матеріалу покриття та його заміна на біль енергоефективний (Texlon); схема встановлення сонячних батарей та монтаж (або демонтаж) сонцезахисних ламелей; та схема розташування на генеральному плані енергоефективних технологій, як малих архітектурних форм. Щоб проілюструвати ці положення, стаття споряджена вичерпними схемами та рисунками.

Проблеми, які розглянуті у статті дають поштовх на оновлення технологічної бази ботанічних садів та оранжерей України, шляхом, який комерційно справджує себе і в майбутньому допоможе створити стійку екологічно активну позицію.

Ключові слова: Оранжерейний комплекс; екологічна архітектура; енергоефективні технології; енергозбереження; забезпечення оранжерей.