Секція 2
Особливості розвитку економічного потенціалу суб'єктів підприємництва в кризових умовах післявоєнного відновлення

INNOVATIVE AND NEW MATERIALS IN THE BUILDING MATERIALS INDUSTRY

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One of the dynamically developing sectors of the national economy is currently the building materials industry. According to various estimates, its share accounts for 3 to 5% of the country's total industrial production, about 3% of the main industrial and production assets. In recent years, the annual growth in the production of basic types of building materials ranges from 7 to 30%. More domestic products began to be produced that meet modern requirements and correspond in quality to world analogues.

The building materials industry consistently holds a leading position among industries in terms of total output with the food industry. The importance of the building materials industry for the country's economy is also due to the fact that it supplies raw materials and materials for the construction complex.

Since ancient times, a person has been building housing for himself to protect himself from the weather, trying to create maximum comfort and coziness for himself. The choice of materials for the construction of walls, windows, roofs and other elements is largely determined by the climate of the area where the house is being built. Throughout the history of construction - until the last decade - the most vulnerable part of buildings in terms of thermal insulation were windows, or, in technical terms, translucent building envelopes. Their peculiarity is that they perform two opposite functions: on the one hand, they must let as much light into the premises as possible, and on the other hand, they must protect from cold, wind, rain ... Rise in the cost of energy and, as a result, the desire to save them has become the motive for numerous studies in the field of building technologies. The efforts of the best scientific centers in Europe and America have been directed in recent decades to solving this problem, a huge amount of money has been invested in scientific development. Moreover, the main focus of the research was placed precisely on translucent structures, as on the weakest thermal elements of buildings. And if we talk about progress in the field of building technologies, then the most impressive discoveries have been made in this direction.

To date, the development of technology has reached such a level that more energy and heat from the sun can be received through windows and glass facades than lost. What will the technologies of the 21st century look like? The design of the

double-glazed window in its original form - two simple window panes with dried air between them - currently does not meet European standards for thermal insulation and is yesterday.

In modern European construction, glass with heat-reflecting coatings is used for double-glazed windows.

The physical basis of the process of saving heat in efficient double-glazed windows are as follows.

The heat flow through double-glazed windows consists of three parts:

1. Radiant heat exchange between glasses (infrared radiation);
2. Thermal conductivity of gas between glasses (heat transfer);
3. Convection of gas between glasses (movement and mixing of gas).

The radiant component of the heat flux accounts for 2/3 of the transferred heat, and only 1/3 for the other two factors! Scientists have taken advantage of this feature. By applying the thinnest metal coatings on glass, they learned how to direct the radiant component of the heat flux back into the room.

The metal coating has the properties of a light filter, which is why it is called "selective", that is, "selective": it transmits short-wave radiation, especially well in the visible region, while for long waves - the infrared spectrum - it works like a thermal mirror, reflecting a large part of the radiation. In practice, this means that while remaining transparent to a person and letting sunlight into the room well, the heat-reflecting coating sends the radiated thermal energy back into the room.

The surface of the glass with a selective coating should be the third in a double-glazed window from the side of the street - only in this arrangement does it make real sense. The heat-reflecting coating has a low abrasion resistance, but the glass installed with the coating inside the package does not need to be cleaned, because due to the tightness of the double-glazed window, the glass is not contaminated from the side of the inter-glass space.

The loss of transparency (light transmission) of a double-glazed window with heat-reflecting glass compared to the usual one is only 5-7%, while when using two-chamber double-glazed windows (with three glasses), their transparency decreases by 21.5%!

However, only a selective coating improves the thermal performance of a double-glazed window slightly, since the temperature difference between the inner and outer glass increases, which increases the air convection inside the double-glazed window, and, accordingly, heat loss. But if a double-glazed window with heat-reflecting glass is filled with an inert gas, for example, argon, then such a double-glazed window holds heat better than walls in our typical panel houses!

Heat-reflecting glasses are produced by depositing thin films of metals and metal oxides on the surface of glass by sputtering, chemical deposition, electrochemical processing, or thermal decomposition. In Europe, where glass with selective sputtering has become the standard, glass with heat-reflecting coatings of gold, silver, nickel, copper, aluminum, chromium, titanium and their oxides is produced in the industry. Gold-coated glasses have the best heat-reflecting properties, but due to their high cost, they have not been widely used. The use of heat-reflecting glasses with oxide-metal coatings is very effective.

In any other house it would be the other way around. But at Wilhelm Stahl in Freiburg, the outer walls of the house are warm, while the inner walls are cool. A physicist lives in a house heated only by the sun, light and air. This happens without a drop of oil, gas or electricity. One of the magic formulas of this house is TWD (transperente Waermedaemmung), or transparent thermal insulation (PTI).

The principle of PTI scientists "peeped" from a polar bear. The white fibers of his coat reliably protect him from the cold, however, they let a lot of light through to his skin, which is black, and which, when heated, gives off heat to the body.

The concept of PTI includes an extensive group of translucent materials, such as acrylic foam, capillary glass, cellular polycarbonate. In addition to transparency, the common properties of these materials are: porous or tubular structure - they are about 95% air, so they have excellent thermal insulation; very small pore size, due to which there is practically no air convection in them; and these materials are opaque to thermal radiation. A layer of such material with a thickness of 20mm retains heat 3 times better than a thick brick wall with a thickness of 310-510mm of a traditional domestic house!

The best properties are materials called aerogels, in particular, silica gel - a material based on silicic acid. This material was invented by the German scientist Kistler in 1931, but it has received practical application only in recent years. The size of the micropores in silica gel is much smaller than the wavelength of visible light, and due to the small scattering, 12mm samples are 10% more transparent than double glazing! In the light, silica gel has a slightly yellowish tint.

Based on the production technology and in order to avoid contamination, PTI is enclosed between two glasses in frames of different materials, that is, in fact, in a double-glazed window. It is used in the construction of PTI in two ways.

The first option, which scientists consider the most promising, is precisely the "polar bear" principle. Transparent thermal insulation is placed in front of a massive wall made of concrete or other heavy material, the outer side of which is painted black, and which plays the role of a thermal energy storage. Solar radiation penetrates through the PTI and is converted into thermal energy on the black surface of the wall. The wall, in turn, gradually releases heat into the building.

Thus, the walls of the house take more heat from the sun than they give it out! "We heat the house with walls…" – this is how Wilhelm Stahl says about his house. And how to adjust such a heating system when the merciless sun shines on the street and the thermometer mark creeps up to 30C? Very simple: between the outer glass and the PHE, there is a shading device controlled by automatic sensors that lowers when the outside temperature is high, ensuring optimal energy flow and maximum comfort in the building. As practice has already shown, the temperature of the inner surface of a wall with transparent thermal insulation is on average 2°C higher during the winter season than walls with opaque insulation, which provides optimal conditions for thermal comfort for residents.

Another of the experimental sites on which PTI was tested was the Paul-Robertson-School in Leipzig. The measurements showed that after the reconstruction of the school with its insulation, transparent thermal insulation, heating costs decreased from 225 kWh/m2 to 58 kWh/m2, which means a reduction in energy

losses by 70%.

The second option for the use of PTIs is external walls that combine ordinary windows and PTIs, which significantly increases their light transmission. Many of our tourists in the West are misled by the crystals of the buildings, when all the outer walls seem to be made of glass. In fact, as a rule, these are hinged glass facades, behind which massive walls with regular-sized windows are hidden. And only PTI gives a real opportunity to make walls almost completely transparent without prejudice to the preservation of heat and thermal comfort of people, opening up new, previously unknown opportunities for architects.

To protect the premises from bright sunlight and from overheating, materials with variable translucency can be used. Such materials change their properties when exposed to light (photochromic), heat (thermochromic) or electric field (electrochromic). One of the newest materials of this kind is TALD gel, developed at the Institute for Building Physics in Stuttgart. TALD is a thermochromic material and is based on organic materials.

A thin layer (0.3mm) of TALD is placed between two glasses. Depending on the temperature of glass heating under the influence of sunlight, the material passes from a transparent state to an opaque one: the higher the temperature, the more molecular chains line up in the material, the size of which is larger than the wavelength of light and which do not transmit light. When the temperature decreases, the material returns to the transparent state again. In a transparent state, TALD transmits 80% of solar radiation; in an opaque state, this value decreases to 10-40%. When using such materials, there is no need to use shading devices in buildings. Variable translucency materials have a big advantage over tinted sunscreens, which significantly reduce light transmission and are not self-adjusting.

Windows unevenly distribute light in the rooms. The farther from the window is the workplace, the less light it receives. In cloudy weather, there is not enough light in the depths of the rooms, and in the sun there is a blinding play of light and shadow. The solution to this problem was taken up by scientists from the Institute of Light and Building Technology (ILB) in Cologne.

They have developed a system that is able to successfully solve the problem. Illumination unevenness can be largely eliminated with the help of light control optical elements. They are thin strips of acrylic or bicarbonate glass bent in a certain way, which are located inside double-glazed windows at the top of the window. These elements redirect diffused and sunny color from the zenith to the depth of the room and to the ceiling. Reflective elements are mounted in the false ceiling, which have a special scattering structure of micro-pyramids. Blinding by sunlight with this system never occurs, since the reflection of the rays takes them away from eye level and scatters them thanks to reflective devices on the ceiling. The upper light-controlling part of the window is never obscured by sun protection devices, while the lower parts of the windows are equipped with shading, which, if necessary, can be used.

Already put into practice houses with light-controlling holograms in Cologne showed the complete correctness of the theoretical calculations of the researchers. The quality and duration of natural lighting have become much better, rooms with a

depth of more than 7m did not require artificial lighting. The feeling of comfort and efficiency of office staff has improved significantly. Measured in Germany, the electricity consumption for lighting has decreased by 80% compared to conventional windows!

Currently, scientists are developing integrated systems of natural and artificial lighting, when light-control holograms will be automatically supplemented with artificial light when the natural light in the premises decreases. More and more often in Europe, when talking about modern building technologies, a new term is being used: intelligent building systems. By these words, scientists and engineers understand energy-efficient, self-regulating, automatic systems.

Today in Europe there is no doubt that the future in construction belongs precisely to intelligent systems.

Literature:

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ОСОБЛИВОСТІ ВІДНОВЛЕННЯ УКРАЇНСЬКОГО БІЗНЕСУ В ПОВОЄННИЙ ЧАС

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Сьогодні, в умовах війни, економіка нашої країни перебуває у стані безпрецедентної кризи. Масштаби втрат, спричиненні війною, є надзвичайно великими і складаються із: фінансових та людських втрат; зруйнованої інфраструктури та виробничих потужностей; знищеного природнього потенціалу; призупинених інвестиційних проєктів, скороченого попиту населення, звуження спектру вітчизняних товарів, дефіциту імпорту енергоресурсів тощо.

Український бізнес опинився у важкій ситуації, коли ланцюжки поставок були зруйновані та заблоковані морські порти і він змушений був переорієнтуватися на нові ринки, здійснювати пошук більш надійних торгівельних партнерів на теренах глобального економічного простору та позбутися залежності від країни-агресора.

Вагомими інструментами підтримки та відновлення бізнесу є державна підтримка та допомога країн-партнерів. З цією метою уряд нашої країни запровадив низку програм:

- грантові програми єРобота;
- програма релокації підприємств з небезпечних територій;
- програма кредитування бізнесу під 5-7-9%.

Найбільшим попитом серед представників бізнесу користуються грантові програми. Державні кошти, отримані у вигляді грантів, мають бути повернуті