**2023 May Day MCM**

**Problem C. Research on low-carbon building under the “Dual Carbon” target**

“Dual Carbon” refers to the abbreviation for “peak carbon” and “carbon neutrality”. China strives to achieve peak carbon emissions before 2030 and carbon neutrality before 2060. The “Dual Carbon” strategy advocates a green, environmentally friendly, and low-carbon lifestyle. China will accelerate the pace of reducing carbon emissions, vigorously promote green and low-carbon technological innovation, and improve the global competitiveness of industries and the economy.

Low-carbon building refers to the reduction of fossil energy use, improvement of energy efficiency, and reduction of carbon dioxide emissions throughout the entire life cycle of building materials and equipment manufacturing, construction, and building use.

Please search for relevant information to solve the following problems：

**Question 1**：There is a single-story flat-roofed building that is 4 meters long, 3 meters wide and 3 meters high. The walls are made of brick-concrete structure with a thickness of 20 centimeters (thermal conductivity coefficient), and the roof is made of reinforced concrete with a thickness of 30 centimeters (thermal conductivity coefficient). The total area of the doors and windows is 5 square meters (thermal conductivity coefficient), and the ground is made of concrete (thermal conductivity coefficient). The average monthly temperature (in degrees Celsius) at the location of the building is shown in the table below for one year (calculated on a 365-day basis).

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Month** | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 |
| **Average Temperature** | -1 | 2 | 6 | 12 | 22 | 28 | 31 | 32 | 26 | 23 | 15 | 2 |

Assuming that the temperature inside the building needs to be maintained between 18-26 degrees Celsius, and that electricity is used to regulate the temperature when it is not suitable(It is known that one unit of electricity consumption is equivalent to 0.28 kilograms of carbon emissions). Please calculate the annual carbon emissions of the building through air conditioning (assuming a heating performance coefficient COP of 3.5 and a cooling performance coefficient EER of 2.7) to regulate the temperature. (Try to use the conditions given in this question to calculate carbon emissions as much as possible, without considering other losses.)

**Question 2**：In the entire life cycle (construction, operation, and dismantling) of residential buildings, there are many factors that affect carbon emissions, such as building design standards, climate, production and transportation of building materials, regional differences, energy consumption during construction and dismantling, decoration style, energy consumption during use, and building types. Please search for and analyze information, establish a mathematical model, identify indicators that are highly correlated with the above factors and easy to quantify, and based on these indicators, conduct a comprehensive evaluation of the carbon emissions of residential buildings throughout their life cycle.

**Question 3**：Based on Question 2, please consider the carbon emissions of residential buildings in three stages of their lifecycle. Relevant data needs to be collected and a mathematical model needs to be established to comprehensively evaluate the carbon emissions of residential buildings in 13 prefecture-level cities in Jiangsu Province in 2021. The effectiveness of the evaluation model will also need to be verified.

**Question 4**：Accurate carbon emission prediction can provide important reference for formulating emission reduction policies and optimizing low-carbon building design. Please establish a carbon emission prediction model, based on historical data of carbon emissions throughout the entire process of building construction in Jiangsu Province, predict the carbon emissions throughout the entire process of building construction in Jiangsu Province in 2023.

**Question 5**：Please provide policy recommendations for carbon emission reduction in the building sector in Jiangsu Province based on the previous discussion.