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SKETCHBOX LESSON Building Expansion:

Energy Cost of expansion

Next Generation Science Standards (https://www.nextgenscience.org/)

Content Standards

HS-ETS1-4 Engineering Design

Use a computer simulation to model the impact of proposed solutions to a complex real-world problem with numerous criteria and constraints on interactions within and between systems relevant to the problem.

Science and Engineering Practices

2. Developing and using models

4. Analyzing and interpreting data

5. Using mathematics and computational thinking

7. Engaging in argument from evidence

8. Obtaining, evaluating, and communicating information

Lesson metatags

building design, computer model, data analysis, efficiency, electricity, energy, energy conservation, energy economics, heating and cooling, HVAC, kwh, natural gas, NG, simulation, utility rates, energy code, math calculations

Student materials begin on the next page.

PARKVIEW SCHOOL DISTRICT	Name: _____ Date: _____ / _____ / _____ Class Hour: _____

SKETCHBOX LESSON Building Expansion:

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Student Activity and Response Guide

INTRODUCTION:

When school districts decide that they need to renovate or expand their current buildings they need to go to the public and ask if it is ok. This process is called a **building referendum**. Before a district can go to referendum they need to know approximately how much the renovation or expansion will cost in the short term and in the long term. The short term is how much will it cost for construction. The long term is how much will the energy and maintenance be on the renovation or expansion. In this activity we will focus on the **energy cost** of the building. This cost will be based on the location and will be a comparison from the current building to the proposed building expansion. We will use **building codes** to also help us determine this cost.

Energy codes are built directly into Sketchbox

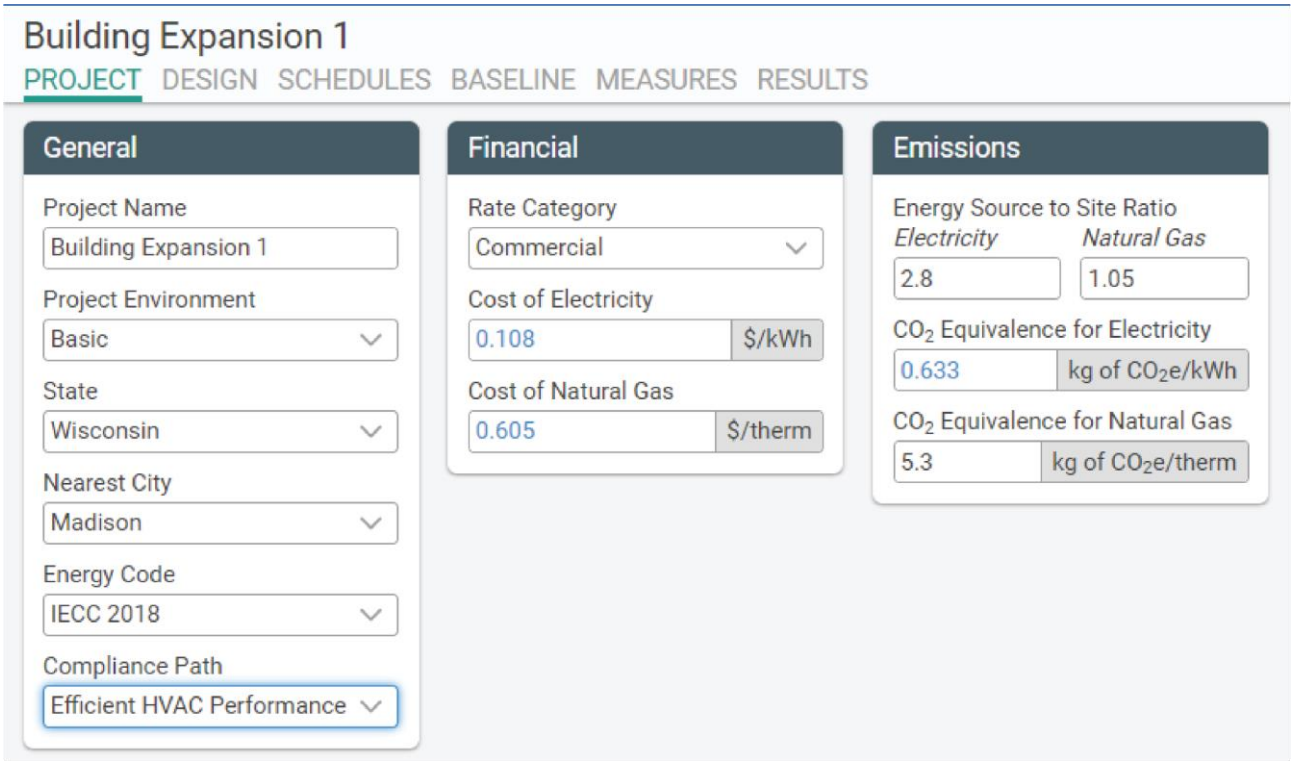
The amount of energy used by a building depends, in part, on the code it was designed to meet so energy code is important for energy modeling. Multiple energy codes are built directly into sketchbox. In this activity you will be using the energy code “IECC2018”.

Beginning the Project

1. Access the web address: https://www.sketchbox.io/login

2. Login to sketchbox using the account you created in lesson 1

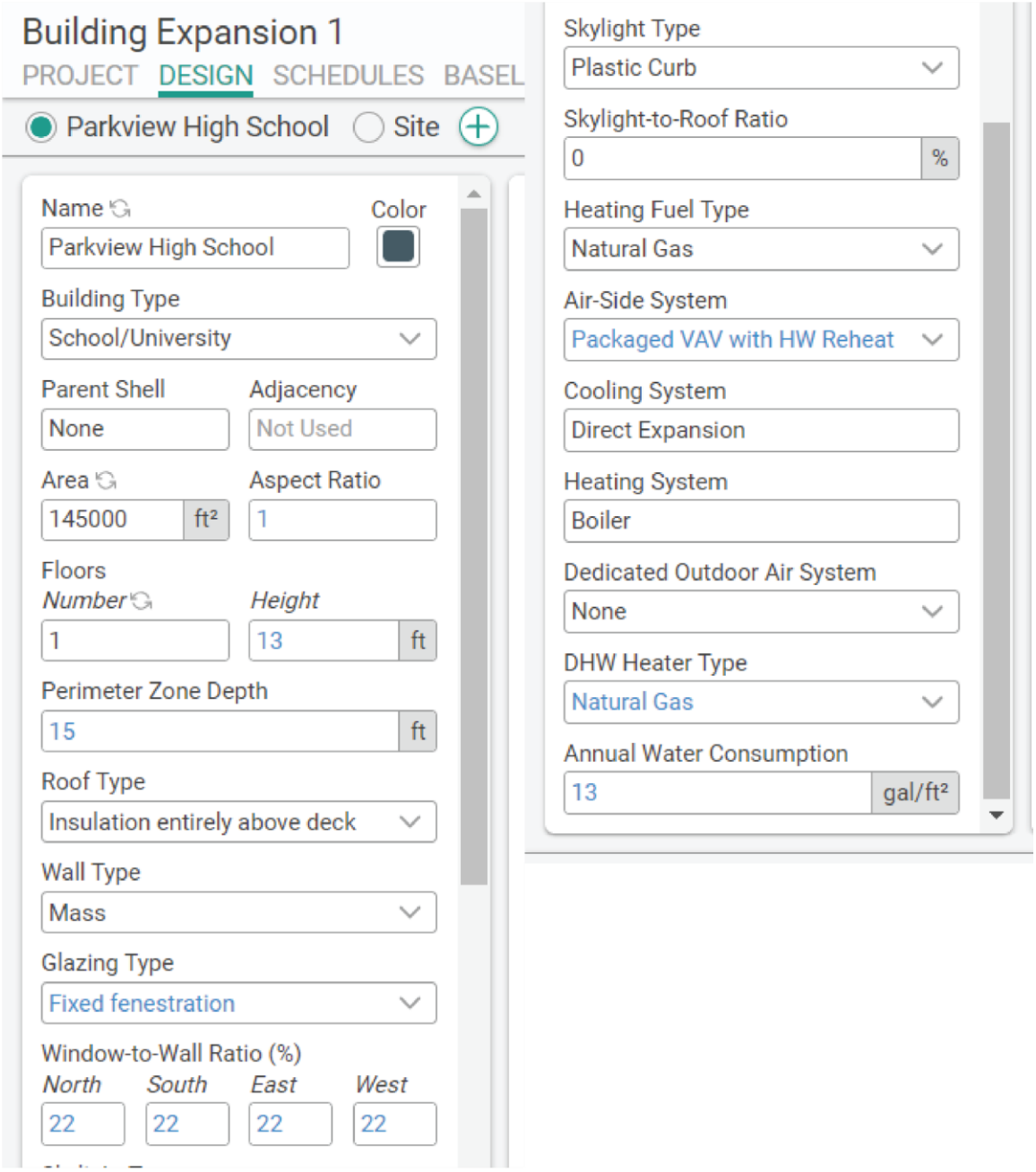
3. When sketchbox opens you should see the "project" tab selected which was used to name your project, **"Building Expansion 1"**,and set the project location, **(State: Wisconsin, Nearest City: Madison)**. Directly below the state and city of the project is the energy code. This starts as IECC 2018, but it can be changed to nine different options. Keep the value set to **IECC 2018**.



Make sure you also change the Compliance Path to **Efficient HVAC Performance**.

Switch to the design tab. Check to make sure the following are set. **Building type: school / university**, **area: 145000 ft²**, **Floors: 1, height: 13ft, Perimeter Zone Depth: 15ft, Roof**

Type: Insulation entirely above deck, Wall type: Mass, Glazing type: Fixed fenestration, Window-to-Wall Ratio: N22, S22, E22, W22, Skylight Type: Plastic Curb, Skylight-to-Roof Ratio: 0, Heating Fuel Type: Natural Gas, Air-Side System: Packaged VAV with HW Reheat, Cooling System: Direct Expansion, Heating System: Boiler, Dedicated Outdoor Air System: None, DHW Heater Type: Natural Gas, Annual Water Consumption: 13

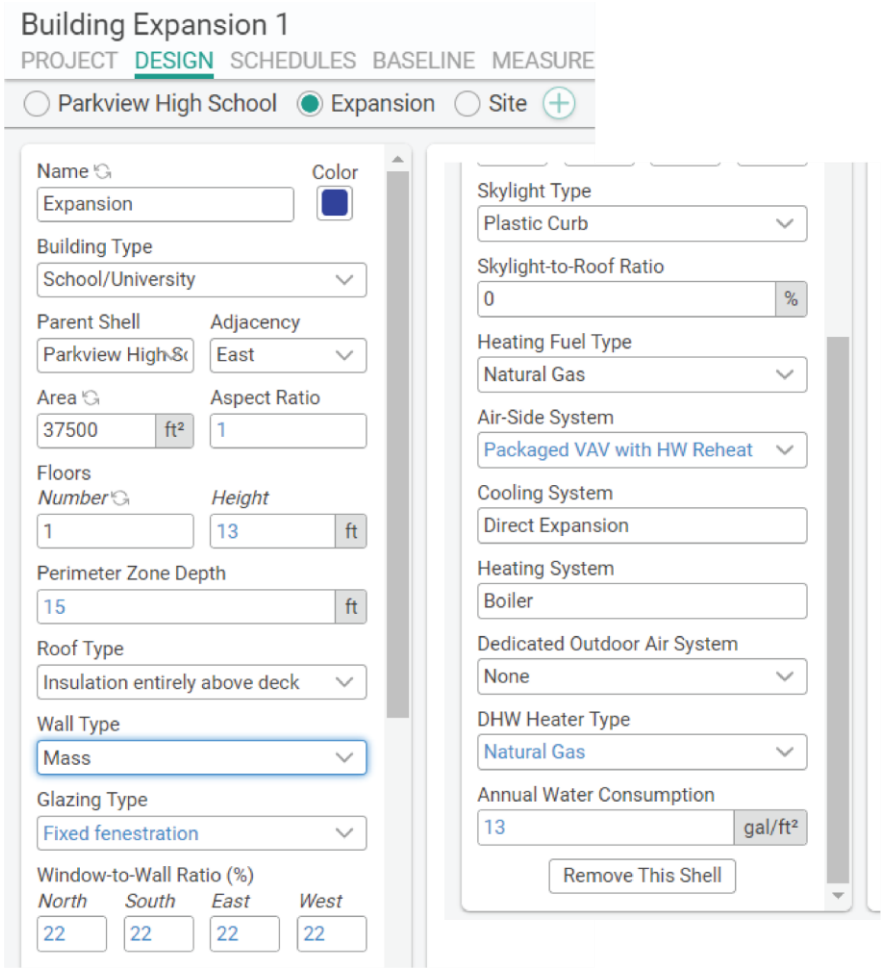


Switch to the **Results tab** and scroll to the bottom to find summary values for the top row in the table:

Table 1

	Peak Cooling (kBTU/hr)	Peak Heating (kBTU/hr)	Peak Electric Demand (kW)	Annual Electric Consumption (kWh)	Annual Natural Gas Consumption (therm)	Annual Energy Cost ($)	Annual Water Consumption (gal/yr)
Baseline							

4. The building modeled by these calculations was designed to meet the 2018 IECC standards. This will be our baseline and is the specs for our current building. Now you need to go back to the **Design tab** and add the building expansion. Set the expansion up according to this image.



5. Switch to the **Results tab** and scroll to the bottom to find summary values for the top row in the table.

Table 2

	Peak Cooling (kBTU/hr)	Peak Heating (kBTU/hr)	Peak Electric Demand (kW)	Annual Electric Consumption (kWh)	Annual Natural Gas Consumption (therm)	Annual Energy Cost ($)	Annual Water Consumption (gal/yr)
Baseline with Expansion							

6. What differences did you notice in the energy performance of building? Calculate the increase or decrease in each category after the expansion was calculated.

Table 3

	Peak Cooling (kBTU/hr)	Peak Heating (kBTU/hr)	Peak Electric Demand (kW)	Annual Electric Consumption (kWh)	Annual Natural Gas Consumption (therm)	Annual Energy Cost ($)	Annual Water Consumption (gal/yr)
Value change							

7. Parkview High School has an annual energy cost of approximately $143,300. Once the expansion is complete will the annual energy cost of the building increase or decrease? Explain why.

8. How many square feet will Parkview High School be once the expansion is completed?

9. How much does it cost per square foot to operate Parkview High School before the expansion?

10. Calculate the approximate cost to operate Parkview High School after the expansion.

11. Parkview High School had a maximum capacity of 425 students and staff before the expansion. The school must expand in order to allow more students to attend the school. However with increased student enrollment, there will also be an increase in staff and an increase in rooms needed. The proposed expansion will allow the district to accommodate an additional 150 students and staff. The state of Wisconsin gives Parkview $500 per student. How many students would the district need in order to offset the increase in cost of the expansion?

12. Based on the calculations above should the district ask the community for the expansion referendum? Explain your answer.