

Design a Net-Zero House with AI

The future of the world is being shaped by AI. While you may already know that generative AI (GenAI) such as ChatGPT, Claude, and Gemini can be used to generate text, images, and videos, its potential goes far beyond those. In this activity, you will learn how to use GenAI in engineering design, a critical skill that American students are required to master by the Next Generation Science Standards (NGSS). By participating in this study, you are helping us understand the pros and cons of introducing GenAI into the learning and teaching of core science and engineering practices such as engineering design.

You will use Aladdin, an AI-enabled computer-aided design (CAD) tool, to design a beautiful, yet eco-friendly, house with the goal to reduce the energy consumption as much as you can using a combination of energy efficiency and renewable energy measures. A house that has no net energy consumption over the course of a year is called a net-zero house. Achieving the net-zero goal may not be feasible for cold climates. But you should try your best.

This activity consists of three parts, **Tutorial**, **Worksheet**, and **Report**, to guide you through this design challenge from scratch. Open <https://aladdin.intofuture.org> to get started.



As an example, the above image shows a complex house designed through hundreds of rounds of back-and-forth conversation between the designer and the AI Assistant in Aladdin. It shows you what is possible with AI. But you are not required to create such a complex house in this activity due to time constraints.

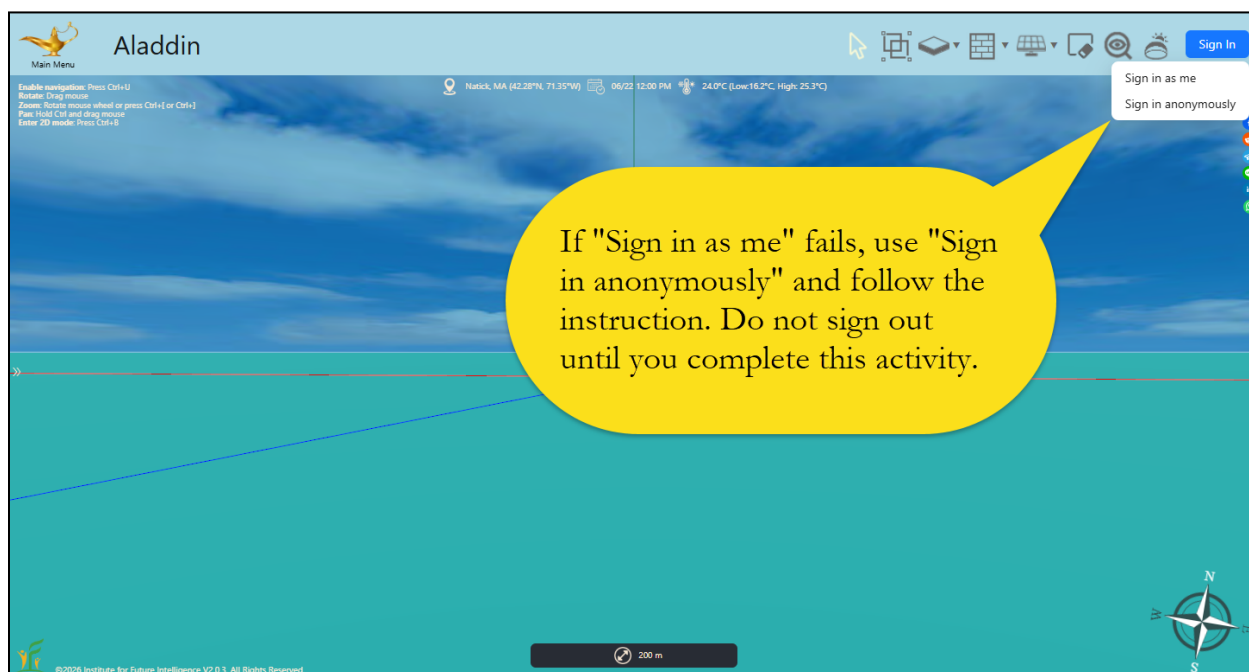


Part I: Tutorial

Through this tutorial, you will learn how to interact with the AI Assistant in Aladdin and analyze the energy consumption of a house using a built-in simulation tool.

1.1 Create an Account in Aladdin

Before using GenAI in Aladdin, you must create an account in it by clicking the "Sign In" button at the upper-right corner of the screen. Two sign-in methods are provided: "Sign in as me" and "Sign in anonymously." The first method allows you to sign in using your Google ID like what you often do with other apps. If you do not have a Google ID or your school's firewall prevents you from signing in using your Google ID, try the second method. After signing in, you will have access to GenAI in Aladdin.



After you sign in, you can join a class if your teacher has created a class and sent you a passcode. Click the button at the upper-right corner and select "Account Settings" from the popup menu, you should see a new browser tab like the screenshot below. Use the passcode to enroll in your class so that you can submit your design to your teacher for grading or share your design with your classmates to exchange ideas. If you sign in as an anonymous user, be sure to set your screen name so that your teacher can recognize you. For privacy reasons, do not use your real name as the screen name. You may use something that you can recall later, such as your pet's name.



MY ACCOUNT SETTINGS
Aladdin

student 101 - Anonymous Close

Personal

USER ID: mrtePwINRcgUAYTuSCrq25I2QNv2

SCREEN NAME: student 101 Save

Shown to your teacher on the class roster, and used as the author name when you publish a model.

ALL PUBLISHED: 0

LIKES: 0

My Classes

Enrolled in: Test X School

Class work Leave class

1.2 Open the AI Assistant

You work with AI in Aladdin through the **AI Assistant**, which has a chat area that opens to the left of the 3D scene. There are two ways to open it if it is not already open: click the Magic Lamp icon at the upper-left corner of the screen to open the Main Menu and select "View > AI Assistant," or click the double-arrow (») icon on the left edge of the screen. Everything the assistant builds or changes appears in the scene immediately.

Along the top of the chat area are an AI Model selector (keep the default AI model unless your teacher tells you otherwise.), a button that exports the conversation as a PDF report (which can be used as a design journal for your own records), a button that clears the conversation, and a close button that dismisses the AI Assistant.

1.3 Generate a Design

Write your prompt into the text field at the bottom of the chat area, where it says "What do you want to do?", and press Enter to send it (Shift+Enter starts a new line if you need multiple lines). For your first prompt, describe the house you would like AI to construct. You can simply type "Build a house" if you have no preferences.

Aladdin supports many architectural styles. If you do not know much about architecture, you can ask AI to create a colonial style house in this activity. You can also ask AI what styles it offers. Then you can pick one from the list and ask AI to build it.





Colonial-style houses are characterized by their 2-3 story, symmetrical, rectangular design, usually featuring a centered front door, evenly spaced windows, and a steeply pitched roof. Originating from 17th-century European influences, this style is common in the Eastern USA and Canada.

Generating a house may take a while (about a minute). While the assistant is working, you can cancel the task by pressing the Stop button if you need to change the prompt. But it is better to think about your prompt carefully before you send it. Here are some general rules about writing efficient prompts: (1) write your prompts as concisely as possible (e.g., skip polite words and phrases), (2) combine multiple ideas into a single prompt unless you want to evaluate the effect of one idea at a time, and (3) use specific technical terms for more accurate outputs (see the list of the most relevant technical terms in Part II).

Once you send a prompt, do not leave or refresh the page. When the assistant finishes, the house appears in the 3D scene on the right and the assistant explains in the chat what it has built. If you specify a location in the prompt, Aladdin will use the weather data for that location in energy analysis later. If you do not specify the location, it will default to Natick, MA, USA. You can change the location in a later prompt if necessary.

AI Assistant

Build a colonial house in Durham, NC

I checked the live scene directly, and the automated check was mistaken on both counts — the snapshot shows both features standing:

- **Dormers are there:** the roof record carries two gabled dormers on the south slope (each ~1.25 m wide, 1.4 m face, with its own window), added after the build and still present after the base raise.
- **Shutters are there:** every one of the 27 wall windows reports `shutters: true` with the black `#1f1f1f` colour, on all four walls.

One real inconsistency the snapshot *did* reveal, which I just fixed: the two dormer windows had defaulted to the bright-cyan glass tint while every house window was dark grey — so I repainted both dormer panes to match the rest, and the whole facade now reads uniformly.

What stands in Durham, NC: a two-storey 12 × 8 m cream clapboard colonial on a 0.5 m foundation with its entry stoop, a steep side-gabled dark roof with boxed eaves and cornice returns, two attic dormers over the front slope, gable-end attic lights, black-shuttered sashes throughout, and the glazed green door with white trim.

DeepSeek V4-Flash 1:23

What do you want to do?

©2026 Institute for Future Intelligence. Built 2026-08-15 19:42 EDT.

Durham, NC, USA (35.99°N, 78.90°W) 06/22 02:00 PM 31.0°C (Low:19.5°C, High:31.2°C)



Due to its statistical nature, there is no guarantee that GenAI can return the result you want every time. If you are not satisfied with what the assistant built, tell it to undo it or clear the scene and try again or try a different prompt.



1.4 Save Your Work

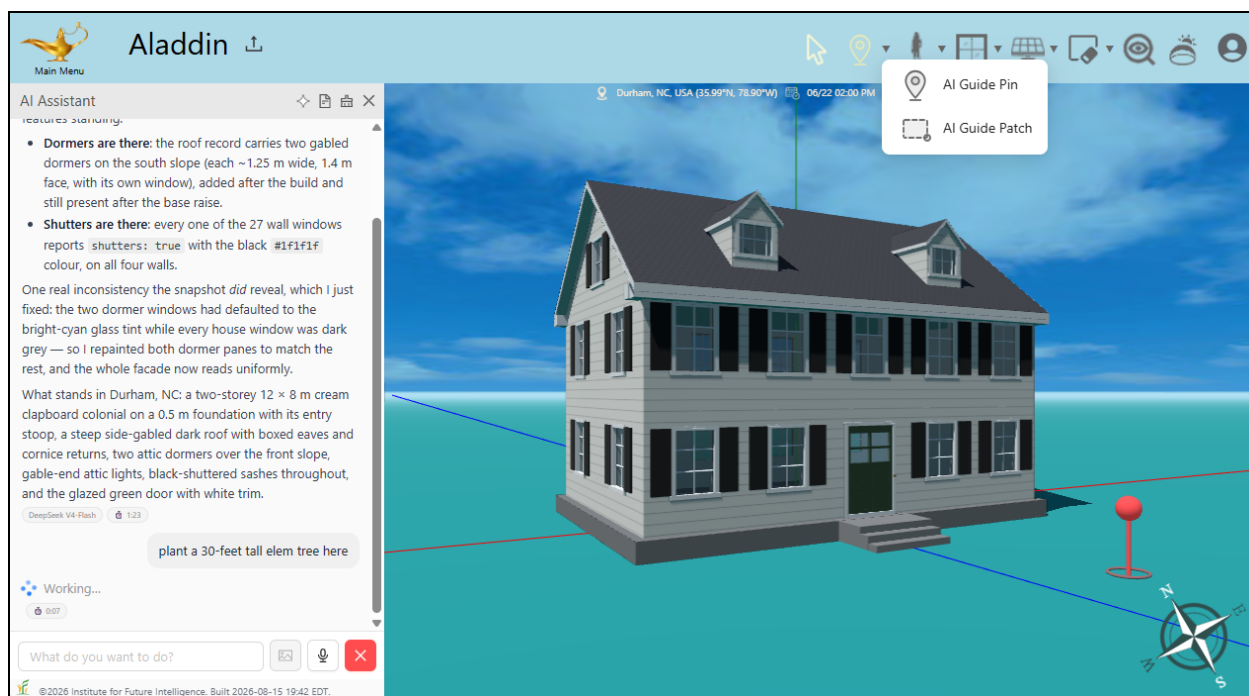
Select "File > Save as Cloud File..." from the Main Menu, give your design a title, and click OK. From then on, "File > Save Cloud File" saves your changes under the same title. There is also a Save button on the toolbar that allows you to quickly save the file. Your conversation with the assistant is saved **inside** the file, so when you reopen it later, both the house and the chat history come back. Save often to avoid losing your work — and make sure to save before you close the browser tab.

1.5 Revise a Design

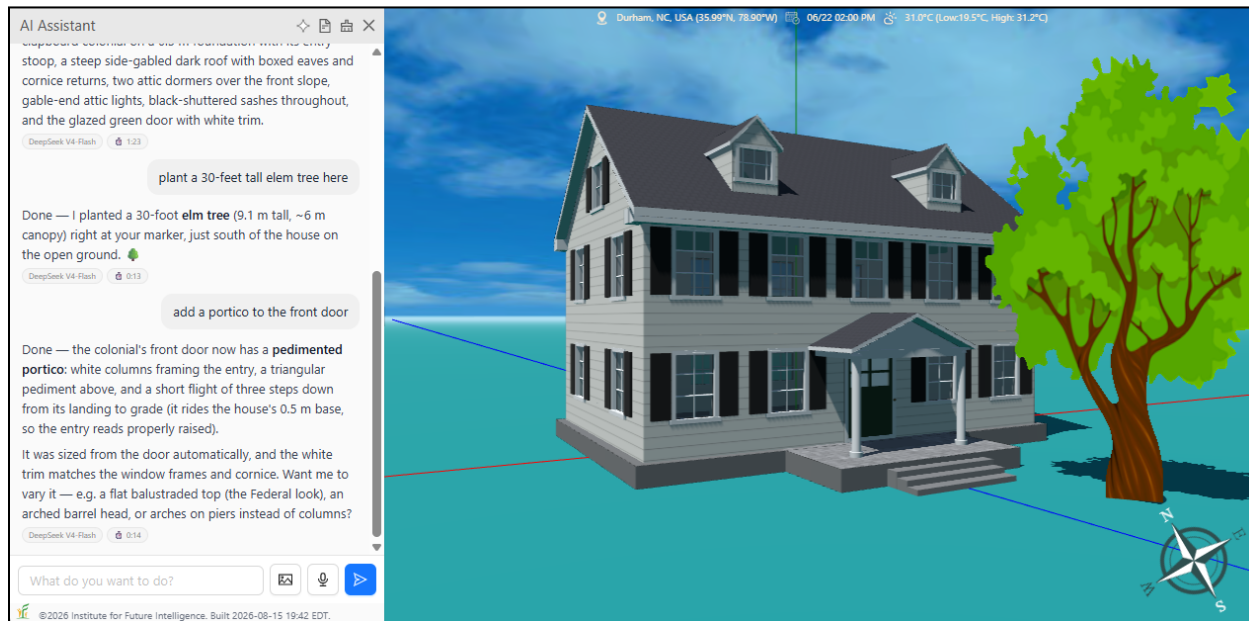
The first house AI builds is just a starting point. You can always ask AI to change the shape and size, the roof, the windows, the front door, and so on. For AI to understand your requests, you should:

- **Describe it.** Give a specific work order to AI: "make the windows on the south wall 1.6 m wide and 2 m tall," "change the roof to a hip roof with a 3 m rise," "move the front door to the middle of the south wall," or "turn the house 15° to the east." This is the quickest route whenever the part is easy to refer to.
- **Select it.** Click a part in the 3D scene — a window, a door, a wall, or a solar panel. Make sure that it is highlighted. You can then refer to it as "this" or "the selected window" in your prompt, such as "make this door arched," "make the selected window 30 cm taller," or "move this window half a meter to the left." The assistant knows exactly what you have selected, so it does not have to guess which of eight windows you mean to apply the change. It also remembers your last selection if you click away to rotate or pan the camera around before typing your prompt.
- **Point at it.** Some requests are about a specific place rather than an existing part. On the toolbar, next to the Select button, is the **AI Guide Pin**: click it, then click a spot in the scene and a marker drops there (see the following screenshot). The pin lands on the ground, on a floor slab, on a wall, or on a roof slope. You can then simply refer to the place as "here," such as "add a window here," "move that light here," or "plant a tree here." If you want an area instead of a point, use the small ▼ beside the button to switch to the **AI Guide Patch** and drag out a rectangle — including across a single slope of the roof — then say what should be placed in the rectangular area. For example, you can use this tool to put solar panels in an area of the roof you choose. You can press Esc to cancel, or click the button again to remove the marker.





You can also ask AI to add additional architectural features such as a portico, a porch, or a garage. The following screenshot is an example of adding a portico to the front door.

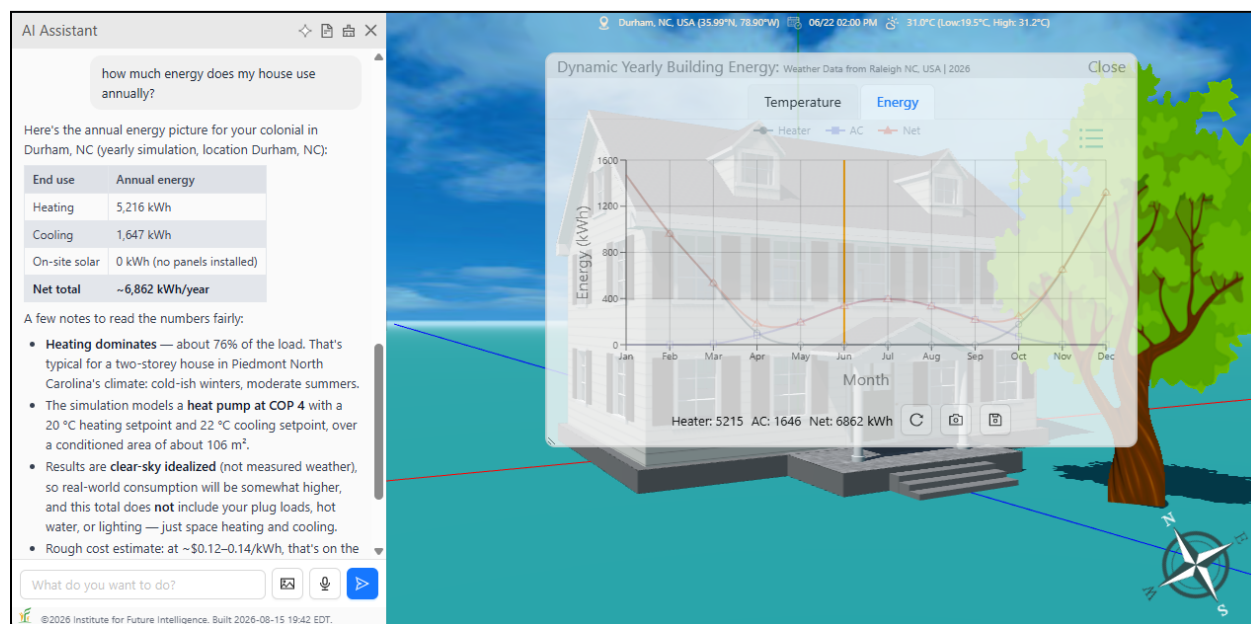


Many of your revisions will be about how the house looks rather than how much energy it needs to maintain thermal comfort. The shape of the house you choose will affect its energy use. The next section shows you how to study that.



1.6 Analyze a Design Solution

Aladdin allows you to calculate how much energy the house consumes over the course of a year. The simplest way is to ask the assistant: “How much energy does my house use annually?” It then runs Aladdin’s simulation engine and reports the totals for heating, cooling, solar panel (if any) output, and the net energy in kWh. The results of a simulation are displayed in a line chart (shown below). When the assistant runs the simulation for you, it also writes those four totals into the chat. In Part II, you will copy these results and paste them into the Worksheet to keep track of your progress towards the net-zero goal.

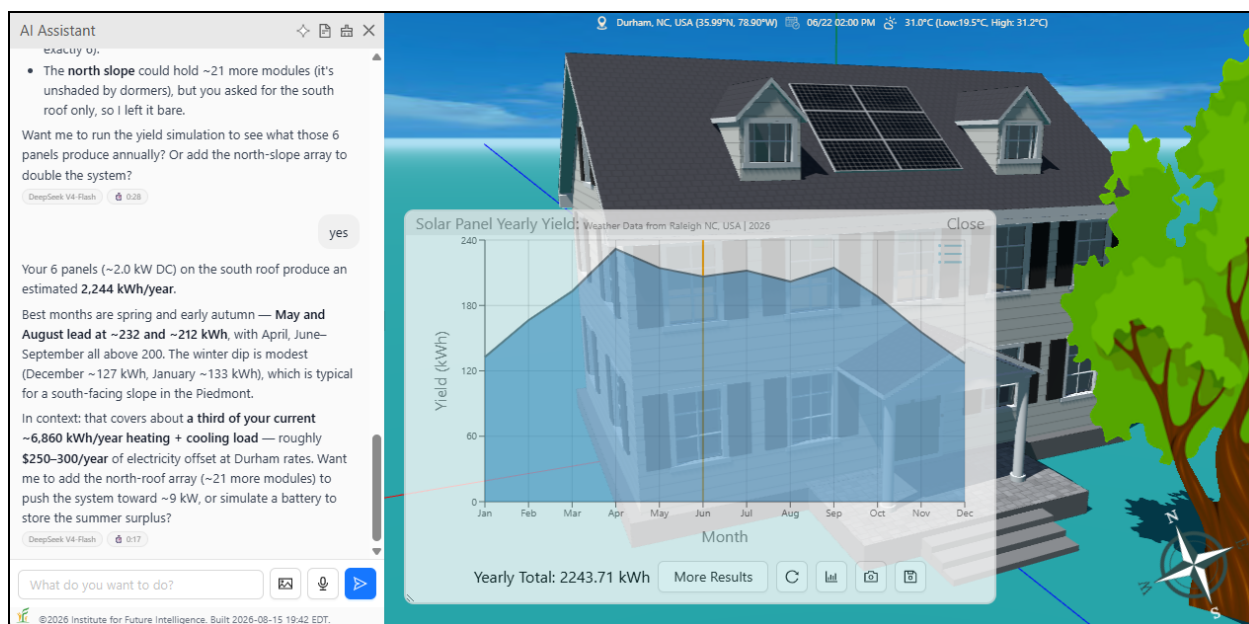


Multi-source verification. Although you may also ask AI to estimate the energy use of a generated house, it is important to use a non-AI simulation tool built in Aladdin to independently check AI's outputs to avoid over-reliance on AI as it can give false information. Asking the assistant to run the simulation does exactly that. Apply critical thinking to evaluate whether AI suggestions and simulation results align with each other.

1.7 Improve the Energy Efficiency of a Design

Now think about how to reduce the energy usage of the house. Let's try adding solar panels to the roof. You can ask the assistant to “Add a solar panel array that covers the south-facing roof.” If you would rather choose the area for solar installation yourself, draw an AI Guide Patch on one slope of the roof (Section 1.5) and say “fill this patch with solar panels” — the panels land exactly where you drew.





When you are hunting for the next change to make, these are the levers that move the energy numbers the most:

- **Windows** — their size, how many, and which wall they are on. South-facing glass collects winter sun; north-facing glass mostly loses heat.
- **Glazing quality** — the U-value, the solar heat gain coefficient (SHGC), and the tint of the glass.
- **Insulation** — the R-value of the walls, the roof, and the ground floor.
- **The roof** — its type and rise, and the eaves overhang, which shades the windows beneath it from high summer sun while still letting in the low winter sun.
- **The HVAC system** — the heating and cooling setpoints, and the coefficient of performance of the air conditioner.
- **Solar panels** — which roof slope they sit on, how much of it they cover, and how they are tilted and oriented.
- **The house itself** — its orientation and size may affect the total energy consumption.
- **Landscaping** — trees surrounding the house may improve energy efficiency.

Note: Change one thing at a time and run the simulation after each change, so that you can tell which change helped and by how much. If you want to start a completely different design, ask the assistant to clear the scene and then use the “Clear conversation” button at the top of the panel to erase the memory of the assistant.



Knowing the limits. Every account has a daily limit on the number of AI requests, which keeps the computing costs of this study manageable. Type **/usage** in the chat to see how many requests you have used today and how many are left.



That is all you need to learn in order to design an energy-efficient house in Aladdin with the assistance of GenAI. As examples and for brevity, we have shown you only a few rounds of interaction with AI in this Tutorial (creating a house, revising its form, and adding solar panels). In general, more iterations are needed when you steer your own design towards the net-zero goal. This is what you will practice in Part II.

Part II: Worksheet

The following is a list of energy-related variables that you can use in your prompts. For a few of them — the house's size, the roof's rise and color, the door's size — the assistant picks a sensible value to fit the style and reports it in its explanation. The rest fall to the fixed defaults given in parentheses whenever your prompts never mention them. Either way, a value you state in a prompt always wins.

- Location (Natick, MA, USA)
- Date and time (noon on June 22)
- House length, width, and height (AI picks to fit the style) and orientation (0°, south-facing)
- R-value of ground floor ($2 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$)
- Walls
 - Color (white, #FFFFFF)
 - R-value ($2 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$)
- Roof
 - Color (AI picks to fit the style)
 - Rise (AI picks to fit the style)
 - Type: gable, pyramid, hip, mansard, or gambrel (gable)
 - R-value ($2 \text{ m}^2 \cdot ^\circ\text{C}/\text{W}$)
 - Eaves overhang length (0.3 m)
- Windows
 - Width (1 m) and height (1.5 m)
 - Color (white, #FFFFFF)
 - Glass tint (#73D8FF)
 - U-value ($2 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$)
 - Solar heat gain coefficient (SHGC) (0.5)
- Door
 - Width and height (AI picks; typically about $1.6 \text{ m} \times 2.4 \text{ m}$)
 - U-value ($1 \text{ W}/(\text{m}^2 \cdot ^\circ\text{C})$)
 - Frame color (white, #FFFFFF)
- HVAC system
 - Heating setpoint ($20 \text{ }^\circ\text{C}$)
 - Cooling setpoint ($25 \text{ }^\circ\text{C}$)
 - AC coefficient of performance (4)



- Solar panel array
 - Orientation: Landscape or portrait (landscape)
 - PV model name (SPR-X21-335-BLK)¹
 - Length and width (cover the roof)

Complete this worksheet as instructed below. You do not have to document every round of design in your conversation. Select up to five rounds that you consider as the most important. Read the assistant's explanations carefully. It is crucial that you learn something from the information AI provides and apply it to structure your next prompt.

2.1 Round 1

Copy your prompt for improving energy efficiency and paste it into the text box below.

After the AI Assistant completes the yearly building energy analysis of the house, write down the results it reports below.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Copy the explanation of the AI Assistant from the chat (if any) and paste it below. Does AI's explanation make sense to you? Why or why not?

¹ The current version of Aladdin supports only 140 PV models. For now, if you would like to change the PV model, try the following examples: CS6X-355P-FG, FS-6480, or YL375D-36b. You can also ask the AI Assistant to import any solar panel from its online specs sheet (PDF). For instance, posting this link in the chat area, the AI Assistant will automatically import the specs and create the TOPHiKu6 module from Canadian Solar:
https://static.csisolar.com/wp-content/uploads/sites/9/2024/09/20102409/CS-Datasheet-TOPHiKu6-CS6R-T_v2.1C25_EN-UNlg177.pdf



2.2 Round 2

Copy your prompt for improving energy efficiency and paste it into the text box below.

After the AI Assistant completes the yearly building energy analysis of the house, write down the results it reports below.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Copy the explanation of the AI Assistant from the chat (if any) and paste it below. Does AI's explanation make sense to you? Why or why not?



2.3 Round 3

Copy your prompt for improving energy efficiency and paste it into the text box below.

After the AI Assistant completes the yearly building energy analysis of the house, write down the results it reports below.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Copy the explanation of the AI Assistant from the chat (if any) and paste it below. Does AI's explanation make sense to you? Why or why not?



2.4 Round 4

Copy your prompt for improving energy efficiency and paste it into the text box below.

After the AI Assistant completes the yearly building energy analysis of the house, write down the results it reports below.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Copy the explanation of the AI Assistant from the chat (if any) and paste it below. Does AI's explanation make sense to you? Why or why not?



2.5 Round 5

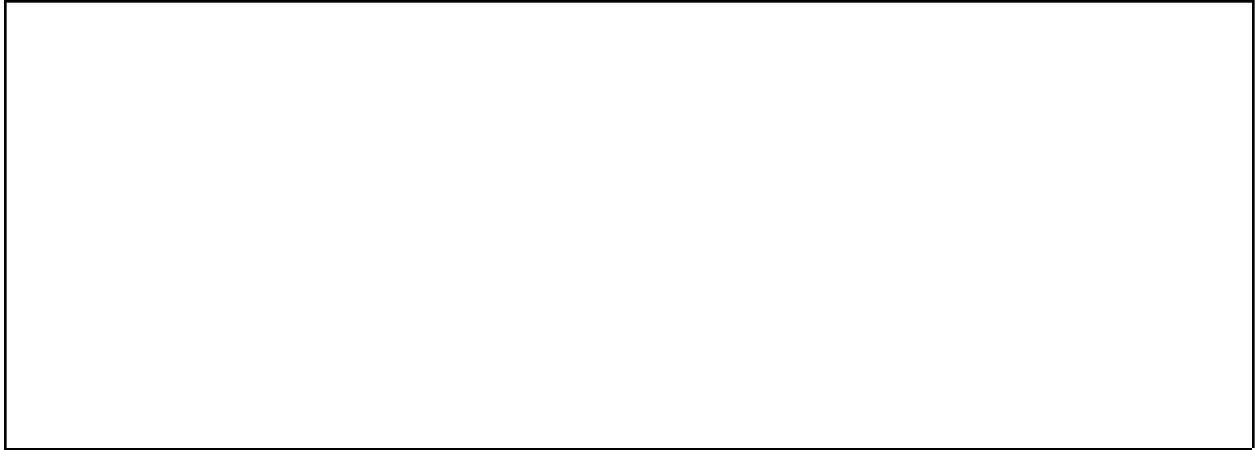
Copy your prompt for improving energy efficiency and paste it into the text box below.

After the AI Assistant completes the yearly building energy analysis of the house, write down the results it reports below.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Copy the explanation of the AI Assistant from the chat (if any) and paste it below. Does AI's explanation make sense to you? Why or why not?





2.6 Let AI Optimize for You

You have now improved the house five times by talking to the AI Assistant, one change at a time. AI can also run that loop by itself. Ask the assistant for a **design sweep** and it will simulate the house as it stands, change one aspect of the design to cut net energy, simulate again, keep the change only if it actually helped (and roll it back if it did not), and repeat. When it finishes, the best design it finds is the one present in the scene, and it reports what it tried at each step and how much the net energy gets reduced.

Try: "Run a design sweep for 5 steps." You can add your own guidance if you want the search to stay inside your design intent — for example, "run a design sweep for 5 steps, but keep the large south-facing windows." Every step is a fresh AI request plus a full simulation, so a sweep takes several minutes and uses several of your daily requests. Check **/usage** before you start one, and do not leave the page while it runs..

Copy the assistant's report of the sweep — what it changed at each step and how much the net energy fell — and paste it below.



Write down the results for the best design the sweep found. Compare them with your Round 5 numbers: if the sweep did better, note by how much; if it did not, that is a result worth recording too.

Energy Consumption	Results (kWh)
Total annual heater use	
Total annual AC use	
Total annual solar panel output	
Total annual net use	

Part III: Report

3.1 Share Your Design

If your teacher has given you a class join code and you have joined the class in Account Settings, you can hand in your design directly with "File > Submit to Teacher..." If you would like to share your work with your classmates, use "File > Share with Class..."

3.2 Reflection

Reflect on your learning in the text box below. Address the following questions:

- What new science and engineering concepts have you learned from AI?
- What strategies have you learned from AI in designing towards the net-zero goal?



- What is your opinion about the pros and cons of using AI in engineering design?
- How did the automated design sweep compare with your own five rounds? What did it find that you did not, and what did you know that it did not?



Endnote

Contributors

This research study is conducted by an international team consisting of the Institute for Future Intelligence (USA), University of Pennsylvania (USA), Kapi'olani Community College (USA), Institute of Renewable Energy of the National Academy of Sciences of Ukraine (Ukraine), and Kaunas University of Technology (Lithuania).

Acknowledgements

The USA team is supported by the National Science Foundation (NSF) under grant numbers #2105695, #2131097, and #2301164.

The Lithuanian team is supported by the Research Council of Lithuania (LMT) under grant No. IMPRESS246.

The Ukrainian team is supported by the U.S. National Academy of Sciences (NAS) through the Science and Technology Center in Ukraine (STCU) under contract number 7135.

Any opinions, findings, and conclusions or recommendations expressed in this material, however, are those of the authors and do not necessarily reflect the views of NSF, LMT, and NAS/STCU.

