

Renewable Energy for Bolstering Ukraine's Infrastructure by Learning and Design (REBUILD)



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Seminar at Kaunas University of Technology
Kaunas, Lithuania, October 11, 2023



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UNITED NATIONS ECONOMIC COMMISSION FOR EUROPE

Rebuilding Ukraine with a Resilient, Carbon-Neutral Energy System



Key Takeaways

Problem:

Rebuilding Ukraine's energy system sustainably is challenged by the ongoing war and destruction, heavy reliance on fossil fuels, and impacted progress on climate targets. The war in Ukraine has caused immense suffering, and deepened existing vulnerabilities and inequalities in the country's weakened economy.

Mission Possible:

There are achievable pathways for Ukraine to build a resilient carbon neutral energy system.

Radical Transformation of the Energy System:

Rebuilding Ukraine's energy system would require phasing out unabated fossil fuels, harnessing modern bio-energy, and doubling electricity demand through solar and wind generation.

Decarbonization Must Start Now:

Decarbonization efforts would lead to significant reductions in reliance on fossil fuels across sectors. By 2050, transport is projected to reduce fossil fuel dependence by 93%, industry by 97%, and buildings by nearly 100%.

Interconnected Energy System Resilience and Sustainability:

Achieving carbon neutrality would enhance Ukraine's energy system resilience and independence. A shift towards domestic renewables and low-emission technologies could make Ukraine self-sufficient in primary energy, reaching 98% by the mid-century. Energy efficiency improvements and electrification efforts would play a crucial role in reducing energy intensity in end-use sectors, resulting in an overall decline of 60% by 2050.

Investment is Essential:

Reaching carbon neutrality in Ukraine would require doubling of the current level of capital investments, investments in the energy sector only would reach up to 5% of GDP by 2050. Prioritizing investments in clean and efficient end-user devices, as well as tripling investments in power generation with a focus on batteries, bioenergy, wind, and solar technologies, would be essential.



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How can scientists help?



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“Citizen science is now a core element of the Pact for Research and Innovation in Europe.”

— European Green Deal Projects Support Office, 2022

But how to meaningfully operationalize citizen science in the field of renewable energy?

Crowdsourcing apps, such as Generation Solar developed in Spain, are available for citizens to register existing solar installations to feed data to research. But the future of renewable energy depends more on creatively identifying and realizing the potential.



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Zoom: Rotate mouse wheel or press Ctrl+[or Ctrl+]
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Natick, MA (42.28° N, 71.35° W) 06/22 10:00 am 23.1°C (Low:16.2°C, High: 25.3°C)

Simulation-Based Engineering and Science for Citizens (Virtual Prototyping)

Enabled by a combination of computer-aided design (CAD) and analysis (CAE) tools, **virtual prototyping** allows a significant portion of design work to be moved to the cyberspace and accessed by citizens.

The underlying discipline, simulation-based engineering and science (SBE&S), is a cornerstone (as part of **digital twins**) of Industry 4.0 — an ongoing industrial revolution.

CAD doesn't have to be difficult to young people. #Minecraft #Bloxburg



Aladdin, a Web-based CAD program developed by IFI, is an open-source platform for engineering research and education.

Freely available at: <https://intofuture.org/aladdin.html>



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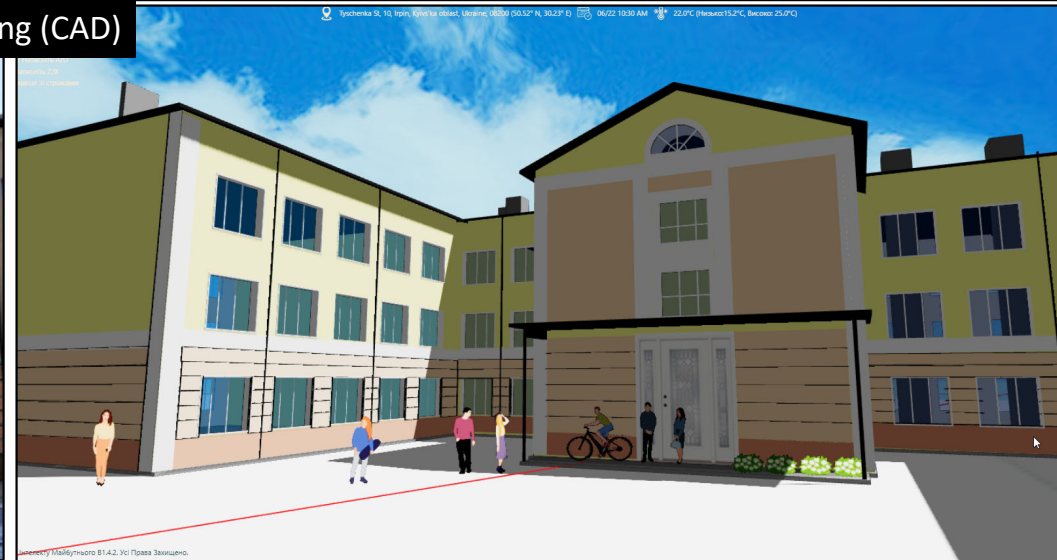
Real-World Photos

(••• digital twins •••)

Aladdin Models



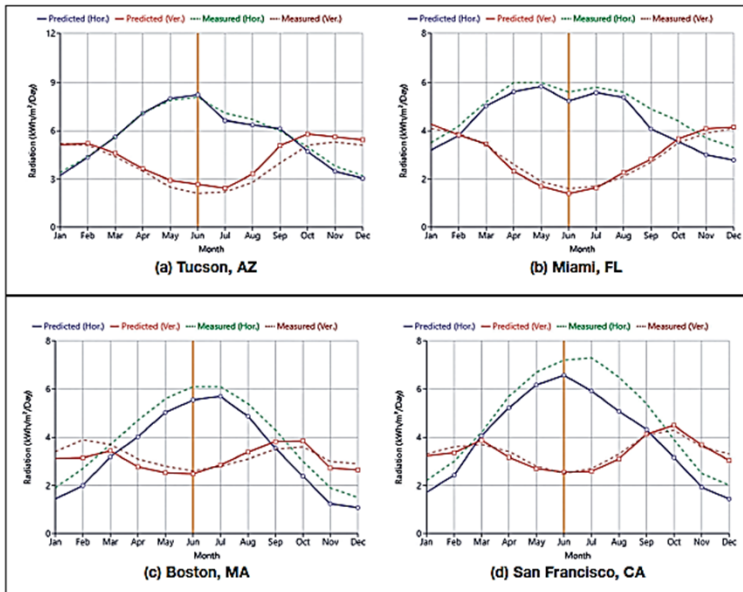
Structural modeling (CAD)



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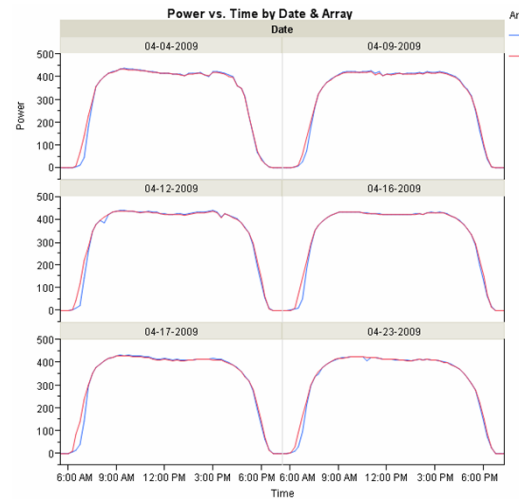
How accurate is Aladdin's simulation?



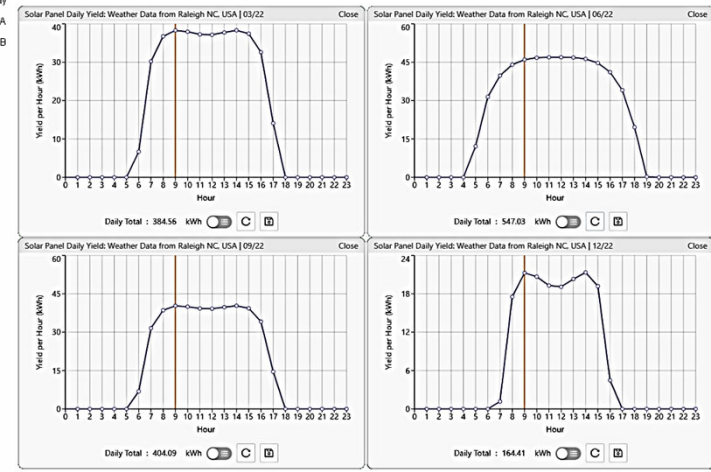
A comparison between the predicted and measured solar radiation intensities for four U.S. locations: Horizontal and vertical (south-facing) sensors

Aladdin's validity was verified by **Warsaw University of Technology** based on U.S. DOE's Building Energy Simulation Test (BESTEST).

Functional modeling (CAE)



Real-world data (spring)
Cary, North Carolina, USA



Aladdin results (four seasons)

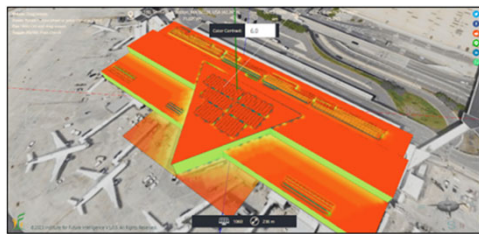
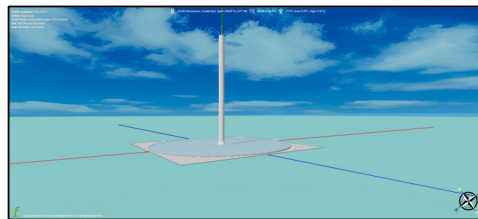
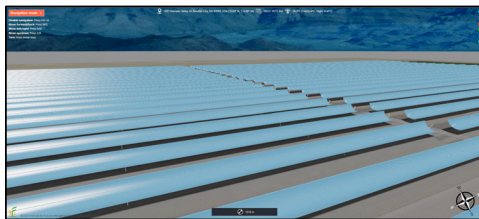
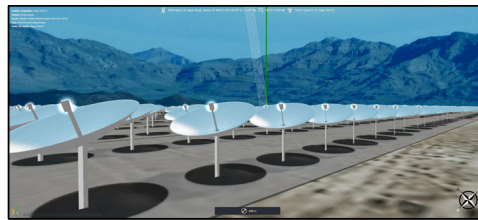
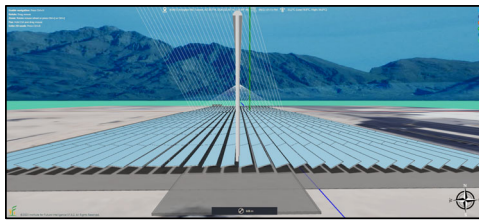
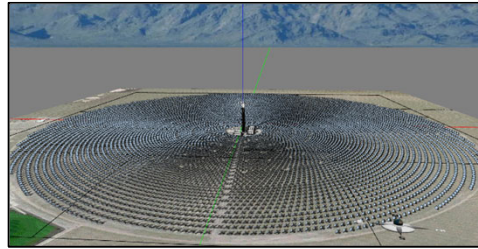
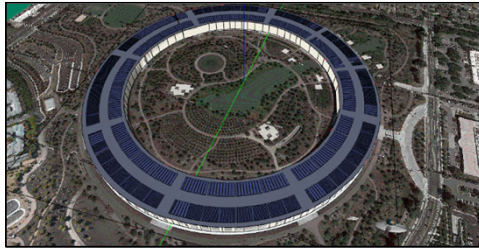


A "surprise" in the pattern of hourly outputs of monofacial solar panels driven by horizontal single-axis trackers (HSAT) – a small dip at noon in the output curve in some seasons.

Aladdin predictions agree with other tools:

- **PVWatts Calculator**, U.S. National Renewable Energy Laboratory (NREL)
- **Photovoltaic Geographical Information System (PVGIS)**, the Joint Research Centre of the European Commission





Why is Aladdin good for citizen science?

Accuracy is not enough.

- **Convenient:** Run within a browser and store data on the cloud (can be used offline, too).
- **Simple:** Eliminate toolchaining by integrating design, simulation, and analysis in a single system (few laypersons can use scripts to create tool chains like professionals do).
- **Visual:** Use computer graphics and scientific visualization to bring science concepts and engineering principles vividly to the computer screen.
- **Deep:** Encapsulate computational tools that support scientific investigation, engineering design, artificial intelligence, generative design, and more.
- **Wide:** Cover a growing set of energy topics (currently support building energy, photovoltaic solar power, concentrated solar power, solar updraft tower; work on wind energy and battery storage)

And...

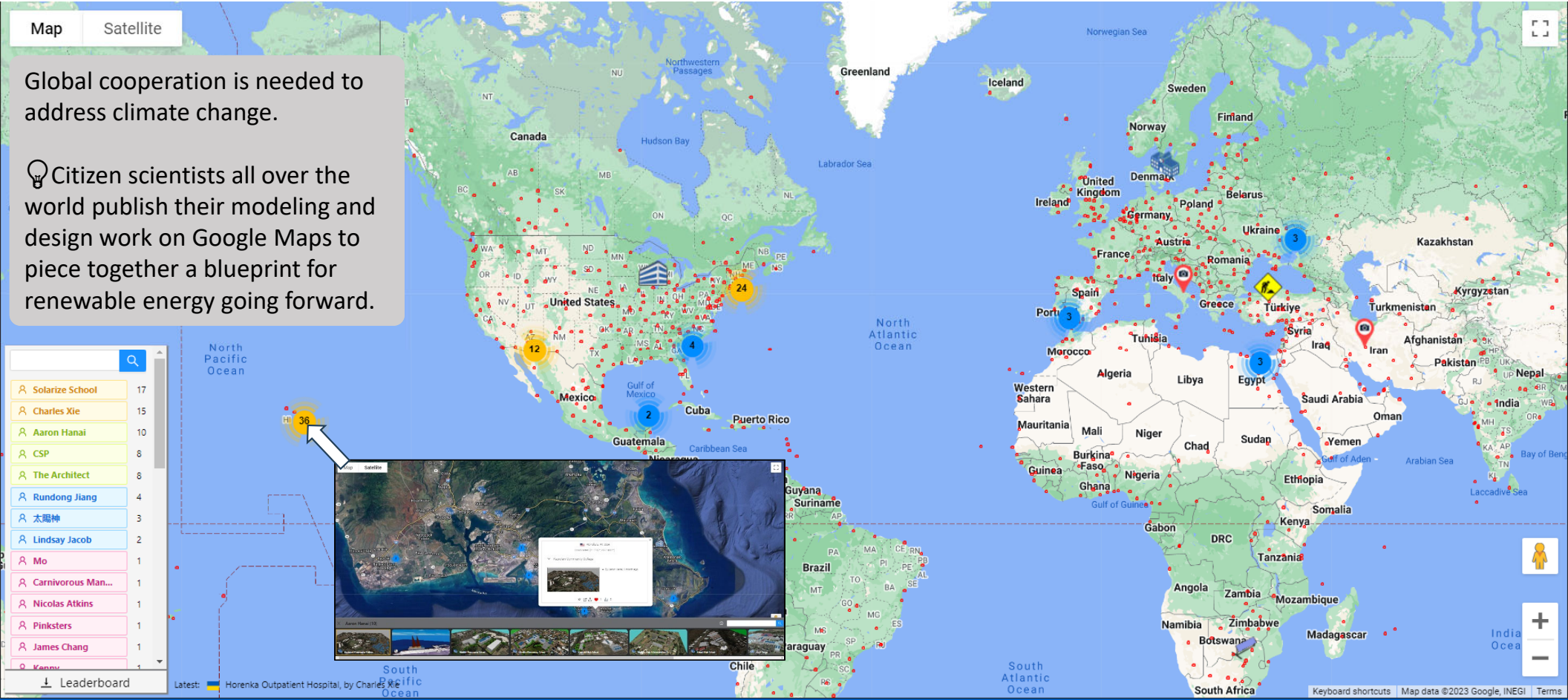


Engineering without Border

Map Satellite

Global cooperation is needed to address climate change.

💡 Citizen scientists all over the world publish their modeling and design work on Google Maps to piece together a blueprint for renewable energy going forward.



Our Ukraine Projects

Stand with
Ukraine



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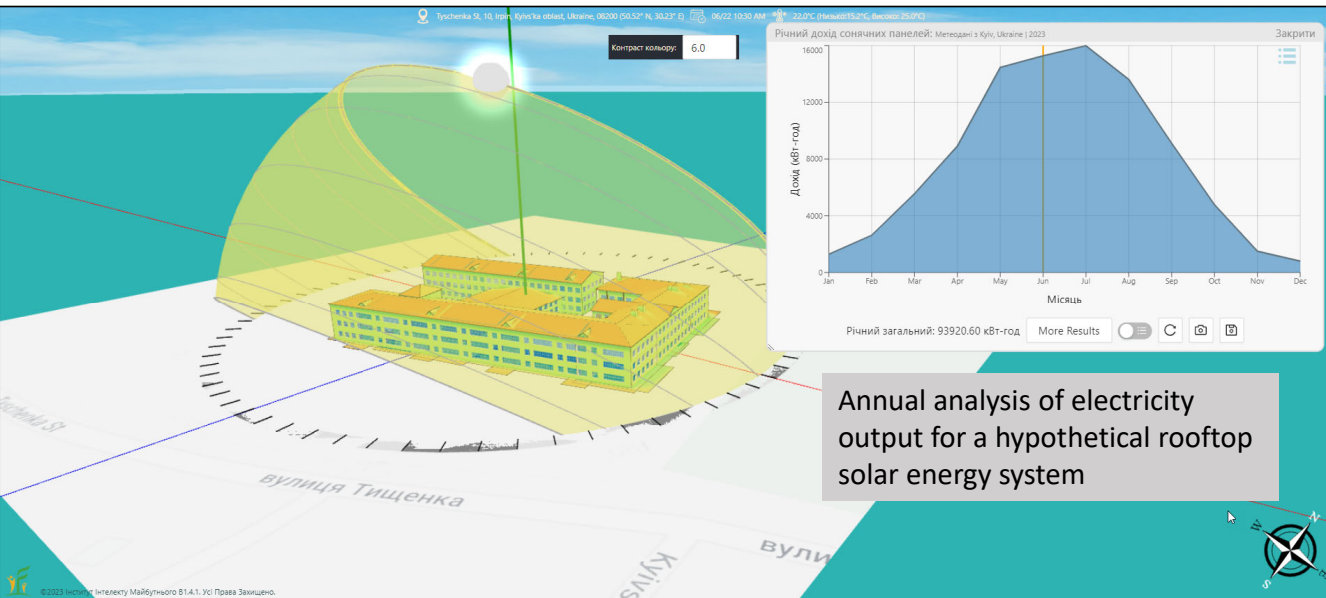
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School No. 17, Irpin, Ukraine
Satellite image

Project 1: Solar Energy to the Rescue

Based on *Solarize Your School* pilot-tested in the U.S.

This project challenges Ukrainian youth to design solar power solutions for their own schools using Aladdin. They can share their solutions in the form of interactive 3D models with the world through social networks and call for help to crowdfund their eventual construction. After the construction, the digital twin will provide real-time data for donors to check the results at any time to increase the transparency about how their donations were used.



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EIT Climate-KIC's Net Zero Cities Pilot coming to Ukrainian city Rivne



NEWS 21/03/2023 Climate

The Western Ukraine city of Rivne (or Рівне in Ukrainian) was selected as one of the 53 Pilot Cities for **NetZeroCities**, a Horizon Europe programme in support of the **EU Mission: Climate-Neutral and Smart Cities**.

The NetZeroCities Pilot Cities Project is a two-year programme led by **EIT Climate-KIC**. With a population of around 240 000 people, Rivne will receive a grant of 38 million hryvnias (EUR 9.23 k) to combat climate change.

Rivne joins 52 other cities in rapid decarbonisation and climate change adaptation

On **Telegram**, Rivne's mayor Oleksandr Tretyak said: "Together with 52 other European pilot cities, we will implement innovative measures to improve climate change adaptation and rapid decarbonisation. Together with local higher education institutions, NGOs, and with the help of experts from EU countries, Rivne will implement a wide range of measures."

pilot project

Green Reconstruction of Ukraine

reconstruction of the hospital heating and electricity system in Horenka village, Bucha district

~ € 56 000
The cost of the Horenka green reconstruction

320 m² Building area

12 kW The capacity of installed solar panels

12,000 kWh Expected electricity production from solar panels

70% Expected energy savings in case of connection via net metering

8 kWh battery capacity

20 kW Heat pump soil-water capacity

9 000 - 12 000 kWh Expected electricity consumption from the heat pump during the heating season

600 kWh Electricity consumption per month on average (before heat pump installation)

~40-60% Will be covered by solar power plant

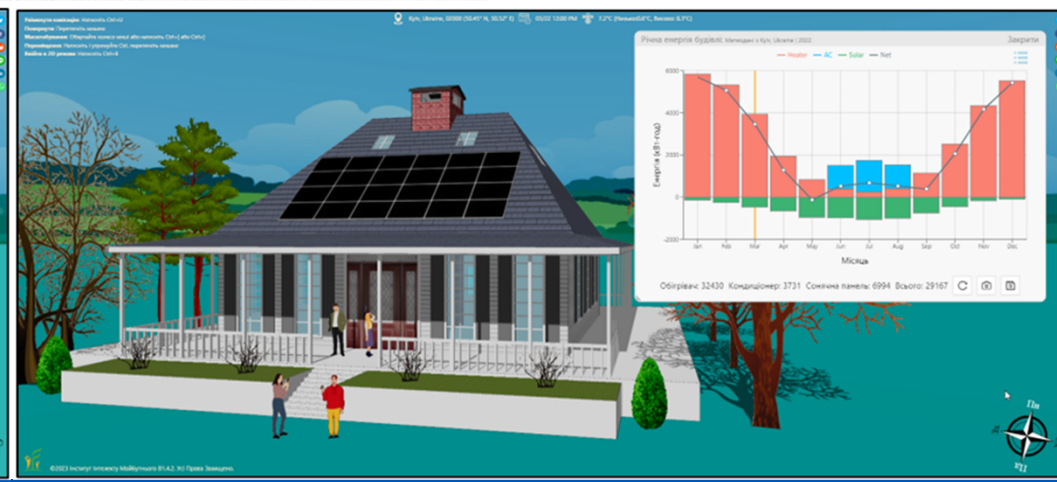
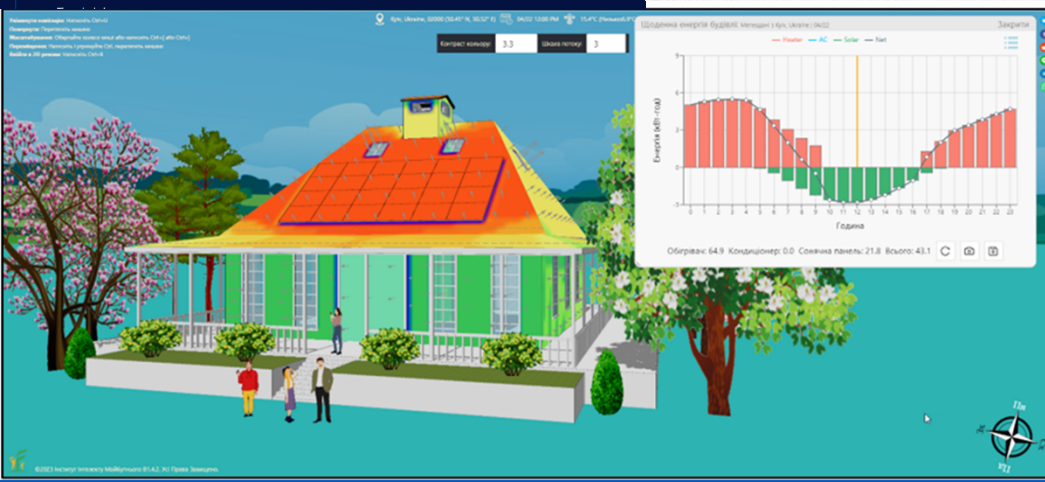
80% Expected money savings

- 60 000 UAN heating costs with a heat pump
- 300 000 UAN expenses for heating with natural gas (actual)

GREENPEACE **ekoдія** **ЕкоКлуб** **ПЕРЕМОГА УКРАЇНИ**

Project 2: The Net Zero Energy Challenge

A net zero energy building itself generates renewable energy no less than the total amount of energy that it consumes over the course of a year. Inspired by the Solar Decathlon sponsored by the U.S. Department of Energy, we create a simplified virtual version on the Internet to support Ukrainian youth to learn how to design sustainable housing to achieve energy independence and reduce carbon footprints.



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Honolulu, HI, USA (21.31° N, 157.86° W) 12/22 08:15 AM 22.1°C (Low:20.0°C, High: 27.2°C)

Thank you
for your time!



Acknowledgements

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



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