Virtual and Hybrid Labs and Remote Collaboration Platform for Energy Efficient Building Technologies

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Presented materials have been developing developed with partial support from the National Science Foundation, ATE-1801090, and OISE-2126534

Overview

- ✓ Virtual energy Efficient House
- ✓ AR Enhanced Learning and Training
- ✓ Hybrid Laboratories
- ✓ Synchronized Collaborative Online Platform (SCOP)

Multi-Purposing

Simulation-based online modules can run in four different modes:

- ✓ The ***Tutorial*** *mode* introduces trainees to the major processes and equipment operation.
- ✓ The ***Practice*** *mode* enables them to perform interactive virtual assignments that exactly match their workplace tasks.
- ✓ In the ***Assessment*** *mode*, performance-based and sequential tests provide instructors with reliable data regarding employees' bona fide qualifications and help trainees self-evaluate their knowledge and progress.
- ✓ The ***Interactive Manual (SOP)*** mode sequentially visualizes procedures and steps demonstrating how to perform them to accomplish a workplace task.

An instructor is able to edit lab instructions and incorporate his/her favorite learning resources to adjust v-Labs to specific educational goals and make learners' experience more personal.

Advanced Tools for e-Learning

Interactive Cloud-based e-Learning Modules on Renewable Energy and Energy Efficiency

(Screenshots)

Web-demo

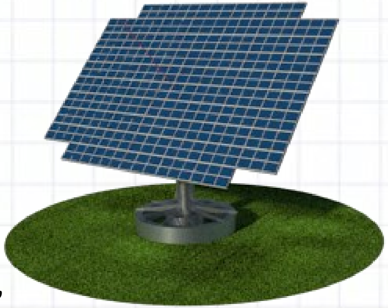
- ✓ Distributed architecture
- ✓ Interdisciplinary contextual learning
- ✓ Familiar objects and processes as educational context
- ✓ Engaging gamified learning
- ✓ Virtual Reality
- ✓ Computational thinking approach
- ✓ Individual and collaborative learning
- ✓ Blended experimentation
- ✓ Adaptable to different ages, level and educational backgrounds (from middle school to university)
- ✓ Complimentary authoring tools
- ✓ Integration with MOOCs

ATeL e-learning tools were developed with partial support from the National Science Foundation.

OVERVIEW

- The multilayered gamified and reconfigurable e-learning environment ***‘Energy Efficient House’*** (*v-EEHouse*) provides a context for cross-disciplinary and activity-based learning and teaching a wide spectrum of STEM topics related to solar energy, energy efficiency, Internet of Things (IoT) and other technologies.
- The highly interactive v-EEHouse helps students better understand technical concepts and study fundamental scientific principles in the context of their practical applications.
- Gamified learning activities engage students in the exploration of the economic and environmental aspects of energy consumption and utilizing renewable energy and energy smart devices.

- The v-EEHouse and its individual components can be easily integrated with online courses including these delivered via MOOC platforms.



- All applications are browser-based and can run under Widows, Android and iOS on PCs, laptops, tablets, and smartphones.

Today

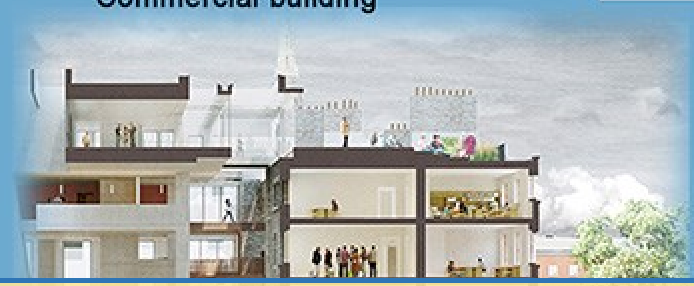
Tomorrow

Accurate 3D virtual copy of real college lab with AR and digital twins of devices and instruments

Green school

Residential house

Commercial building



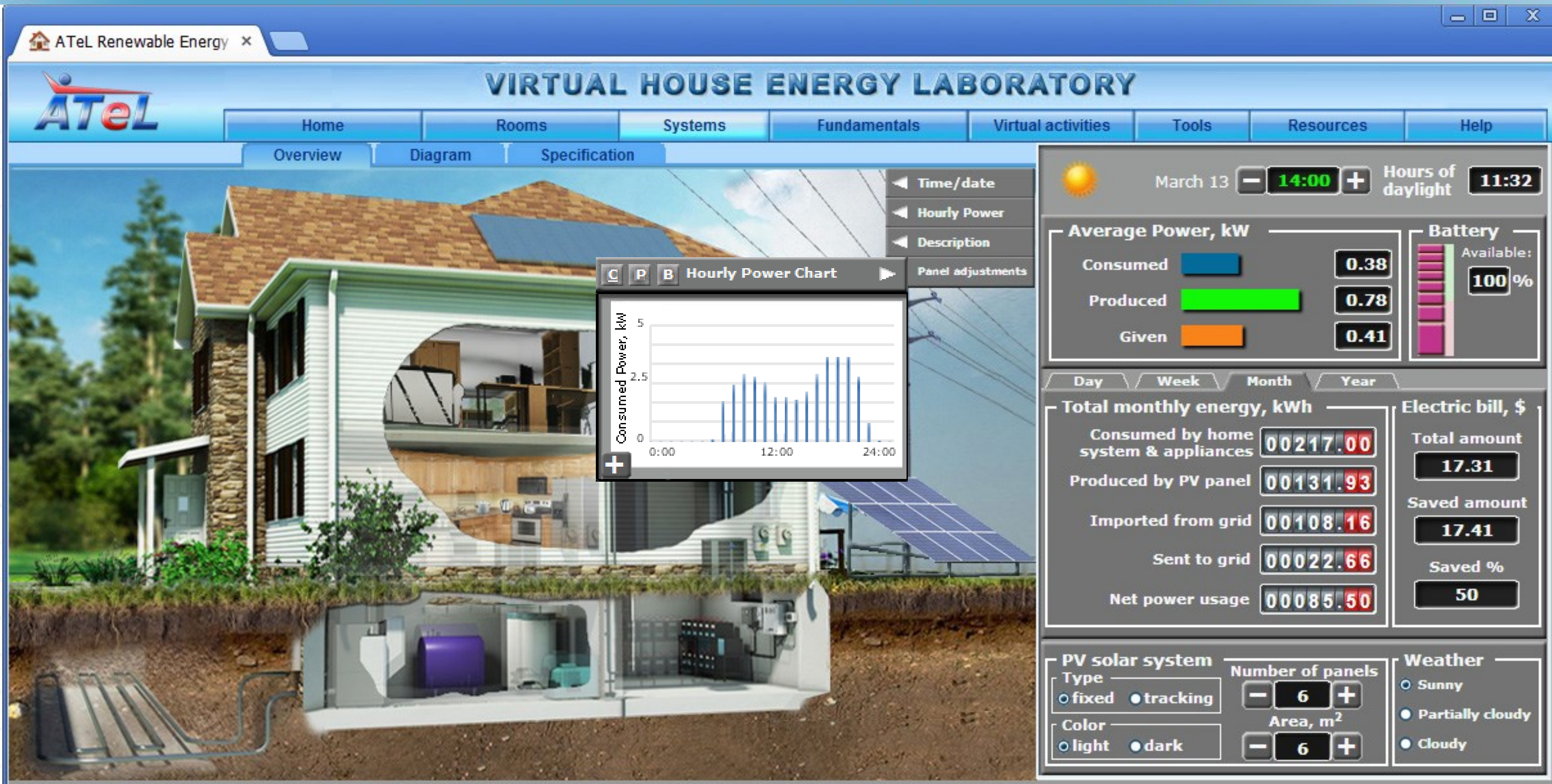
ATeL plans to extend its current virtual residential house and develop:

- Realistic 3D virtual copy of college labs and facilities equipped with Ar and digital twins of sensors, smart monitoring and control systems for building automatization, output devices, etc. for authentic online skills training
- Virtual commercial building that will include sensors and systems for control and monitoring HVAC, lighting, security, etc.
- Gamified virtual green school.

VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies

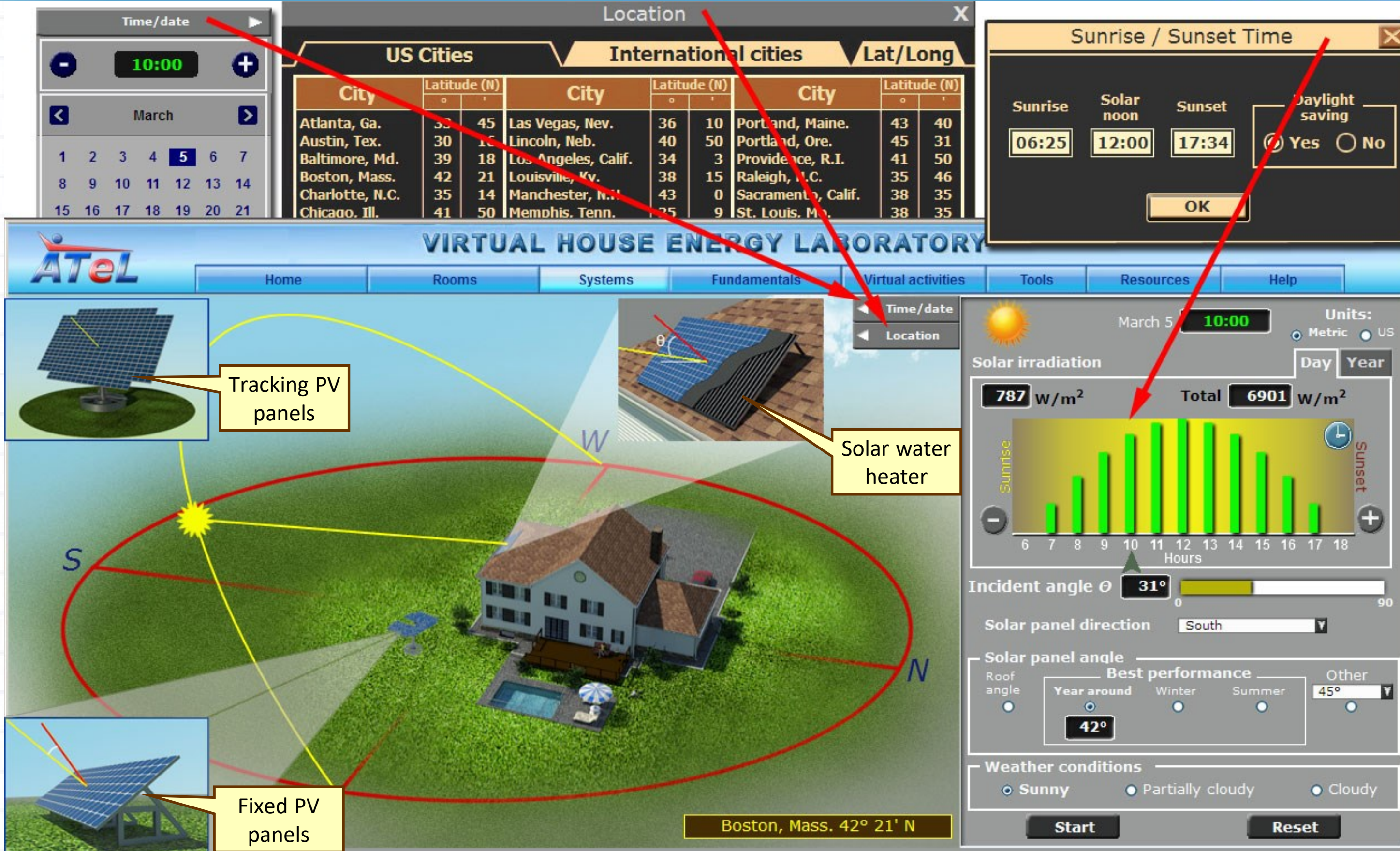
Educational modules presenting major house systems enables users to explore design and operation of home appliances and utility systems, as well as to study underlying scientific and engineering laws and principles.

VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies



The user can monitor a balance between energy consumption by domestic systems and appliances and energy produced by solar panels. The dashboard on the right displays amount of energy imported from and sent to grid, total electric bill amount and saved amount. The user is able to change a type, number and size of solar panel, weather condition, and electrical power load. The time chart of electric power produced and consumed can be displayed and analyzed.

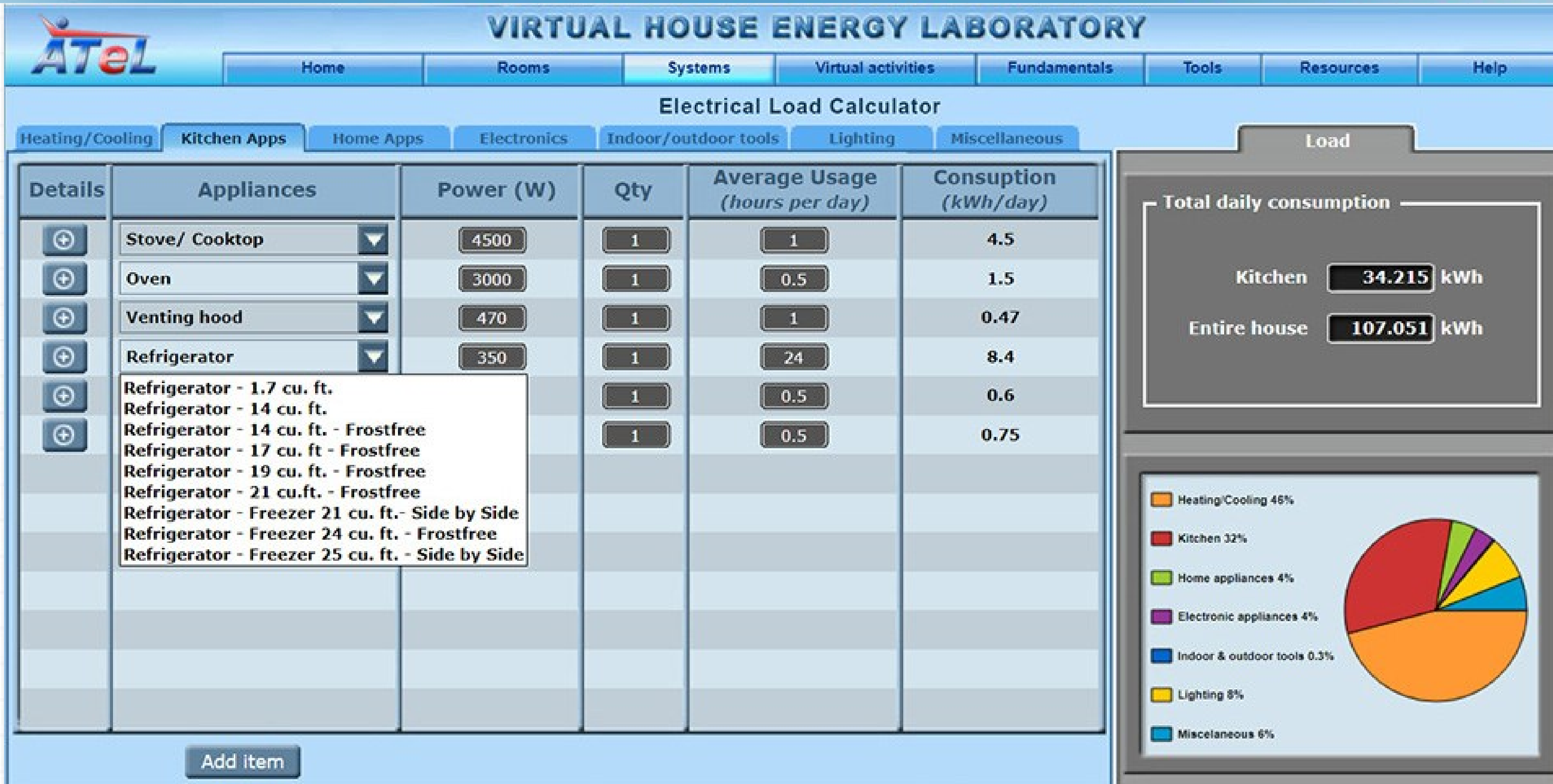
VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies



Solar Photovoltaic and Water Heating Systems

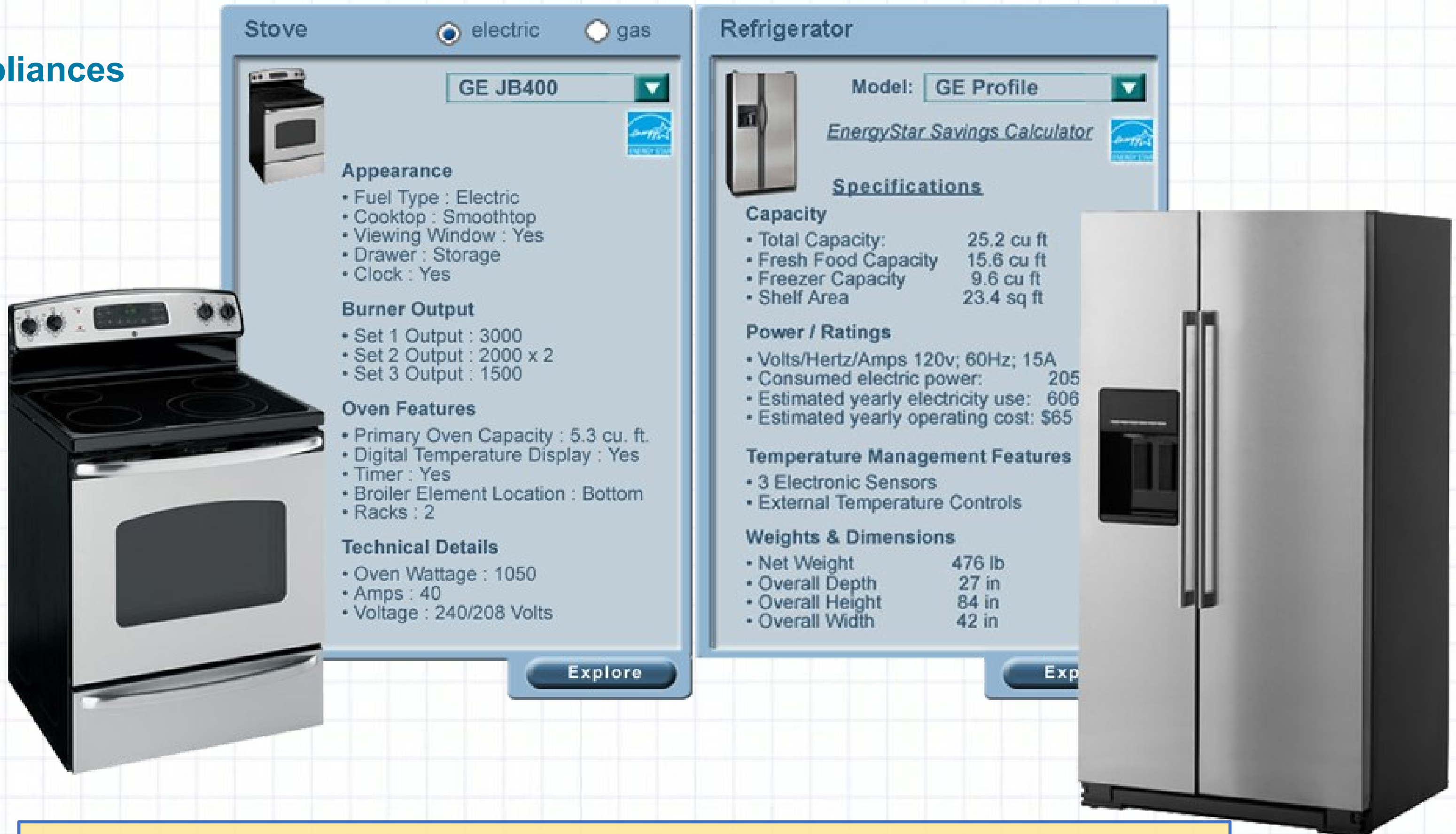
The virtual labs ***Solar Water Heating*** and ***Photovoltaic (PV) Systems*** enable users to investigate how the amount of solar radiation reaching the earth's surface depends on geographical location, seasons, and weather conditions. He/she can explore the impact of factors such as panel model and direction, tilt angle, daytime, etc. efficiency of the systems. The economic issues related to the use of renewable energy in the household are considered as well.

VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies



The ***Electrical Load Calculator*** enables users to examine energy consumption by different models of devices, appliances and lightings. By varying the models (e.g. Refrigerators), the user can estimate and compare expected energy savings vs. investment in a new appliance.

Selecting Home Appliances

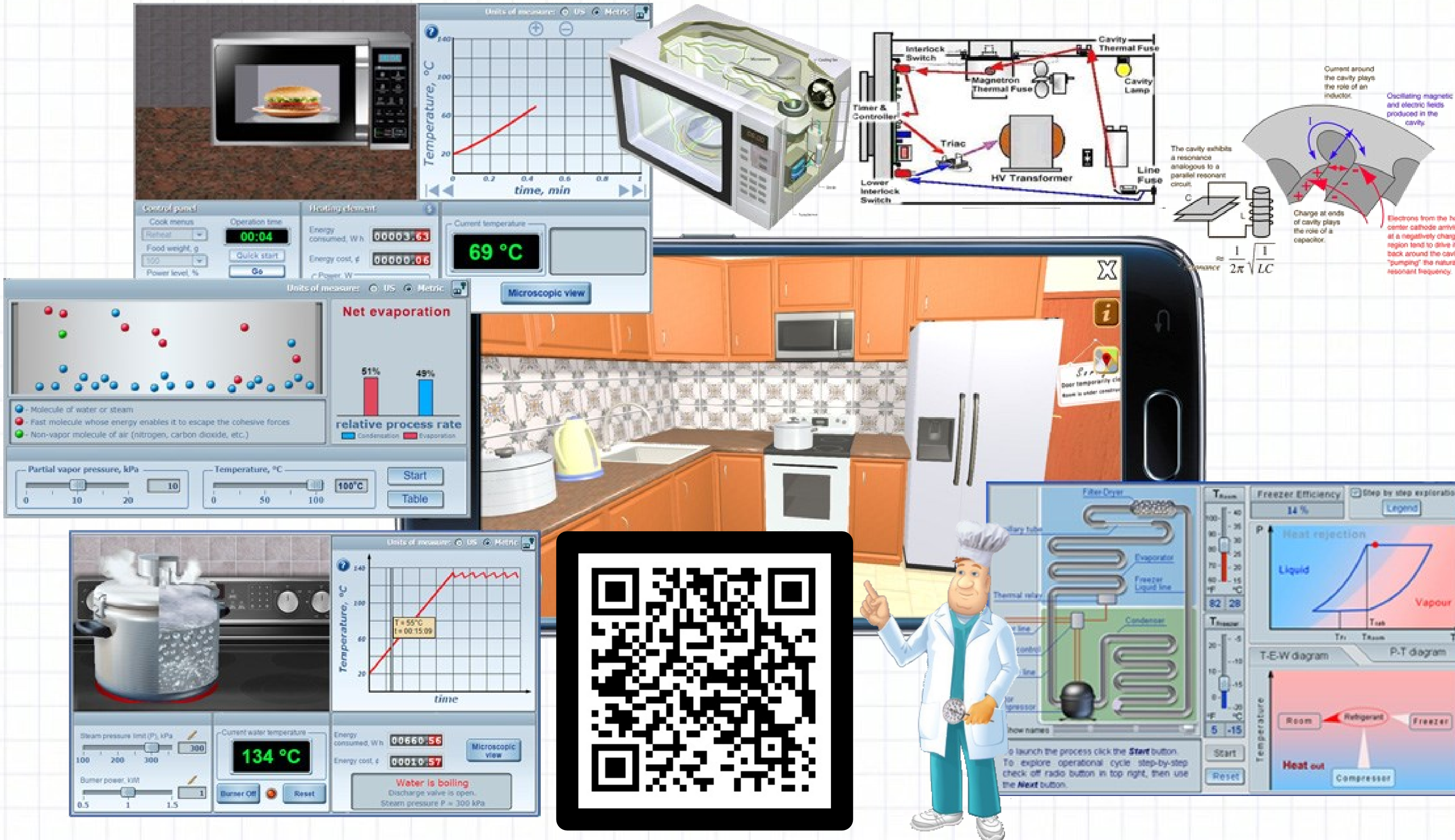


User is able to change heating/cooling systems, home appliances, lightings, building and insolation materials, etc. and examine the impact of various system configurations on energy consumption and utility bills.

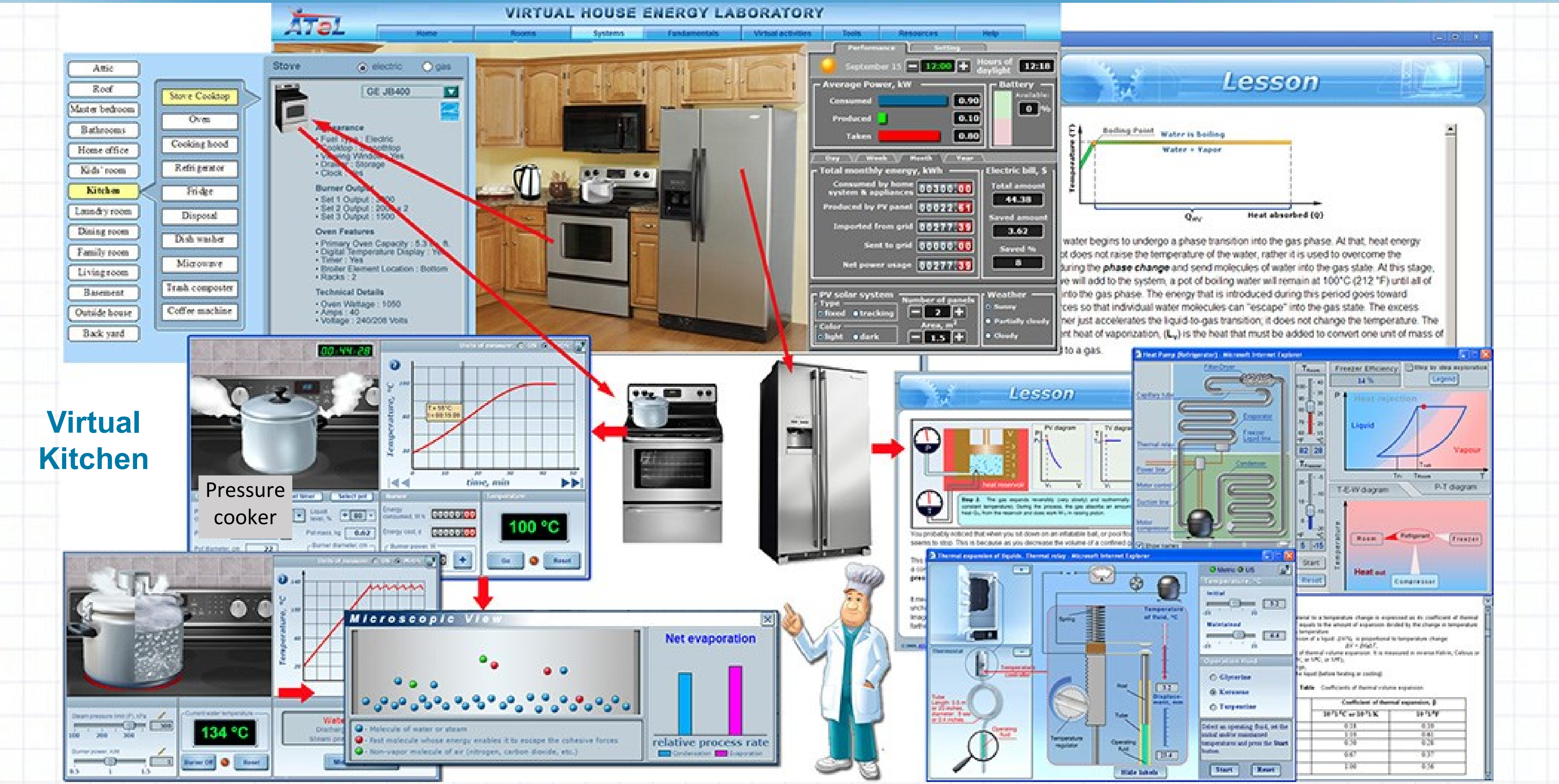
Virtual Kitchen

The gamified 3D VR version of the interactive ***KITCHEN*** brings more fun and excitement to STEM learning.

Gamified 3D Virtual Kitchen



VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies

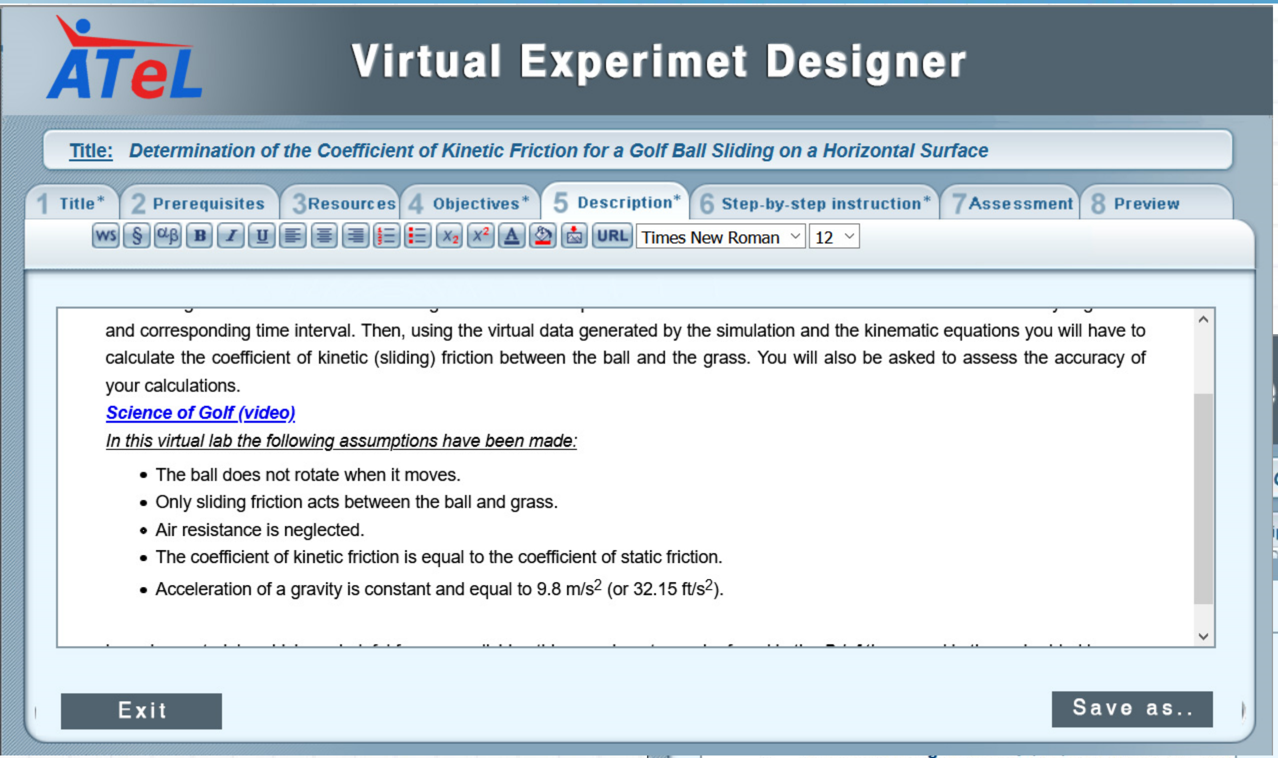


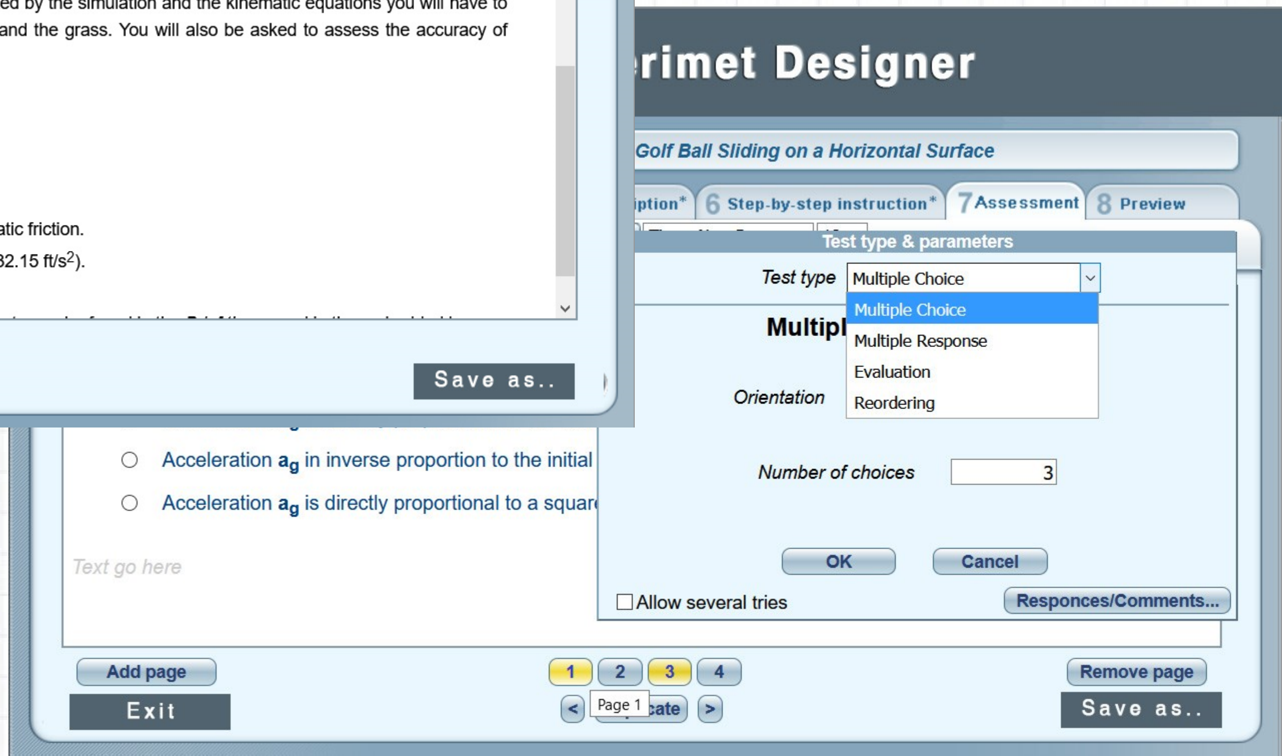
The ***Virtual Kitchen*** module aims to help learners study and better understand STEM principles and laws underlying kitchen appliances, cookware, and cooking. The primary focus is on energy efficient appliances and cooking technologies.

Biomanufacturing Laboratories

This slide illustrates how our virtual biomanufacturing labs are used for developing technical skills in assembling, calibrating and operating a disposable rocking motion bioreactor and preparing learners for hands-on training and workplace practice.

VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies





The complementary ***Virtual Experiment Designer*** allows instructors to modify existing online experiments/activities or create new ones.

Cloud-based Virtual Facilities and Equipment and for Science and Engineering Education and Technical Training

A lot of times, people don't know what they want until you show it to them. And then, once people get it, they can't imagine their life without it.

Steve Jobs

A modular distributed architecture, innovative open and flexible framework and authoring tool will provide the following benefits:

High Interactivity: Embedded accurate math/science models make it possible to vary process parameters, collect and handle data, and simulate abnormal situation for training troubleshooting skills.

Adaptivity and Personalization: By adjusting scenarios, instructions, educational resources, and assessments, learning and training assignments can be tailored to specific educational goals and student ages, backgrounds, and levels (secondary schools, two-year colleges, and universities.)

Performance-based assessment student knowledge and skills are evaluated in terms of his/her performance of an authentic workplace task without (or with minimal) instruction.

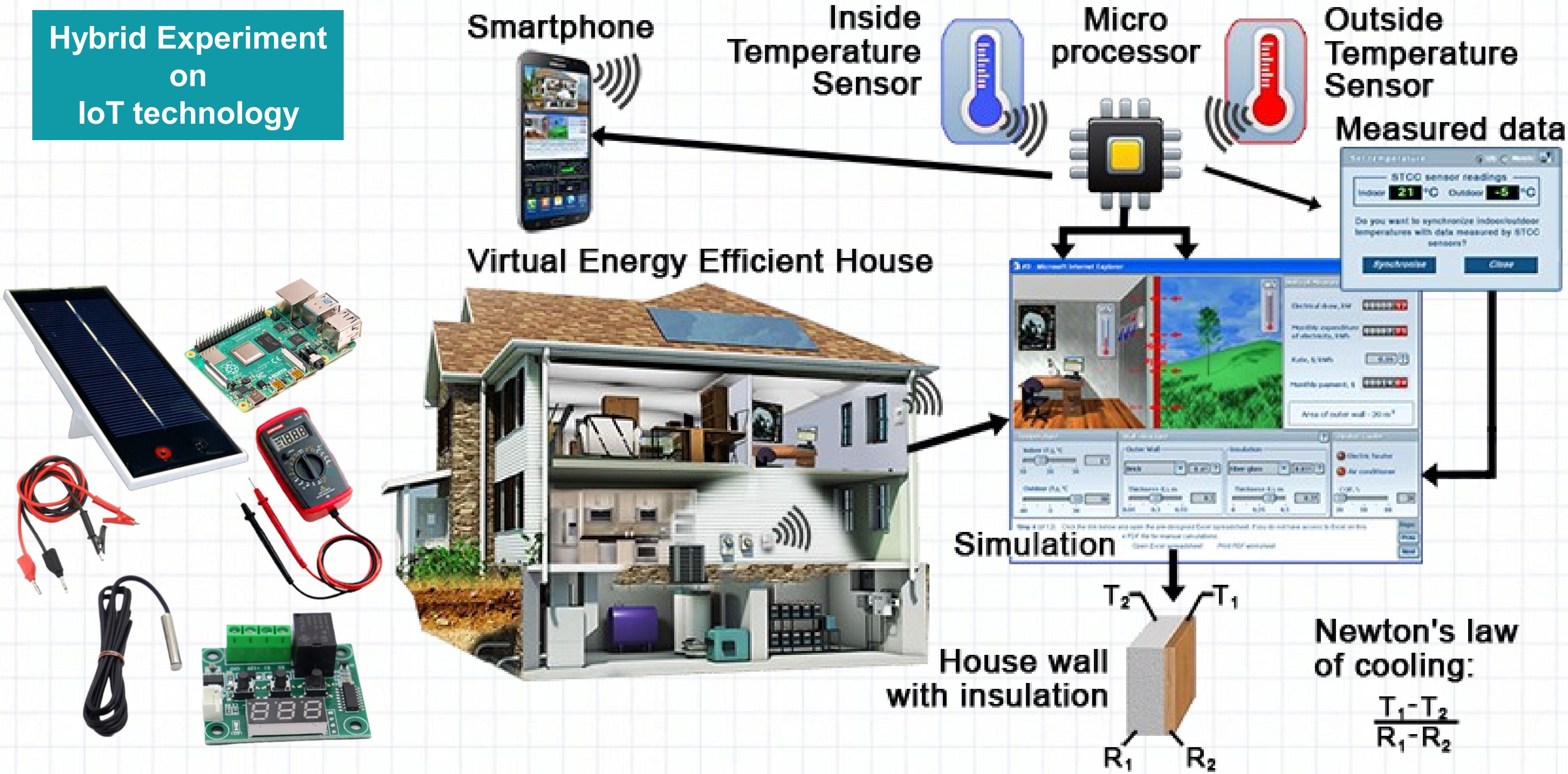
Reusability: Virtual activities based on the same simulation can facilitate the learning or training cycle that includes: (i) introducing technological processes or equipment operation to students, (ii) performing a workplace task following on-screen instruction, (iii) assessing student's knowledge and skills, (iv) fulfilling a hands-on assignment using interactive SOPs that sequentially visualize procedures and guide the user through the task performance.

Customization: It will possible to select various initial cultures from a virtual tissue bank and add new instructor samples, alter production processes, select various models of equipment from a collection, modify VR environment to mirror the workplace of a specific company, and create multilingual versions for multinational companies.

VR/AR and Hybrid Labs and SCOP for Energy Efficient Building Technologies

HI-TEC · ATeL · STCC

Hybrid Experiment on IoT technology



Using the IoT technology, the physical temperature sensors installed inside and outside of Springfield Technical Community College are linked and synchronized with v-EEHouse simulations.

New STCC Equipment

(State Funded)

New Roxbury Community College (RCC) facilities and equipment *(State Funded)*

Online experiment on measuring the burner efficiency and energy consumed for heating and boiling Augmented Reality (AR)

Synchronized Collaborative Online Platform

Solar Energy/v-House | X-Ray | Biomanufacturing

SCOP

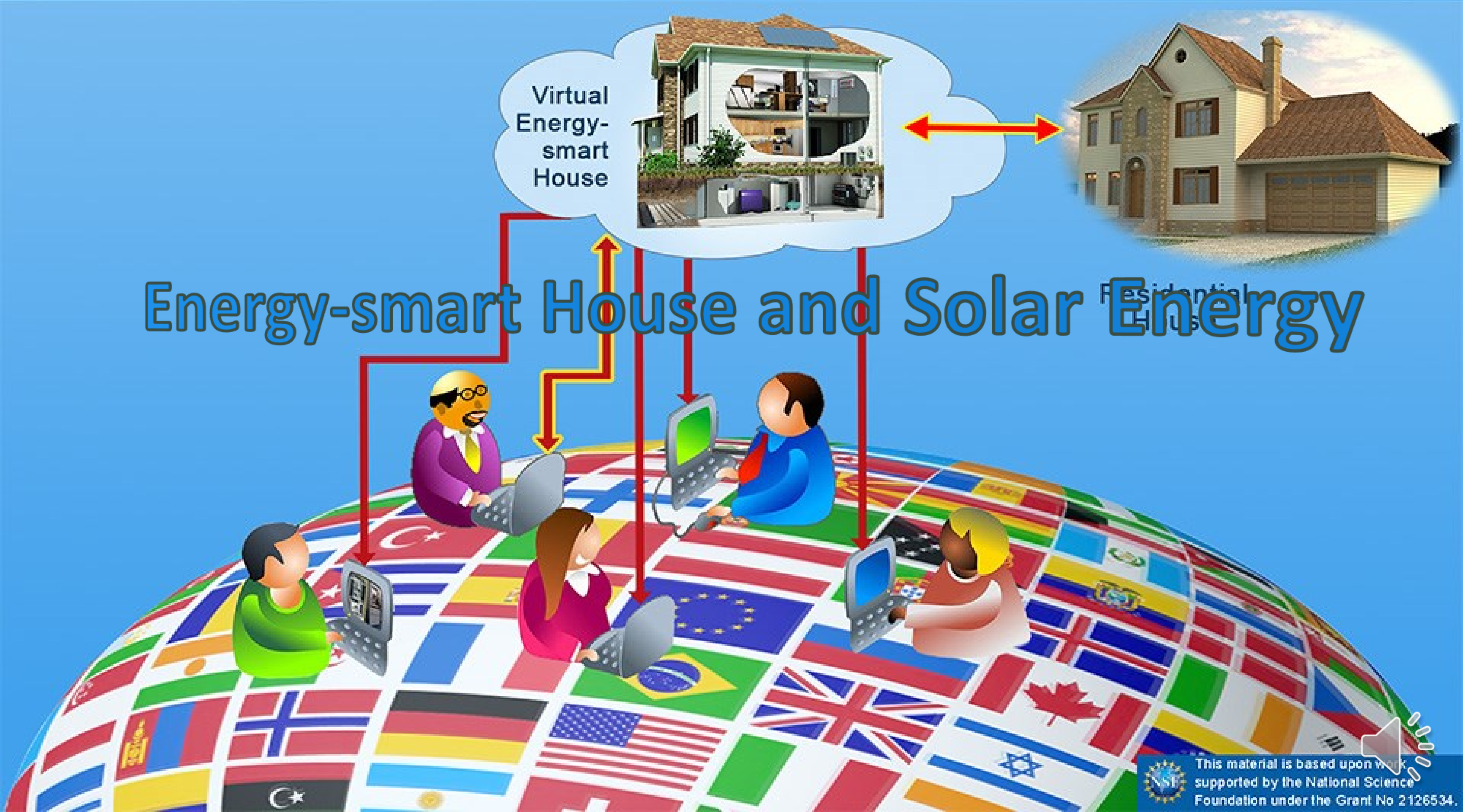
Browser-based Synchronized Collaborative Online Platform

This material is based upon work supported by rhe National Science

Synchronized Collaborative Online Platform

RENEWABLE ENERGY AND ENERGY-SMART HOUSE

Energy-smart House and Solar Energy



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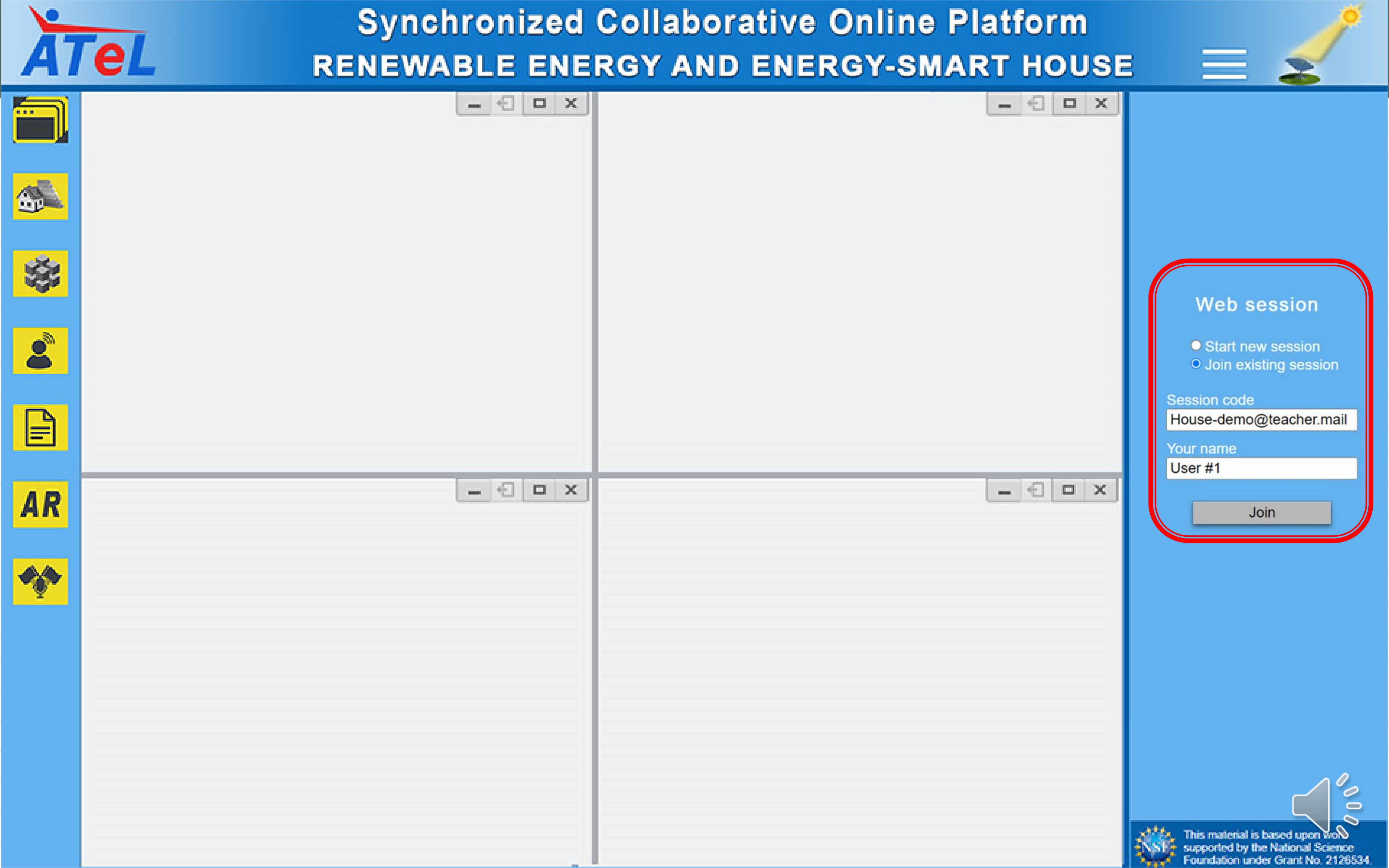
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RENEWABLE ENERGY AND ENERGY-SMART HOUSE
AR
Web session
Start new session
Join existing session
Session code
House-demo@teacher.mail
Your name
User #1
Join
This material is based upon
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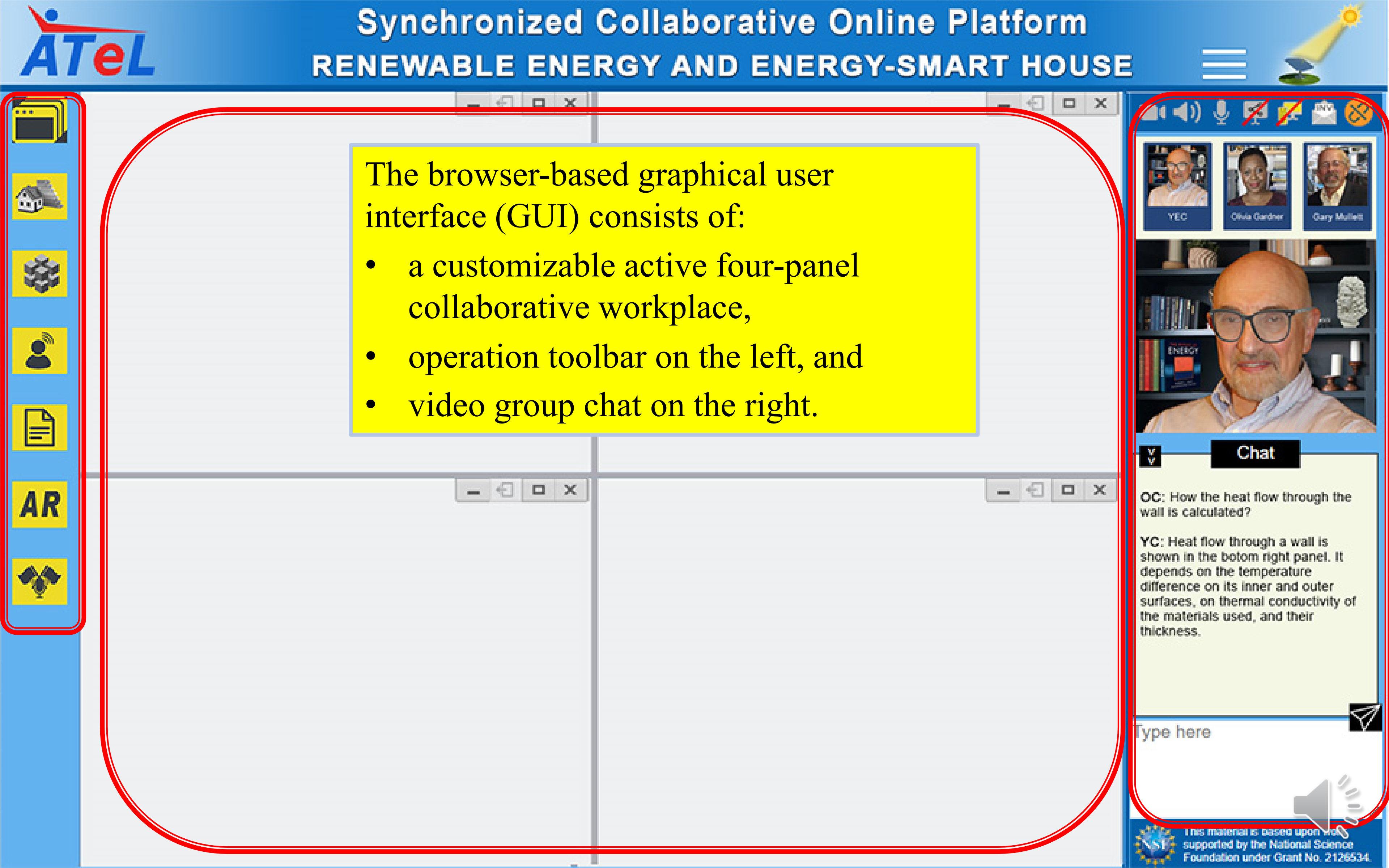

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RENEWABLE ENERGY AND ENERGY-SMART HOUSE
AR
The browser-based graphical user interface (GUI) consists of:
• a customizable active four-panel collaborative workplace,
• operation toolbar on the left, and
• video group chat on the right.
YEC
Olivia Gardner
Gary Mullett
Chat
OC: How the heat flow through the wall is calculated?
YC: Heat flow through a wall is shown in the botom right panel. It depends on the temperature difference on its inner and outer surfaces, on thermal conductivity of the materials used, and their thickness.
Type here
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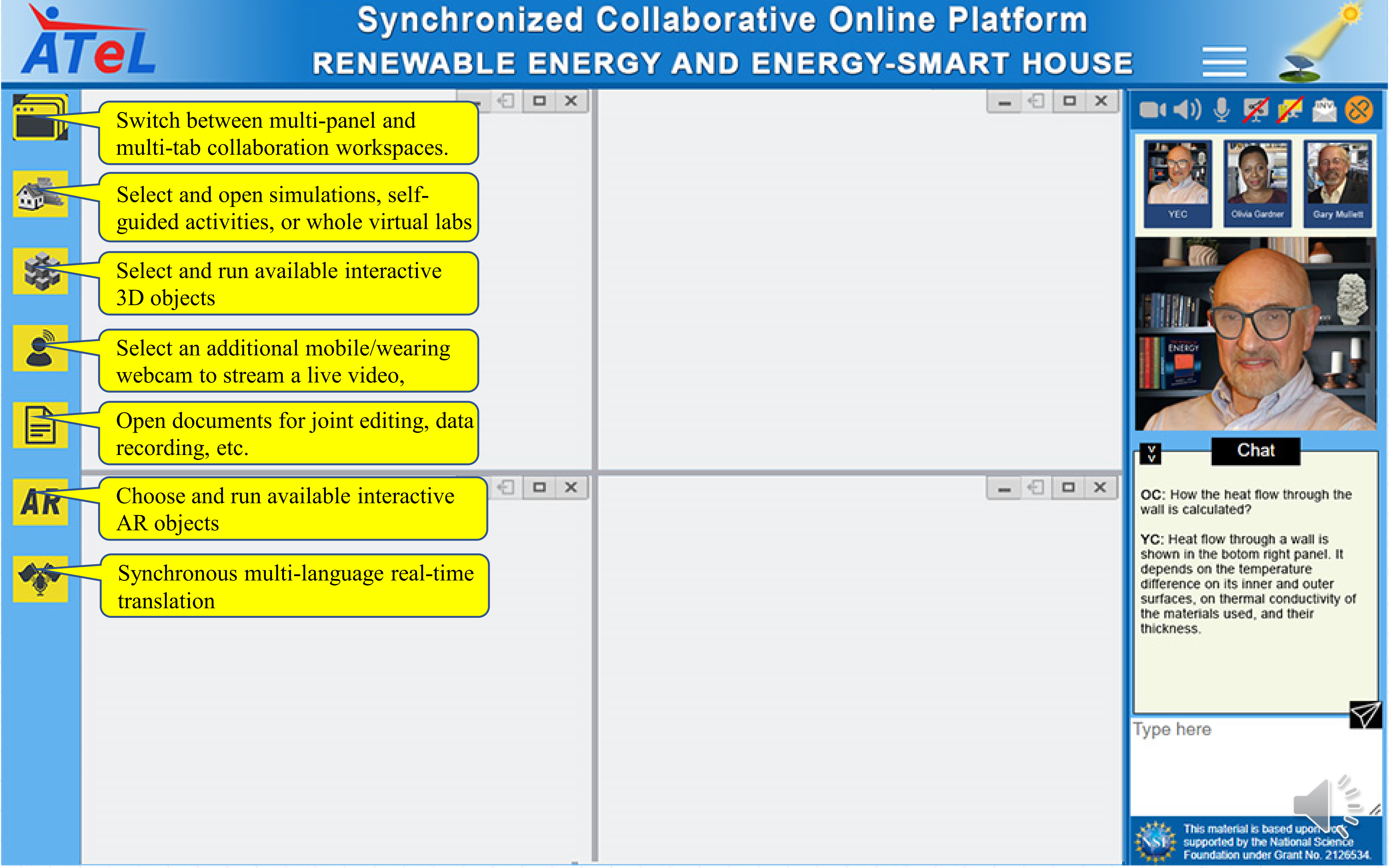
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RENEWABLE ENERGY AND ENERGY-SMART HOUSE
Switch between multi-panel and multi-tab collaboration workspaces.
Select and open simulations, self-guided activities, or whole virtual labs
Select and run available interactive 3D objects
Select an additional mobile/wearing webcam to stream a live video,
Open documents for joint editing, data recording, etc.
AR
Choose and run available interactive AR objects
Synchronous multi-language real-time translation
YEC
Olivia Gardner
Gary Mullett
Chat
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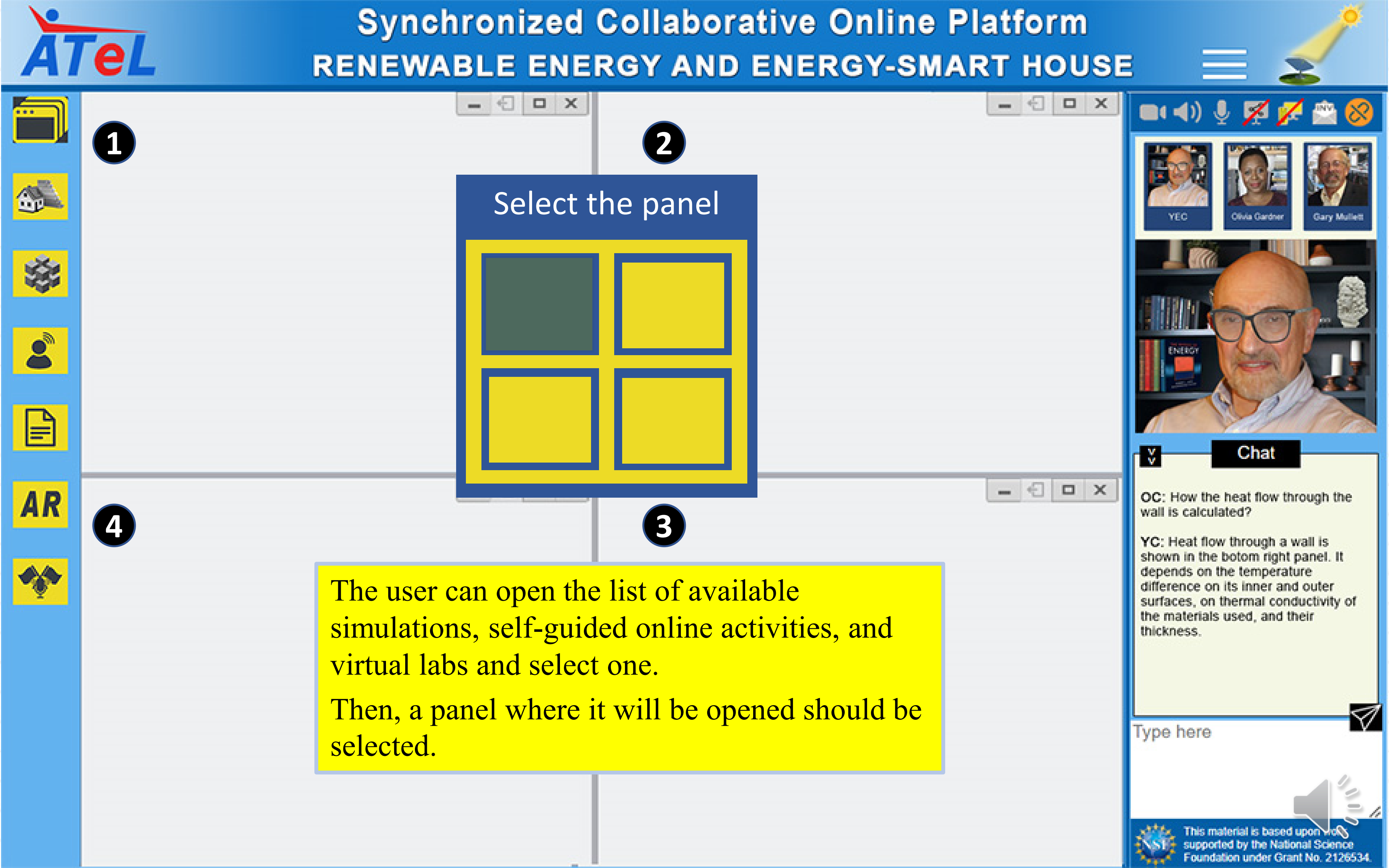
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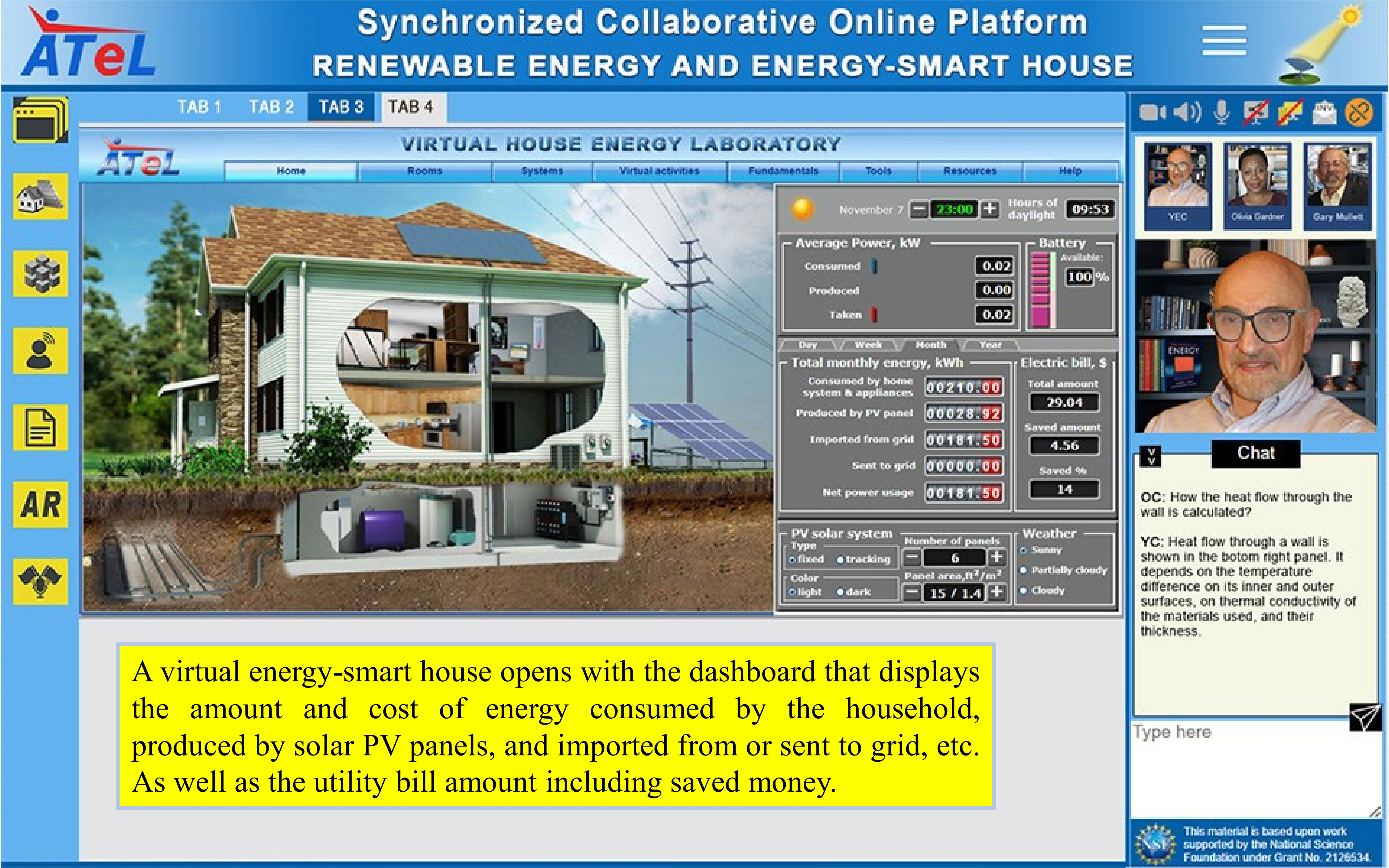
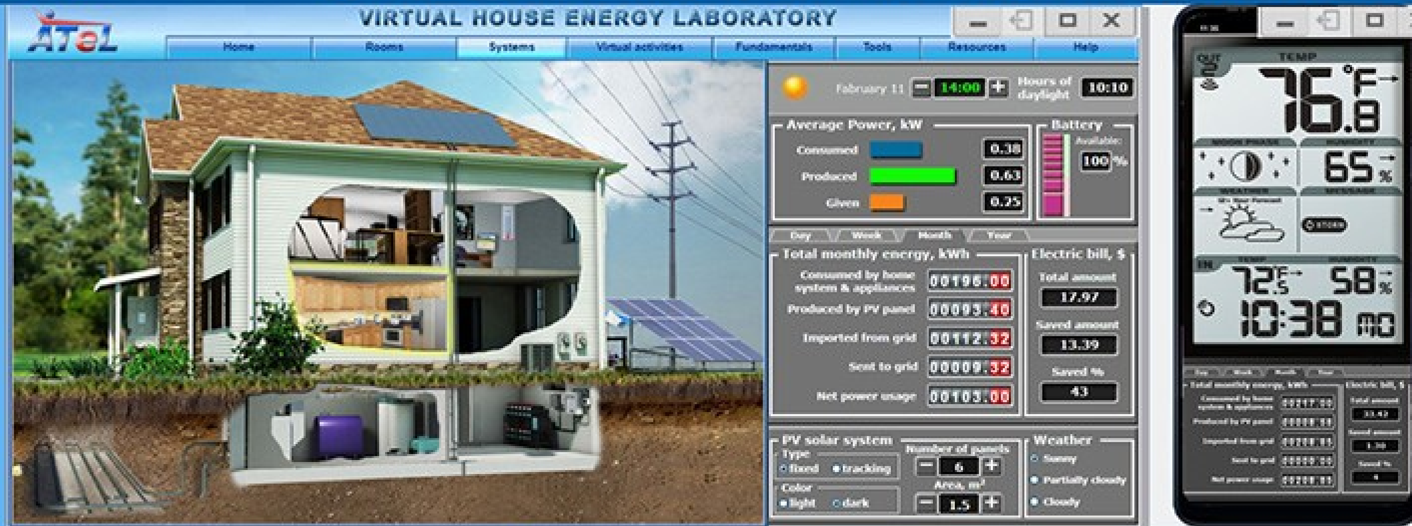
AR
1
2
3
4
Select the panel
YEC
Olivia Gardner
Gary Mullett
Chat
OC: How the heat flow through the wall is calculated?
YC: Heat flow through a wall is shown in the botom right panel. It depends on the temperature difference on its inner and outer surfaces, on thermal conductivity of the materials used, and their thickness.
Type here
The user can open the list of available simulations, self-guided online activities, and virtual labs and select one.
Then, a panel where it will be opened should be selected.



A virtual energy-smart house opens with the dashboard that displays the amount and cost of energy consumed by the household, produced by solar PV panels, and imported from or sent to grid, etc. As well as the utility bill amount including saved money.

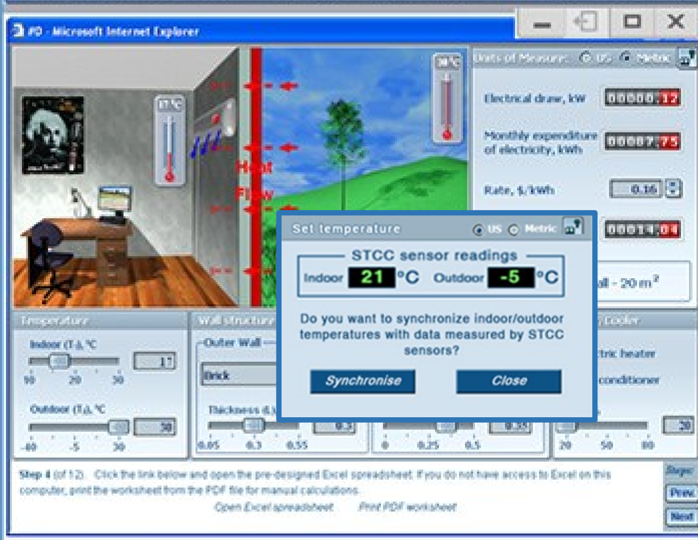
Synchronized Collaborative Online Platform

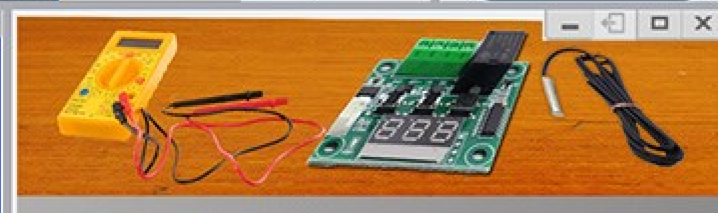
RENEWABLE ENERGY AND ENERGY-SMART HOUSE



The control and operation information presented on a smartphone home assistant dashboard can be streamed to another panel.

Click to join Web Session





Students can use self-guided online activities to explore processes (e.g., heat flow through a building wall). Virtual labs can synchronize physical process parameters measured by real sensors with data simulated by software.

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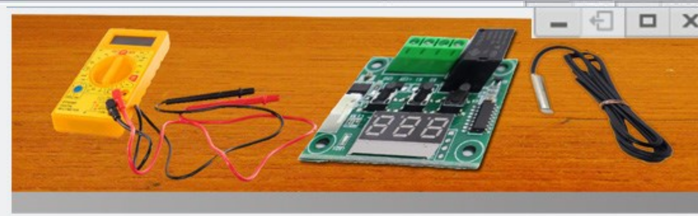
Synchronized Collaborative Online Platform

RENEWABLE ENERGY AND ENERGY EFFICIENT HOUSE



Virtual labs can be linked with physical equipment and facilities of a partnering college. Real-time video can be streamed from a college lab.

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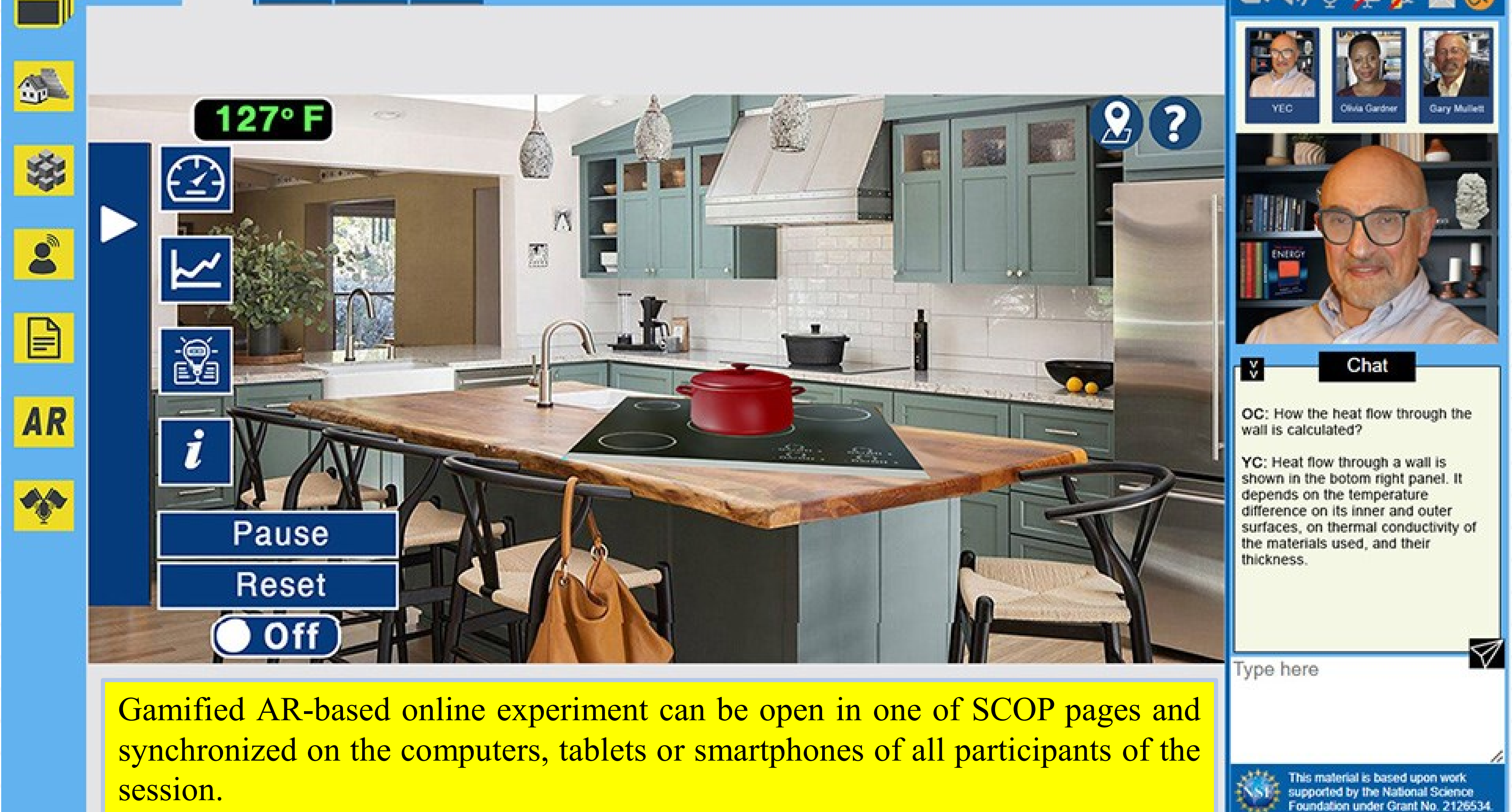

Gamified AR-based online experiment can be open in one of SCOP pages and synchronized on the computers, tablets or smartphones of all participants of the session.

Inviting to Partnership

We are inviting organizations and individuals to work together for creating new digital equipment, virtual labs and comprehensive customizable learning environments.

Questions

Websites:

- ATeL – Advanced Tools for e-Learning - https://atelearning.com
- Virtual Energy Efficient House Demo
  https://atelearning.com/Energy/Demo/v-House/

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