

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

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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.

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

(Screenshots)



Web-demo



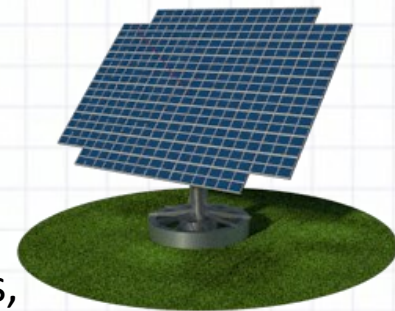
- ✓ Distributed architecture
- ✓ Interdisciplinary contextual learning
- ✓ Familiar objects and processes as educational context
- ✓ Engaging gamified learning
- ✓ Virtual Reality
- ✓ Computational thinking approach
- ✓ Individual and collaborative learning
- ✓ Blended experimentation
- ✓ Adaptable to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





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 Windows, Android and iOS on PCs, laptops, tablets, and smartphones.



Today

Residential house



Tomorrow

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



Commercial building



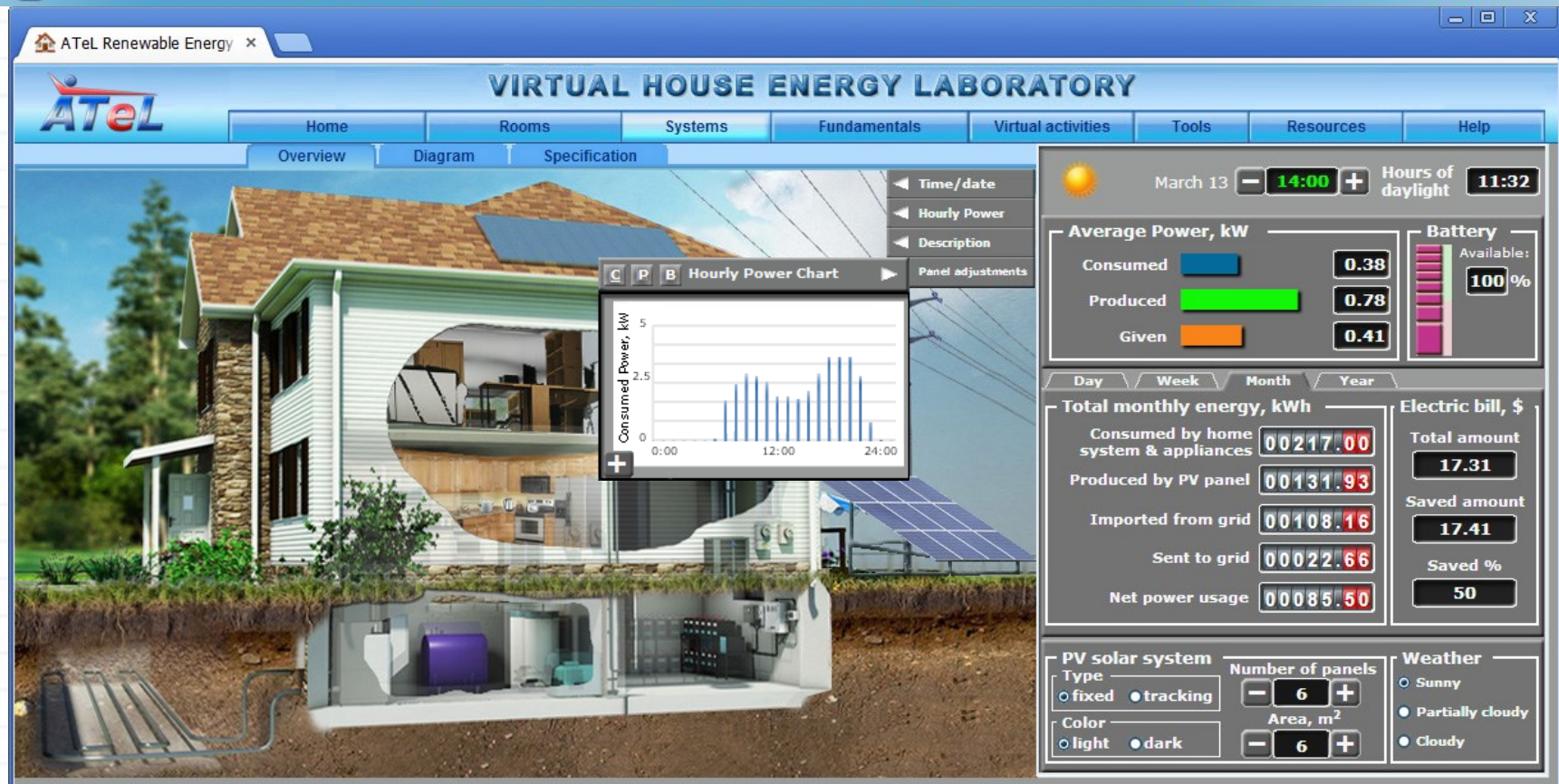
Green school

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.

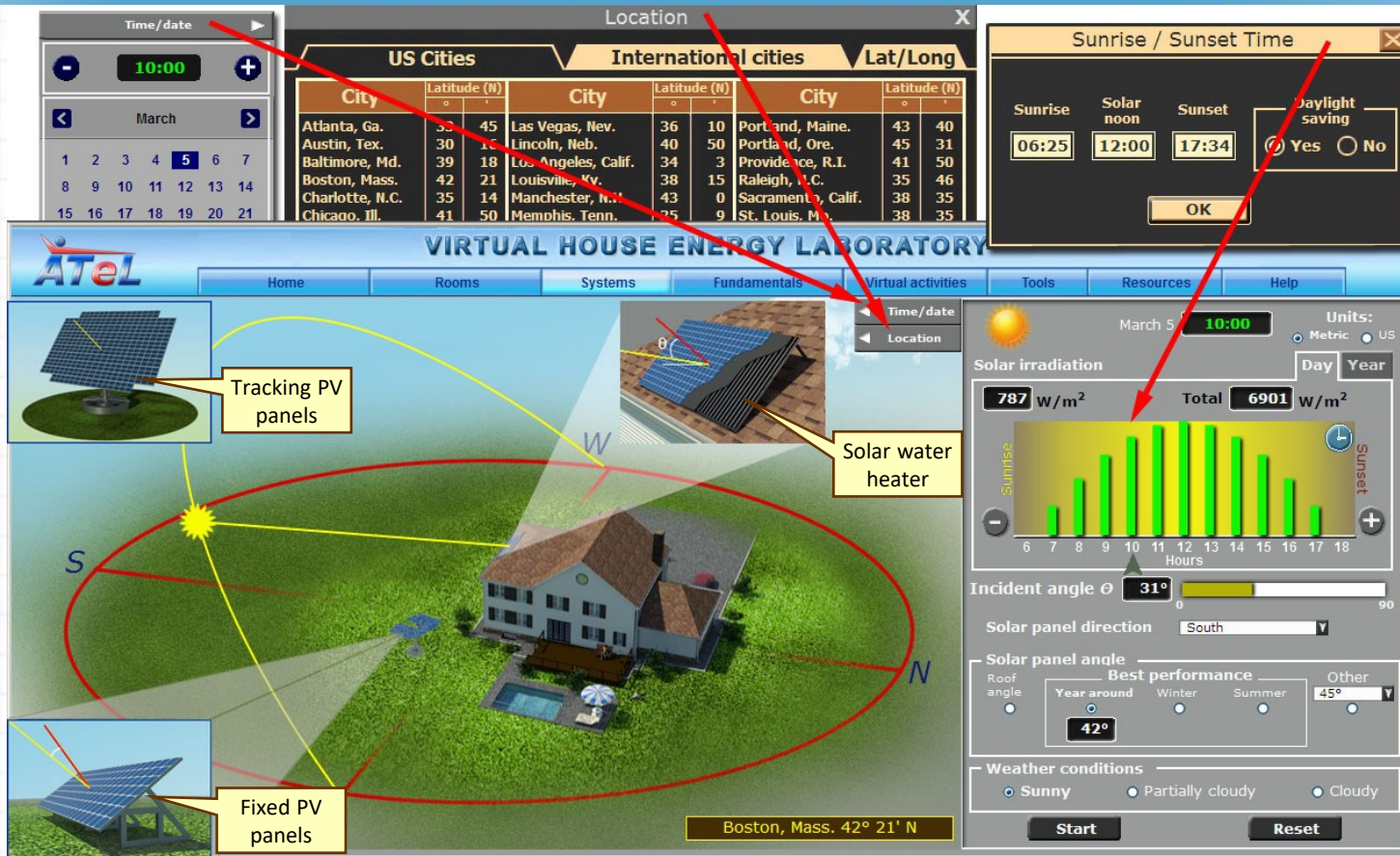


Educational modules presenting major house systems enables users to explore design and operation of home appliances and utility systems, as well as to study underlying scientific and engineering laws and principles.



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.

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.

VIRTUAL HOUSE ENERGY LABORATORY


[Home](#)
[Rooms](#)
[Systems](#)
[Virtual activities](#)
[Fundamentals](#)
[Tools](#)
[Resources](#)
[Help](#)

Electrical Load Calculator

[Heating/Cooling](#)
[Kitchen Apps](#)
[Home Apps](#)
[Electronics](#)
[Indoor/outdoor tools](#)
[Lighting](#)
[Miscellaneous](#)
[Load](#)

Details	Appliances	Power (W)	Qty	Average Usage (hours per day)	Consumption (kWh/day)
	Stove/ Cooktop	4500	1	1	4.5
	Oven	3000	1	0.5	1.5
	Venting hood	470	1	1	0.47
	Refrigerator	350	1	24	8.4
	Refrigerator - 1.7 cu. ft.		1	0.5	0.6
	Refrigerator - 14 cu. ft.		1	0.5	0.75
	Refrigerator - 14 cu. ft. - Frostfree				
	Refrigerator - 17 cu. ft. - Frostfree				
	Refrigerator - 19 cu. ft. - Frostfree				
	Refrigerator - 21 cu.ft. - Frostfree				
	Refrigerator - Freezer 21 cu. ft.- Side by Side				
	Refrigerator - Freezer 24 cu. ft. - Frostfree				
	Refrigerator - Freezer 25 cu. ft. - Side by Side				

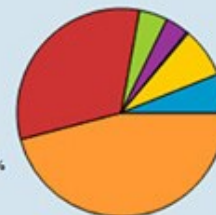
[Add Item](#)

Total daily consumption

Kitchen **34.215** kWh


Entire house **107.051** kWh

Heating/Cooling 46%
 Kitchen 32%
 Home appliances 4%
 Electronic appliances 4%
 Indoor & outdoor tools 0.3%
 Lighting 8%
 Miscellaneous 6%



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



Stove

☒ electric ☐ gas

Model: **GE JB400**

Appearance

- Fuel Type : Electric
- Cooktop : Smoothtop
- Viewing Window : Yes
- Drawer : Storage
- Clock : Yes

Burner Output

- Set 1 Output : 3000
- Set 2 Output : 2000 x 2
- Set 3 Output : 1500

Oven Features

- Primary Oven Capacity : 5.3 cu. ft.
- Digital Temperature Display : Yes
- Timer : Yes
- Broiler Element Location : Bottom
- Racks : 2

Technical Details

- Oven Wattage : 1050
- Amps : 40
- Voltage : 240/208 Volts

Explore

Refrigerator

Model: **GE Profile**

EnergyStar Savings Calculator

Specifications

Capacity

- Total Capacity: 25.2 cu ft
- Fresh Food Capacity 15.6 cu ft
- Freezer Capacity 9.6 cu ft
- Shelf Area 23.4 sq ft

Power / Ratings

- Volts/Hertz/Amps 120v; 60Hz; 15A
- Consumed electric power: 205
- Estimated yearly electricity use: 606
- Estimated yearly operating cost: \$65


Temperature Management Features

- 3 Electronic Sensors
- External Temperature Controls

Weights & Dimensions

- Net Weight 476 lb
- Overall Depth 27 in
- Overall Height 84 in
- Overall Width 42 in

Exp



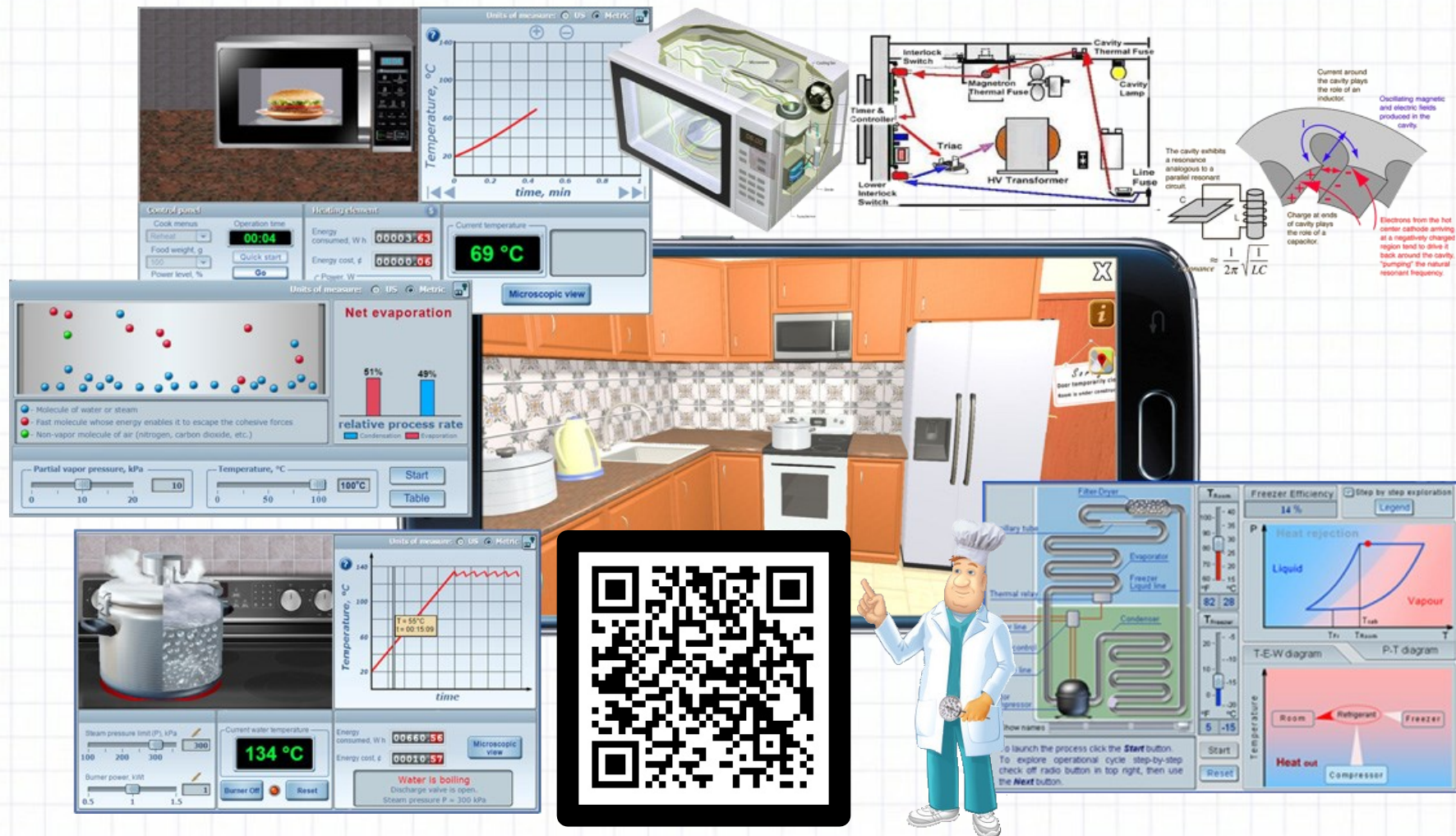
User is able to change heating/cooling systems, home appliances, lightings, building and insulation materials, etc. and examine the impact of various system configurations on energy consumption and utility bills.

Virtual Kitchen

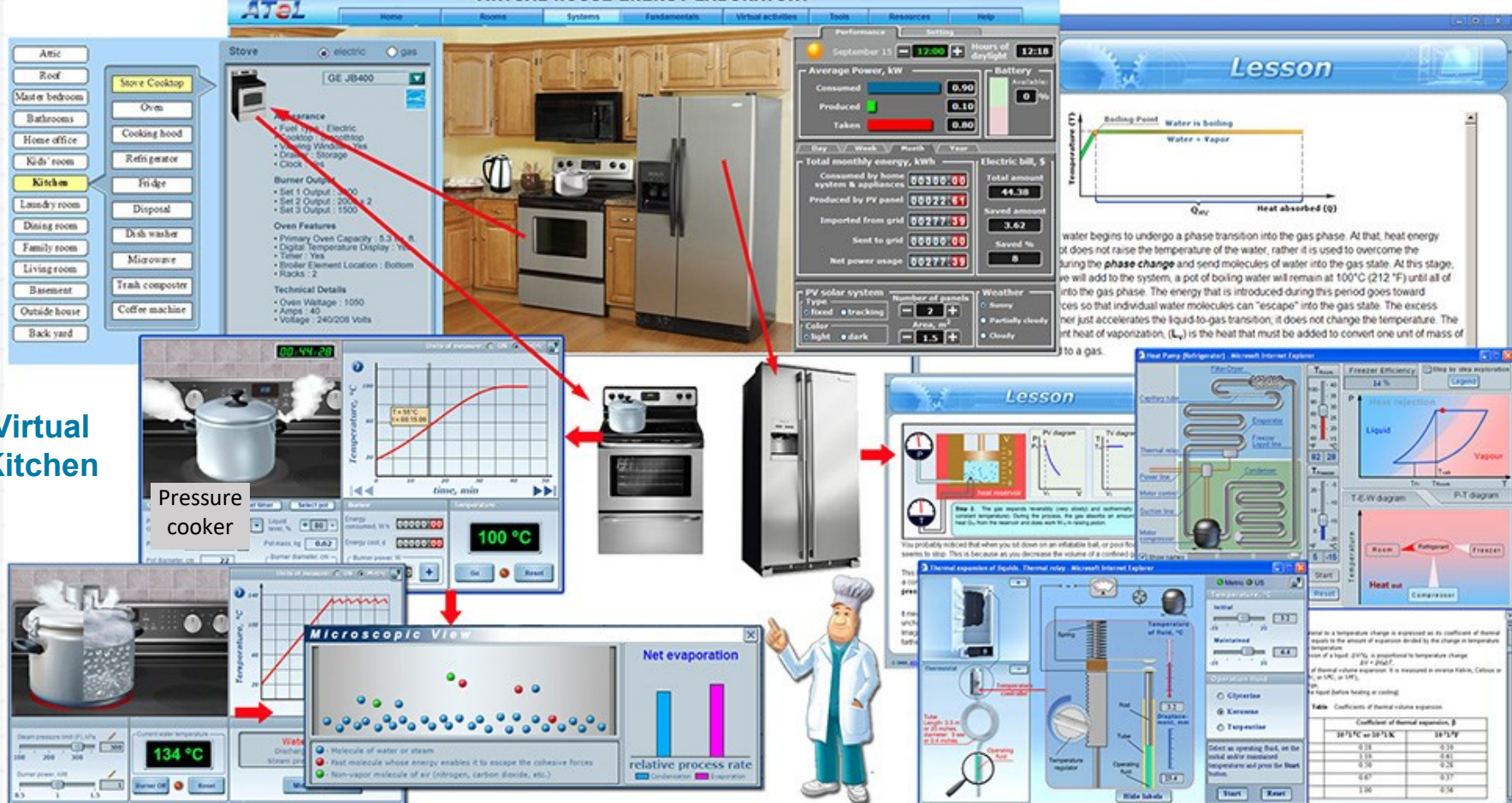


The gamified 3D VR version of the interactive **KITCHEN** brings more fun and excitement to STEM learning.

Gamified 3D Virtual Kitchen



VIRTUAL HOUSE ENERGY LABORATORY



Virtual
Kitchen









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.

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.



Title: *Determination of the Coefficient of Kinetic Friction for a Golf Ball Sliding on a Horizontal Surface*

1 Title* 2 Prerequisites 3 Resources 4 Objectives* 5 Description* 6 Step-by-step instruction* 7 Assessment 8 Preview

ws                                                                            

and corresponding time interval. Then, using the virtual data generated by the simulation and the kinematic equations you will have to calculate the coefficient of kinetic (sliding) friction between the ball and the grass. You will also be asked to assess the accuracy of your calculations.

Science of Golf (video)

In this virtual lab the following assumptions have been made:

- The ball does not rotate when it moves.
- Only sliding friction acts between the ball and grass.
- Air resistance is neglected.
- The coefficient of kinetic friction is equal to the coefficient of static friction.
- Acceleration of a gravity is constant and equal to 9.8 m/s^2 (or 32.15 ft/s^2).

Exit

Save as...

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

- Acceleration \mathbf{a}_g in inverse proportion to the initial

- Acceleration \mathbf{a}_g is directly proportional to a square

Text go here

Add page

Exit

Primet Designer

Golf Ball Sliding on a Horizontal Surface

6 Step-by-step instruction* 7 Assessment 8 Preview

Test type & parameters

Test type Multiple Choice

Multiple Choice

Multiple Response

Evaluation

Orientation Reordering

Number of choices

OK

Cancel

☐ Allow several tries

Responses/Comments...

1 2 3 4

Page 1

Remove page

Save as...

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.

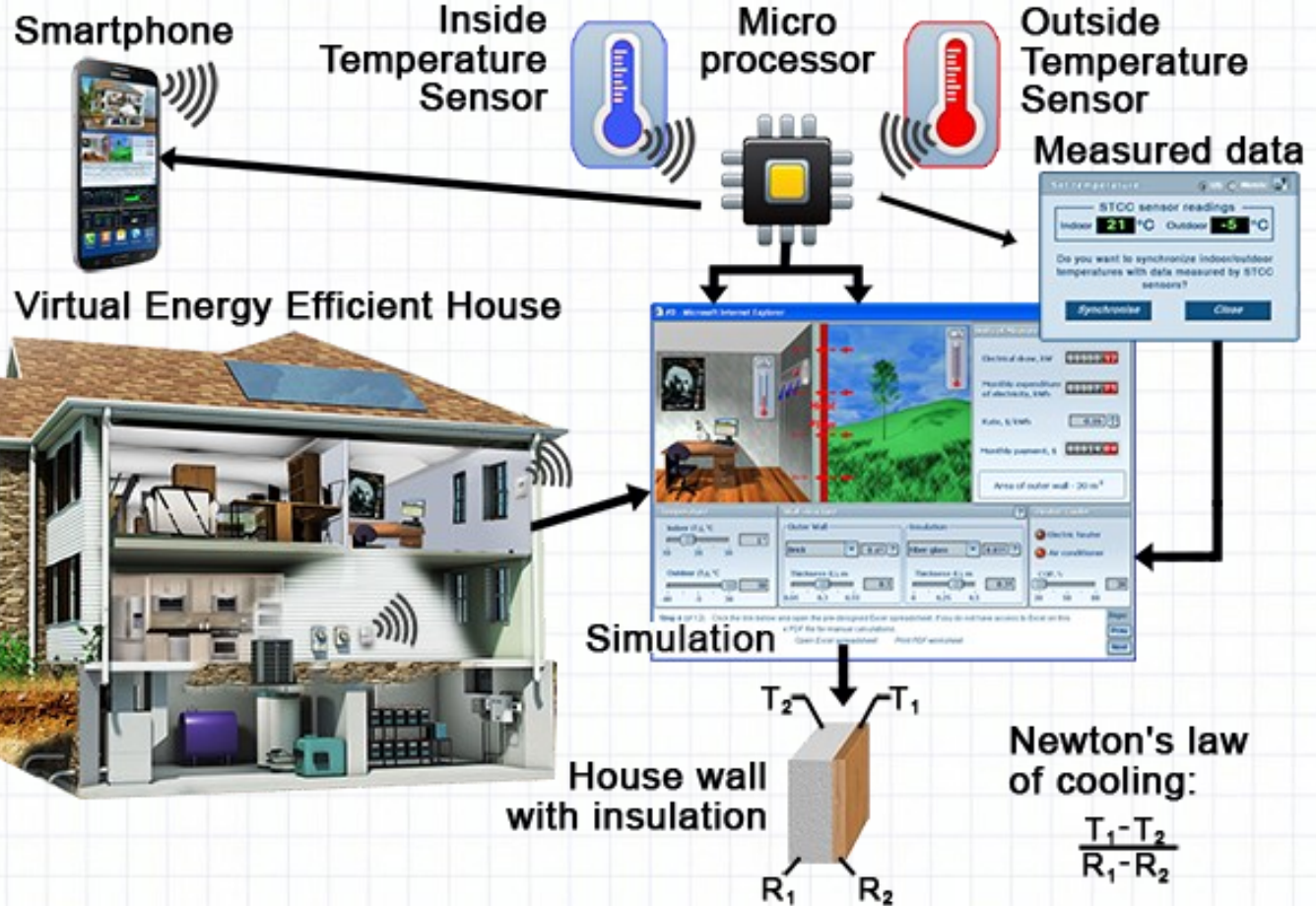
Adaptivity and Personalization: By adjusting scenarios, instructions, educational resources, and assessments, learning and training assignments can be tailored to specific educational goals and student ages, backgrounds, and levels (secondary schools, two-year colleges, and universities.)

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.

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

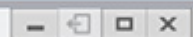
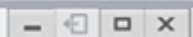
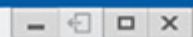
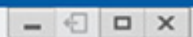


This material is based upon work supported by the National Science



Energy-smart House and Solar Energy





Web session

- ☒ Start new session
- ☐ Join existing session

Session code

House-demo@teacher.mail

Your name

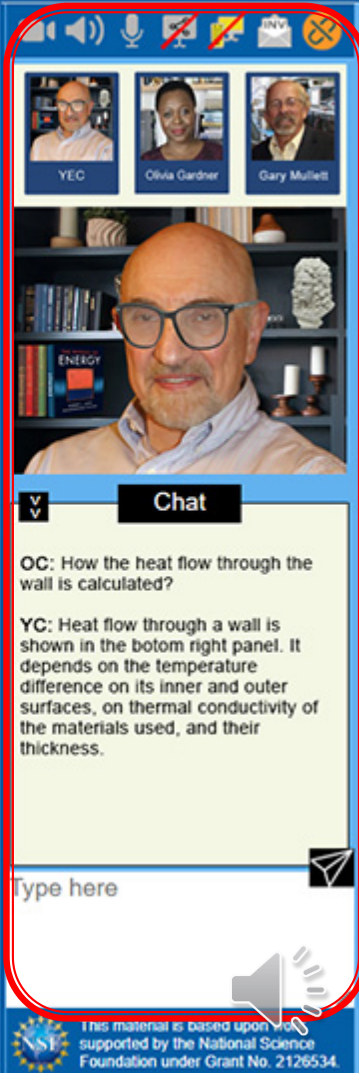
User #1

Join



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.



The screenshot shows the right side of the GUI. At the top, there is a video group chat window with three participants: YEC, Olivia Gardner, and Gary Mullett. Below the video chat is a chat window titled "Chat". The chat history shows a question from OC: "How the heat flow through the wall is calculated?" and an answer from YC: "Heat flow through a wall is shown in the bottom right panel. It depends on the temperature difference on its inner and outer surfaces, on thermal conductivity of the materials used, and their thickness." At the bottom of the chat window is a text input field labeled "Type here" and a send button. In the bottom right corner of the entire GUI, there is a small speaker icon and a text box stating: "This material is based upon work supported by the National Science Foundation under Grant No. 2126534."



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,



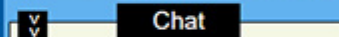
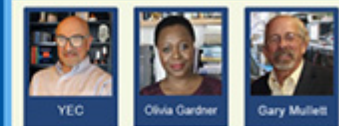
Open documents for joint editing, data recording, etc.



Choose and run available interactive AR objects



Synchronous multi-language real-time translation



OC: How the heat flow through the wall is calculated?

YC: Heat flow through a wall is shown in the bottom right panel. It depends on the temperature difference on its inner and outer surfaces, on thermal conductivity of the materials used, and their thickness.

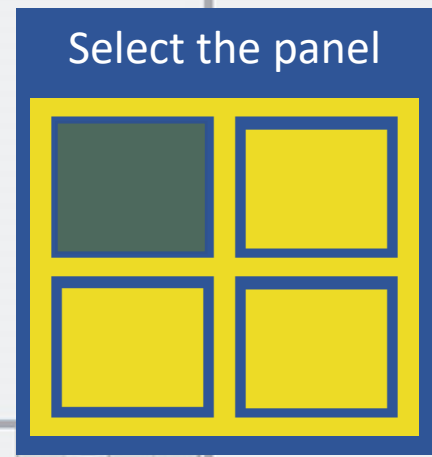
Type here





1

2



4

3

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.



Chat

OC: How the heat flow through the wall is calculated?

YC: Heat flow through a wall is shown in the bottom 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



TAB 1 TAB 2 **TAB 3** TAB 4



VIRTUAL HOUSE ENERGY LABORATORY

Home

Rooms

Systems

Virtual activities


Fundamentals

Tools

Resources

Help




November 7
23:00
Hours of daylight 09:53

Average Power, kW

Consumed	0.02
Produced	0.00
Taken	0.02

Battery

Available:	100%
------------	------

Day	Week	Month	Year
Total monthly energy, kWh			
Consumed by home system & appliances		00210.00	
Produced by PV panel		00028.92	
Imported from grid		00181.50	
Sent to grid		00000.00	
Net power usage		00181.50	

Electric bill, \$

Total amount	29.04
Saved amount	4.56
Saved %	14

PV solar system

Type	<input checked="" type="radio"/> fixed <input type="radio"/> tracking	Number of panels	6
Color	<input type="radio"/> light <input checked="" type="radio"/> dark	Panel area, ft ² /m ²	15 / 1.4

Weather

<input type="radio"/> Sunny <input checked="" type="radio"/> Partially cloudy <input type="radio"/> Cloudy
--



Chat

OC: How the heat flow through the wall is calculated?

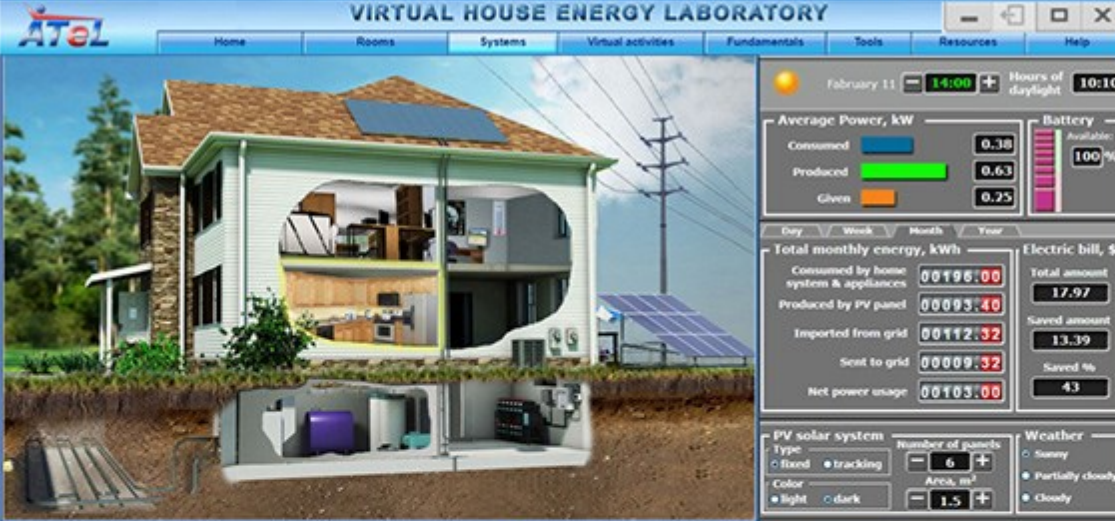
YC: Heat flow through a wall is shown in the bottom right panel. It depends on the temperature difference on its inner and outer surfaces, on thermal conductivity of the materials used, and their thickness.

Type here



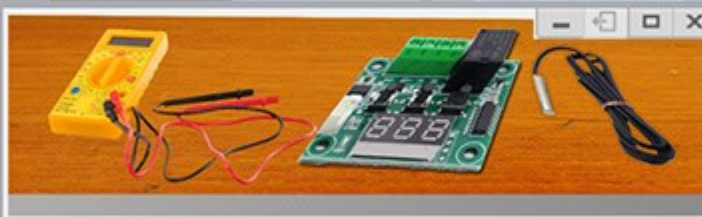
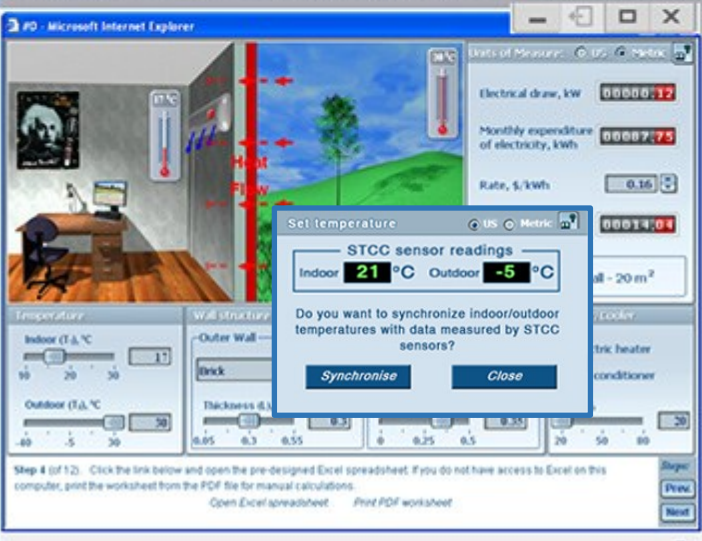
This material is based upon work supported by the National Science Foundation under Grant No. 2126534.

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.



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.



VIRTUAL HOUSE ENERGY LABORATORY

Home Rooms Systems Virtual activities Fundamentals Tools Resources Help

November 7 2:00 Hours of daylight 09:53

Average Power, kW

Consumed	0.02
Produced	0.00
Taken	0.02

Battery

Available: 100%

Total monthly energy, kWh

Consumed by home system & appliances	00210:00
Produced by PV panel	00028:92
Imported from grid	00181:50
Sent to grid	00000:00
Net power usage	00181:50

Electric bill, \$

Total amount	29.04
Saved amount	4.56
Saved %	14

PV solar system

Type: ☐ fixed ☒ tracking

Number of panels: 6

Color: ☐ light ☒ dark

Panel area, ft²/m²: 15 / 1.4

Weather

☐ Sunny ☒ Partially cloudy ☐ Cloudy

Surprise

0 W/m² Total 4737 W/m²

Day: Week: Month: Year

Total monthly energy, kWh

Consumed by home system & appliances	00217:00
Produced by PV panel	00008:88
Imported from grid	00208:88
Sent to grid	00000:00
Net power usage	00208:88

Electric bill, \$

Total amount	33.42
Saved amount	1.30
Saved %	4

Heating/Cooling 45%

Kitchen 32%

Home appliances 4%

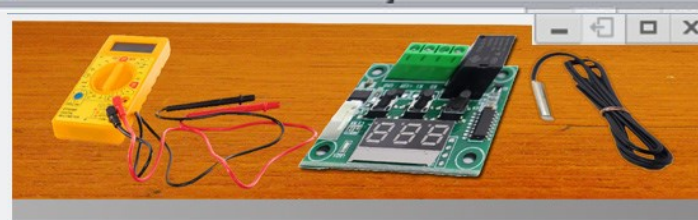
Electronic appliances 4%

Lighting 8%

Miscellaneous 6%

YEC Olivia Gardner Xi Jingli

Chat



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



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.


YEC


Olivia Gardner


Gary Mullett



VV

Chat

OC: How the heat flow through the wall is calculated?

YC: Heat flow through a wall is shown in the bottom 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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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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