

# *Web-based Interactive and Adjustable e-Learning Environment for Energy Education*



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## Virtual Energy Efficient House - Concept





## Target audience

- Two-year and four-year college students and faculty
- Traditional K-12 and vocational/technical school students and teachers
- Home schoolers
- Students who are preparing for specific certification exams
- General public



## Solar Water Heating System

ATel Renewable Energy and Energy Conservation - Mozilla Firefox

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**VIRTUAL HOUSE ENERGY LABORATORY**

Home Rooms **Systems** Fundamentals Virtual activities Tools Resources Help

Time/date  
Location

Solar irradiation

March 10 08:00 Units: Metric US

303 W/m<sup>2</sup> Total 4606 W/m<sup>2</sup>

Sunrise Sunset

Hours

Incident angle  $\theta$  60°

Solar panel direction South

Solar panel angle

Roof angle Best performance Other

Year around Winter Summer 45°

42°

Weather conditions

Sunny Partially cloudy Cloudy

Start Reset

Boston, Mass. 42° 21' N

## Solar PV Electrical System

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Time/date: March 10 06:00 Units: Metric US

Location: Boston, Mass. 42° 21' N

Solar irradiation: 33k W/m<sup>2</sup> Total 465k W/m<sup>2</sup>

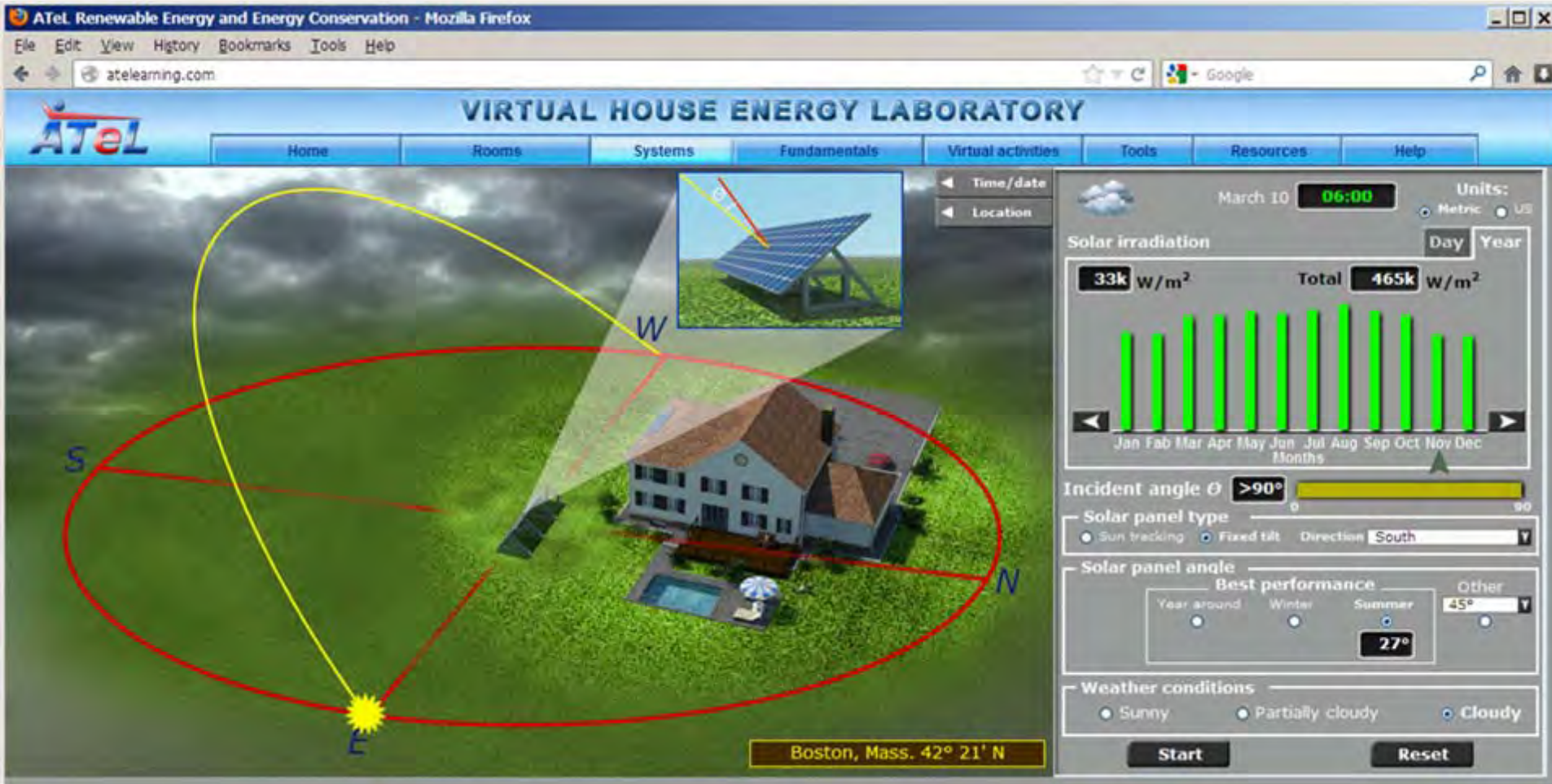
Incident angle  $\theta$ : >90°

Solar panel type: Sun tracking Fixed tilt Direction: South

Solar panel angle: Best performance Other 45°

Weather conditions: Sunny Partially cloudy Cloudy

Start Reset



Fixed solar panels

## Solar PV Electrical System

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Time/date: March 8 08:00  
Location: Boston, Mass. 42° 21' N

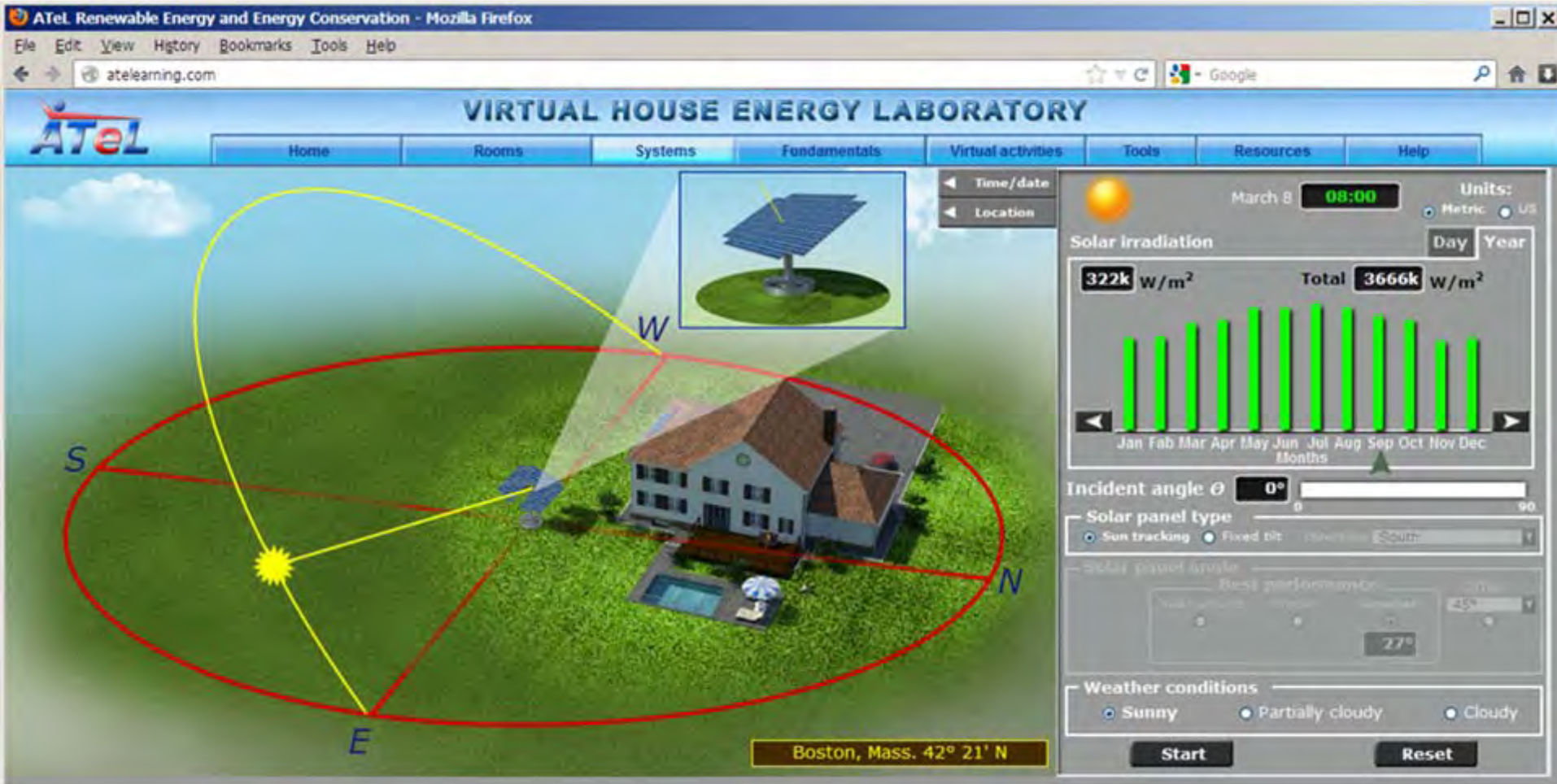
Solar irradiation: 322k W/m<sup>2</sup> Total 3666k W/m<sup>2</sup>

Incident angle  $\theta$ : 0°

Solar panel type:  Sun tracking  Fixed tilt

Weather conditions:  Sunny  Partially cloudy  Cloudy

Start Reset



Sun tracking system

## House Electrical System: Overview

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Overview Diagram Specification



Time/date  
Hourly Power

Performance Setting

March 8 14:00 Hours of daylight 11:18

**Average Power, kW**

Consumed	0.63
Produced	0.92
Given	0.29

**Battery**  
Available: 100%

Day Week Month Year

**Total monthly energy, kWh**

Consumed by home system & appliances	00217.00
Produced by PV panel	00213.06
Imported from grid	00020.03
Sent to grid	00012.60
Net power usage	00007.43

**Electric bill, \$**

Total amount	3.20
Saved amount	31.52
Saved %	91

**PV solar system**

Type  
 fixed  tracking

Number of panels: 6

Color  
 light  dark

Area, m<sup>2</sup>: 4.5

**Weather**

- Sunny
- Partially cloudy
- Cloudy

## House Electrical System: Diagram

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### VIRTUAL HOUSE ENERGY LABORATORY

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Overview Diagram Specification

The diagram illustrates the electrical system components and their connections:

- Power grid**: Connected to the **Meter**.
- Meter**: Connected to the **Breaker panel**.
- Breaker panel**: Connected to **Load** (appliances) and the **SW Inverter**.
- SW Inverter**: Connected to the **Battery bank**.
- Battery bank**: Connected to the **Charge controller**.
- Charge controller**: Connected to the **Tracking PV Solar panel**.

**Hourly Power Consumption Chart**

Time/date: April 8, 20:00, Hours of daylight: 12:46

**Performance**

**Average Power, kW**

Consumed	0.35
Produced	0.00
Taken	0.35

**Battery**

Available: 0 %

**Day** | Week | Month | Year

**Total monthly energy, kWh**

Consumed by home system & appliances	00210:00
Produced by PV panel	00014:80
Imported from grid	00195:20
Sent to grid	00000:00
Net power usage	00195:20

**Electric bill, \$**

Total amount	31.23
Saved amount	2.37
Saved %	7

**PV solar system**

Type:  fixed  tracking

Color:  light  dark

Number of panels: 2

Area, m<sup>2</sup>: 1.5

**Weather**

Sunny  Partially cloudy  Cloudy

**METER**

126

Charge controller

Total daily consumption, kWh: 7



## House Electrical System: Specifications

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### VIRTUAL HOUSE ENERGY LABORATORY

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Overview Diagram Specification

**Devices**

- Electrical service/power line
- Solar panel**
- Mounting system
- SW Inverter
- Battery bank
- Breaker panel
- Charge controller
- Meter box

**Solar panel**

Solar cells capture the sun's energy and change it to electricity. Inside a solar panel, each cell contains silicon, an element found in sand that absorbs sunlight. The energy in this absorbed light produces a small electrical current. Metal grids around the solar cells direct the currents into wires that lead to the power controls. The solar array is comprised of one or more solar PV modules (solar panels) which convert sunlight into clean solar electricity. PV is short for Photo voltaics, which means electricity from light. The solar modules need to be mounted facing the sun and avoiding shade for best results.



A solar panel (also solar module, photovoltaic module or photovoltaic panel) is a packaged, connected assembly of photovoltaic cells. The solar panel can be used as a component of a larger photovoltaic system to generate and

[More resources](#)

**Solar panel**

Time/date  
Hourly Power

**Grape Monocryst PV Panel**

**Solar panel type :**

- Monocrystalline silicon panel
- Amperage (amps) : 7.92 A
- Number of panels : 1
- Voltage (volts) : 12 V
- Wattage (watts) : 100 W

**Dimension and weight :**

- Panel Height (in.) : 64.6 in
- Panel Width (in.) : 39 in
- Panel Length (in.) : 1.57 in
- Panel Weight (lb.) : 44.1 lb

[Explore](#)

**Performance** **Setting**

April 2 17:00 Hours of daylight 12:29

**Average Power, kW**

Consumed 0.90  
Produced 0.57  
Taken 0.13

**Battery**

Available 80%  
Discharging

Day Week Month Year

**Total monthly energy, kWh**

Consumed by home system & appliances 00300.00  
Produced by PV panel 00311.28  
Imported from grid 00040.21  
Sent to grid 00050.56  
Net power usage 00-10.35

**Electric bill, \$**

Total amount 6.43  
Saved amount 41.57  
Saved % 87

**PV solar system**

Type  
 fixed  tracking  
Number of panels 6  
Color  
 light  dark  
Area, m<sup>2</sup> 3

**Weather**

Sunny  
 Partially cloudy  
 Cloudy

## Multilayered Lab: Home Appliances

Specifications, Pertinent Processes, Underlying Fundamental Principles

The screenshot displays the 'VIRTUAL HOUSE ENERGY LABORATORY' interface. At the top, it shows navigation tabs for Home, Design, Monitor, Systems, Subsystems, Information, Risk, Resources, and Help. A central 3D model of a kitchen is shown with a red arrow pointing to a GE JG430 stove. To the left is a navigation menu with categories like Attic, Roof, Main bedroom, Bathroom, Home office, Kids room, Kitchen (highlighted), Laundry room, Dining room, Family room, Living room, Basement, Outside house, and Back yard. The Kitchen section lists various appliances: Stove Cooktop, Dish, Cooking hood, Refrigerator, Freezer, Disposal, Dishwasher, Microwave, and Trash compactor. The Stove section provides detailed specifications for the GE JG430, including features like Power Type (Electric), Control (Electronic), and various outputs. To the right, a 'Lesson' window displays a graph of Temperature (°C) vs. Heat absorbed (J) showing a phase change plateau at 100°C. Below this, text explains that during the phase change, heat energy is used to overcome intermolecular forces rather than to raise the temperature. Other windows show energy usage statistics (Average Power: 0.4500 kW, Total monthly energy: 0.9390 kWh), a 'Lesson' window with a diagram of a water cycle, and a 'Water is boiling' window with a graph of Temperature (°C) vs. Time (s) showing a plateau at 100°C. A 'Relative process rate' window shows a bar chart comparing 'Intensifying' (0.768) and 'Exhaustive' (0.421) processes. A 'Thinking About It' window shows a graph of relative vapor pressure (p/p<sub>0</sub>) vs. Temperature (°C) with a legend for different states of water.



**Electrical system**

- PV solar power
- Wind turbine
- Smart Grid

**Heating, cooling and ventilation**

- Solar water heating
- Geothermal

**Walls and Insulations**

- Cavity walls
- Loft insulation
- Double Glazing

**Lighting**

- LED

**Home appliances**

- Energy Star products

**Recycling**

- Compost heap
- Water conservation



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