
Developing VR-Based Solar Cell Lab Module in Green Manufacturing Education

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What is Green Energy Manufacturing



Renewable Energy



It's about choices in manufacturing methods that support and sustain a renewable way of producing products and/or services that do no harm to you or the environment - maximizing energy and material recovery while minimizing environmental impact.

In other ways...To prevent pollution and save energy through the discovery and development of new knowledge that reduces and/or eliminates the use or generation of energy technology in the design, manufacture, and processes.

Objectives

- To develop virtual reality (VR) solar cell laboratory effectively used for engineering education within the engineering field.
- To create a VR simulation of how solar cell laboratory can be used for applications in environment and manufacturing.
- To learn to design 3D models in SOLIDWORKS and Unity3D and to simulate the virtual reality flow in VR renewable energy systems.
- To get a better understanding of solar cell laboratory through virtual reality.



Renewable Energy in Virtual Reality (VR)

SET UP ENVIRONMENT IN UNITY 3D

- When opening a new program, the blank scene will show up, ready for development (Fig 1.)
- A plane needs to be defined as everything will be built upon this plane
- Position the center of the plan at the origin of the entire model ($x = 0; y = 0; z = 0$)
- Moving around the plane can be done with controller. However, motion sickness tends to be side effect for someone new to virtual reality
- The solution is to use teleporting to allow instant change of location within the plane (Fig 2.)

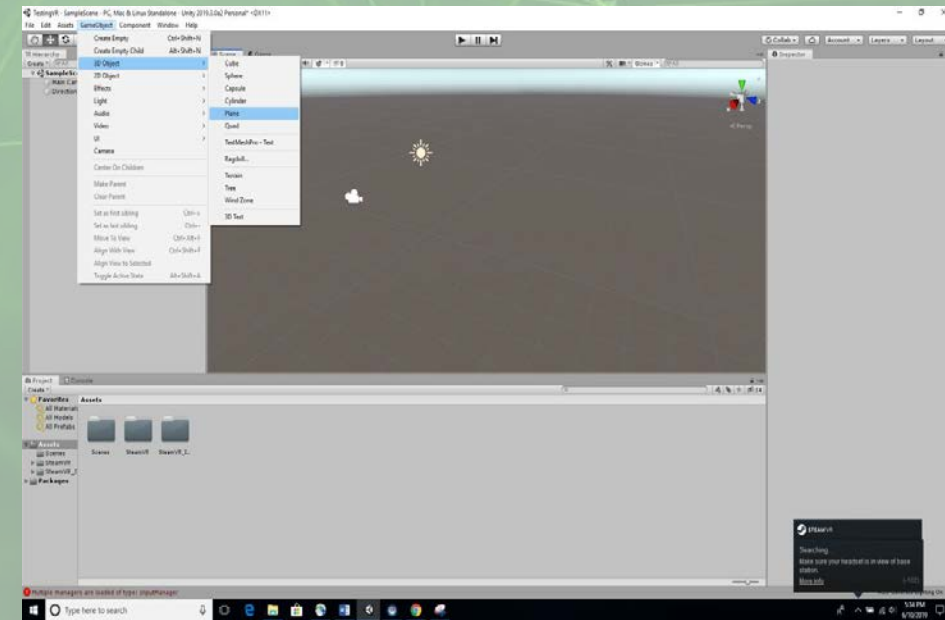


Figure 1: Blank scene

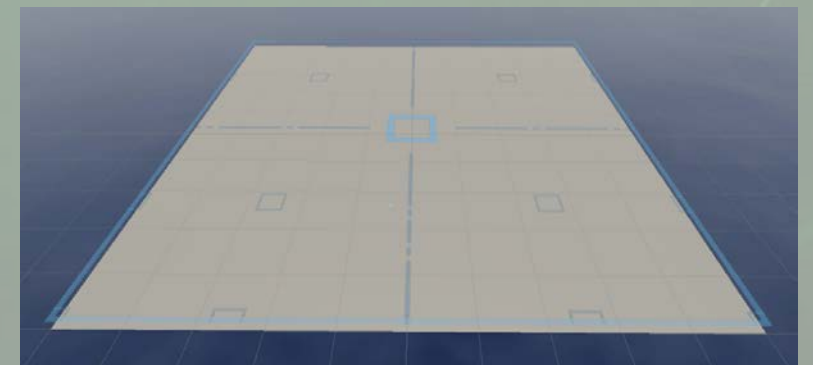


Figure 2: Base plane and teleporting area

SET UP ENVIRONMENT IN UNITY 3D

- In the simplest set up for the solar lab, objects were imported from Unity 3D prefab
- Table, lever, and rectangular plane to imitate solar panel
- A sphere was used to imitate the sun and heat source. It is set to float above the module

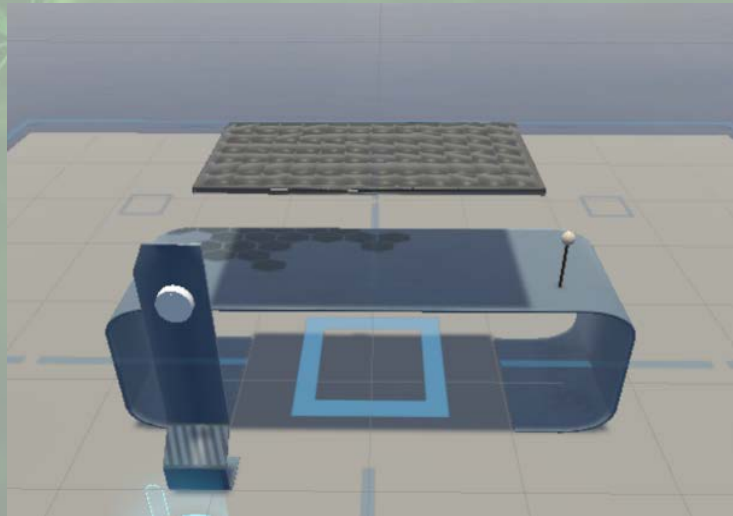


Figure 3: Components

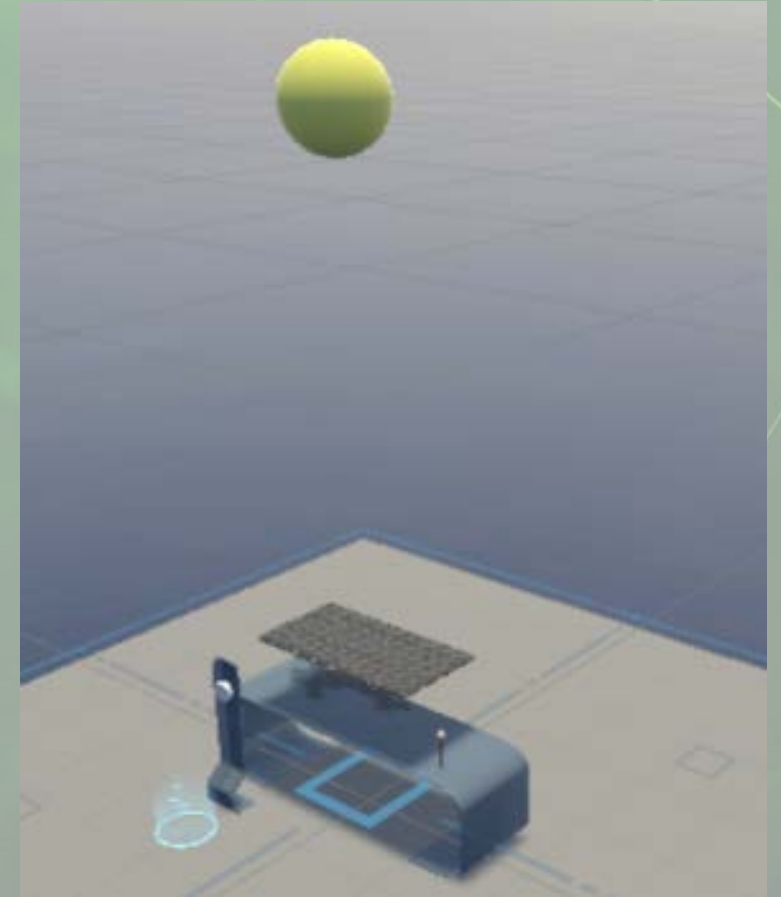
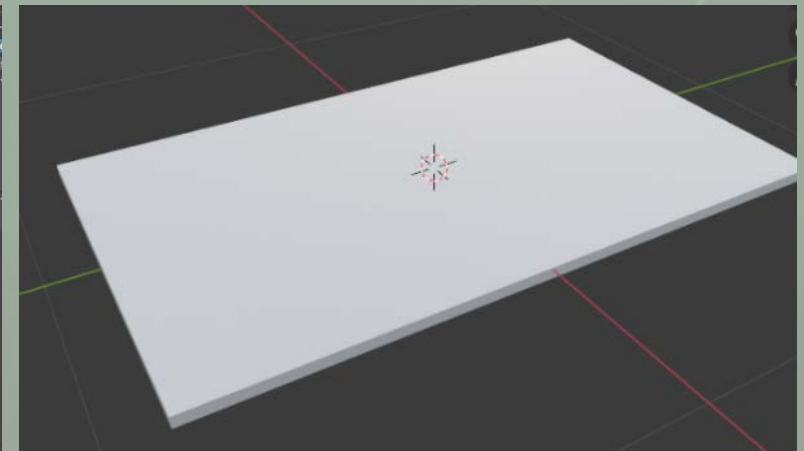
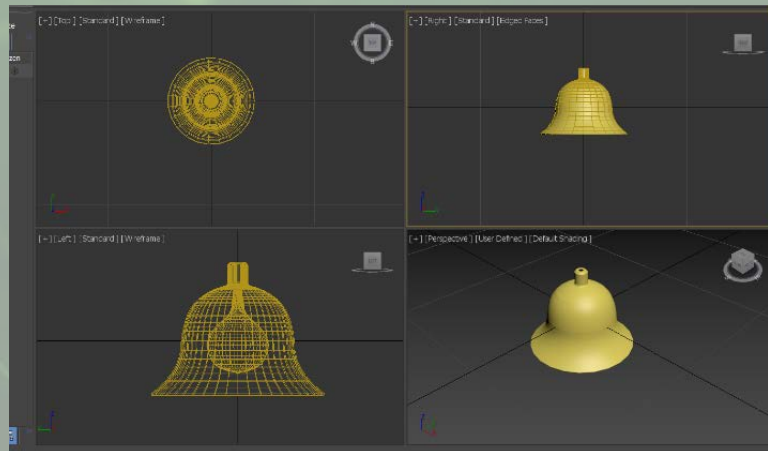
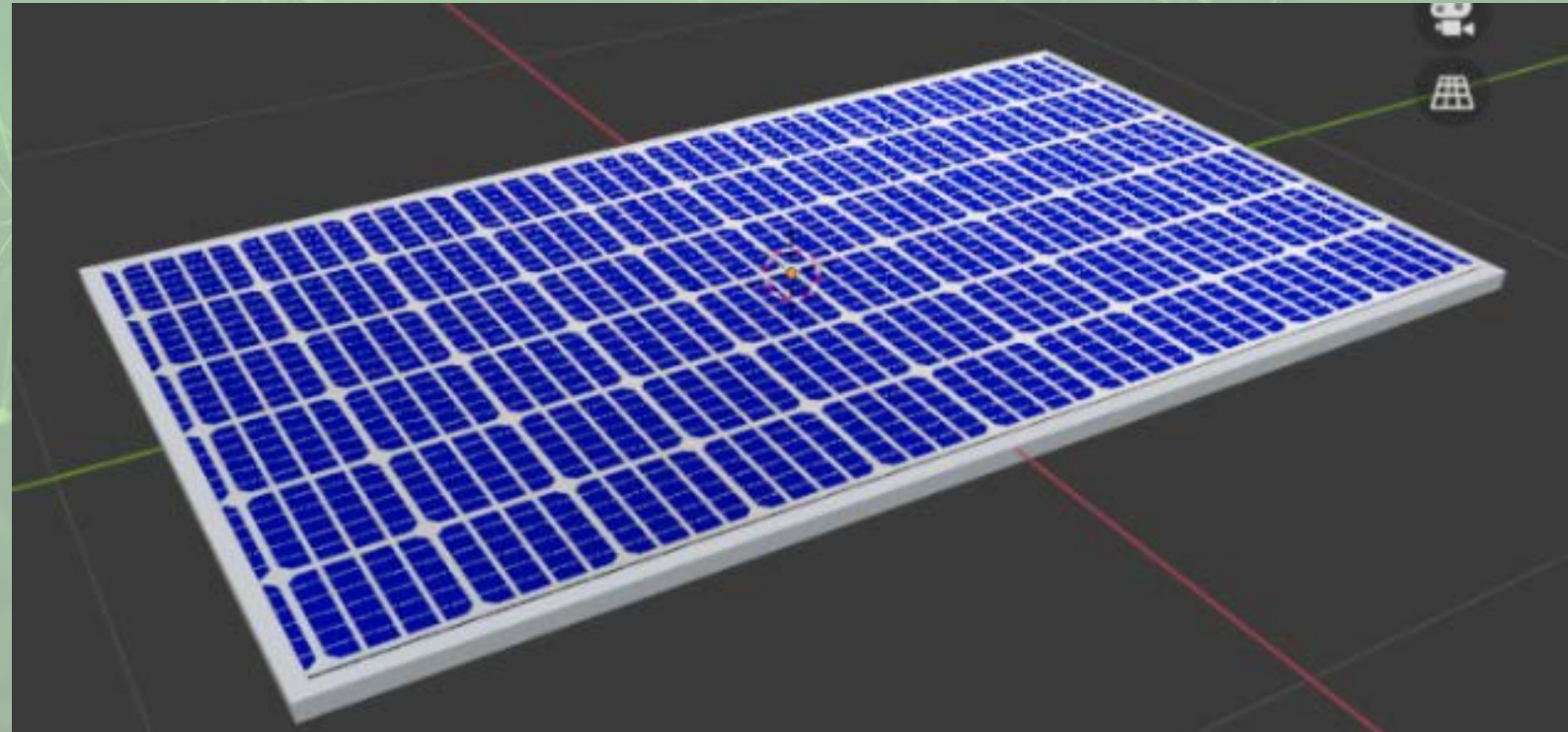


Figure 4: Sun floating above module

3D OBJECT DEVELOPMENT IN BLENDER

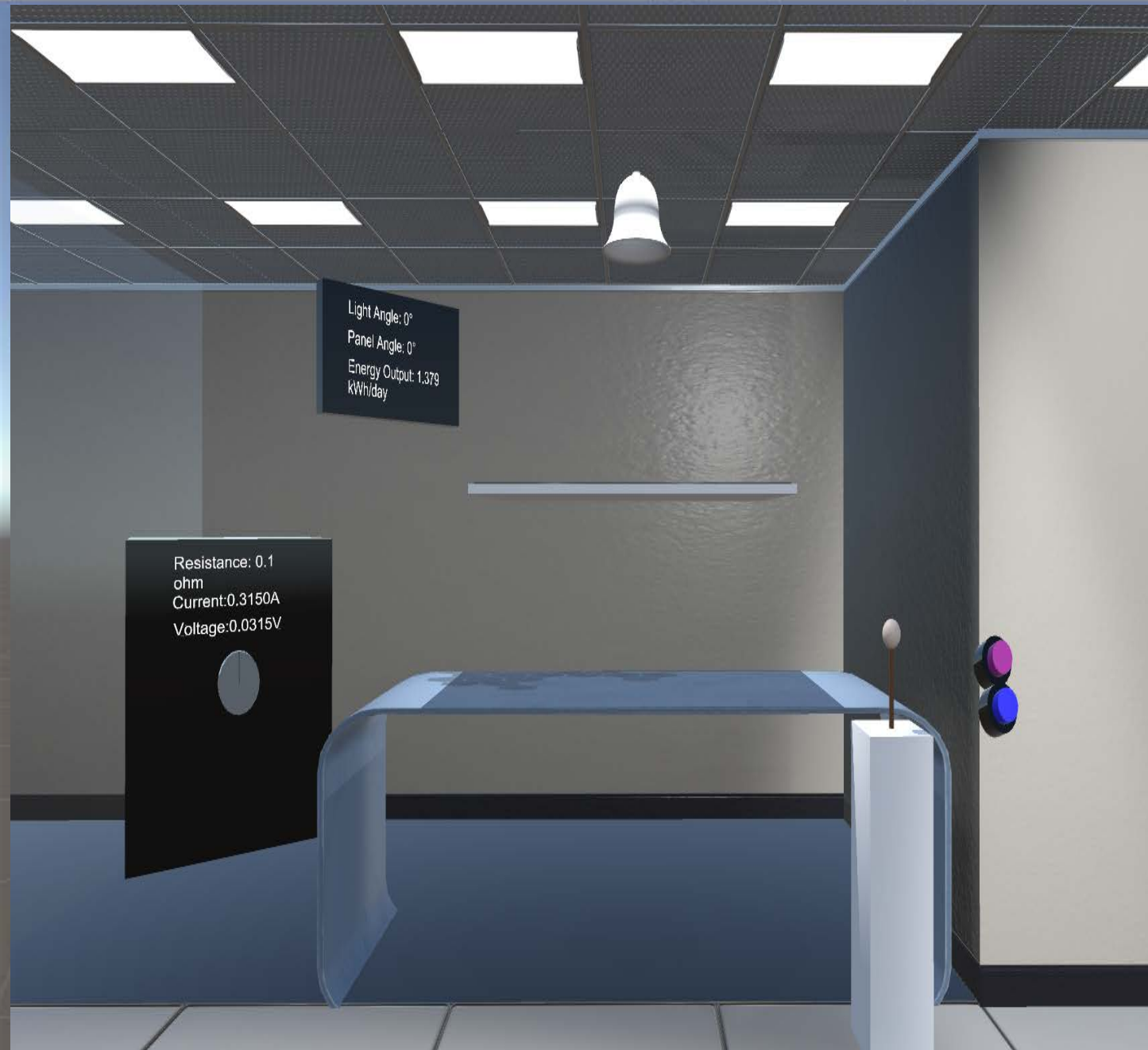
- Many common objects (table, lever, chair, etc) can be imported directly from Unity 3D prefab
- To achieve a more realistic look for the lab, custom objects were built and imported to Unity via Blender
- The heat lamp and solar panel were built in Blender



Rendered Panel with Solar Cell Pattern

SOLAR CELL MODEL UNITY3D (IMPORTED IN UNITY3D)

- Each part is converted into .obj file with the help of blender or Autodesk 3ds max software to define pivot points and assembly is imported into unity3D as an asset.
- Hierarchy is set up for each part in unity3D so that parent-child relationship for each part is maintained.

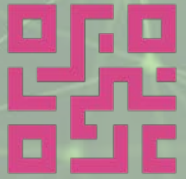


SOLAR LAB MODULES PLACED IN THE VR RENEWABLE ENERGY LAB

- The panel and heat lamps were imported from Blender into Unity 3D
- The module consists of:
 - A solar panel and a table
 - A lever to change the panel angle
 - Knob to change resistance
 - Display boards to show simulation results



VIRTUAL VIEW OF VR SOLAR LAB



Virtual View of the
lab in Unity



Instruction on how
to use the program

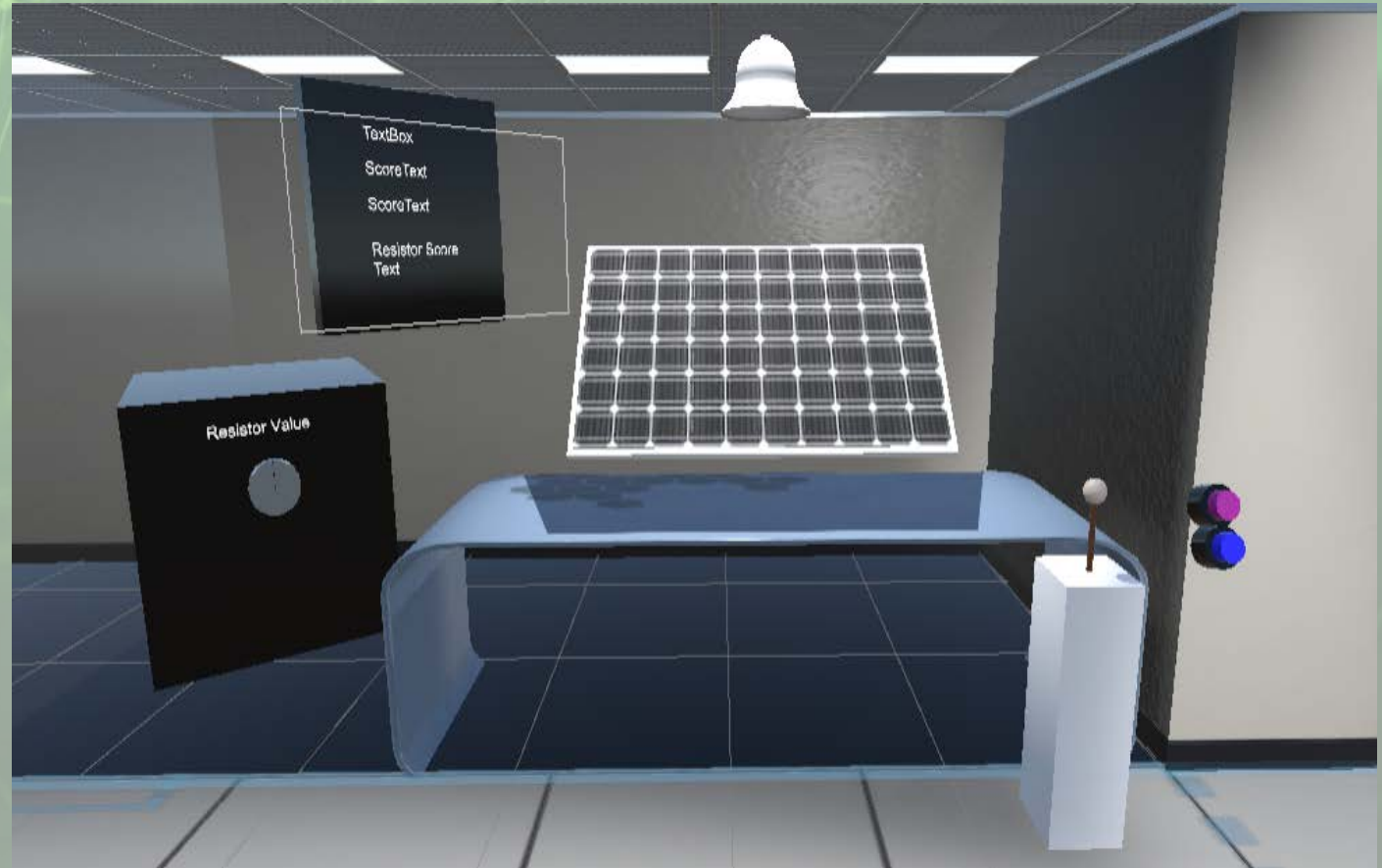


When student first open the program, this is the view they will see

UNITY 3D - ANIMATOR

Solar Lab Modules Placed in the VR Energy Lab

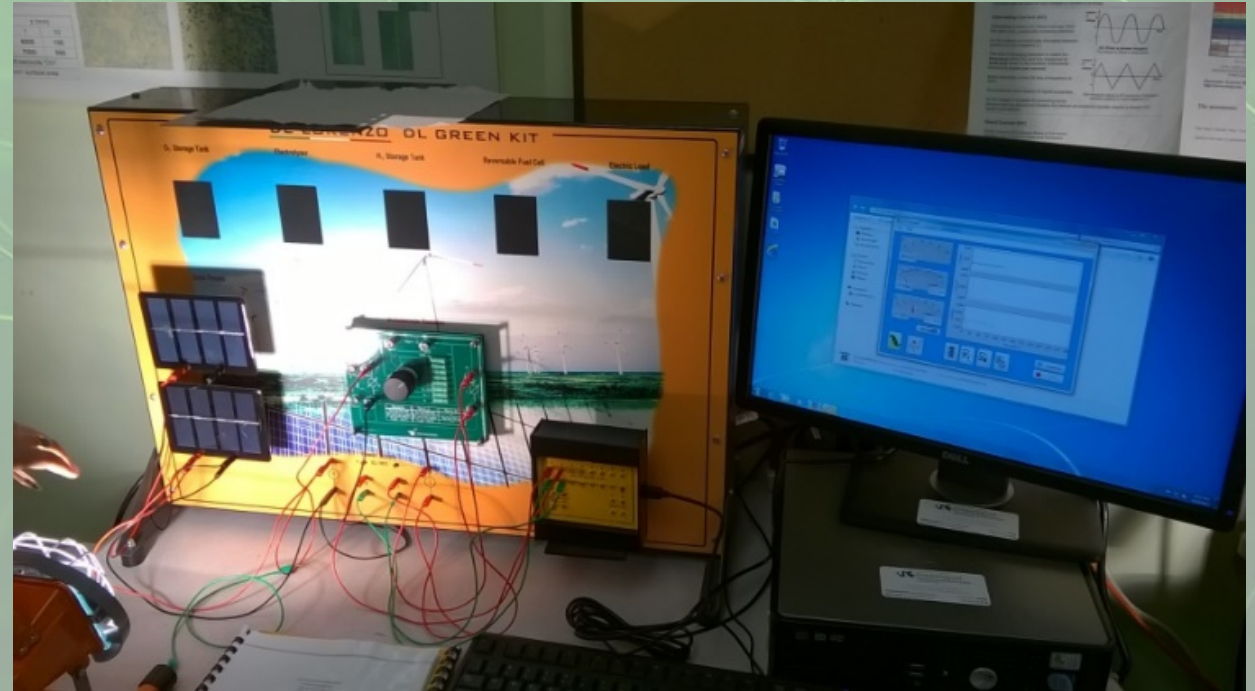
- Animator is used to simulate robot in unity 3D.
- We set different conditions generating multiple ways of solar panel simulations and select one out of many simulations.
- Different positions are added at different frame lengths as seen in 'Animation' window.
- Unity 3D has property of physics - hinge joint is at every joint for each arm so that we can define limit for angles for arm movement.



TOPICS COVERED: PHOTO-VOLTAIC CELLS

Solar Experiments

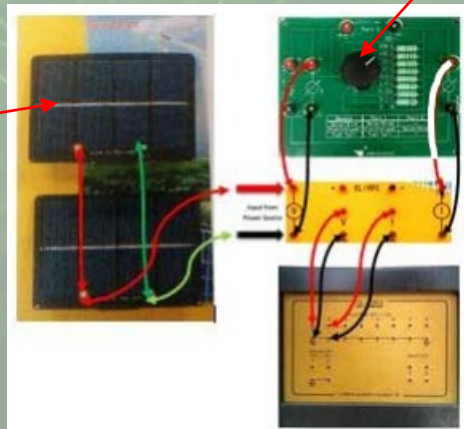
- Power vs Panel Angle
- Current vs Voltage Characteristics
- Power vs Voltage Characteristics
- Effect of Temperature on Solar Panels
- Demo of DL Lorenzo Green Kit



TILT ANGLE MODULE

In Real Life

Panel to tilt

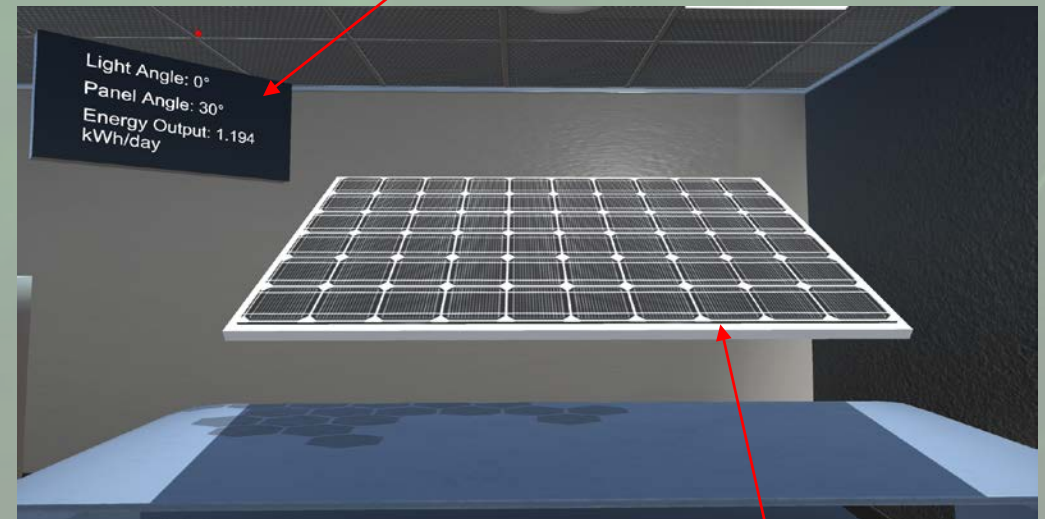


Resistor set at
33 Ohm

Figure 2.1. Experiment setup (solar panels connected in parallel)

In Virtual Reality

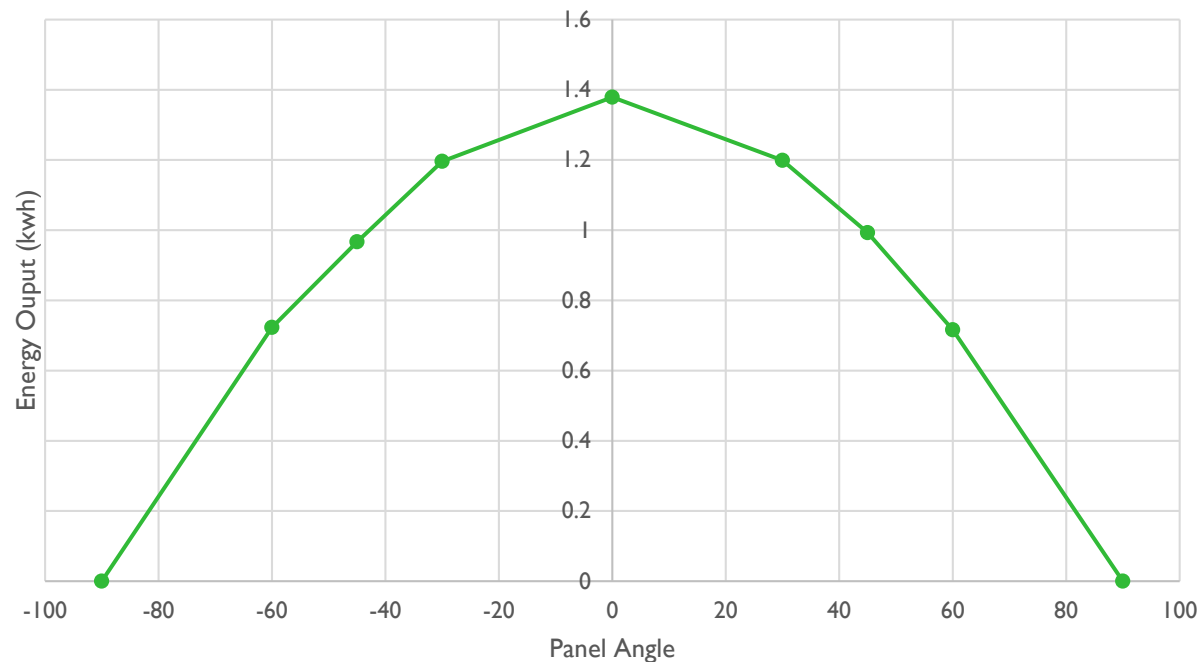
Results
displayed



Panel to tilt

IMPLEMENTATION OF ANGLE MODULE

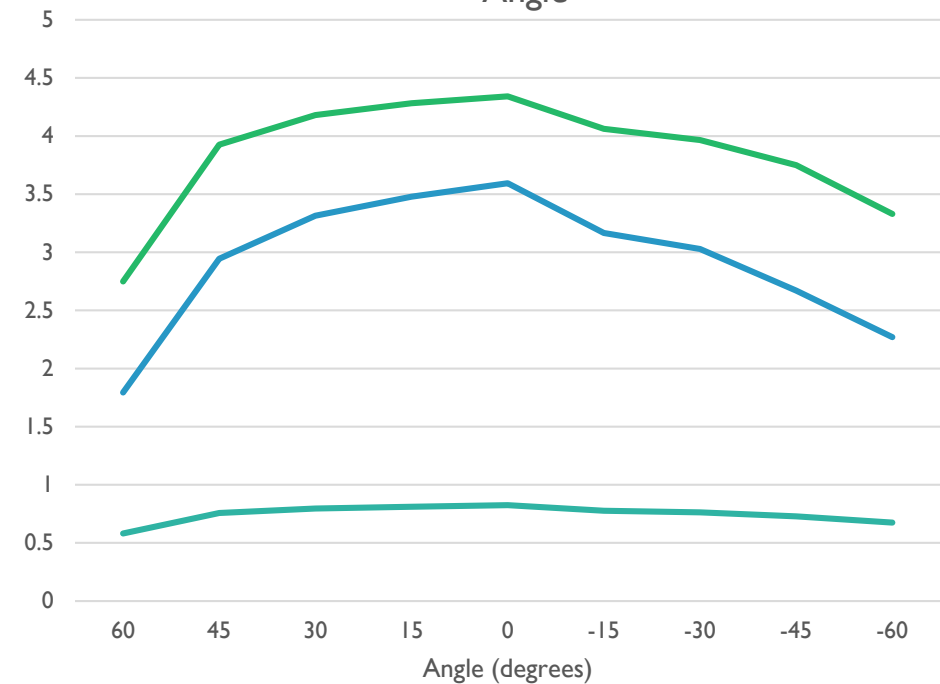
■ Unity 3D Simulation result



Energy output (kwh) vs Panel Angle (degree)

Experimental result

Power, Voltage and Current as a Funtion of The Angle



— Voltage (V) (Volts) — Current (I) (Amps) — Power (P) = V*I (Watts)

Measured values while the angle of the light sources is changed

ACKNOWLEDGEMENTS



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