

## **Final Report for the SUNYIT IITG Project**

### **"Integration of Virtual and Real Equipment Related to Sustainability Education"**

#### **Virtual Exercises Created & Updated**

##### **1. [Green Home Builder Game](#) / Informal Learning Tool for Secondary School Students and Public Outreach**

A Student Research Assistant, Thaddeus Randazzo, programmed a game that engages the user with the benefits & costs of home renewable energy options.

- 5 to 10 minute game experience
- initial budget to install equipment is monthly electric bill \* 60 months
- make decisions about which renewable energy modules (solar panels & small wind turbines) and how many units to install on a single family residential home
- animated installation of equipment
- animated functioning of electrons flowing from grid power lines to household appliances (TV, lights, fan, etc.)
- animated functioning of solar panel creating electrons that flow into the household appliances and to the grid via power lines
- animated functioning of small wind turbine rotating and creating similar electron flow to appliances and grid
- animated sun rays and clouds/wind
- implemented in HTML 5 using construct 2. Use variables so that values can be imported from an outside source in the future.
- identify monthly savings on electricity bill
- evaluate return on investment by calculating simple payback of equipment
- identify environmental benefits of renewable energy (ie. reduced CO2 emissions)

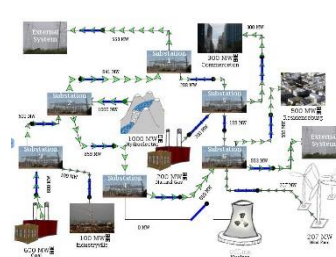
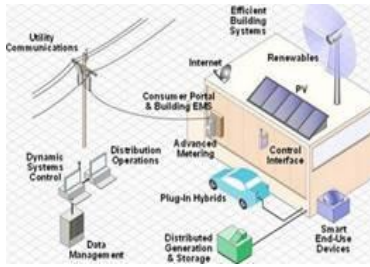
To evaluate the effectiveness of the game, we utilized 50 students from Stacey Smith's 8<sup>th</sup> grade class at Holland Patent Middle School to make suggestions for improvements. They made several valuable suggestions which were incorporated into later versions of the game, including:

- add a tutorial of game function and controls at the beginning
- add decorations and animations to the home to make it more real
- include a timer for build time countdown
- make winning flashier and more recognizable

##### **2. Development of University-Level Virtual Exercises**

Several virtual exercises were developed for both in class and informal educational purposes. They include exercises around the theme of planning and building a smart grid, the management of the smart grid and the positive impacts of renewable energy on the environment.

There were two virtual exercises that were developed around the theme of smart grid management. One is based upon the day ahead load and power generation planning and the other is based upon the impact of the weather and environment of real time grid management.



a. Additions made to initial IITG virtual exercise.

- 1) Real-time grid management component. This exercise allow the user to make simulated hour to hour and even minute to minute simulated electrical grid management decisions in much the same way that grid operators do during actual grid management. Challenges can be tailored for various what if scenarios that include all of the renewable energy types. An example of a challenges user would be given would be how to manage the grid when there are losses of renewable energy generation do to the weather conditions. User has the ability to explore such factors in “what-if” type scenarios such as the cost –benefit of adding storage to the grid in terms of more fully utilizing renewable energy. (Note – components of this exercise are from open source components external to this project.)
- 2) Day ahead planning –allows user to make realistic power purchasing decisions. In these sets of exercise the user is given the ability to play the role of load and power purchasing planners under very realistic situations using real historical data as input in to the decision making process. This virtual exercises allow the user to make power purchasing decisions and see the cost or benefit of their decision to include the impact of weather on that decision. For example not enough power is purchased a day ahead because of a drop off in the winds, the result is the need to purchase power at very expensive cost on the “spot” market. This illustrates the necessity of very accurate wind and cloud forecast to effectively use renewable energy.
- 3) Add ability to use teaching tool for all four seasons. The initial tool provided data and interfaces only for the summer season. Data and interfaces to support exercises for all fours season plus a training session, were added to the current version.

b. Addition of new exercises. (Some new exercises utilize open source virtual exercise components developed outside of this project).

- 1) Load energy demand planning exercises. This exercise tool allows the user to virtually estimate the load requirements of an existing community or for new community. It allows the user to play what if scenarios on the cost – benefits of using efficient technologies in the construction or retrofitting of existing buildings.
- 2) Customize building exercises. This exercise allows users to look at specific cost-benefits of building energy efficient homes and using energy efficient appliances
- 3) Wind Power planning. This exercise allow a user to virtually go through the siting and planning process to include costs and carbon savings analysis for the entire life cycle of a wind farm.
- 4) Solar power planning exercise. This exercise allow a user to virtually go the siting and planning process to include costs and carbon savings analysis for the entire life cycle of the commercial or home solar power generator.
- 5) Energy foot print. This exercise allows the user to perform an analysis of a person’s energy use and carbon cost as well as compare against the use of the averages of other people in the US and other cultures.

- 6) Embedded links to green building exercise that was developed as part of the project on to the SUYIT project web site.

### 3. In Class Virtual Exercise Testing

In class testing of the exercises was done in three class rooms.

The purpose of the three classes and the connection to the project was three fold.

- (1) A way to test the virtual exercises and get feedback before their use in the project classes.
- (2) Provide an opportunity to specifically train instructors in how to use the exercises.
- (3) Provide value of the project to a broad range of State of New York University students

Class 1: SUNYIT ESC 120 Design Process and Tools engineering class

Professor: Dr. Steven Wei

Monday March 29, 2014 12:00 to 1:55

The prototype of the grid management exercise was first tested at SUNYIT in Dr. Steven Wei's ESC 120 Design Process and Tools engineering class (15 students). Dr. Van Knowe worked with Dr. Wie and his students on the virtual exercises to get essential feedback so modifications can be made before further testing in the college classroom.

Class 2: UAlbany ATM 413 Weather, Climate, and Societal Impacts

Professor: Dr. Brian Tang

Monday April 7, 2014 11:30 to 12:25

The day ahead grid planning exercise was tested in this classroom by 16 seniors, 75% were atmospheric science (meteorology) majors, and the remainder were environmental science students. The students performed the sequence of virtual exercises that involved both load and generation planning from the perspective of how meteorologists and weather forecasts are needed to support grid management operations and from the perspective of the grid managers who utilize this information. Pre- and post-evaluation questions along with an exercise worksheet were accomplished in order to evaluate the effectiveness of the exercises and to determine if any modifications are needed.

The evaluation of the pre, post survey and worksheet indicated that approximately 75% percent of the class grasped the main message that renewable energy is much harder to manage in terms of weather variability than conventional power generation. There were a few who didn't quite understand how temperature affected demand and there were also a few who didn't understand how various weather elements contribute to specific challenges in forecasting supply (i.e. precipitation was tied to hydro power, cloud cover was tied to solar power, etc), but in general, all got an appreciation for how forecast errors and uncertainty have real-world implications on electricity generation and decision making.

From the feedback there were areas of improvements identified that need to be made to the web interface before using the exercises in other classrooms and the SUNYIT summer teens camp. Instead of lists of numbers, adding selected graphs would be a better gauge of relative differences

between forecast load and generation. Some students didn't quite know which numbers to focus on to assess their bottom line energy 'call up' decision. That will be corrected.

Class 3: UAlbany ENV 250 / GEO 250 Sustainable Development: Energy and Resources  
Professor: Dr. Robert Keesee  
Monday April 7 2014 12:35 to 1:30

The day ahead grid planning exercise was tested in this classroom by 40 sophomores and junior from various science and non-science majors. These students performed the sequence of virtual exercises with perspective of both the impact the environment has on load and power generation and the impact that conventional energy and renewable energy has on the environment and electrical grid management.

Pre- and post-evaluation "clicker" questions along with an exercise worksheet were accomplished in order to evaluate the effectiveness of the exercises with a relatively large class size. The feedback from the students was overwhelmingly positive both from an objective and subjective perspective. Objectively the students could answer more questions correctly about the management of the electrical grid, the impact of the environment on the grid and the grid's impact on the environment. Subjectively, the students gave many positive statements in the fact that using such an exercise helped them keep engaged in the class and take away more information from the class.

#### **Support from MESO, Inc.**

- Developed the project website (<https://drupal2.cs.sunyit.edu/sustainability/>) hosted at SUNYIT.
- Provided funding and resources to create a project video on the project website home page.
- Provided management over site to Lucas Halbert, student programmer for the project.

#### **Renewable Energy Equipment & Outreach Displays**

##### **1. Upgraded system controller for SUNYIT solar trailer**

- installed [Mate 3](#) & Mate 3 USB card capable of connecting to a laptop computer to monitor and display performance of system

##### **2. 24" Display monitor, laptop computer, wifi antenna range extender for SUNYIT solar trailer**

- to enhance educational display of solar trailer performance data
- ability to connect solar trailer to internet-based project website via wifi network using laptop

##### **3. 12V Air Breeze Marine small wind turbine for SUNYIT solar trailer**

- roof-mounted to SUNYIT solar trailer
- electrically integrated to charge batteries

##### **4. Internet-connected SUNYIT Sustainability Path solar PV and small wind installation**

- Digi [connectport x2 gateway xtend to ethernet](#) and [rf modem 9xtend](#)
- pull performance data from [PROwatt SW 2000 Xantrex](#) inverter to be shown on real-time renewable energy dashboard
- transmits via rf 900mhz, uses 1 watt, capable of 14 miles with 2.1 dipole antenna

## **5. Axeos Exia and Xoos floor stands for Galaxy Tab 10.1s**

- to be installed in Student Center and Wildcat Field House at SUNYIT campus
- wifi-connected to internet in order to display project website to students, staff, faculty, and visitors to campus

## **Utilization of Renewable Energy Equipment at SummerITeens Renewable Energy Camp, August 11-14, 2014.**

Nat Grid scholarships made available. Description below:

Renewable Energy Camp

Faculty:

Dr. Glenn Van Knowe

Dr. Xinchao Wei

Mr. Mark Bremer

Target Student Population: Ages 13 and up - some Algebra required

Camp will run for 4-5 days from 9am - 3pm daily during one of the first two weeks of August 2014, on the SUNYIT campus.

Camp Topics:

Solar Energy - solar car races; solar roof; sustainability pathway demo

Wind Energy - sustainability pathway demo; KidWind Challenge - turbine design; field trip to Fairfield site

Hydro Energy - hydro powered turbine workshop; research project on hydro applications world-wide

Power Grid - traditional and Smart Grid; Grid Management workshop

Career Exploration - NYS energy careers

College prep - Admissions presentation; college course options

Tuition for 24 or 30 hour camps: \$200 for 24 hour; \$250 for 30 hour experience

Camp will include at least one and preferably two Ropes Course Leadership Training experiences on SUNYIT campus

Students will receive a SummerITeens bag and tee shirt, as well as all needed materials for camp projects (i.e. solar car kits and KidWind turbine challenge kits)

(SUNYIT will offer early bird discounts of 175/200)

Scholarships available, based on qualification for free/reduced school lunch. Centro bus passes also available for scholarship students.