EULiST Blended Intensive Program

Course Project

for an " Eco-Friendly Sustainable Campus"

Within the framework of the **Alliance EULiST "European Universities Linking Society and Technology"**, the National Technical University of Athens (NTUA), organizes in cooperation with Lappeenranta-Lahti University of Technology (LUT), Jönköping University (JU), Leibniz University Hannover (LUH), Institut Mines-Télécom (IMT), Slovak University of Technology in Bratislava (STU), University L'Aquila (UnivAQ), a **Blended Intensive Program** (BIP) with the title **"Monitoring clean energy in the EULiST campuses"**.

Within Action 2 of the BIP Onsite Workshops | Athens NTUA, June 19- June 26th 2023

Onsite visits and presentation of challenges are planned in three NTUA campuses [Historic Patission campus in the centre of Athens – Lavrion Technological and Cultural Park – main Zografou campus] on renewable energy sources, combination with hydrogen, solar engineering, eco racing, biofuels, monitoring of energy uses, and the NTUA virtual campus. It also includes **challenge selection, assignment, and initial preparation on group projects**. The first outcomes of the onsite workshop will be presented on Monday June 26th, within the EULiST General Assembly and Open Session "EULiST towards linking Society and Technology" in NTUA, Athens. Social and cultural events are also scheduled in Athens.

Project Launch

Introduction

Building and operating an eco-friendly sustainable campus is not merely an idealistic endeavour but a necessity in the face of environmental crises. By adopting sustainable practices, investing in green infrastructure, promoting environmental education, and engaging the campus community, we can create a thriving environment that nurtures both academic excellence and environmental stewardship. An eco-friendly sustainable campus paves the way for a greener future and empowers individuals to make positive changes that extend beyond the campus boundaries, ultimately contributing to a sustainable planet for generations to come. Moreover, universities are acting as educational and research hubs that form the environmental consciousness of the next generation and should lead in a broader social behavioural transformation and ecological consensus.

Learning outcomes

- a combination of theoretical knowledge with the combination of practical and simulations
- Interdisciplinary approach, from technique to society approach
- Towards positive energy buildings by means of cost effective measures in a) building envelope, b) Utilization of Renewable Energy sources c) HVAC and Automation systems

A holistic approach

Ready to participate in positive energy building competitions.

The 2023 "Project for an Eco-Friendly Sustainable Campus" focuses on a new Prototype building model designed and constructed in the School of Mechanical Engineering of NTUA Zografou Campus with the following criteria:

A) nZEB and ZEB (Nearly Zero Energy Building)
B) Possibility of alternating masonry and glazing
C) Easy switching of thermal and electrical energy production systems.
D) Monitoring and controlling of building's passive and active operational systems.

In view of understanding the sustainability possible measures for energy efficiency in campus buildings, the EnergyPlus software will be applied for the simulation of the Prototype Buildings'energy performance. EnergyPlus software is a powerful tool for analyzing energy performance and evaluating energy efficiency measures in buildings.

Here are some energy efficiency measures that can be implemented using EnergyPlus during the Project:

- Building Envelope Improvements:
  The impact of building envelope upgrades on energy consumption will be examined. By modeling insulation levels, windows, and shading devices, the student can assess the effectiveness of different envelope strategies. Enhancements may include adding insulation, installing high-performance windows, and implementing shading systems to reduce heat transfer and improve thermal comfort.

- HVAC System Optimization:
  Detailed modeling and analysis of heating, ventilation, and air conditioning (HVAC) systems will be applied to the prototype. By optimizing HVAC schedules, airflow, and temperature setpoints, energy consumption can be minimized while maintaining occupant comfort. Integration of advanced controls, such as demand-controlled ventilation and variable air volume (VAV) systems, can further improve energy efficiency.

- Lighting Upgrades:
  EnergyPlus can simulate various lighting systems, allowing for the comparison of energy consumption and daylighting strategies. Upgrading to energy-efficient lighting fixtures, such as LED bulbs, and implementing lighting controls like occupancy sensors and daylight harvesting can significantly reduce electricity usage.

- Renewable Energy Integration:
  The simulation of renewable energy systems like solar photovoltaics (PV) and wind turbines will be facilitated. By modelling the renewable energy generation and its integration with the building's electrical system, the model can estimate the energy production and evaluate the economic and environmental benefits of renewable energy installations.

- Occupancy and Demand Control:
  Occupancy schedules, occupancy sensors, and demand response strategies could be also modelled. By adjusting HVAC and lighting systems based on actual occupancy levels, energy waste can be minimized.

Project presentation:

In this project, you will learn how to use a BEM software like EnergyPlus to analyze and optimize the energy design of a prototype building. EnergyPlus is a powerful simulation tool developed by the U.S. Department of Energy that allows you to assess the energy performance of buildings and make informed decisions to improve their energy efficiency.

In order to organize the group of EUList BIP students to collaborate on the essay " Eco-Friendly Sustainable Campus", the team will be divided into four groups. Each group should follow the following steps:

STEP 1: Software Setup

1. Download and install Openstudio software on your computer.
   https://openstudiocoalition.org/getting_started/getting_started/

You can find the software and documentation on the official EnergyPlus website.
https://energyplus.net/

2. Familiarize yourself with the /Openstudio interface and the basic concepts of building energy simulation.

Energy plus: https://www.youtube.com/watch?v=e-4xIRUmQVg&list=PL83CB71B24D2650E9&ab_channel=GARDAnalytics

Openstudio:

https://www.youtube.com/watch?v=w-yVgOvcQaA&list=PLRW2KXkdSVUdY2iQ6yjohNT5E5ElLVIhU&ab_channel=HelixEnergyPartnersLLC

STEP 2: Prototype Building Setup - Simulation run

a. Open the given model in openstudio.

b. Specify the weather data for the location where the PB is situated. You can obtain weather data from enrgyplus site (https://energyplus.net/weather) or reputable sources such as https://climate.onebuilding.org/. Both Annual weather data and design days should be entered.

c. Determine the construction materials, insulation levels, and glazing characteristics for different building elements (walls, roof, windows, doors, etc.)

d. Configure the simulation settings, such as the simulation period, time step, and output variables.

e. Input the occupancy schedule, lighting loads, and other internal gains

f. Run the simulation with Ideal loads.

g. Review the simulation results

i. Define the HVAC (Heating, Ventilation, and Air Conditioning) system parameters, including equipment types, efficiency ratings, and control strategies

j. re-run the model with the HVAC system

k. Review the energy consumption per fuel

l. Monitor internal conditions (Temperature, Humidity) and possible unmet load hours Input

STEP 3: Energy Optimization:

a. Implement energy-saving strategies to improve the PB's energy efficiency. Consider options (for example increased insulation, efficient HVAC equipment, Heat Pumps with VAV, Control strategies for the HVAC system (e.g. outdoor air reset, Demand control ventilation, economizer), Daylight control with sensors, BIPVs etc.)

b. Modify the relevant parameters in the Openstudio model based on your chosen strategies.

c. Explore involved costs with each scenario for a 25 year life cycle

d. Rerun the simulation to evaluate the impact of the energy-saving strategies on the PB's energy performance. d. Compare and analyze the simulation results before and after implementing the energy-saving strategies.

STEP 4: Documentation and Analysis:

 a. Document the key findings and observations from the simulation results. (Compare with measured)

 b. Analyze the energy consumption patterns and identify areas for further improvement.

c. Summarize the effectiveness of the energy-saving strategies implemented and their impact on the PB's energy performance.

d. Investigate the cost optimal scenario (cost vs energy savings and return of investment)

Through this project, you have gained hands-on experience in using the Openstudio and EnergyPlus software to analyze and optimize the energy design of a Prototype Building. Energy simulation tools like EnergyPlus are essential for architects, mechanical engineers, and building designers to make informed decisions regarding energy-efficient building design. By employing these tools, we can strive towards creating sustainable and energy-efficient campus buildings.