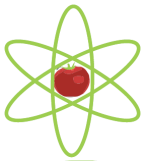


AtomIc PROduce 342



Utilizing Waste Heat for Greenhouses



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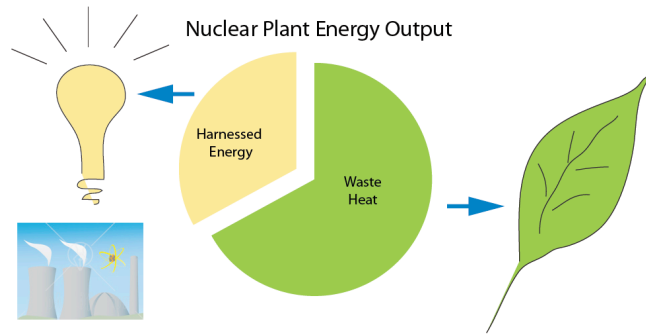
Acknowledgment:

IPRO 342 would like to thank Exelon Nuclear, specifically their Braidwood Generating Plant Staff for collaborating on this project and sponsoring this IPRO group. A special thanks is extended to Victor Gloria for being the main source of coordination between the teams. IPRO 342 would also like to thank our faculty advisor Blake Davis for proposing the project idea.



Problem Statement:

Approximately one third of all energy produced by nuclear power plants is converted to electrical energy. The remainder is thermal energy that is released into the environment, either in the form of steam or hot water in cooling lakes. This large amount of heat released becomes thermal pollution that may harm local ecosystems. Finding a way to harness this waste heat and finding an innovative use for it would provide Exelon with a way to increase their environmental commitment along with an enticing business opportunity.



Objectives:

- To develop a structural design for a land and water based greenhouse
- Determine the most cost effective and efficient heating method
- Analyze market and climate feasibility of specific greenhouse crops
- Study previous attempts at similar projects
- Overall: Reduce the amount of thermal pollution from nuclear power plants and use waste heat for a profitable means
- To analyze data throughout the semester in attempts to develop a project proposal to present to Exelon Nuclear staff

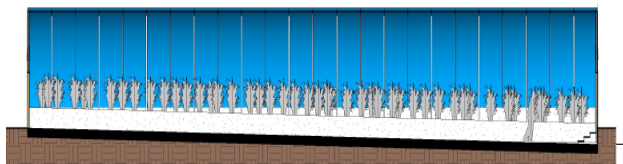
Methodology:

- Visit Braidwood Generating Plant to collect site and plant details
- Research previous attempts at similar projects to avoid similar mistakes
- Calculate heat loss and the soil and air temperatures using multiple proposed heating methods
- Determine crop selection based on possible greenhouse temperatures
- Research and design greenhouse structures and materials to conduct lifetime cost analysis for them
- Use AutoCAD, SKM, Revit, Adobe Design Premium, and other software to visualize our ideas

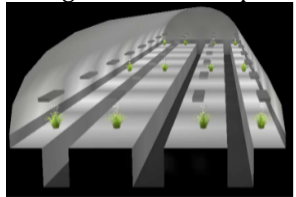
Land Based Hoop House

• Structural Design:

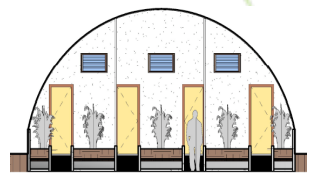
This design incorporates a hoop house style greenhouse that includes internally sloped pathways below ground level. Inside there are 5 troughs of water flowing downhill in which the plants are located.



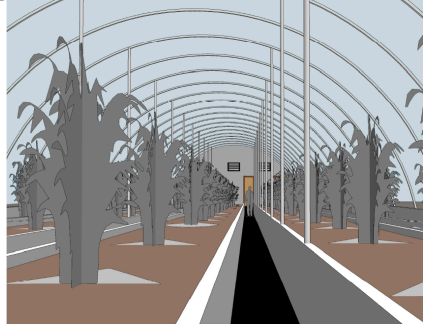
Long section of hoop house showing internal slope



Electric lighting diagram



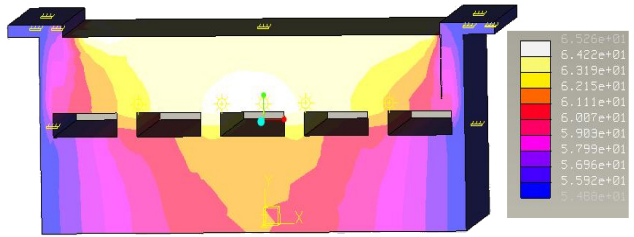
Section through troughs



Interior perspective of hoop house showing pathways, troughs, and structure

• Heating Process:

This heating method utilizes the waste hot water from the power plant that has been released into the cooling lake. The water is then pumped into the greenhouse troughs to heat the plants located in aluminum planter boxes. With this design, the flow rate will be adjusted based on the hot water temperature.

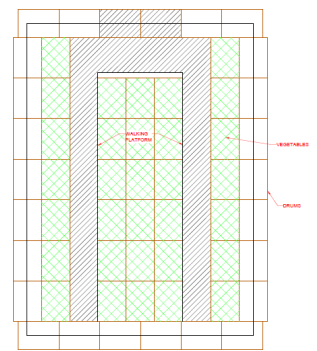


Temperature distribution through water and soil in the troughs

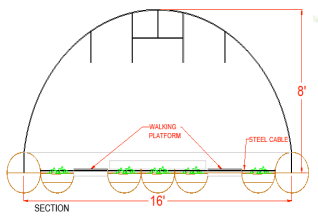
Water Based Hoop House

• Structural Design:

This design is a self-contained floating hoop house. It utilizes empty barrels to provide buoyancy. The planters are strung on cables that are connected between the structure and pathways in the center. The planters are partially submerged in the hot water channel of Exelon's cooling lake.



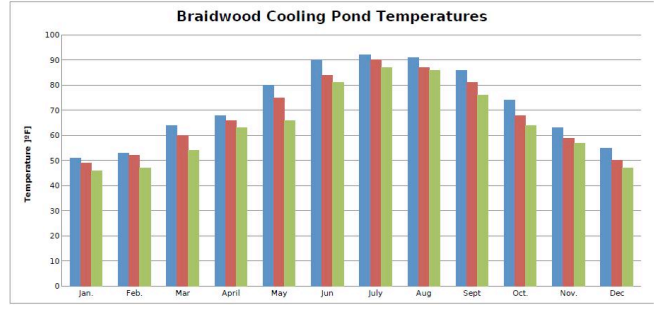
Aerial perspective of plant and path layout



Section through planters and pathways

• Heating Process:

This heating method utilizes the hot water channel to heat the plants directly. Since the planters are submerged in the water channel, it is in direct contact with the heat source. With this design the entire structure will need to be moved to a cooler part of the lake during the summer months to keep from overheating based on the lake temperatures near the hot water inlet.



Average lake temperature 1998-2009

Results:

- AutoCAD drawings were developed for each greenhouse structural design
- Water channels were chosen as a land based heating system while a floating greenhouse was chosen as a water based heating method
- Crops were decided based on greenhouse climate and market profitability

Conclusion:

The information gathered throughout the past semester has provided us with results to provide a theoretical plan for Exelon to pursue as a pilot project at their Braidwood Generating Plant. It was determined that the mechanical and economic feasibility is real. A proposed outline of the research and data will be proposed to the Exelon Nuclear staff in the hopes that this project will be initiated.