**COS10025 Technology in an Indigenous Context**

**Semester 2 2023**

**Research Report**

Project Title: Sustainable Energy Projects

Project Team: Group 4

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# Table of Content

[**Table of Content 2**](#_1fob9te)

[**1 Literature review 3**](#)

[**2 Project background 5**](#)

[**3 Project Goals and Objectives 5**](#)

[**4 Desired outcomes and benefits 6**](#)

[**5 Learning issue/problem (individual) 6**](#)

[**6 Project Scope and Exclusions 7**](#)

[**7 Project Deliverables 7**](#)

[**8 Project Management Plan 7**](#)

[**9 References 9**](#_id8y5iwoach6)

# Literature review

This literature review will analyse some of the current software applications to control green energy projects as well as how these softwares are implemented in some cities around the world. By using these findings which can help us elaborate a better solution for the world nowadays.

***Software application comparison***

It is crucial to compare multiple software solutions as each one can have their own pros and cons which fits each consumer’s requirements or each phase of the whole project. As this allows us to know which features are unique to each software and which are more valuable to our budget. There was a research from Sinha et al. (2013) that gives a comprehensive comparison between 19 softwares by their main features and ongoing status as well as its real life application on different locations globally. This research is really useful for our project as it provides some insights for us to find out which practice is the best for developing a better solution using softwares which is ongoing on the market as this research also highlights different competences from each software.

There was also research from Markovi et al. (2011) that divided these tools into 4 different types based on their aims and achievements in different categorizations which will assist the many stages of a successful community project execution.

The downside is that this type of research can easily get outdated as technology innovates swiftly from day to day.

***Providing energy for cities around the world by sustainable energy***

For environmental preservation, climate change mitigation, energy security, economic growth, public health, and long-term cost savings, it is essential to supply energy for cities across the world. Cities can set the example for developing a sustainable and resilient future for their citizens and the world by embracing renewable energy alternatives. A research by Rehan et al. (2022) stated that the utilization of renewable resources, especially biomass feedstock, and the advancement of green energy are both necessary in Pakistan.This can be useful for us to understand a better view on how sustainable energy is interpreted in a specific country such as Pakistan. The generation of bioelectricity might rise dramatically by 2050, according to research conducted using the Low Emissions Analysis Platform (LEAP®) software. This leads us to understand that biomass is a potential and promising alternative to non renewable resources. Additionally, installing biomass facilities would significantly lower CO2 emissions. For the purpose of promoting renewable and sustainable energy systems in Pakistan, this study offers crucial information to stakeholders and policymakers.

Another research for India by Bhowmik et al. (2015) showed that globalization is a factor that has influenced a rise in the use of green energy sources in many parts of the world. As this is a very civilized trend which will enhance our planet to another level in protecting our precious planet which is vital nowadays. Clean, ecologically friendly energy sources that are less harmful to the environment than traditional energy sources are referred to as "green energy". In the strategic planning of a nation's energy, it is essential. Because of its abundant energy resources, India in particular has importance in the world's energy landscape. In contrast, there are differences in a number of ways between the energy systems in various Indian states and provinces. To define and address the energy management issue, researchers have suggested a number of decision-making processes, integrated approaches, and combination methodologies. Instead of focusing exclusively on energy usage as a single component, examination of various green energy solutions in contemporary power management takes into account a number of factors. This study provides a thorough analysis of the body of literature on different approaches, integrated approaches, and multi-criteria decision-making techniques for issues relating to green energy planning and scheduling. This research has shown that energy management techniques outperform conventional techniques. The results of this research also seek to help academics and decision-makers implement these processes to promote sustainable energy practices in an efficient manner.

However these researches are just some area based so it can be irrelevant or may not be applicable to other continents or countries.

***The combination between best of top end softwares***

It is important to combine between top end softwares on the market right now to create the best software as it fills each other's cons. It is really great to create a modelling framework which will help developers like us to write a new program which combines these two much more easily. But creating a modelling framework can be a daunting task as it requires many technical skills. A research by Salehin et al. (2016) had addressed this issue by proposing a framework idea to overcome this hardship. This study provides an introduction of a modeling framework for evaluating renewable energy systems with an emphasis on power systems producing electricity, using two well-known software tools, HOMER and RETScreen. A useful technique for examining and researching the possibilities of renewable energy technology in diverse applications is energy system modeling. For modeling and developing renewable energy systems, a variety of software tools are available, and the choice of software relies on the study's unique goals. The modeling software for this study has been chosen from HOMER and RETScreen. The energy system's components are optimized, the cost is calculated, and the system's portion of the electricity produced is calculated using HOMER. As well as other pertinent inputs, the HOMER data are then entered into RETScreen for a thorough project analysis and energy scenario evaluation.

On Kutubdia Island in Bangladesh, the suggested modeling framework is used as a case study to evaluate the solar PV-diesel and wind-diesel energy systems. This framework enables researchers and policymakers to carry out techno-economic optimization and energy analysis for renewable energy systems by exploiting the distinctive features of HOMER and RETScreen. It offers insightful information that may be used to better comprehend the viability, cost-effectiveness, and performance of renewable energy projects. Researchers and decision-makers may examine renewable energy systems in great detail thanks to the use of HOMER and RETScreen in this modeling framework. The framework allows the creation of sustainable energy plans by fusing the optimization capabilities of HOMER with the thorough project analysis offered by RETScreen.

However this is totally on paper which hasn’t got many technical details which would help us much more time in developing a new software to accommodate those needs.

***Methodology***There are many methods which are applied throughout those researches.

The first two papers by Sinha et al. (2013) and Markovi et al. (2011). Those researches are written very detailly in analysing pros and cons from each software based on their features and usability. Those researches are written based on the program which the writers had researched based on their documentation, list of features and technical details and specifications . However, these research recommendations can be incorrect as the opinions are completely based on the writers. The next two researches which are by Rehan et al. (2022) and Bhowmik et al. (2015) are written completely based on researcher’s findings as well as other secondary sources such as other researches or some source qualified graphic figures. These 2 researches are limited to a specific location so it isn’t too comprehensive or give a good overview insight. It just provides a limited view of the system because it is just one example.

# Project background

In Phu Tho, the absence of affordable, stable energy sources has a negative socioeconomic impact and harms the ecology. The goal is to develop a software-driven system that utilizes renewable energy, skillful power management, and community involvement to provide the community with a dependable and effective energy source, while also enhancing energy efficiency and providing residents with real-time monitoring and information on sustainable energy practices.

In order to overcome Phu Tho's energy problems, the project's objective is to develop a secure software-powered system. Due to the region's residents' often restricted access to economical and dependable energy sources, both the socioeconomic situation and the environment are negatively impacted. This project will leverage software technology to create a unified system that combines renewable energy sources (especially solar energy), competent power management, and local involvement in order to give the community a reliable and efficient energy supply. The viability of renewable power technologies as possibilities for rural electrification has improved along with their accessibility and affordability.

By applying demand-side management and smart grid technologies, it is recommended that energy demand may be balanced, waste can be reduced, and the overall dependability and resistance of the solar energy system can be improved. With the use of this platform, it is possible to monitor the creation, consumption, and distribution of electricity in real-time, enabling informed decisions to be made while also indicating potential areas for development. Residents may observe and track their own electricity use using the individual tracker, which gives them thorough knowledge of sustainable energy methods.

# Project Goals and Objectives

***Energy Access and Equity***

Increase all community members' access to cheap and dependable energy services, especially among underprivileged groups.

Ensuring that marginalized groups have equitable access to the advantages of sustainable energy systems would improve energy equality.

***Environmental Sustainability***

Reduce the environmental effects of energy production and use, such as greenhouse gas emissions, air pollution, and waste production.

Promote sustainable energy methods and reduce ecological footprints to preserve and conserve natural resources.

***Utilizing Renewable Energy***

To decrease dependency on fossil fuels and advance a sustainable energy system, more renewable energy sources should be included in the energy mix.

Encourage the creation and application of renewable energy technologies such as solar, wind, biomass, hydro, and others.

# Desired outcomes and benefits

We hope that our teammates will integrate and work with others flawlessly to successfully create a modeling framework integrating the skills of two software tools which are named HOMER and RETScreen that have been developed with the goal of capturing various aspects of energy systems. Using this modeling approach, extensive energy scenario analysis and techno-economic optimization of renewable energy systems are obtained which can be very helpful for users. This paradigm for modeling may also be used for energy systems that produce thermal energy or other non-conventional energy sources. By combining the capabilities of HOMER and RETScreen and utilizing their advantages, this framework may examine renewable energy systems while utilizing the strengths of these two software programs.

# Learning issue/problem (individual)

The problem that I will look into is: How do we integrate these two softwares together ?  
An ideal system design must be in place in order to use RETScreen to examine a project properly. This guarantees that the program will be able to evaluate the project's performance properly and deliver accurate findings. On the other hand, the HOMER program may deliver insightful information on energy systems and optimization. Users can improve the precision and thoroughness of their project analysis by feeding the HOMER results into RETScreen.

The backend of the program must be altered in order to integrate HOMER and RETScreen, though. In order to use them in the backend of RETScreen, pertinent HOMER methods or classes must be extracted and either translated or integrated. A smooth exchange of information and messages between the two applications is made possible by this connection.

The frontend of RETScreen will also need to be modified in order to support these modifications, in addition to the backend. The user interface and overall software user experience are referred to as the frontend. New features or functions are added to the frontend as a result of the changes, enabling users to input the HOMER findings and view the integrated analysis results on the RETScreen interface.

Another issue is that HOMER and RETScreen use different programming languages. Microsoft Visual C++ is used primarily in HOMER while Visual Basic and C are combined to create RETScreen. In order to assure compatibility and easy communication between the two software systems, the integration process necessitates migrating or changing the codebase.

Depending on the programming language used by RETScreen, this shift may require rewriting or translating specific pieces of code. A data interchange standard or protocol may also need to be developed in order to make it easier for HOMER and RETScreen to communicate data.

In general, incorporating pertinent HOMER methods or classes and translating them into the programming languages used by RETScreen requires changing the application's backend. At the same time, changes are made to the frontend to make it possible for HOMER results to be entered and shown on the RETScreen user interface. It may be necessary to rewrite or translate code parts and build data transfer protocols since the two systems' programming languages differ. Users may take advantage of both HOMER and RETScreen's advantages by making these adjustments, which will eventually improve project analysis's precision and efficacy.

# Project Scope and Exclusions

In order to fulfill the objectives and aims above, a software will be created that will have these features:

* Get the optimal system architecture, the component costs, and the energy mix of the power producing components.
* With the aid of RETScreen, the energy mix and cost data collected from HOMER were utilized to further assess the improved energy systems.
* RETScreen was used to acquire thorough cost analysis, financial analysis, and sensitivity analysis.

These features are in scope as these are our 3 main tasks that will be archived throughout this project in effort of creating a combined software.

# Project Deliverables

This software will be delivered in:

* Source code
* A demo application or prototype abstracts those main features that will be implemented
* Documentation to explain key features and user manual for this software to help users have a better understanding on how to use it and what features have been added.

# Project Management Plan

***Timeline***

The overall timeline of the project is as follows:

| Green Software  Project | Week 6 | Week 7 | Week 8 | Week 9 | Week 10 | Week 11 |
| --- | --- | --- | --- | --- | --- | --- |
| Build an UML diagram | ✅ |  |  |  |  |  |
| Design the frontend or user interface | ✅ | ✅ |  |  |  |  |
| Design the backend and database side | ✅ | ✅ |  |  |  |  |
| Writing code for the frontend of the software |  | ✅ | ✅ | ✅ | ✅ |  |
| Writing code for the backend of the software |  | ✅ | ✅ | ✅ | ✅ |  |
| Writing test case and testing |  |  | ✅ | ✅ | ✅ |  |
| Pre-Alpha release |  |  | ✅ |  |  |  |
| Alpha release |  |  |  | ✅ |  |  |
| Beta release |  |  |  |  | ✅ |  |
| General  availability |  |  |  |  |  | ✅ |

***Goals and Milestones***

* ***Build an UML diagram***
* Finishing drawing and noting UML diagram
* Taking ideas from teammates
* ***Design the front end***
* Create using figma
* Make sure the interface is user friendly and informative
* ***Design the back end***
* Design the backend using respiratory pattern and Object oriented programming applied
* Review to make sure the code is clean and containing short functions
* ***Writing code for front end***
* Using reactJS to design application overall
* ***Writing code for back end***
* Writing the classes for software
* Adding variables, property and methods for each classes
* ***Writing test cases and testing***
* Noting which parts to be tested and writing instruction for testing which includes testing instructions and requirements
* Writing test cases using NUnit test kits
* Running the test
* ***Pre alpha phase***
* Testing software by us developers
* ***Alpha phase***
* Release on github for other developers can do testing
* ***Beta phase***
* Available on our website which users can download to test and report bugs
* ***General availability***
* Release and announce software on multiple platforms

***Team breakdown and duties***

| Name | Role |
| --- | --- |
| Tran Hoang Hai Anh | Project manager, developer |
| Nguyen Manh Dung | Project owner, developer |
| Tran Yen Nhi | Software checking, developer |
| Nguyen Tran Yen Binh | Writing ideas, developer |
| Tran Hai Long | Interface design, developer |

As seen above, my role is a project manager as well as developer also. Being a project manager, I will have to ensure everyone is following the requirements closely and also monitoring closely the quality and testing units to make sure the software works seamlessly. On the other hand, I’m also a developer who creates classes and methods which will be added to the software, implementing features and running unit tests.

Word Count: 2600 words

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