High Level Design HLD Document 

**HIGH LEVEL DESIGN(HLD) DOCUMENT**

ENERGY EFFICIENCY

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**Energy Efficiency 1**

High Level Design HLD Document **Document Version Control**

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High Level Design HLD Document **Abstract**

This work aims at improving the energy efficiency of buildings by assessing the heating load and cooling load requirements as a function of building parameters. Improving the efficiency not only reduces the energy needs but also helps the environment by decreasing fossil fuel consumption. The work includes performing classical and non-parametric statistical analytic tools on the data to highlight and utilise highly correlated features for training a variety of Machine Learning models with a wide range of hyperparameters to obtain the optimum model. In order to train the model, data was obtained and processed at Oxford Centre for Industrial and Applied Mathematics, University of Oxford, UK). The model will be available for public usage with the feature of retraining the model with any dataset with the correct features through a web application.

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High Level Design HLD Document **1 Introduction**

**1.1 Why this High Level Design Document?**

The purpose of this High Level Document (HLD) Document is to add the necessary detail to the current project description to represent a suitable model for coding. This document is also intended to help detect contradictions prior to coding, and can be used as a reference manual for how the modules interact at a high level.

The HLD will:

● Present all of the design aspects and define then in detail

● Describe the user interface being implemented

● Describe hardware and software interfaces

● Architecture of the project

● List and describe the non-functional attributes

**1.2 Scope**

The HLD documentation presents the structure of the system, such as the database architecture, application architecture, application flow and technology architecture. The HLD uses non-technical to mildly technical terms which should be understandable to the administrators of the system.

**1.3 Definitions**

| Term | Definition |
| --- | --- |
| AI | Artificial Intelligence |
| ML | Machine Learning |
| Database | Collection of all the information monitored by this system |
| IDE | Integrated Development Environment |

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High Level Design HLD Document **2 General Description**

The web application based Energy Efficiency solution is a machine learning based model which will help in estimating the heating and cooling load required by a building.

**2.1 Problem Statement**

To create an AI solution implemented through a web application for following use cases:

● To determine the heating and cooling load of a building

● To retrain a new model based on new data to have up to date predictions

**2.2 Proposed Solution**

The solution here is a web application through which a machine learning model can be trained as well as accessed for prediction of heating load and cooling load. This ensures that for the given set of required inputs we get an estimate of power needed to have efficient heating and cooling systems. If more data or latest data is obtained for training a better or up to date model a feature is provided to retrain a newer model. In order to train the model the data will first be subjected to classical and non parametric tests to obtain features highly correlated to the output labels.

**2.3 Further Improvements**

The solution employs a method to write logs to .txt files. At the moment logs are written in a sequential manner i.e. until logs are written to the files further execution of the code is halted and latency increases. An asynchronous code for logging can decrease the latency and make our web application more responsive. However since the logs are made within the server the difference in latency will be very small.

**2.4 Technical Requirements**

For implementing this work we require the following:

1. A database to store the validated dataset and the logs created during web application runtime.

2. A framework that creates ML models

3. A framework that will create the web application.

4. A service to host our web application online.

5. A service to observe our code and ensure that the latest version of the source is employed in the web application

**2.5 Data Requirements**

Based on the Data Service Agreement the data must provided with the following constraints:

1. The data must be provided as an Excel Document(.xlsx).

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2. The name of the data file must follow the naming convention “ENB{YYYY}\_data.csv” where the “YYYY” string refers to the 4 digit year. 3. The data must be provided in 10 columns for training. The description of the columns are stated below:

a. “X1” (input) - Relative Compactness

b. “X2” (input) - Surface Area

c. “X3” (input) - Wall Area

d. “X4”(input) - Roof Area

e. “X5” (input) - Overall Height

f. “X6” (input) - Orientation

g. “X7” (input) - Glazing Area

h. “X8” (input) - Glazing Area Distribution

i. “Y1” (output) - Heating Load

j. “Y2” (output)- Cooling Load

The terms in double quotes are the column names of data that should be provided.

4. For prediction the data should have only the inputs.

**2.6 Tools Used**

The following languages, frameworks and services are to be utilised to implement the work.

1. Pycharm IDE

2. Python Programming Language

3. Pandas Framework

4. Pandas-Profiling Framework

5. Scikit-Learn Framework

6. Flask Framework

7. GitHub

8. CircleCi

9. Docker

10.Heroku

11. Cassandra Database



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**2.7 Constraints**

The Energy Efficiency solution must be user friendly, as automated as possible and users should not be required to know any of the workings.

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High Level Design HLD Document **3 Design Details**

**3.1 Process Flow**

For predicting the heating and cooling load. We will use the machine learning model with the process flow diagram as shown below

**Proposed Methodology**

**3.1.1 Data Injection and Validation**

**3.1.2 Model Training and Evaluation**

**3.1.3 Deployment Process**

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**3.2 Event Log**

The system should log every event so that the user will know what process is running internally.

**3.3 Step-by-Step Description**

1. The System identifies at what step logging is required

2. The System should be able to log each and every system flow. 3. Database logging has been chosen.

4. System should not hang even after using so many loggings.

**3.4 Error Handling**

An error is defined as anything that falls outside the normal and intended usage. Should errors be encountered, an explanation will be displayed as to what went wrong.

**3.5 Performance**

1. Reusability

The code written and the components used are able to be reused because of code modularity.

2. Application Compatibility

The different components for this project will be using Python as an interface between them. Each component will have its own task to perform and it is the job of Python to ensure proper transfer of information.

3. Resource Utilisation

When any task is performed, it will be provided all the processing power until that task is finished

4. Deployment

The Web Application will be deployed to Heroku using Github, CircleCI and Docker.

5. Key Performance Index

The performance of the model will be indicated by Mean Squared Error and R2 metric.

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High Level Design HLD Document **4 Conclusion**

The Designed Web Application predicts the Heating and Cooling Loads for the building whose parameters are uploaded to the Web Application for prediction to improve the Energy Efficiency of buildings. The model can also be retrained by uploading a new dataset.

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