Visualization of Energy Consumption by UTP (VisCO2)

By

Siti Maisarah binti Sewandi (12849)

Dissertation submitted in partial fulfilment of
the requirements for the
Bachelor of Technology (Hons)
(Business Information Systems)

MAY 2012

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CERTIFICATION OF APPROVAL

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Approved by,

_____
(Prof. Dr. Alan Oxley)

UNIVERSITI TEKNOLOGI PETRONAS
TRONOH, PERAK
MAY 2012

CERTIFICATION OF ORIGINALITY

This is to certify that I am responsible for the work submitted in this project, that the original work is my own except as specified in the references and acknowledgements, and that the original work contained here in have not been undertaken or done by unspecified sources or persons.

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(SITI MAISARAH BINTI SEWANDI)

ABSTRACT

The author has done some research in order to support on Green IT and reduce Greenhouse effect via saving energy in an organization. This research has lead to the development of a website that could monitor and display the energy consumption in real time on any PC. This internet based visualization tool can help the senior management to review the whole general energy consumption of UTP and can take immediate action or decision that required energy saving.

With the scope of the top management Universiti Teknologi PETRONAS (UTP), hopefully this system can help and assist the management people to review energy consumption data in cumulative number. The objective of this project is mainly to do research on important of energy saving for an organization in order to contribute to greenization and prevent global warming. This objective is essential because it will help to develop a front-end system that could visualize the total number of UTP energy consumed. This will assist them to make decision making as well as save energy use in UTP. This system is using language PHP and HTML language by using Adobe Dreamweaver CS5 that makes it easy to apply other programming strategies if needed.

Next, this report will cover on methodology used to develop this system, which is Rapid Application Development methodology. These implementations, using methodology for compressing the analysis, design, build and test phases into a series of short, iterative development cycles. This has a number of distinct advantages over the traditional sequential development model. This system will focus on how to develop a helpful visualization system that could manage energy use in order to reduce the wasted energy consumption. Therefore, this project is called as Visualization of Energy Consumption by UTP (VisCO2) and relevant to be applied and used by UTP management in the future.

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CHAPTER 1

INTRODUCTION

1.1 Background of study

The system for the Visualization of Energy Consumption by UTP (VisCO2) is a new system development for UTP senior management facility. Energy management is the key to saving energy in our organization. There are many importance of energy saving stems from the global need to save energy. This global need affects energy prices, emissions targets, and legislation, all of which lead to several convincing reasons why we should save energy at our organization specifically. Therefore, Universiti Teknologi PETRONAS is one of the industry sectors that plays important role to improve energy efficiency of the society by utilizing IT solutions.

Besides that, our government have begun to address issues of carbon emissions from all sectors including non-domestic sector which is universities. Globally we need to save energy in order to reduce the damage that we are doing to our planet, Earth. As a human, we would probably find things rather difficult without the Earth, so it makes good sense to try to make it last. The implementation of this system is aimed to support evaluation of building management by visualizing data such as energy consumption to optimize and reduce the usage from action taken made by top management.

1.2 Problem Statement

1) The top management do not have any effective way to review energy consumption
    - This is new approach for management in order to play they role to contribute to greenization to our nation and the world. Before this and until now, there are no reviews and action taken is made towards energy usage in UTP. Each department and building uses any machines, air conditioning and electricity without limitation. Hence, these actions ultimately have contributed to emission of greenhouse gases such as CO2 widely.

2) The data is difficult to get and be retrieved

- Truth, there is no specific medium for manager of an organization to review the energy consumption from activities of their company. He or she has to get the information by themselves from company data centre and server. The same condition happens in a university. Consequently, there is no action taken will be done as no data to visualize energy consumption easily and effectively that provide a norm among top management including UTP. There is a need to develop a front-end system for the top management in making decision immediately. There are two roles played by Green IT are that of "saving energy from IT devices themselves (of IT)" and "society's saving energy by IT (by IT)" that can be utilized for new system development.

From this situation, there is an idea to create VisCO2 for UTP senior management to review and manage the cost of energy to drive company to "green". For example, do we really know where to find the information about cost of electricity usage for a month? The usual cause of the electrical usage problem happen is because of the disconnection between the people who are using electricity and the one who are paying the bills. For scope of UTP, the senior management can use the system as main reference in order to take immediate action regarding energy consumption such as from facility systems, equipment structures to change inefficient instrument or improving operation.

1.3 Aims and Objectives

For the development of the Visualization of Energy Management Systems, the objective is to develop a system that can provide the following functionalities:

1) To build up a user interface for senior management to get overall view of energy consumption to take immediate action.

2) To monitor the overall energy consumption area by UTP in order to review the effectiveness and efficiency of energy saving system project.

1.4 Scope of the Study

This study focuses on how to visualize the whole measurement of energy consumption from daily activities in UTP including academic building, electricity and transportation management. Besides that, the study focuses on how to show the energy consumption in graphic chart so that the senior management can make an analysis from the visual aid and information. This study involves an intelligent system containing to indicate the waste of electricity consumption.

1.5 Relevancy of the Project

The implementation VisCO2 is very relevant with the current condition where nowadays many organization want to contribute energy saving in society via IT especially UTP as there is no intelligent system for top management to monitor energy consumption in interactive way. This system may assist UTP senior management to make better decision making in order to address efficient use of energy consumption.

1.6 Feasibility of the Project within the Scope and Time Frame

The system will be completed within the given period. Regarding the period, the project development will takes two semesters of study, which is enough for the author to complete the development of the project. For the first semester, the author will focus on planning, analysis and design phases, which are concentrating more on research paper. On the other hand, during the second semesters, the author will focus more on implementing the Visualization of Energy Consumption by UTP (VisCO2).

CHAPTER 2

LITERATURE REVIEW

2.1 Contribution to Green IT for energy saving

Nowadays, we can read many statements of our energy consuming and supply throughout the world is unbalance and must be considered by all people. We can see the current trend stated by to the International Energy Agency (IEA) regarding this matter. In its efforts to stabilize and reduce total primary energy consumption by 20%, and to cut greenhouse gas emissions by at least 20% by year 2020. [1] Therefore, we must contribute some idea although it is just a simple action in order to make this mission reality.

In order to preserve the earth and make up a low-carbon society that is comfortable for living beings, we need to control of information and communication technologies (ICT) that offer solutions to these environmental issues. Green Technologies is the reduced environmental impact from running an Information Technology (IT) department (Lawrence, W. & Michael, W., 2009). Green technology is the development and application of products, equipment and systems used to conserve the natural environment and resources, which minimizes and reduces the negative impact of human activities[2]. IT is highly expected to serve as one of the solutions to this problem. It saves companies money, if viewed over their useful life.

2.2 Visualizing energy consumption activities as a tool

Starting with the development of intelligent systems in the early seventies, and computer software, scientists always seek to resolve problems through intelligent program. Starting from that, many of the renovations and new system were made to enhance the quality of life. However, there is not many intelligent systems were developed to increase the awareness towards our daily energy consumption (Markus, W., 2010). Hence, the development of Visualization of Energy Consumption by UTP (VisCO2) is mainly to assist senior management to practices good Energy Management in order for top management and employees become more aware of how

[1] http://ec.europa.eu/clima/policies/package/index_en.htm
[2] http://www.greengrowth.org/download/2010/Malaysia/Malaysia.National.Green.Technology.Policy.and.Fund.Ahmed.Zairin.Ismail.pdf

energy is used, the actual cost of energy and the methods and equipment that can be used to control and reduce energy waste.

In order to build up this system, web applications require a higher level of involvement and knowledge of the system. Besides that, the most important thing to identify the users of system as they will use it to perform their daily business tasks (Janko Jovanovic, 2010). Web application is dynamic and interactive systems that assist to perform business critical tasks and increase their productivity. For the enterprise, the ability to update and maintain web applications without deploying and installing software on potentially thousands of client computers is a key reason for their popularity. Besides, one of the advantages is direct access to latest data with interactive way is also as the strength (Blain, P.& Pugh, T, 2010). Thus, it is easier for senior management that can access and get updated energy performances through VisCO2 as it is web based application.

Closed systems or line-of-business applications are usually not accessible outside the organization and they can be considered as "offline" applications. This type of web application generally carries on the organization's local network and is available only to employees (Janko Jovanovic, 2010). In the case of development of Visualization of Energy Consumption by UTP, it will use closed application concept, as all the information betrayed is confidential (Margaret, D., 2002). Only certain person can have privileges to access all the information regarding UTP energy consumed.

2.3 Proposed System

In order to find the best solution to the problem, the author decides to create Energy Management System for UTP environment that the name is Visualization of Energy Consumption by UTP (VisCO2). It is a web based system that helps senior management of UTP to have general view or visualization on energy consumption for the whole UTP. Thus, the production of VisCO2 is hoped can assist senior management of university or people work for it to have better information and take remedial action taken in their decision making.

Other than that, this new project system also will have a feature that has database ability, which is capable of storing and organizing data only for important

people who have authority to access the close system. For time being, there is no large quantities of data can be accessed from UTP data centre as this system is still at early stage and need further research in order to well developed for future implementation.

Besides that, it is capable of quickly visualize the stimulating graph from raw dataset made based on few types of energy consumed by UTP. Finally yet importantly, before the system can be used, the prototype or idea can be the first step forward for UTP management to improve the usage of energy consumption to save our earth. In order to understand the movement in energy consumption, it is required to look at the past context of emissions and then to make a judgement as to how they will move in the future.

CHAPTER 3

METHODOLOGY

3.1 Rapid Application Development (RAD)

This project will undergo the basic Software Development Life Cycle. The methodology chosen for this project is using Rapid Application Development (RAD) model. This model is selected because it uses iterative prototyping method and suitable for project which has a time constraint that very limited. (Mortimer,1995).

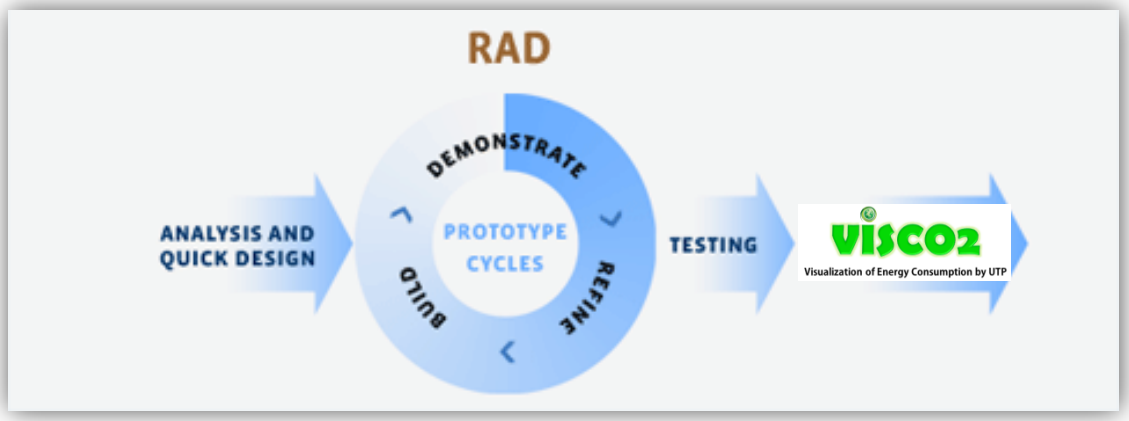

Figure 1: RAD methodology

The Rapid Application Development model consists of four main phases (Martin, 1991):

1) Analysis and Quick Design
2) Prototype Cycle
3) Testing
4) Implementation

The author believes that using this model in developing the system will help to complete the system within the time frame given. It is because author only has two (2) semesters to complete the project. RAD model is more applicable than Waterfall model because the author can constantly put an effort with the prototyping until it

fulfils the user requirements. It force author to keep build on the system itself and continue developing prototypes until finish.

There are many advantages in adopting RAD model for the development of the system. Some of them are:

1) Flexibility

According to Purcell (n.d), RAD model allows a quick requirements gathering process and development of the system prototype. Feedbacks from the users then will be used as a platform for the developers to increase the feature of the system and gain a further insight into the business requirements as the development goes along.

2) Appropriateness and speed

The author has only about 2 semesters to finish the completed system. Therefore, by using RAD model, the author would be able to start of the development stage as early as the primary scope been defined; and the enhancements can be carried on along the development stage. Besides, the author will also be able to produce prototypes, test them, and enhance from time to time until the complete working system is produced within the period.

Below is the first stage of VisCO2 project development. The methodology starts with Planning and Data Gathering stage and followed by Analysis and Quick Design phase, Prototype Cycle, Testing and last but not least is Implementation phase.

3.2 Planning and Data Gathering

Planning and data gathering is the first stage of the project development. This stage is very important since it gather all data and information required to ensure the development of the project running successfully. During the planning and data gathering stage, the studies are conducted to determine the overall objectives of the projects. It is to ensure that the topic chosen is relevant and focus. Then the background study, problem statement, objectives, scope of the system and existing research paper that related to this project are identified and documented properly.

After that, the author specifies the important features and scope of the project and identifies the sources of knowledge including the Green IT experts such as Manager of Unit Asset of KM Department, Group Technical Solutions (GTS), PETRONAS and UTP lecturer, the lab technician and from other sources of knowledge such as books, annual report, Internet and others. Author also has decided the tools that required for the development of the system, which is Dreamweaver application. Lastly, the author will implement the Gantt chart to plan the project scheduling and time allocation for each necessary task. (Appendix 1)

3.3 Analysis and Quick Design

After going through the planning stage, the author continues to the next phase of the project development, which is analysis stage. This phase is important because result of the analysed data will be used to determine whether system proposed meets the user requirements or not.

For this project, this phase includes the process of interpreting and analysing the knowledge and data collected during planning phase. This process provides the guidance in designing the new technique for collecting the additional knowledge from the human expert and other sources. Hence, the author has decided to choose Prof Dr Alan Oxley who is the expert in Green IT and Mr. Izwan Hafiz, the manager if Unit Asset of Knowledge Management Department, Group Technology Solutions in order to guide the author to get the right information on the data selection and scope of study.

During the quick design stage, the overall structure and organization of the system's information are defined. In this phase also, an initial design prototype system of Visualization of Energy Consumption by UTP (VisCO2) is built. These designs are based on the result of the data analysis. Basically, the designs are made to build real project development and have same functionalities needed for implementation.

After gather all the required information, the author can start with the design of the system. The design should be user-friendly and interactive. Through designation of the system, the author also can start to work out with the system development. The

author needed to find out other type of technologies use nowadays that capable to apply to visualize attractive information of consumed energy.

To ensure the system can be run smoothly, several testing need to be done. The author can start with the technical testing where testing the system by his or her own. Next, the system needs to be test with the other person who does not familiar with the system. Lastly, the system needs to be test by the user. Commonly, there should be slightly changes in every test done in order to meet the user expectations. Before the system can be implementing, the author needs to train the staff on how to use the system so that they can be familiar with the system.

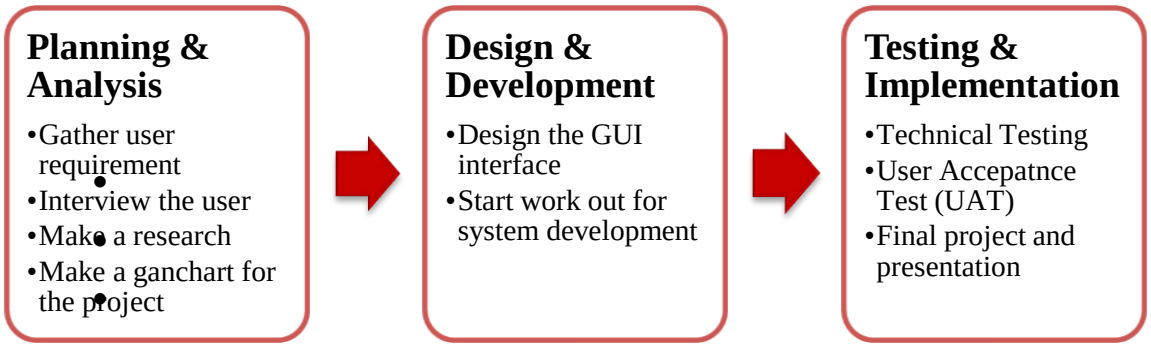

Figure 2: VisCO2 phases

- **Graphical User Interface**

Before starting with the coding execution, the author needs to develop and test the paper-based graphical user interface design. The paper-based graphical user interface design should be based on the data that has been analyzed. Then, the paper-based design needs to be evaluated by the users and get the response towards the existence interface.

- **Physical Design**

The project will be developed using a personal computer using Dreamweaver CS5 and XAMPP application.

- **Project Tools**

Below are the tools, hardware and software used in the development of VisCO2:

1) Software: Adobe Dreamweaver CS5, PhpMyAdmin 3.3.9 and Microsoft SQL Server.
2) Programming Languange: HTML, XML, PHP
3) Hardware: Laptop and server

3.4 Prototyping Cycle

The next stage for RAD model is prototyping cycles. During this stage, the author can continuously improve, construct and demonstrate the prototype until it fulfils user requirement. The author also needs to install all the software required such as Adobe Dreamweaver CS5 application before starting to develop the prototype. Below are the steps to carry out for the prototype stage:

1) The author will improve the current design for prototype model until it meets user requirement.

2) The prototype's design will be coded based on the conceptual and the graphical user interface during design phase earlier.

3) The author then codes the class diagram of the prototype, which consists of the attributes and function for each class using Dreamweaver application.

4) Lastly, the author will demonstrate the prototype to the users. All of the three steps above will be repeated until the users satisfy with the developed prototype.

3.5 Testing

After meeting the user satisfaction for the developed prototype, author can start to make a test on the prototype. By making a test on the prototype, author will realize the improvement that can be considered into the prototype. However, testing and verification stage will be a continuous process throughout the projects.

The author will modify the systems along the process, as the system should be up-to-date and following the current trend. The new technology also can be added to the system and directly to the knowledge base if there is any. The system then will be

validated by the supervisor in order to ensure all the information regarding green IT and energy consumption are correct and relevant.

3.6 Implementation

VisCO2 will not have implementation of project development for user since the development is only for front end of user interface. The scope of development does not involve any huge database that should be applied to extract actual data from data centre. This system is very useful as the main user interface to interact with static data and how the static data visualize the interesting graphs for clear view. The author hopes this development can be enhanced in the future with further implementation and could completely run as the Energy Management System.

CHAPTER 4

RESULT AND DISCUSSION

4.1 Data Gathering and Analysis

The author has used interview technique for development of VisCO2 project. Several interviews have been conducted during the analysis phase in order to gather all the information about staff development program. There are few users have been selected as the interviewees. They are technician of Mechanical Department, manager of KM Department, GTS, PETRONAS and expert Green IT in UTP. Recently, the author has done several interviews session including with an senior executive who manage the billing invoice for energy consumed monthly by UTP.

Date	Activities	Purpose of Interview
28 February 2012 **10.00-11.00am**	Interview with Dr. Alan Oxley	Make correction regarding project idea of VisCO2 as the whole
20 March 2012 **9.00-10.00pm**	Interview with Mr. Izwan Hafiz	The suitable software to be used and the main source to collect information for VisCO2
16 April 2012	Interview with Mr. Paris B Mohd Said, technologist of Mechanical Engineering Department	Get the main idea of problem and the waste of energy consumption without limitation of use by staff and students.
2 **July 2012** **10am-11am**	Interview with Ir Mohd Fatimie Irzaq B Khamis, Senior Executive of Property Mgmt. & Maintenance	The details information regarding budget used and several Energy Saving project applied by management.

	Department	
2 **July 2012** **10am-11am**	Mr. Azhar b Mohd Isa, Security Personnel, Mrs. Suhaila bt Mohd Zakir, senior clerk of Security Department.	Get average total number of transportation registered for students, staffs and vendors UTP.

Table 1: Interview Schedule

First interview had been done with Dr. Alan Oxley from Computer and Information Department. The purpose of this interview is to get full understanding the current idea of Visualization of Energy Consumption and gather the requirements for the system. The author gets a lot of information regarding this new idea, suggestion and opinions from interviewees in order to build this new system. Apart from that, they also give their concern and feedback for this project.

Second interview had been conducted with Mr. Izwan Hafiz, who is one of manager in Knowledge Management Department, Group Technical Solutions (GTS). The objective of this interview is to get a better view on the suitable software that can be used to develop VisCO2. Mr. Hafiz also explains on the current method on how manager get the data of energy consumption in an organization. The choosing of suitable software is very important in order to ensure the top management in the future can apply the system to review general energy consumed per month.

Mr. Paris B Mohd Said is one of technologist who works in Mechanical Engineering Department. From the interview session with him discover that daily experiments and machines conducted during working hour never limit in use. They can operate continuously until finish including over working hours. From this information given, it clearly informs us that the usage of energy for academic building are not in control and free to use without any restriction and rules implemented.

This development of VisCO2 will not complete without interviewing the UTP management people. Mr. Ir Mohd Fatimie Irzaq B Khamis is senior executive of Property Management and Maintenance Department. He is the focal person who gets

directly all data of energy consumed from data centre and create billing invoice of the whole energy of electricity and air conditioning used in bulk for a month. UTP have annual budget for energy consumed including electricity and air conditioning and water. The process of billing invoice transaction involved the Chief Financial Officer, Mr. Hasbullah b. Hj. Ihsan who will endorse the energy consumed bills by month.

From this information, it clearly stated that the top management has full responsible to endorse the budget. There is about 60% of monthly energy consumed for mechanical driven and equipment at academic building while 40% is the whole electricity for others building. There is no restriction or law for energy use as long as do not exceed monthly budget. Otherwise, the management need to review and cut down budget from other subjects. In addition, UTP has been applied few energy saving project for example automatic switch off the lamp at the tennis and futsal courts by setting the timer until1am. However, the energy saving project are done without technical review and analysis.

Regarding transportation for UTP students and staffs, there is quite large number of transportation registered under security department. There are more than 3700 motorcycles and 5400 cars have registered under securities department. Mrs. Suhaila and Mr. Azhar who one of the important security staffs said that the parking lot provided is lessen than the number of vehicles registered excluded number of vehicles that not registered yet. Therefore, the fossil fuel consuming a day is higher compared to other public university that is directly effect our green world environment

Figure 3: Interview session on 2th July 2012 with Mr Fatimie, Mrs Suhaila, and Mr Azhar.

4.2 System Development

System Development consist prototyping which is used to demonstrate working ideas in constructing the architecture of the system. VisCO2 has been developed using php and html programming language while MySQL database is been used as the mechanism to stored data of admin. The main actor is only the top management of UTP such as the Chief Financial Officer (CFO) of UTP that the highest level that endorsed invoice for monthly billing process.

The Visualization of Energy Consumption by UTP system responsible in visualize the whole energy use in UTP as general view so that the user can understand and analyst the data immediately. Besides that, the VisCO2 system can visualize interactive visual aid such as graph for better comparison on energy consumed data for electricity, academic building and vehicles.

Prototype Development Environment	
Items	**Prototyping Tools**
Programming Language and GUI Design	Macromedia Dreamweaver CS5
Database	phpMyAdmin – MySQL database
Operating System	Microsoft Window 7
Computer Browser	Mozilla Firefox, Internet Explorer, Google Chrome

Table 2: Prototype Development Environment

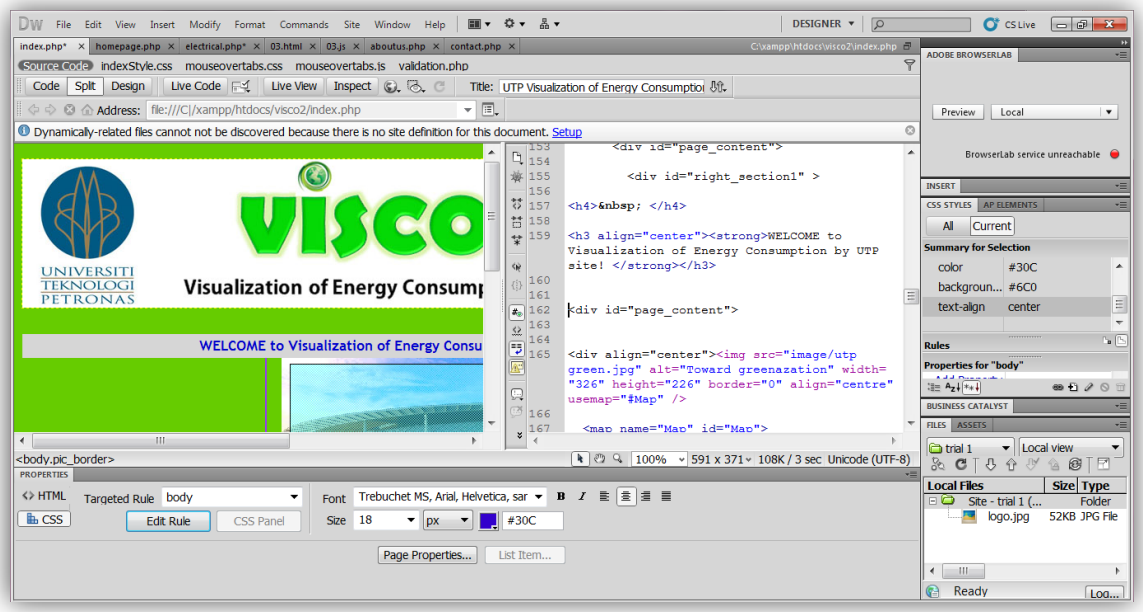

Figure 4: Snapshot of Dreamweaver CS5 application for website development

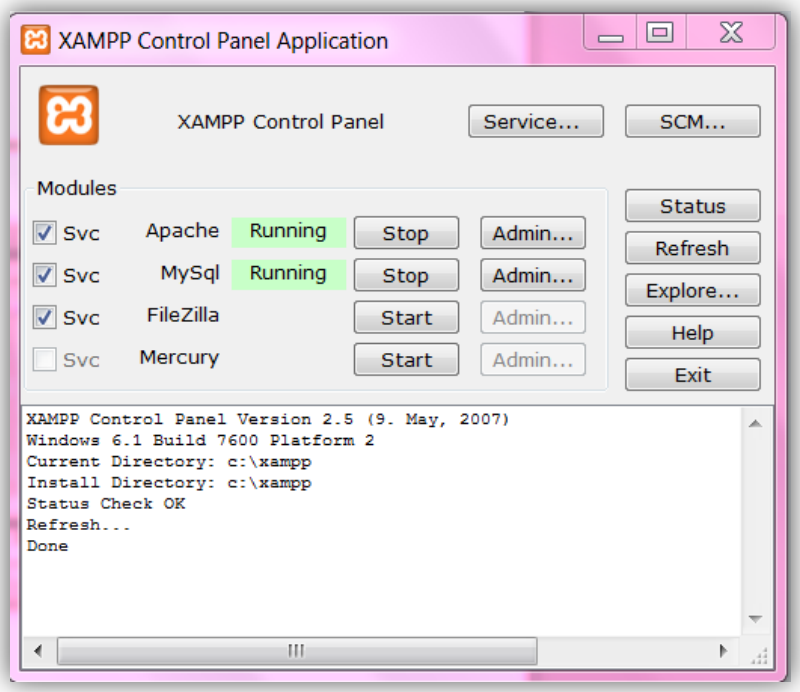

Figure 5: Snapshot of XAMPP Control Panel Application to run MySql database

4.3 Functional Modelling

4.3.1 Use Case Diagram for the System

The Use Case Diagram is one of the functional models in Unified Modelling Language (UML). UML is used to provide a common vocabulary to model any system. Use case is a simple description of a system's functions. It captures business requirements for the system and illustrates the interaction between the system and its environment. In the use case of this web application, there is ONLY one actor that is the admin. Below is the use case for admin.

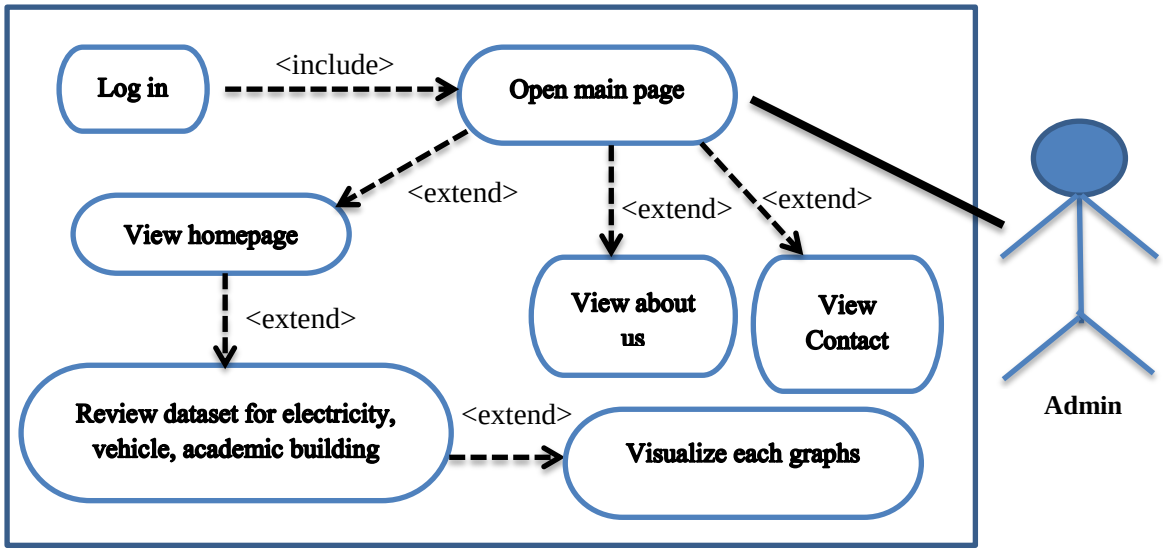

Figure 6: Use case diagram for admin

From the figure 6, we can see that admin the only people will go through the log in process. After that, he or she will go to homepage and have full access in the application. At the homepage, there are link to review energy consumption dataset of electricity, vehicle (fuel) and academic building. After reviewing the dataset, the admin can directly view the attractive graphs after one click to visualize the data. For this time being, the dataset is using raw dataset instead of data extraction or input data.

4.3.1 Activity Diagram for the System

Now, we look into activity diagram. Activity diagram is also one of functional model that illustrates the flow of activities in the system. In this activity diagram, we go to activity diagram for admin.

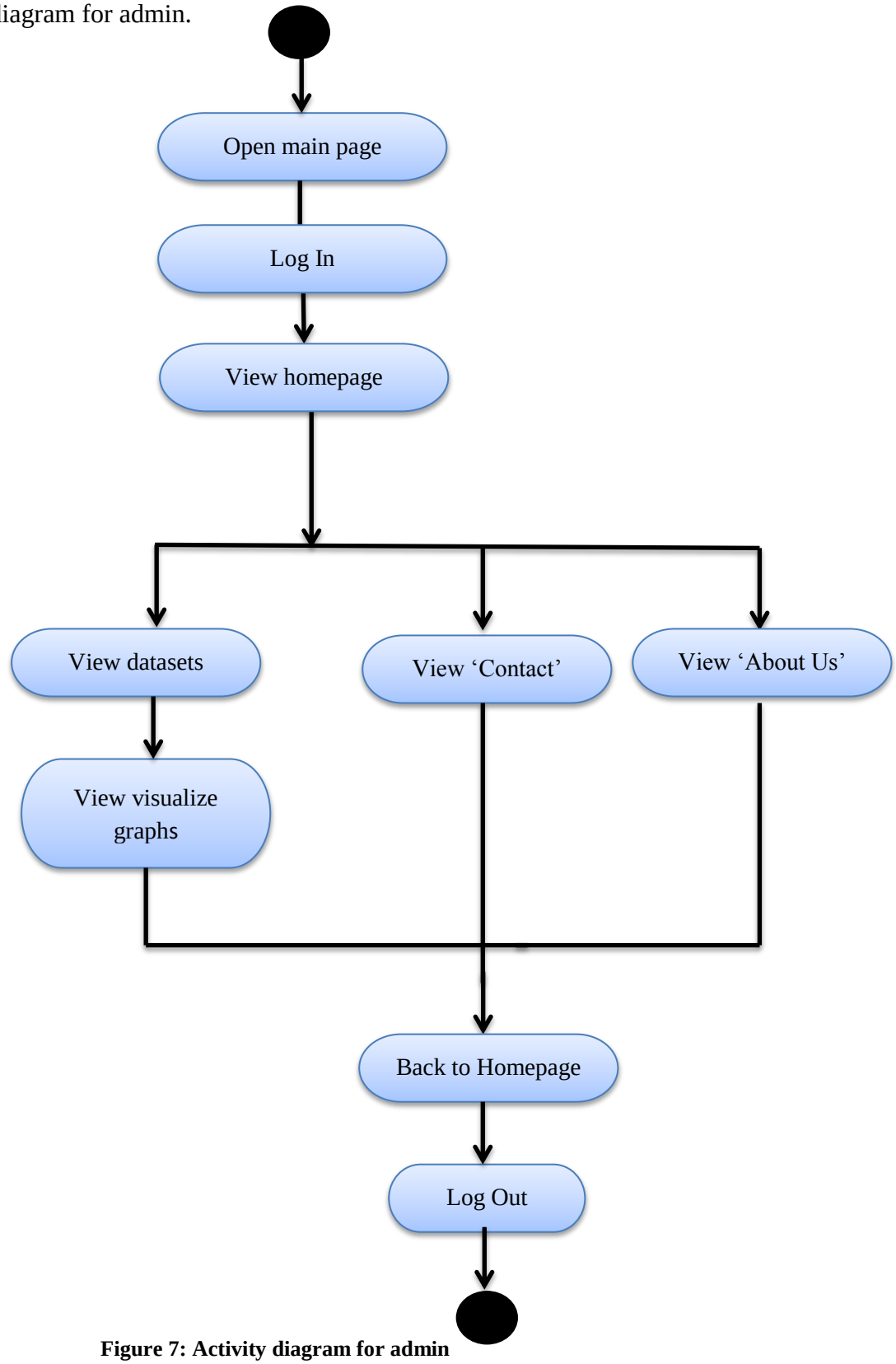

Figure 7: Activity diagram for admin

In the activity diagram, it shows the flow of the activity for the admin. When the admin log in, admin will directly go to homepage and can choose either to view which dataset or visualize the dataset into graph. Admin also can view ‘Contact’ and ‘About Us’ page.

4.4 System Interface

4.4.1 Visualization of Energy Consumption by UTP (VisCO2) main page description

This is the default page when the user logs in start to run the application. The user is only admin. Therefore, the admin need to log in by using private username and password in order to go to homepage. Only valid username and password can access the system.

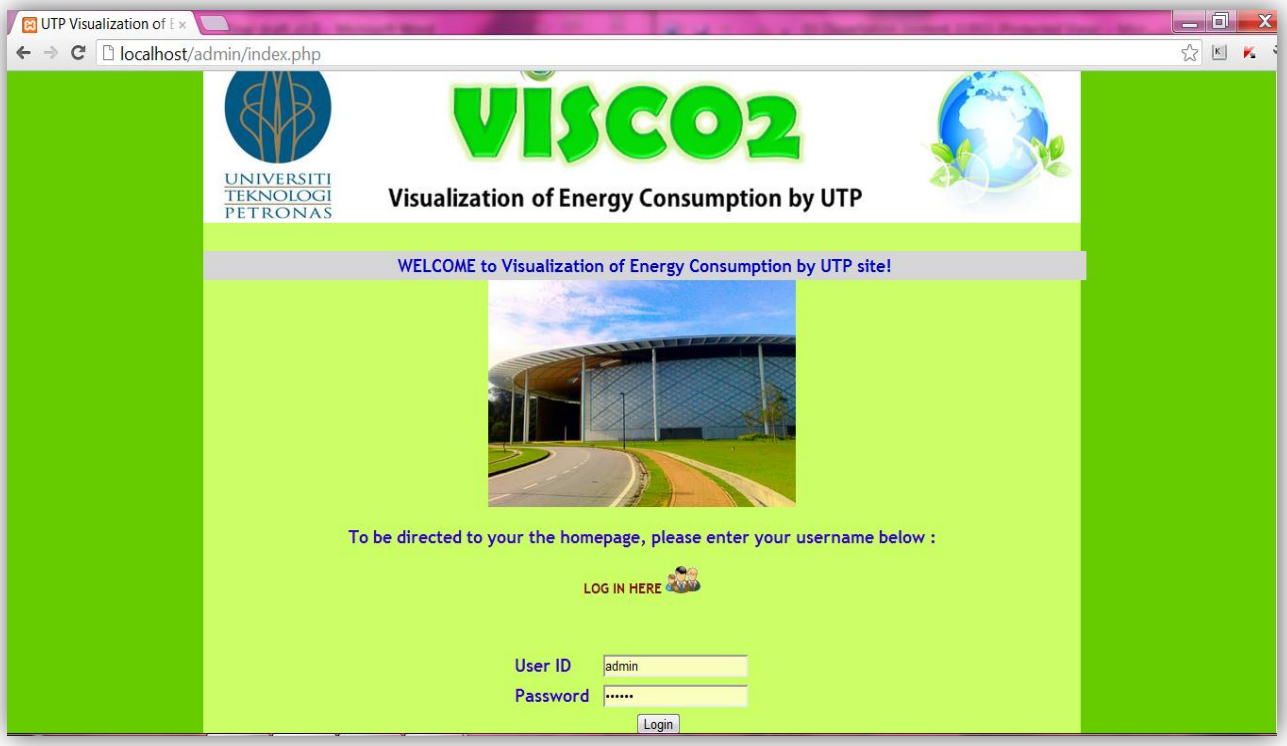

Figure 8: Snapshot of VisCO2 Main Page

Figure 9: Snapshot of login on the main page

4.4.2 Homepage description

Figure 10: Snapshot of VisCO2 homepage

This page is the focal page for admin to view few type of dataset for example electricity, vehicle and also academic building dataset of energy consumption by month. The admin can also review the total energy consumption for all energy consumed by UTP for comparison. Besides that, admin has the authority to view 'Contact' and 'About Us' page. Below is example of dataset and visualize graph for total energy consumed per energy by month of year 2012.

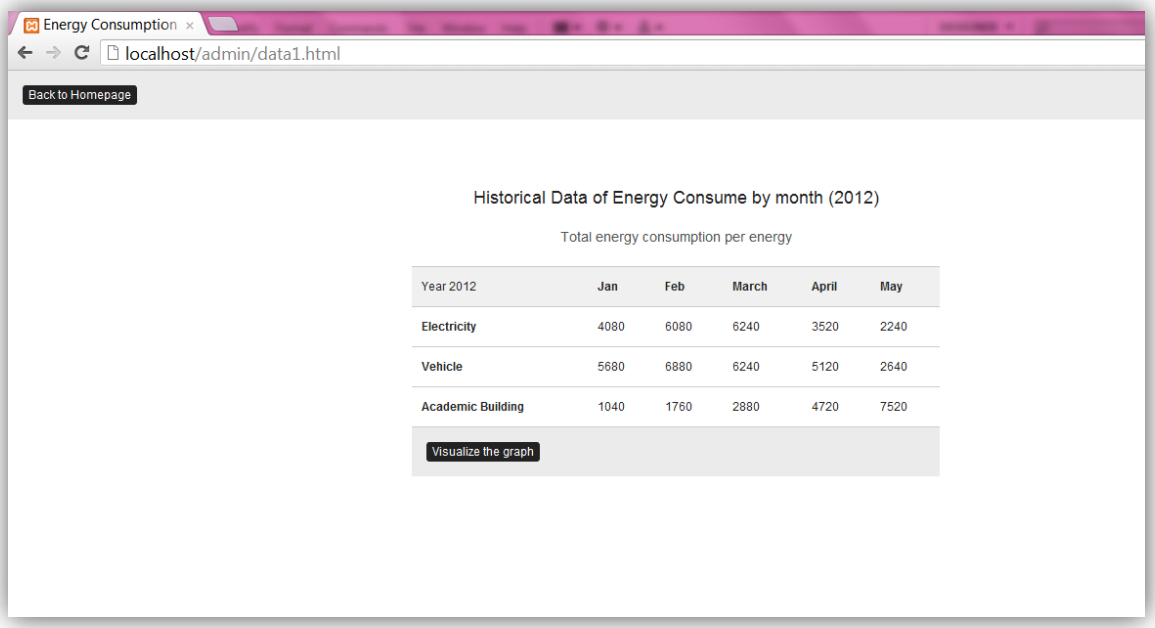

Figure 11: Snapshot of historical data of energy consume by month year 2012

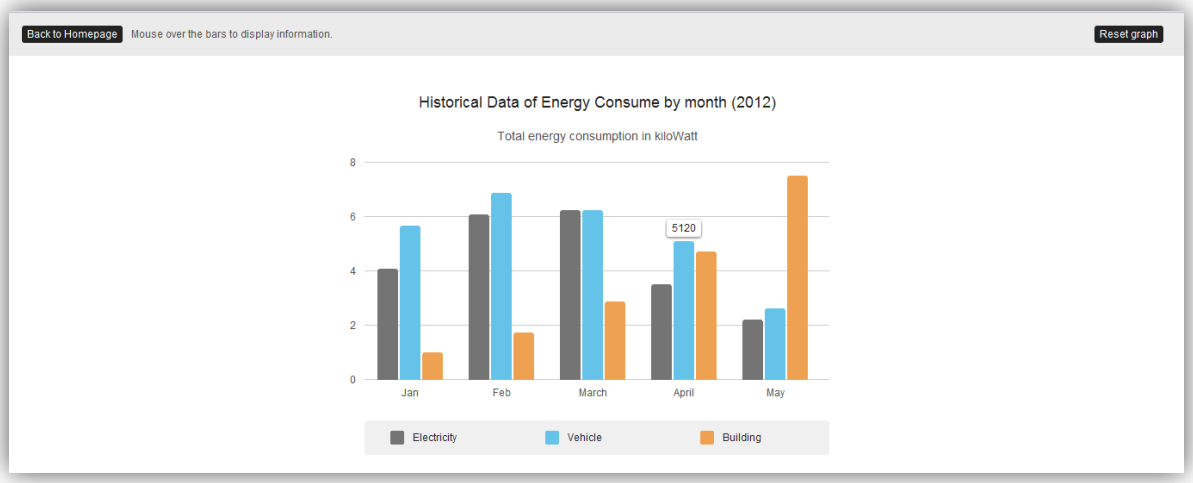

Figure 12: Snapshot of bar graph of energy consume by month year 2012

Based on the figure 12 above, the graphic graph is interesting to review for each type of energy consumes and the actual value of kilowatt displays at each bar. The reset button can show us one by one the bar shows from January until May. From this clear view, the senior management can make immediate conclusion the level of energy have consumed per month either it increase, static or decline by month. The graph below is from electricity dataset.

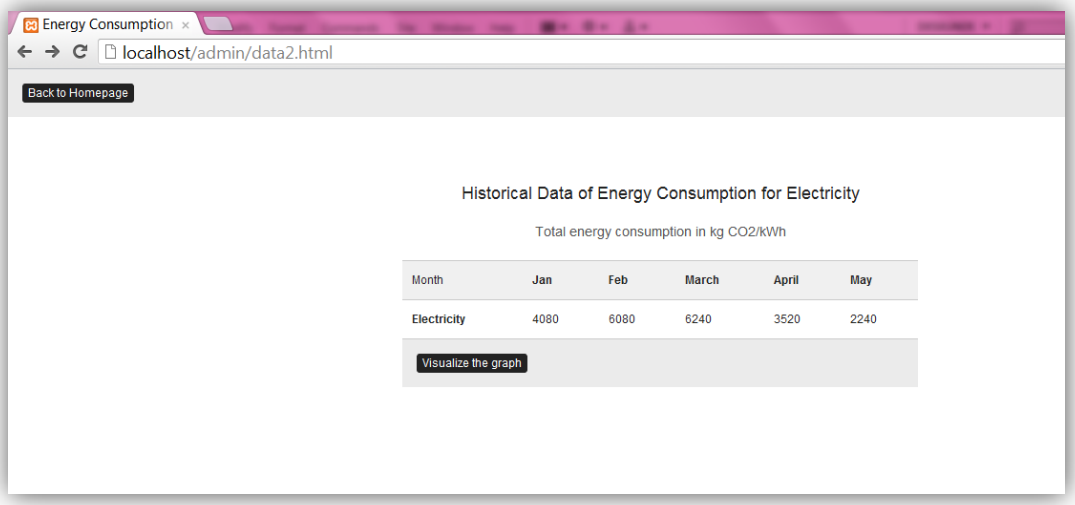

Figure 13: Snapshot of electricity dataset

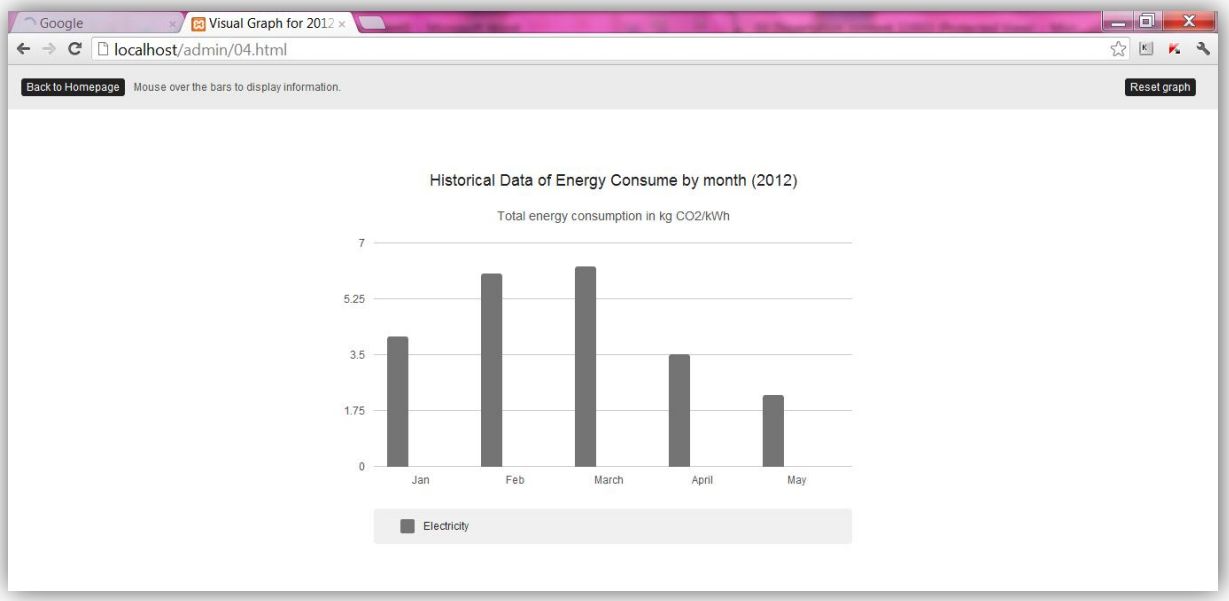

Figure 14: Snapshot of bar graph of electricity dataset

Below are the figures of dataset and bar graph for vehicles and academic building:

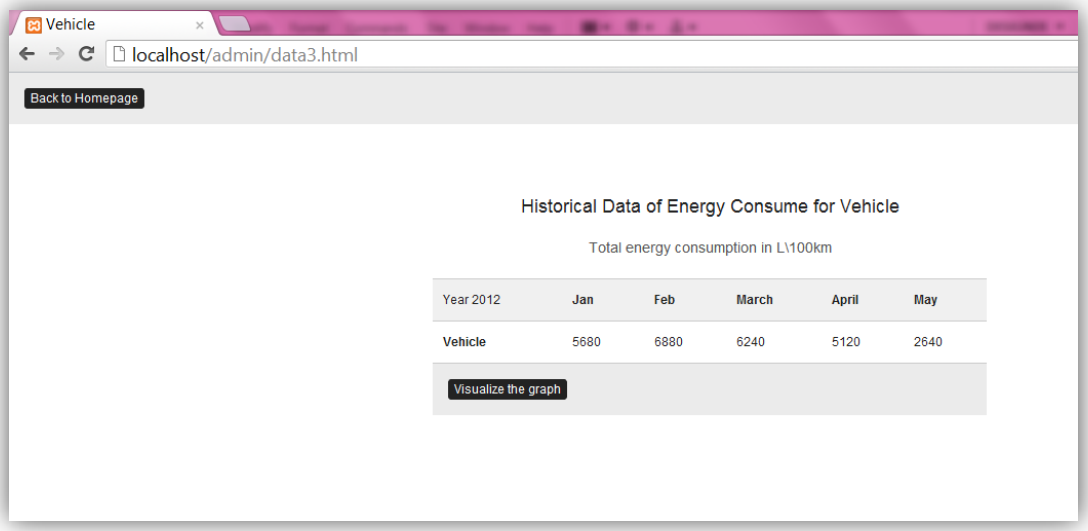

Figure 15: Snapshot of vehicle dataset

Figure 16: Snapshot of bar graph of vehicle dataset

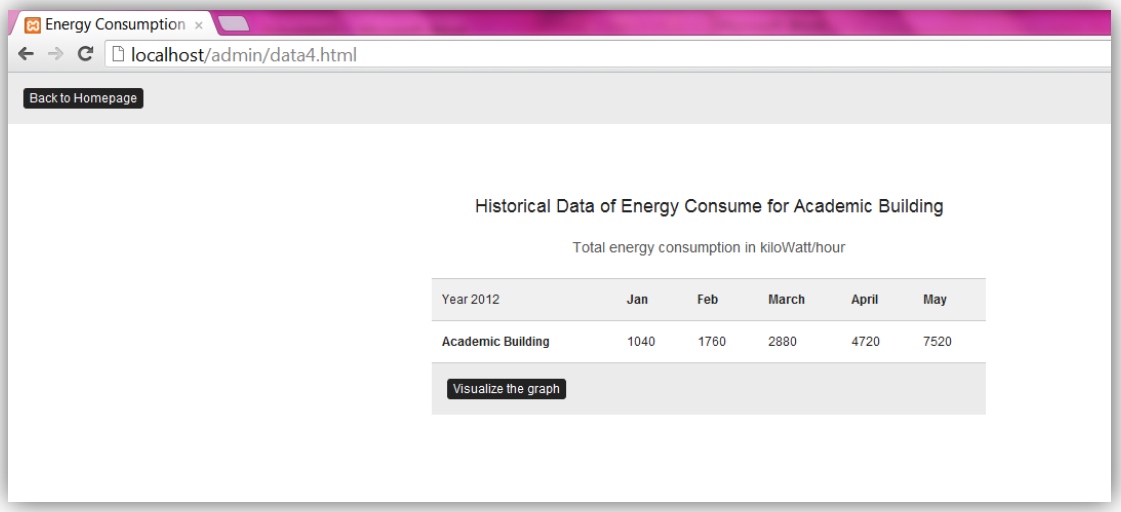

Figure 17: Snapshot of academic building dataset

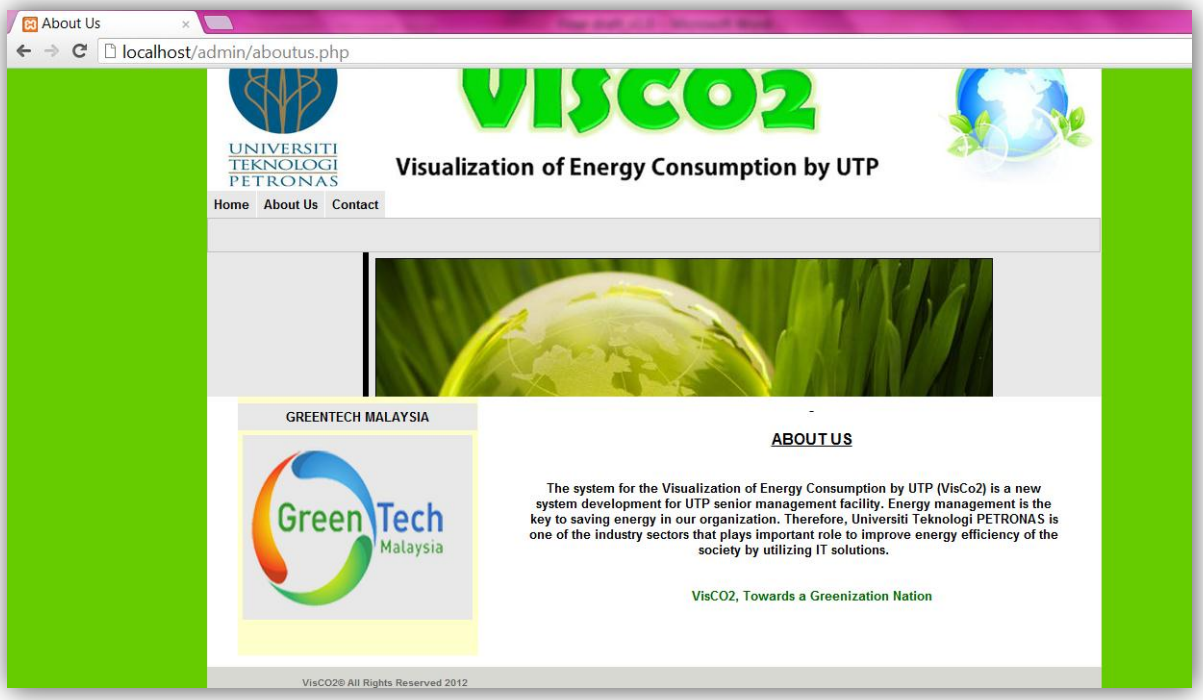

Figure 18: Snapshot of 'About Us' page

Last but not least, the phpmyadmin of local host application is used to store the username and password for user that capable to access VisCO2 application. VisCO2 has one (1) database named admin and a table has created that contains both username and password. Below is the figure that shows a default username and password is set to login the main page.

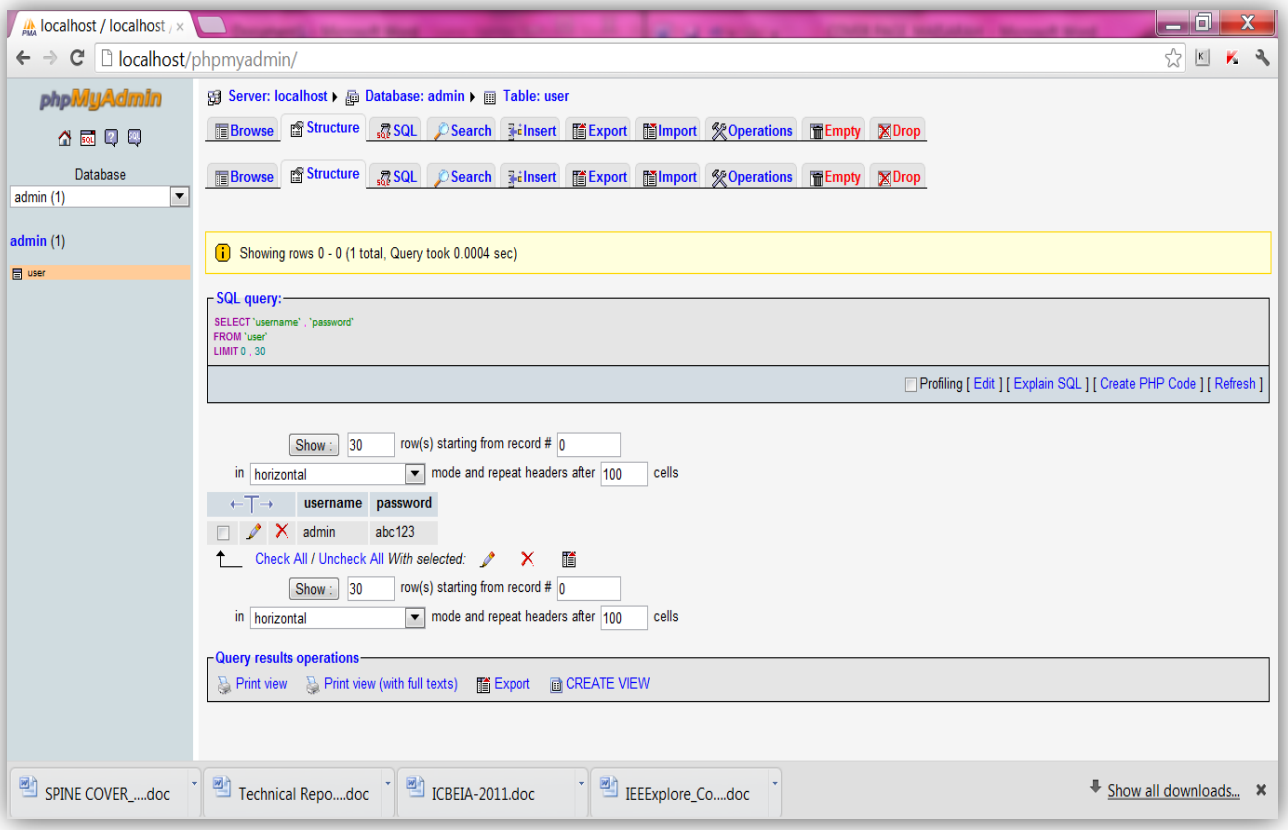

Figure 19: Snapshot of user table created in admin database by using phpmyadmin

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

The project progress went out smoothly as planned, thanks to supervisor who helped a lot during this project development. However, there are few key issues in developing this project, such as the difficulty in finding the journals regarding this new system and field. This is because most of the information is gathered from website driven from Google search engine and from the Visualization of energy consumption product review, due to the limitation in research paper shared on business field and lack of examples.

For future continuation of this project, it is important for the programmer to understand the programming language and if possible to research on interactive interface in order to make a visual aid more compatible with the platform. This is because by using this interface offer is unique so that interest everyone by just looking at it and helpful the senior management to make decision making right away.

In conclusion, the objective of this project, which is initiated in the early stage, seems to be achievable and satisfying due to the hard work and constant progress and continuous research in producing a high quality project. This project is still need of continuous research. Hopefully the development of Visualization of Energy Consumption by UTP (VisCO2) could give a positive impact in the Green Technology in the future.

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Books:

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[7] Website from http://www.oursouthwest.com/SusBus/susbus9/eemguide.htm

[8] Website from http://www.canon-its.co.jp/environment/enecon/

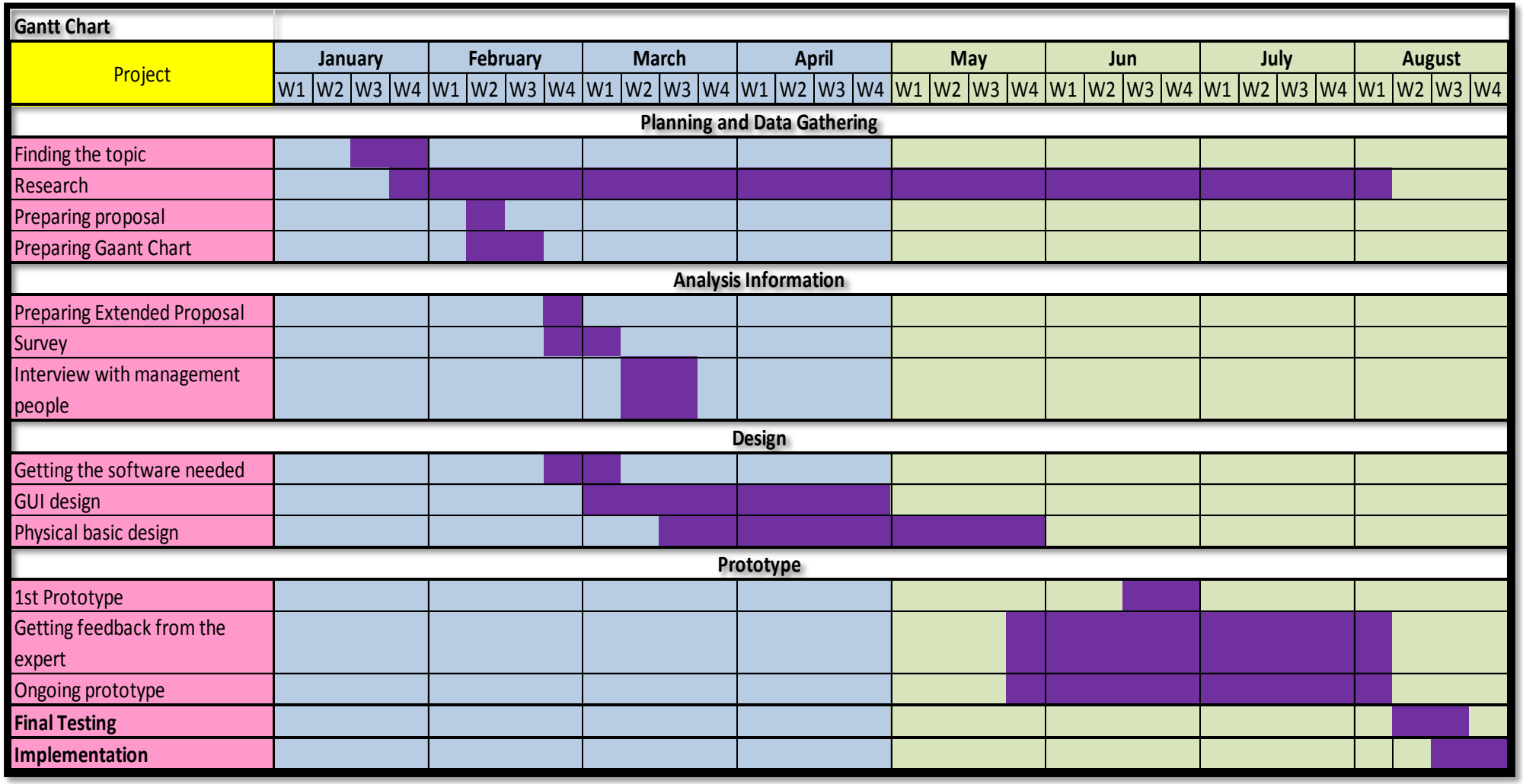
[9] Website from http://www.energylens.com/articles/energy-management

[10] Website from http://www.greensystems.net/

[11] Website from http://uxdesign.smashingmagazine.com/2010/02/25/designing-user-interfaces-for-business-web-applications/

APPENDICES

- **Appendix 1**



Visualization of Energy Consumption by UTP (VisCO2)

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***Abstract* —This project aims to help the senior management to review and visualize the whole general energy consumption of UTP. This aim has lead to development of website that could display few type of energy consumptions so that the top management can take immediate action taken to implement energy saving as well as reduce the Greenhouse effect. VisCO2 acts as front- end system that will be able to visualize few datasets in interactive manner and ease the management people to do comparison. From this development, VisCO2 could contribute greenization and prevent global warming in the future.**

I. INTRODUCTION

Our government have begun to address issues of carbon emissions from all sectors including non-domestic sector which is universities. Globally we need to save energy in order to reduce the damage that we are doing to our planet, Earth.

Visualization of Energy Consumption by UTP (VisCO2) is a web based front end system that provides a user interface to visualize the few type of energy consumed in UTP. The system is used for top management to optimize and reduce the usage of energy consumption from action taken made by senior management.

A. Problem Statement

UTP top management does not have any effective way to review energy consumption. Each department and building uses any machines, air conditioning and electricity without limitation. Hence, these actions ultimately have contributed to emission of greenhouse gases such as CO2 widely. Besides, the data is difficult to get and be retrieved. Senior management people have to get the information by themselves from company data centre and server. Consequently, there is no action taken will be done as no data to visualize energy consumption easily and effectively.

B. Objective

- To build up a user interface for senior management to get overall view of energy consumption to take immediate action.
- To monitor the overall energy consumption area by UTP in order to review the effectiveness and efficiency of energy saving system project.

C. Scope of study

This study focuses on how to visualize the whole measurement of energy consumption from daily activities in UTP including academic building, electricity and transportation management. Besides that, the study focuses on how to show the energy consumption in graphic chart so that the senior management can make an analysis from the visual aid and information.

II. LITERATURE REVIEW

A. Contribution to Green IT for energy saving

Green Technologies is the reduced environmental impact from running an Information Technology (IT) department [2]. IT is highly expected to serve as one of the solutions to this problem. It saves companies money, if viewed over their useful life.

B. Visualizing energy consumption activities as a tool

There is not many intelligent systems were developed to increase the awareness towards our daily energy consumption. In order to build up this system, web applications require a higher level of involvement and knowledge of the system. Besides that, the most important thing to identify the users of system as they will use it to perform their daily business tasks [11].

III. METHODOLOGY

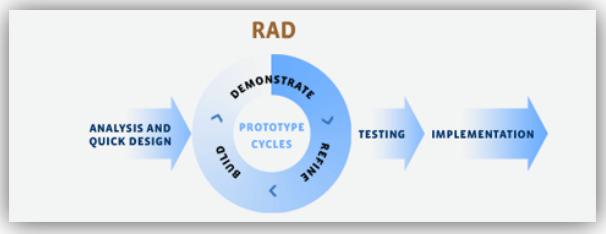

Figure 1: RAD model

The Rapid Application Development model consists of four main phases that this model in developing the system will help to complete the system within the time frame given.

- Analysis and Quick Design

- Prototype Cycle
- Testing
- Implementation

A. *Project Tools*

- Software: Adobe Dreamweaver CS5, PhpMyAdmin 3.3.9 and Microsoft SQL Server.
- Programming Languange: HTML, XML, PHP
- Hardware: Laptop and server

IV. RESULT AND DISCUSSION

A. *Data Gathering and Analysis*

Several interviews have been conducted during the analysis phase in order to gather all the information about staff development program. There are few users have been selected as the interviewees. They are technician of Mechanical Department, manager of KM Department, GTS, PETRONAS and expert Green IT in UTP. Then, the author has done several interviews session including with an senior executive who manage the billing invoice for energy consumed monthly by UTP.

B. *System Development*

VisCO2 has been developed using php and html programming language while MySQL database is been used as the mechanism to stored data of admin. The main actor is only the top management of UTP such as the Chief Financial Officer (CFO) of UTP that the highest level that endorsed invoice for monthly billing process.

Besides that, the VisCO2 system can visualize interactive visual aid such as graph for better comparison on energy consumed data for electricity, academic building and vehicles.

C. *Functional Modelling*

- Use Case Diagram for the System

. In the use case of this web application, there is ONLY one actor that is the admin. Below is the use case for admin.

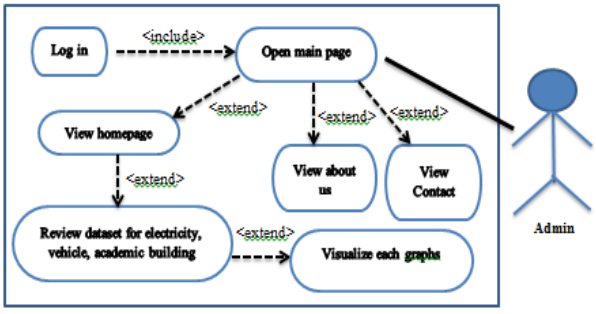

Figure 2: VisCO2 Use Case Diagram

- Activity Diagram for the System

In this activity diagram, we go to activity diagram for admin.

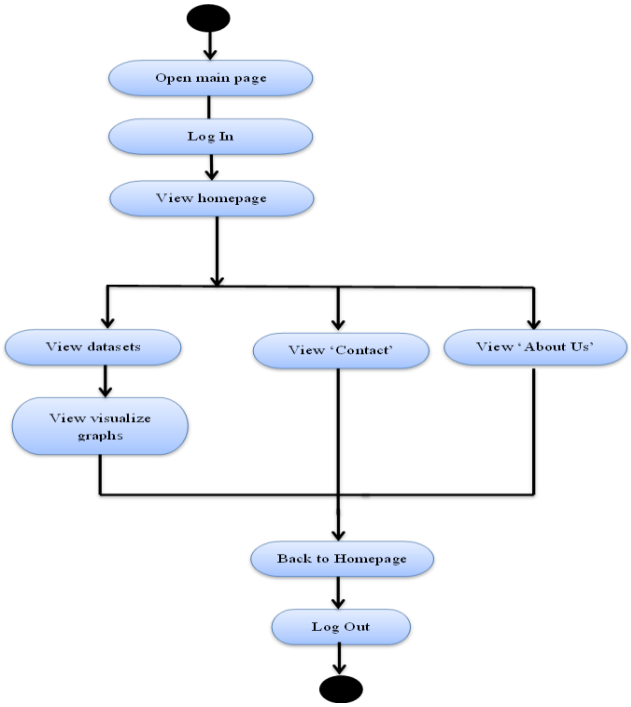

Figure 3: VisCO2 Activity Diagram

D. *System Interface*

The following figures are some of the snapshots of the system.

Figure 4: VisCO2 Main Page

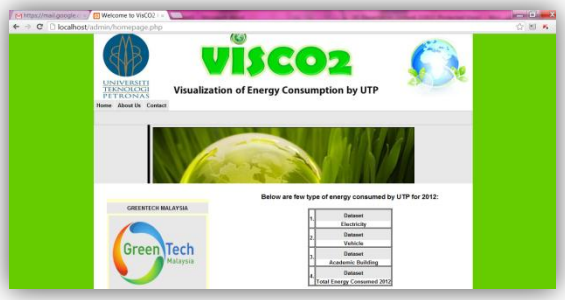

Figure 5: VisCO2 Homepage

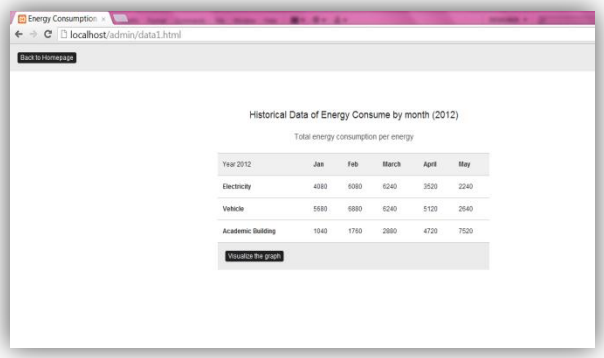

Figure 6: Example of historical data of energy consume by month year 2012

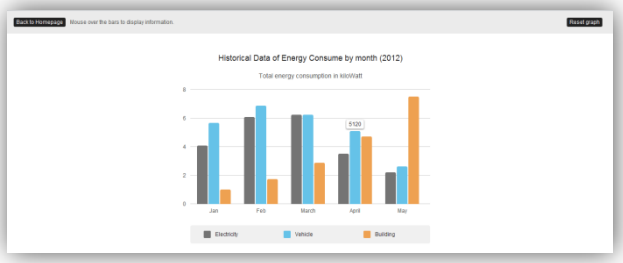

Figure 8: Bar graph of energy consume by month year 2012

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