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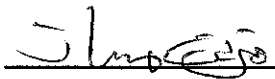
**GHG Inventory Research Assistance Systems**

by

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A project dissertation submitted to the  
**Business Information System Programme**  
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Approved by,



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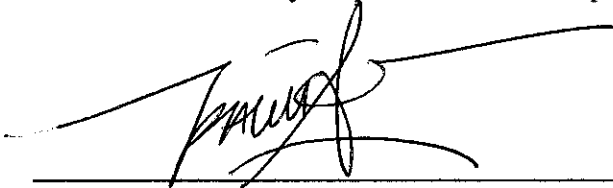
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2) IT/IS - thesis

## **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 herein have not been undertaken or done by unspecified sources or persons.



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MOHD RAIMI BIN MOHD ALWI

## **ABSTRACT**

One of the important actions in reducing the Greenhouse Gas (GHG) emission is by monitoring it. GHG Inventory is one of the ways to record all related data regarding the GHG emission. It is important for a country to record GHG Inventories. Research Officers (RO) from Pusat Tenaga Malaysia (PTM) is responsible for the process in Malaysia. A system is to be study and developed and it has its own objectives; the ability for the whole system to assist the Research officers in doing the GHG Inventory research and managing the data and information. The Research Officers will be able to record data for the GHG Inventory for more than one base year, they can monitor and update the data for any changes and then the system will help them in producing any relevant reports required for the research. The system will also be able to help a new user with no experience in GHG Inventory to do the work as guidance and the information are given to the users. The objectives are defined from the problem occurred in the current system used by the RO in the organization. The data and information for GHG Inventory cannot be recorded dynamically, and the process is complicated which requires more time, cost and other resources. This study has been utilizing computer technology to ease in managing the data and information in GHG Inventory. The system was developed by using the phased development methodology which will breaks the overall system into a series of versions that are developed sequentially. Many findings have been made and new ideas are implemented to improve the system.

## **ACKNOWLEDGEMENT**

After 2 semesters of development period, this final year project is finally done. It was a great exposure working along with all of the individuals that involved in this project. They have given so many contributions. They have provided guidance, advice and assistance that I really consider to be priceless. I would like to thank them all for such commitment and support in realizing the goals and the successful completion of the project. Special Thanks would be pointed to Pn Mazlina Mehat who had supervised me throughout the year. Her kindness and time spent to guide me are highly appreciated. She gave her very best for the sake of knowledge and experience.

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## **ABBREVIATIONS**

<b>PTM</b>	<b>Pusat Tenaga Malaysia</b>
<b>PARM</b>	<b>Policy Analysis and Research Management</b>
<b>NRE</b>	<b>Ministry of Natural Resources and Environment</b>
<b>IPCC</b>	<b>the Intergovernmental Panel on Climate Change</b>
<b>RO</b>	<b>Research Officer</b>
<b>CEO</b>	<b>Chief Executive Officer</b>
<b>GHG</b>	<b>Greenhouse Gas</b>
<b>UTP</b>	<b>Universiti Teknologi Petronas</b>
<b>EFDB</b>	<b>Emission Factor Database</b>
<b>TSU</b>	<b>Technical Support Unit</b>
<b>CO2</b>	<b>Carbon Dioxide</b>

# **CHAPTER 1**

## **INTRODUCTION**

### **1.1 Background of the study**

Temperatures around the world are, on average, going up. If no steps taken into action to stop this from happening, the global temperature will rise. The main cause of global warming is the emission of what are called “greenhouse gases” (GHGs). GHG consist of carbon dioxide, methane and nitrous oxide.

One of the important actions to reduce the GHG emission is to monitor them. GHG Inventory is one of the ways to record all related data regarding the GHG emission. It is important for a country to record GHG Inventories. The Data is then being analyzed and submitted to the NRE (Ministry of Natural Resources and Environment) and to the “Intergovernmental Panel on Climate Change” (IPCC).

Pusat Tenaga Malaysia is an independent and non-profit company devoted to energy research in Malaysia. One of the divisions in the company is the “Policy Analysis and Research Management” (PARM). PARM is responsible for recording all data.

Currently, the ROs in PARM are using a spreadsheet provided by the IPCC to record the GHG data. They also provide several materials for guideline and standards that being followed in recording the GHG Inventory.

Basically, the overall view of this study is to provide the solution for managing the data and researches related to the GHG Inventory specifically in Malaysia. Knowing the importance of controlling our activities that might affect our environment, steps has been taken in addressing the problem. One of them is Malaysia’s commitment in recording



the GHG Inventory under the Kyoto Protocols. However Malaysia is still new with the process and activities. The numbers of people who have the related knowledge to manage the GHG Inventory processes are limited which is the PTM Research Officers (RO).

There are two types of ROs for the recording GHG Inventory. The first type comprises of expert ROs who are familiar with the GHG Inventory processes. These are the ROs who serve in PARM. The other is the non-expert ROs. They have little or no knowledge about the GHG Inventory process as they are from other research department in PTM. But from time to time, they do help the expert ROs in the research process.

In this study, the research in GHG Inventory includes monitoring, analyzing and to produce related reports about the GHG Inventory data. The GHG Research Assistant System is developed to fulfill the ROs requirements. The system is designed to ease the ROs to do their Research process by using familiar interfaces and systems.

## **1.2 Problem Statement**

### **1.2.1 Problem Identification**

Currently, the ROs in PARM are using a spreadsheet provided by the IPCC to record the GHG data. They also provide several materials for guideline and standards that we are going to follow in recording the GHG Inventory. However, the ROs are complaining that the spreadsheet has several limitations.

One of the main limitations of the spreadsheet is that it could only record data for one year. They cannot enter data for 2 or more years. In order to record next year's data, they would have to make another copy of the spreadsheet. The spreadsheet is also complicated and it was hard to enter data. It is hard to find a particular fuel type in the spreadsheet. If the particular fuel type is found, the user has the tendency to do a simple error like putting a data in the wrong cell in the spreadsheet. The interface for the current system is also very hard to understand. Sometimes, the RO do not know whether they are doing the correct procedure in entering data. They have to open the IPCC guidelines for reference each time they encountered any problems.

The number of ROs in PTM is limited and they are the expert on GHG Inventory. If this person is on leave or not available, the process is going to be delayed and it would affect the time management and cost of a project.

Furthermore, PTM's Chief Executive Officer (CEO) needs to be updated with the GHG Inventory report. He needs to forecast the emission in the future.

### **1.2.2 Significance of the Project**

The project and the study itself would probably address the problems that have been identified which are the limitations of the spreadsheet and the complicated research process. Each problem will be solved using the system. The system is basically aimed to help the RO to do their research using the minimum input for the maximum output. The time, cost and other related resources such as man-power, and references are the inputs and the reports and findings are the outputs.

The project is going to demonstrate the ability of the new system developed by fully utilizing the main Microsoft products and other plug-in systems that are currently being used in the company to help the GHG Inventory Research process.

## **1.3 Objective and Scope of the Study**

### **1.3.1 Relevancy of the Project**

As an overview, the main objective of the study is to develop and introduce a new system, which can assist the ROs to do their GHG Inventory research and manage the data and information. The system will reduce the complexity of the process of managing the GHG Inventory research and information management.

Other expected results would help in Human Resource Management as it will guide the non experts to aid the experts to fulfill their tasks. The person in charge of doing the GHG Inventory Research and Information Management can be a non-expert ROs. The system can guide this type of user to follow a step by step instruction and it is fully understandable even if the user have no knowledge about the GHG Inventory process.

The scope of the study is primarily to improve the current GHG Inventory process. The workflow of the system is designed to help the user. This will save time and money in doing the GHG Inventory research processes. The system is suitable for Malaysian GHG

Inventory from the energy sector only. In Malaysia, the energy sectors contribute more GHG emission than the other sectors.

The system will help to store and manage the data collected by the RO. These data can be for different years and this will make the data more recognizable. Previously, the RO have to make another copy of the spreadsheet as a template and store it in a different file. They tend to forget where the files are kept and new users do not know how the files are managed.

The system will also help to ease the RO's research activities even if they do not have any experience in GHG Inventory. The system will have its own guide to assist the user for doing the research. This includes the step by step guide, the related formulas, and other relevant information for the research. The info is referring to the IPCC guidelines.

The system will help the RO to forecast the trend for the actual CO<sub>2</sub> emission in the short coming future. This is done by plotting the data that has been collected into a graph. The graph that will be displayed will help the RO to identify the potential trend of the GHG emission in the future.

With all of the guides that the system can provide to the user, this will help to reduce the time to do the data collecting activities and do the research. The non-expert RO can learn quickly and get the job done. It does not require any training as the system will help the user on how to use the system. The user interface is improved from the present spreadsheet that is being used. The relevant reference can also be accessed from the system.

### **1.3.2 Feasibility of the Project within the Scope and Time Frame**

From what being observed and analysed, this project is able to be completed throughout the given semesters. From here it could be seen that, the available time frame (Refer to Appendix I) could be spend towards integrating the software, rather than in focusing upon the issue of configuration. Most of the time would be needed in focusing upon the problems which could be occurring from the data given and the issue of integration. But completion has been achieved.

## **CHAPTER 2**

### **LITERATURE REVIEW AND THEORY**

The aim of the study is to introduce a new system that can assist the ROs to use GHG Inventory and utilize the outcome for their research. Another aim of this study and project itself is to reduce the complexity of GHG Inventory information management. If the complexity of the process is reduced, the cost and the time that are going to be spent on the yearly research could also be reduced. Other expected results would be from the Human Resource Management point of view. The person in charge of doing the GHG Inventory Research and Information Management can be a non-expert RO by using the system.

The current System uses the tools provided by the IPCC. However, not all of the methods are relevant to the research that is being done in Malaysia. The Reference that is being used now, the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, is created to suit all countries in the world. So the information in the guidelines is created to suit any possibilities but some of the methods cannot be done in Malaysia.

The current tool is not equipped with the related information on how to conduct the GHG Inventory related work and cannot help the users to identify the trend of the GHG emission in the future.

A database on GHG emission factors with supporting scientific information would also support the future review.

“In response to this need, the Technical Support Unit (TSU) of the IPCC National Greenhouse Gas Inventories Programme (IPCC-NGGIP) has developed an emission factor database (EFDB). The primary goal of the EFDB is to grow towards a recognized library, where users can retrieve and submit emission factors and other parameters with background documentation that can be used for estimating GHG emissions in national inventories.” (Magino, p.1)

The EFDB currently provides a web-based platform for submission and retrieval of new emission factor and parameter data, as well as an intermittently released CD ROM version of the database. An EFDB Editorial Board has also been established with the objective of ensuring all emission factors and other parameters contained in the EFDB are technically sound according to pre-defined criteria.

The primary goal of the EFDB is to become a recognized library of well-documented emission factors and other parameters to estimate emissions of direct greenhouse gases. However, this information is designed suitable for the European countries. If the Malaysian ROs would want to use the reference, it requires time to understand which information is needed that suite for local GHG Inventory work and activities. However, the EFDB concept of being the library of well-documented emission factors and other parameters to estimate emissions of direct greenhouse gases can be used in this study by focusing to the related information in Malaysia.

Emco2, an application that collects and analyze of data for carbon dioxide emission (greenhouse gas emission) has also been developed by Anasoft Inc.

“Fuel consumption data and emission source details are collected by fuel consumers’ through data entry screens. Data for a year and a department can be exported as automated data entry spreadsheet, populated and imported back in system.” (Anasoft Inc., 2004)

"Various reports can be generated to monitor emission volume and compare source of emissions by departments, fuel types, fuel sources and emission models. This will provide enough information for a corporation management to identify critical emission generators, monitor and evaluate actions for greenhouse gas emission reduction and promoting energy efficiency projects to deliver comprehensive benefits, including attractive financial performance" (Anasoft Inc., 2004)

Emco2 only calculates the CO2 emission and all source of data needed to be input in this application is not the same in this study. However, the workflow of the application can be implemented and does help in this study.

This study is not searching for a way to calculate the system or to make a research on what are the information needed for doing the GHG Inventory, but to find a way on how to utilize all of the resources to make the process of the GHG Inventory research and managing the data and information. All of the resources found during this study will be used in developing the system.



## **CHAPTER 3**

### **METHODOLOGY/PROJECT WORK**

#### **3.1 Procedure Identification**

The methodology chosen for this study and the development of the application is known as the phased development.

A phased development methodology breaks the overall system into a series of versions that are developed sequentially. The analysis phase involves with the overall system concept, users, and system sponsor then categorize the requirements into a series of versions. The most important fundamental requirements are bundled into the first version of the system. The analysis phase then leads into design and implementation, but only with the set of requirements identified for version 1. (Refer to Appendix 1)

In Version 1 of the system, the main goal is to make sure the system could at least collect data from the user and they store them in the database. This is done by doing the analysis on the calculation of the GHG emission first. This information is obtained both from the IPCC Guideline and from the Spreadsheet. Appendix II shows the interface for the spreadsheet that is currently being used. This phase of completing version 1 also include the design for the system. The product would have the functions listed in Appendix III where the RO can do the monitoring, analysis and reporting about the GHG Inventory with the system. The data flow diagram of the system is shown in Appendix IV.

In version 1, the database and its interface has been developed and designed for storing the data. After all the design is completed, the system is tested whether it can surely store the required data. The design will be subject to change in the development process from one phase to another. However the interface is ready and integrated with the current database model.

Once version 1 is implemented, work begins on version 2. Version 2 requires more information about producing the report. The expected reports are in charts and tables that can present the GHG Inventory data. The reports can be in a form of word documents or the spreadsheet. So, in the early stage of Version 2 development, most of the time would be the period of doing the research on what kind of form to produce and how to produce them.

In the process of getting the required information, along the way, the information is implemented. This is the designing phase in developing version 2. Designing the system in Version 2 requires revising the system that has been designed from Version 1. There will be changes in the overall design whether from the database design or the interface and the workflow. Changes would be made in the design of Version 1 or version 2 or both. After completing all of these processes, the system was again being tested for implementation. This process involves usability testing on the system and also conducting interviews with the RO. The RO has given several guidelines to follow for the system's improvements. The guidelines include additional reading materials and also a few of their latest reports on the GHG related researches.

Version 3 includes the final feature which is the help and information feature. The system is equipped with a help feature which can guide the user through almost all of the process using the system. To complete this feature, additional information is needed and they are to be restructured so that it suite the system. If the information is not enough for the user, the system could at least recommend where to go to search for advance reference. The design of the interface was changed for this additional feature and finally, the system was tested again.

The advantage of this kind of methodology is quickly getting a useful system for the users. The system does not perform all of the functions the users need at first but will deliver them after the completion.

### **3.2 Tools**

The development of the system will require a number of software and tools as what would be described as follows;

#### **3.2.1 Software Requirements**

The project would be focusing upon the mission of fully utilizing the system that is being used in PTM and integrate them into a new solution system. Basically, the software which is needed in completing this particular project would be;

- Microsoft Access (This software would be the database for the system. A few of the Interfaces would be created from this software as well)
- Microsoft Excel (This software would likely to be use for producing the reports such as spreadsheets and graphical reports.)

## **CHAPTER 4**

### **RESULTS AND DISCUSSIONS**

The Development process involves 3 phases. Each phase has come up with a prototype as mentioned in the methodology. This part of the report will be discussing on the analysis, design and implementation that involves in all three version of the system. This includes the results of the interview and questionnaires given to the users.

#### **4.1 Phase 1: Version 1 prototype**

During the development of the first version of the system, several finding are crucial in improving it. The analysis part in developing the first version involved giving surveys to the ROs who are going to use the program. From the survey, each person has different opinion on what is the most important thing that they are going to expect from the system.

One of the RO put a major concern on the end result which is the output of the system. The reporting that are going to be output from the system must follow the guideline accordingly as the data are very crucial for their research findings. These data are used to make other reports that are going to be published to public. The RO does not care if the workflow is very complex as long as they will produce information that meets certain quality.

Meanwhile, other ROs care about the workflow and the interface of the program. The spreadsheet that they are using is not easily understandable. They often forget how to enter the data in the spreadsheet. They suggested that the program's workflow must be understandable. They requested for the fuel type listed in the spreadsheet to be found

easily. The current spreadsheet lists down all possible fuel type even if it is not suitable for Malaysia.

From the development of the database design of the first version, the system is very likely to be a complex system which requires many tables link together so that they can produce the required results. They are carefully designed so that they will meet the guideline requirements.

Designing the new workflow for version 1 of the system has created a new process in recording the GHG emission data. This process, however, still refer to the IPCC guidelines and the spreadsheet. The interface of this system can guide the user to record specific data that is required. The user can simply find the fuel type, and the system will lead the user to enter all data step by step. They can also preview the calculation from their input. The systems guide the user through the process of data recording.

Transforming the spreadsheet into this system creates a new interface that can be understood easily. The fuel type can be easily found and nicely presented in the interface. The fuel type is aligned according to their categories.

Realizing that not all of the fuel type listed in the guideline and the spreadsheet are used or suitable for Malaysia, only the fuel type that are suitable are selected to be included in the database. This is to reduce the complexity of the system and to reduce errors from user. All of the research processes are according to the guideline given as mentioned earlier in this report. The process and calculations involved in the research will not be obsolete at least in the next 8 years.

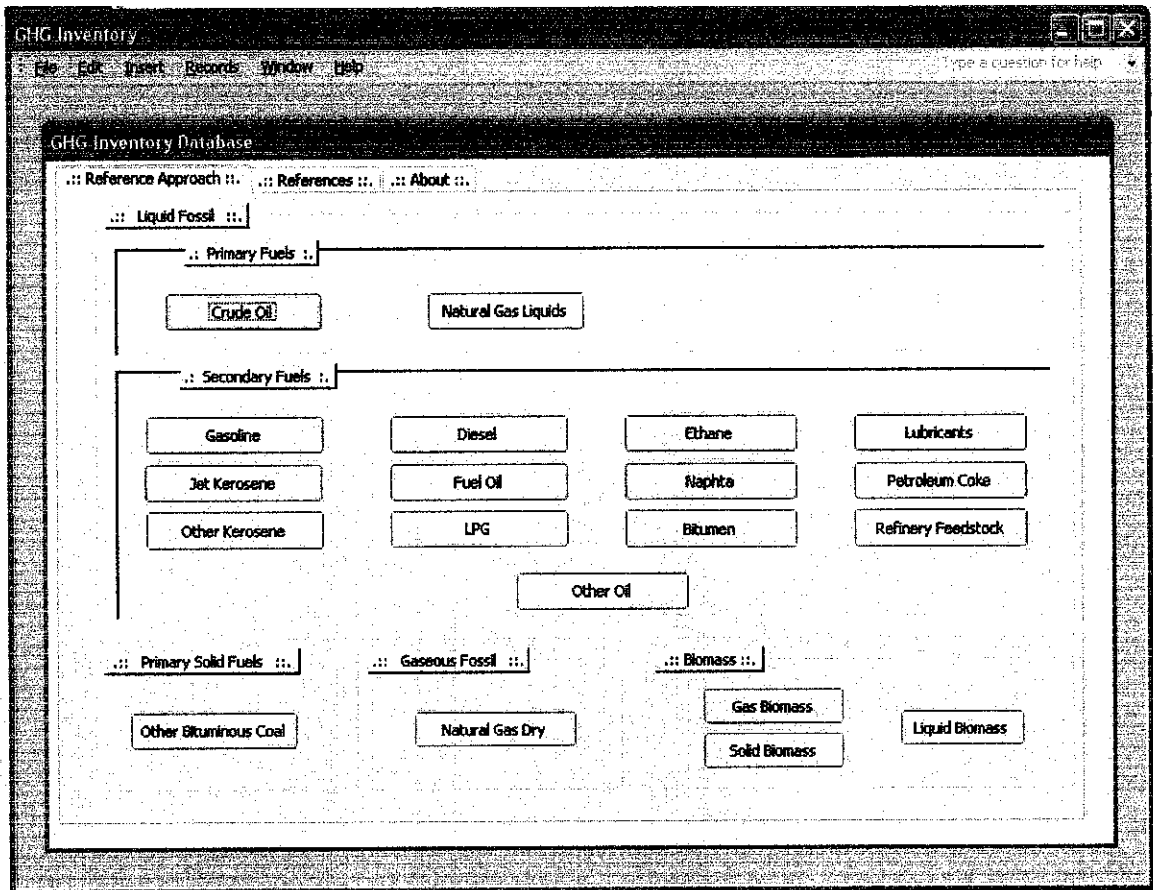


Figure 4.01: The Main menu for GHG Inventory Research Assistant.

Figure 4.01 is the main menu for version 1 of the system. The fuel type is listed in the main menu so that the users can easily find the fuel type in their category. Once the Fuel type button is clicked, the user will be guided by the system for data recording process.

GHG Inventory Database

## Crude Oil

::: Fuel Type : Liquid Fossil > Primary Fuels :::

Year:	2002	
Production:	34838	ktoe
Imports:	7083	ktoe
Exports:	18100	ktoe
International Bunkers:	0	ktoe
Stock Change:	989	ktoe
Carbon Emission Factor:	20	tCO <sub>2</sub> /t
Carbon Stored:	0	tCO <sub>2</sub>
Fraction of Carbon Oxidised:	0.99	ktoe

Advanced >>

- Lubricants
- Petroleum Coke
- Refinery Feedstock
- Liquid Biomass

Figure 4.02: Data Input Form

The Data input form will appear and requires input from user (Figure 4.02). After saving the record, User can see the calculated results from their input in the data input form. This is done by clicking at the “Advanced” button. A new form will appear as shown in Figure 4.03 showing the calculated results.

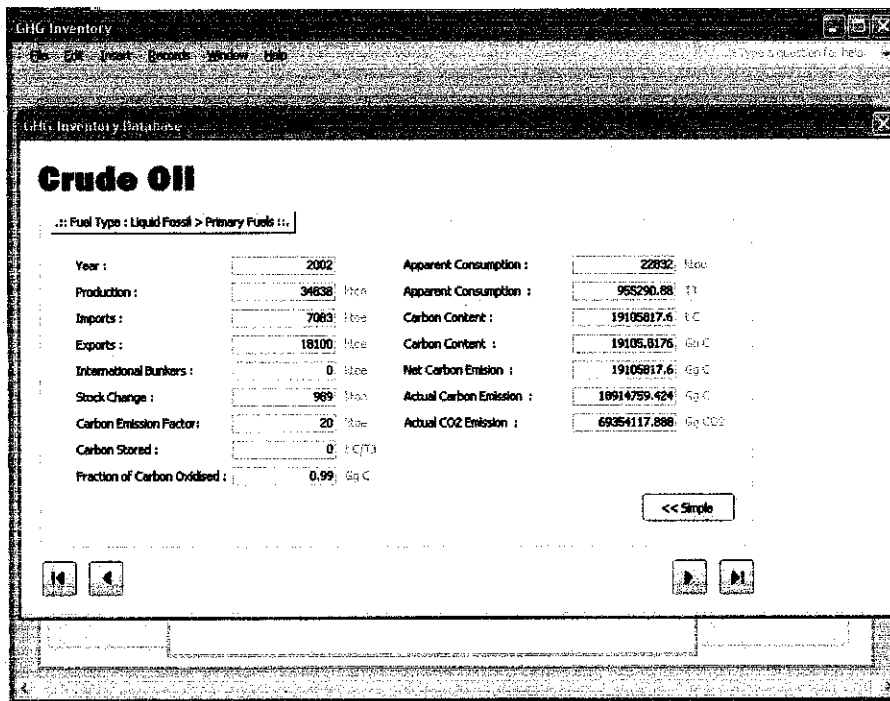


Figure 4.03: Calculated Form

After the user interface is ready, the screenshots of the interface are given to the user and they gave feedback. Overall, they are satisfied with the interface but certain things from the design have caught their attention and they gave comments on them. All of them are not familiar with common terms that IT professional use. They are also not familiar with the icons for saving, deleting or updating the records. These problems can be solved by replacing the icons with words or adding the icon with “tool tips” or “tip text”. This information is useful for designing the next version of the system.



## **4.2 Phase 2: Version 2 prototype**

The main focus in Version 2 prototype is to develop a fully functional system. This includes generating reports from the data that has been calculated by the systems. The early stage of development process involves acquiring user requirements from the ROs. This includes sending them emails and scheduling phone calls to ask them on how do they want the report to be presented.

Based on the feedback, they want the report to be straightforward and not all of the fuel types are required to be on the report. The reason for this is that they want the report to be easily customized as a lot of research and other reports require the same data. The fuel type that are important in the report are the fuel type name, the carbon emission factor, the apparent consumption of the fuel type, the fraction of carbon oxidized, and the actual CO<sub>2</sub> emission which is the main focus of this system.

Another kind of report is to see the trend of the overall CO<sub>2</sub> emission of each year. This can be represented by a bar graph. By having this report, the RO can review the impact of the fuel consumption in a year to the overall CO<sub>2</sub> emission. They can see whether the CO<sub>2</sub> emissions are increasing or decreasing.

After acquiring the important information, the development processes continued by improving the Version 1 prototype and also adding the new feature which is generating reports from the calculated GHG data. The systems' workflow has been improved by adding a new interface for the expert user and the non-expert user. The non expert user will use the interface that will guide the user through out the data input process. The Expert user will use the interface that is straight forward as they are familiar with the systems. The followings are the new system workflow and also the reports generated by the systems.

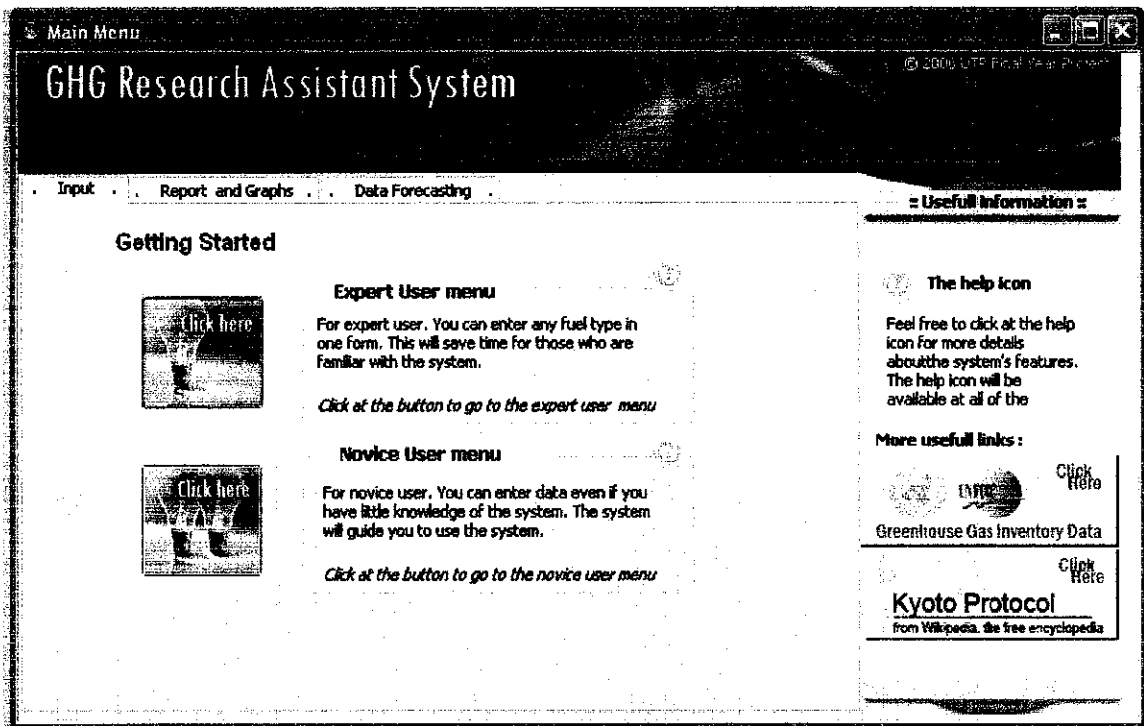


Figure 4.04: The GHG Research assistant Systems Main menu.

Figure 4.04 is the main menu for the system. Basically the systems interface has three tabs which is the “Input” tab where user can input data, the “Reports and graph” tabs which will have the option to generate reports and graphs, and also the “Data Forecasting” tab. There are also small help icons that can be found in the interface. These small icons will prompt a window that will give information and guides for the user that is not yet familiar with the systems. However, the “data forecasting” tab and the help icons’ functionality was developed in the third phase (In version 3).

This is the “Input” tab where the user will find two buttons. The buttons will bring the user either to the “Expert User Menu” or the “Novice User Menu”. The Expert user menu has the interface that is straight forward for the users that are familiar with the system or the Research process. (Refer to Figure 4.05)

GHG input form :: Expert user menu ::

## Data Input Form

### GHG Research Assistant System

Input Data		Calculated Data	
Year:	2000	Apparent Consumption:	20650 ktoe
Fuel Category:	Liquid Fossil	Apparent Consumption:	863996 TJ
Fuel Type:	Crude Oil	Carbon Content:	17279920 t C
Production:	LNG	Carbon Content:	17279.92 Gg C
Imports:	Gasoline	Net Carbon Emission:	17279920 Gg C
Exports:	Other Kerosene	Actual Carbon Emission:	17107120.8 Gg C
International Bunkers:	Diesel	Actual CO <sub>2</sub> Emission:	62726109.6 Gg CO <sub>2</sub>
Stock Change:	Fuel Oil		
Carbon Emission Factor:	LPG		
Carbon Stored:	0 t C/TJ		
Fraction of Carbon Oxidised:	0.99 Gg C		

Navigation Buttons

First record	Previous record	Delete record	Save record	New record	Next record	Last record
--------------	-----------------	---------------	-------------	------------	-------------	-------------

Figure 4.05: The Expert User Menu

In the “Expert User Menu”, the expert user can simply select the fuel type that they want to store. This involves only one interface. The Expert user can save time by using this interface.

Unlike the “Expert User Menu”, the “Novice User Menu” will guide the user for recording the data. First, the system will allow the user to choose which fuel type that the user wants to enter the data as shown in Figure 4.06.

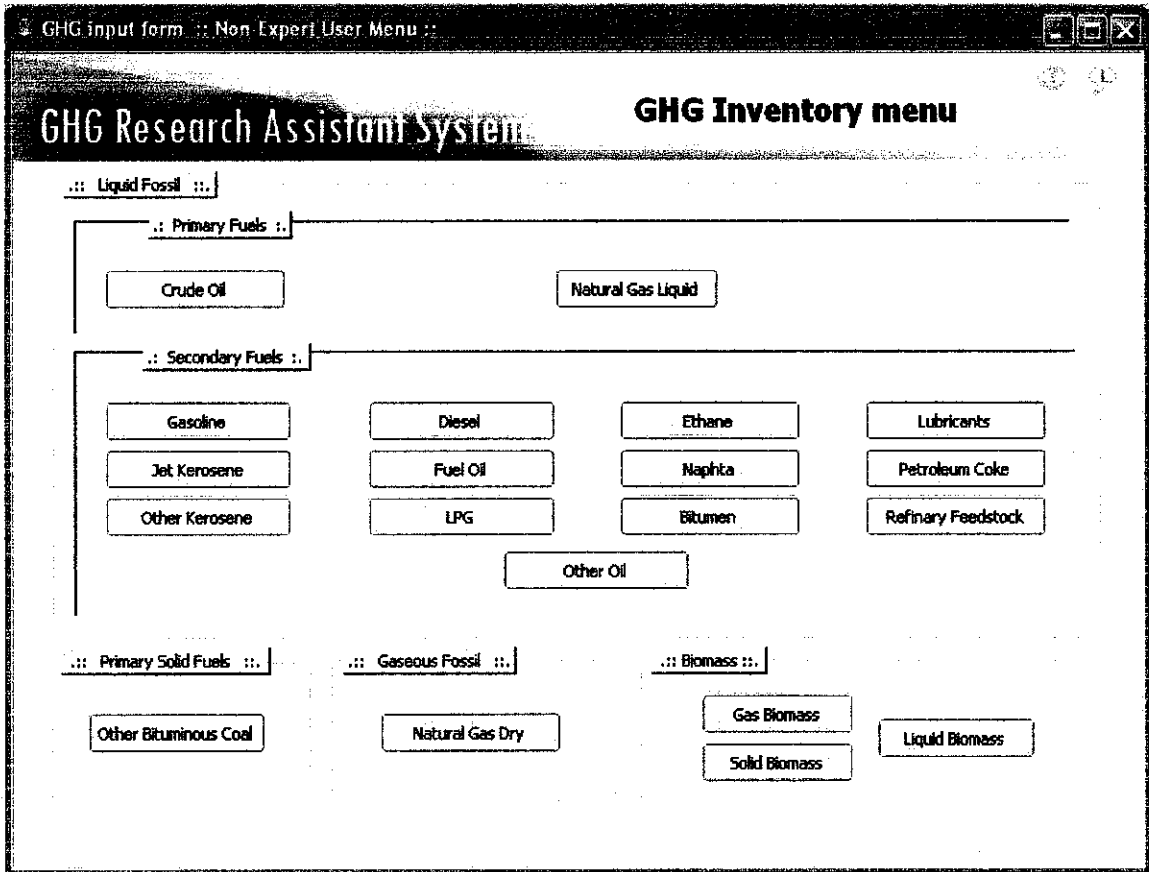


Figure 4.06: The Novice User Menu where the user can choose the fuel type.

From this menu, the user will then click at the fuel type button and this will bring the user to the input data form as shown in Figure 4.07. The flow of the interface is exactly the same with the Version 1. There are minor improvements on the design and the layout of the interface to make it presentable and easier to use.

GHG input form :: Non Expert User Menu ::

## Crude Oil

### Data Input form

#### Input Data

Year:	2011
Fuel Category:	Liquid Fossil
Fuel Type:	Crude Oil
Production:	30839 ktoe
Imports:	7218 ktoe
Exports:	17254 ktoe
Stock Change:	153 ktoe
Carbon Emission Factor:	20 ktoe
Carbon Stored:	0 t C/TJ
Fraction of Carbon Oxidised:	0.99 Gg C

#### Calculated Data

Apparent Consumption:	20650 ktoe
Apparent Consumption:	863996 TJ
Carbon Content:	17279920 t C
Carbon Content:	17279.92 Gg C
Net Carbon Emission:	17279920 Gg C
Actual Carbon Emission:	17107120.8 Gg C
Actual CO2 Emission:	62726109.6 Gg CO2

#### Navigation Buttons

First record	Previous record	Delete record	Save record	New record	Next record	Last record
--------------	-----------------	---------------	-------------	------------	-------------	-------------

Figure 4.07: The Novice User Menu's data input form

After the user has input the data for certain years and fuel types, the user can monitor and review the results using this systems. They can just click at the "Report and Graphs" tab. The interface for the tab is shown in Figure 4.08.

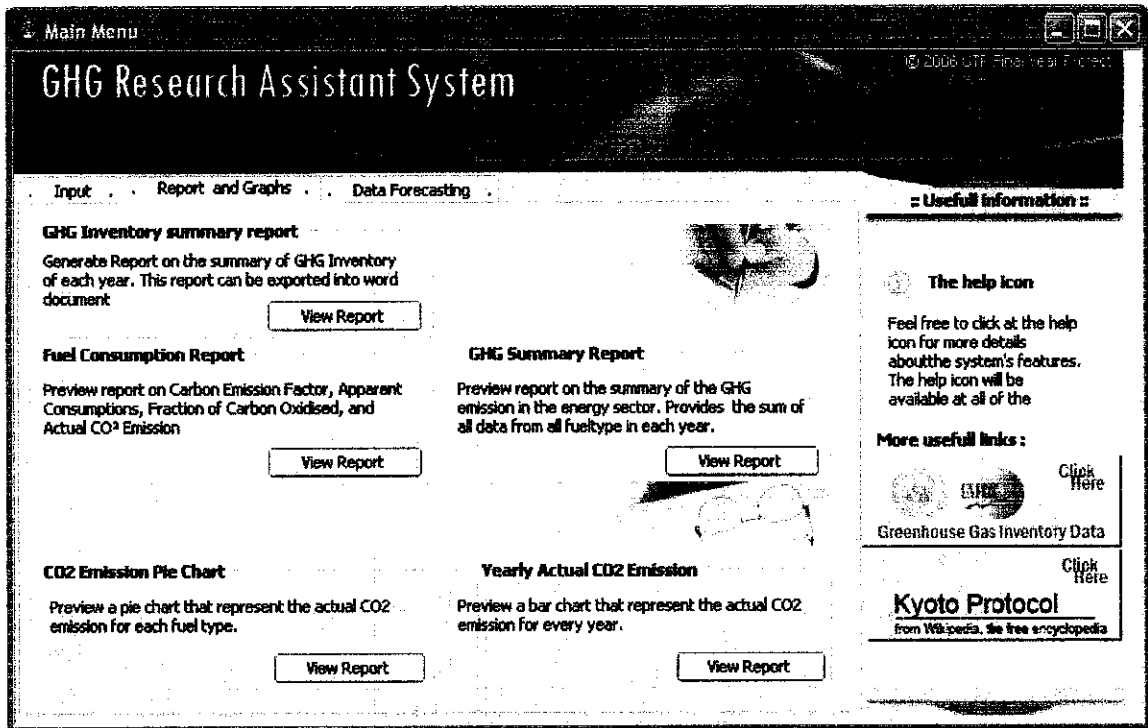


Figure 4.08: Report and Graphs menu

From this menu, the user has an option to preview several types of reports. The reports that are generated from this system were based on the user requirements that have been acquired earlier in the development process.

Figure 4.09 shows one of the reports generated by the system. In this report, the data that are being displayed are the Fuel type, the Fraction of Carbon Oxidized, and the Actual CO2 emission. This report also displays the sum of the actual CO2 emission for each year as shown in Figure 4.10.

GHG Summary 3

GHG Research Assistant System

GHG Summary

Year 2000

Fuel Type	Carbon Emission Factor	Apparent Consumption	Apparent Consumption (TJ)	Fraction of Carbon Oxidised	Actual CO <sub>2</sub> Emission
Lubricants	20	32	1338.88	0.99	95248.0036
LNG	17.2	-17229	-720861.36	0.995	-45233011.48848
Gasoline	18.9	2348	98240.32	0.99	6739973.63424
Jet Kerosene	19.5	-812	-33974.08	0.99	-2404855.2528
Other Kerosene	19.6	-302	-12635.68	0.99	-893003.36064
Diesel	20.2	-306	-12803.04	0.99	-938795.71104
Fuel Oil	21.1	-262	-10962.08	0.99	-839618.59344
LPG	17.2	-843	-39455.12	0.995	-2476102.9429767
Ethane	0	0	0	0	0
Crude Oil	20	20650	863696	0.99	62726109.6
Bitumen	22	320	13388.8	0.99	1068150.2964

Page: 1

Figure 4.09: The report generated from the system

GHG Summary 3

Gas Biomass	0	0	0	0	0
Solid Biomass	0	0	0	0	0
Liquid Biomass	0	0	0	0	0
Naphtha	20	-17	-711.28	0.99	-52200.2712

Summary for Year = 2000 (20 detail records)

Sum			2265008.4	15.835	139575330.929487
-----	--	--	-----------	--------	------------------

Page: 2

Figure 4.10: The sum of actual CO<sub>2</sub> emission of a particular year.

Figure 4.11 shows the report on the trend of the actual CO2 emission for each year. The data are presented in a bar chart so that it is easier for the user to see the CO2 emission. They can review if the CO2 emission for each year is decreasing or increasing.

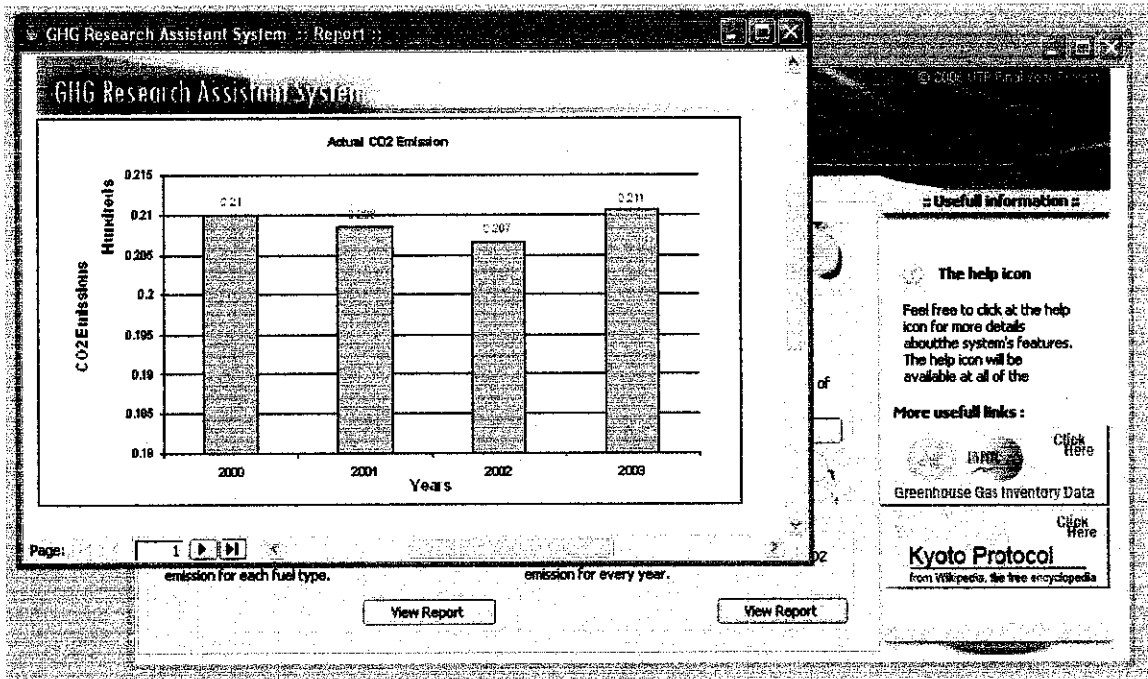


Figure 4.11: The Actual CO2 emission trend analysis

Apart from the type of reports mentioned earlier, another type of report is created to help the RO to generate a report that is in short essay format. Figure 4.12 shows the report generated from the system. This report can be exported into a word document format. The user can simply edit the fonts, the style or even change the sentences to make it personalized. This will help the ROs to complete the reports related to GHG inventory.

Figure 4.13 shows how the report can be exported into a word document and Figure 4.14 is the report that is in the word document format. The other reports can also be exported into word document using the same method.



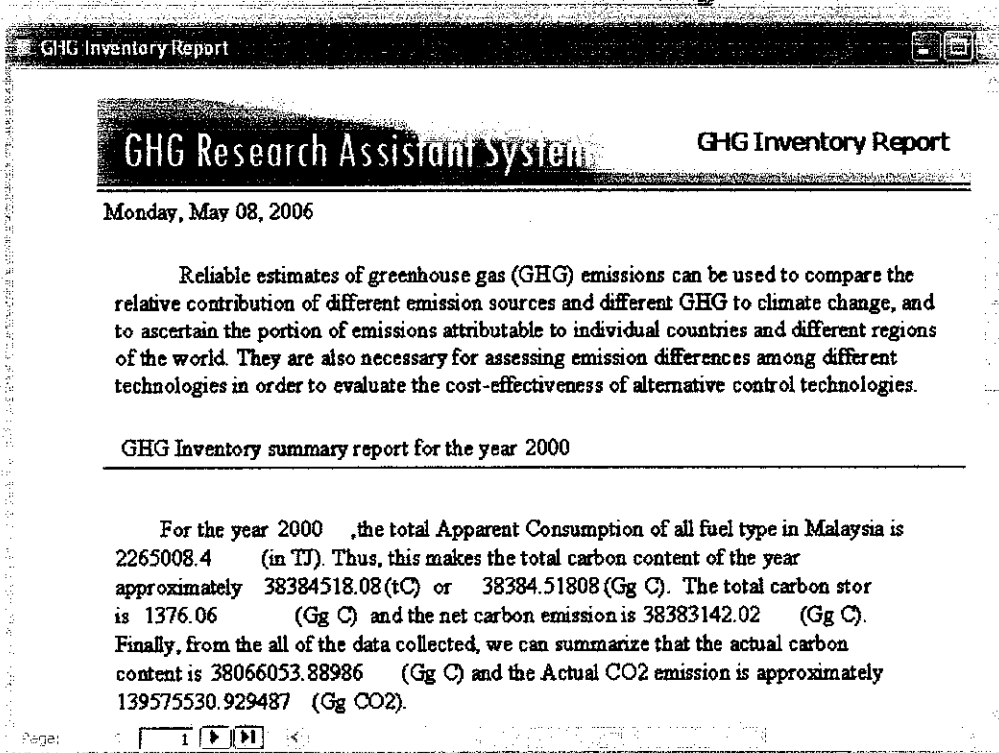


Figure 4.12: A short essay type of report generated by the system

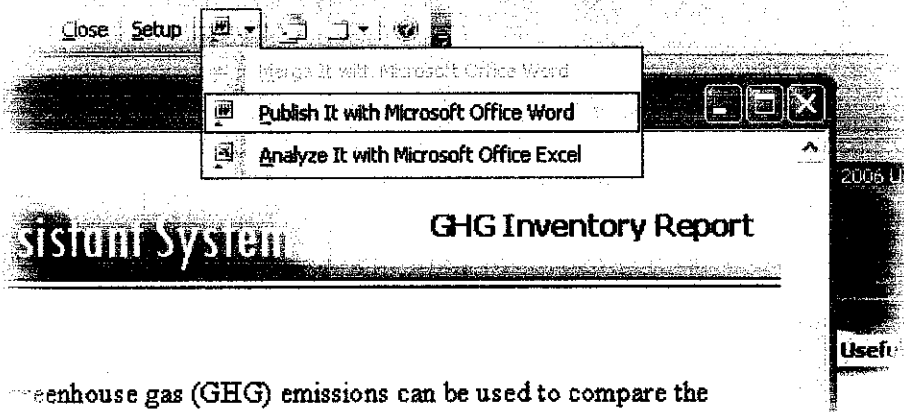


Figure 4.13: How to export the report into word document

## GHG Inventory Report

Monday, May 08, 2006

Reliable estimates of greenhouse gas (GHG) emissions can be used to compare the relative contribution of different emission sources and different GHG to climate change, and to ascertain the portion of emissions attributable to individual countries and different regions of the world. They are also necessary for assessing emission differences among different technologies in order to evaluate the cost-effectiveness of alternative control technologies.

### GHG Inventory summary report for the year 2000

For the 2000, the total Apparent Consumption of all fuel type in Malaysia is 2265008.4 (in TJ). Thus, this makes the total carbon content of the year approximately 38384518.06 (tC) or 3838451806 (Gg C). The total carbon is 1376.06 (Gg C) and the net carbon emission 38383142.02 (Gg C). Finally, from the all of the data collected, we can summarize that the actual carbon content is 38060053.88986 (Gg C) and the Actual CO<sub>2</sub> emission is approximately 139375530.929487 (Gg CO<sub>2</sub>).

### GHG Inventory summary report for the year 2002

For the 2002, the total Apparent Consumption of all fuel type in Malaysia is 955290.88 (in TJ). Thus, this makes the total carbon content of the year approximately 19105817.6 (tC) or 191058176 (Gg C). The total carbon is 0 (Gg C) and the net carbon emission 19105817.6 (Gg C). Finally, from the all of the data collected, we can summarize that the actual carbon content is 18914759.424 (Gg C) and the Actual CO<sub>2</sub> emission is approximately 69354117.888 (Gg CO<sub>2</sub>).

### GHG Inventory summary report for the year 2003

Figure 4.14: The word document generated from the report.

Usability testing, a questionnaire and a short interview have been conducted with the user. The usability testing that is use is the "Cognitive Walkthrough" method.

"The origin of the cognitive walkthrough approach to evaluation is the code walkthrough familiar in software engineering. Walkthroughs require a detailed review of a sequence of actions. In the code walkthrough, the sequence represents a segment of the program code that is stepped through by the reviewers to check certain characteristics" (C Lewis, p.5)

The ROs is given a set of instruction which basically entering data and preview the report generated by the systems. Based on the results of the walkthrough, the interface is understandable and the ROs manage to do the instructions given.

A severity rating questionnaire is given to the ROs to get the overview evaluation of the system.

“Severity ratings can be used to allocate the most resources to fix the most serious problems and can also provide a rough estimate of the need for additional usability efforts. If the severity ratings indicate that several disastrous usability problems remain in an interface, it will probably be unadvisable to release it. But one might decide to go ahead with the release of a system with several usability problems if they are all judged as being cosmetic in nature.” (J Nielsen, p.1)

All of the systems' function met the requirements. They think that the system is acceptable as long as it could calculate the data according to the guidelines and generate the report as they wanted.

Based on the questionnaire, an interview session was conducted. This is to get any additional information and recommendation that can improve the system. They just want to see the help feature and also the data forecasting feature in the final product.

As an overview of the Version 2 development process of Version 2 in the system, the system managed to add another function which is generating the reports. This was the user requirements acquired in the early stage of the development process. A cognitive walkthrough, questionnaire and a short interview was conducted to evaluate the system so that we know it met the requirements and could be improve in Version 3 of the system.

### 4.3 Phase 3: Version 3 prototype (Final product)

The Version 3 prototype focused on the help function and also the data forecasting feature that was requested by the ROs. The help feature will guide the user through out the process of using the systems. In the entire interface, there are help icons as shown in Figure 4.15.

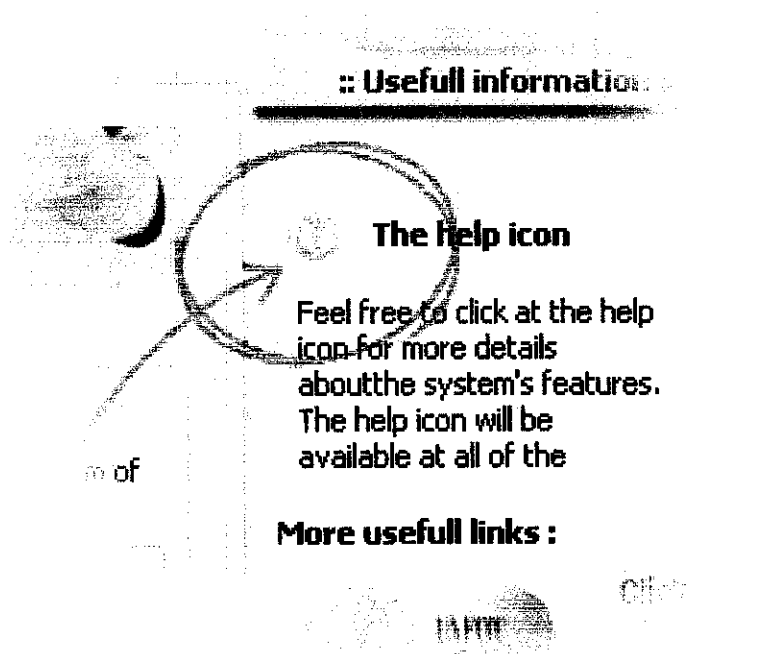


Figure 4.15: The Help Icon

These help icons are clickable and placed near the buttons and all features. When the help icons are clicked, a new special window will appear giving more information about the features and also screenshots on what will happen if the user clicks a button or enter any data. This is useful as the user will not be afraid to do anything as they are guided by the system. Figure 4.16 shows one of the help windows that appear when the help button is clicked.

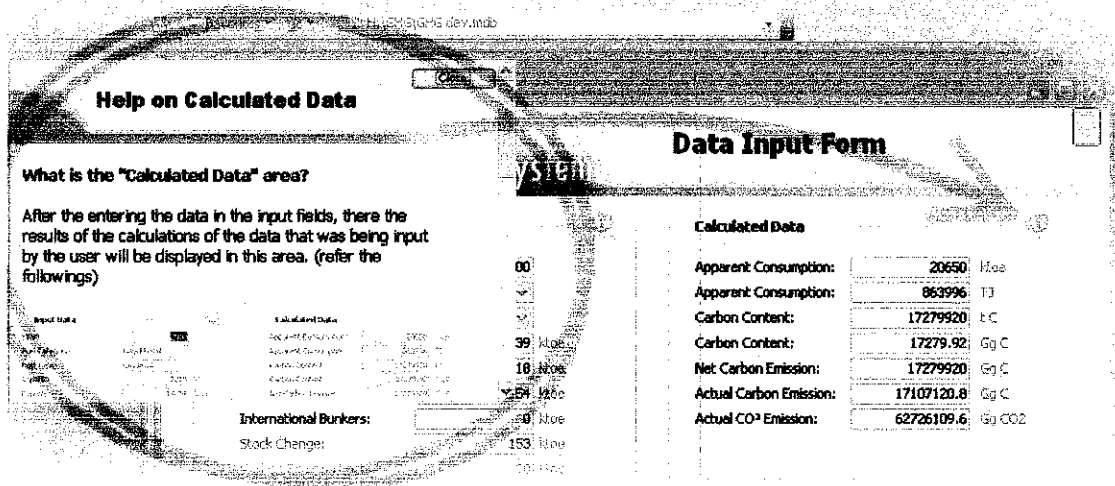


Figure 4.16: The Help window

The "Data Forecasting" was developed during the Phase 3 development process. This feature was basically to play with the existing data and look at the results on how the actual CO<sub>2</sub> emission of a particular year. For example, the RO can reduce the fuel consumption on the Crude Oil. Then the RO will take a look at the results and see whether the CO<sub>2</sub> emission will increase or decrease. This feature can also predict the next year's actual CO<sub>2</sub> emission by entering the estimated fuel consumption of the following year. Figure 4.17 shows the interface for the feature.

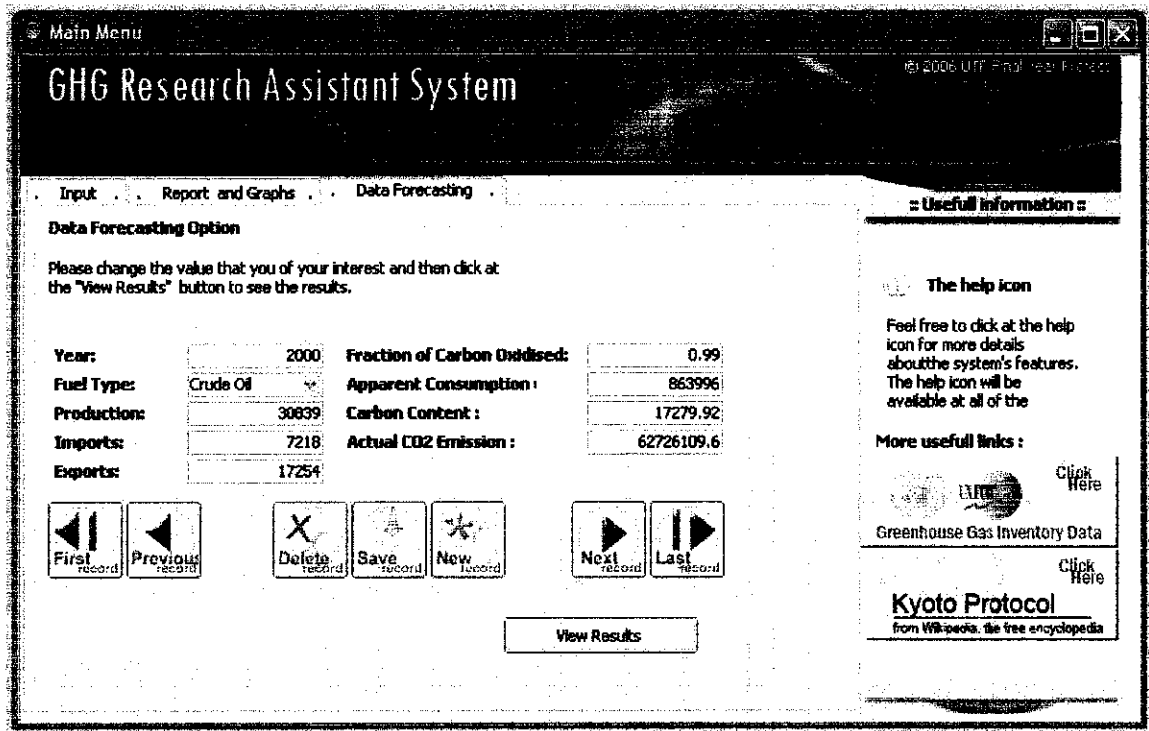


Figure 4.17: “Data Forecasting” Interface

From the interface just modify the data and click at the “view results” button to view the results. Changing the data here will not affect the original data in the database. Figure 4.18 shows the results after clicking the “View results” button. There are two charts. The first one is the current data in the database. This is the original data. The original data will be compared with the data in the second chart which uses the data that has been changed earlier.

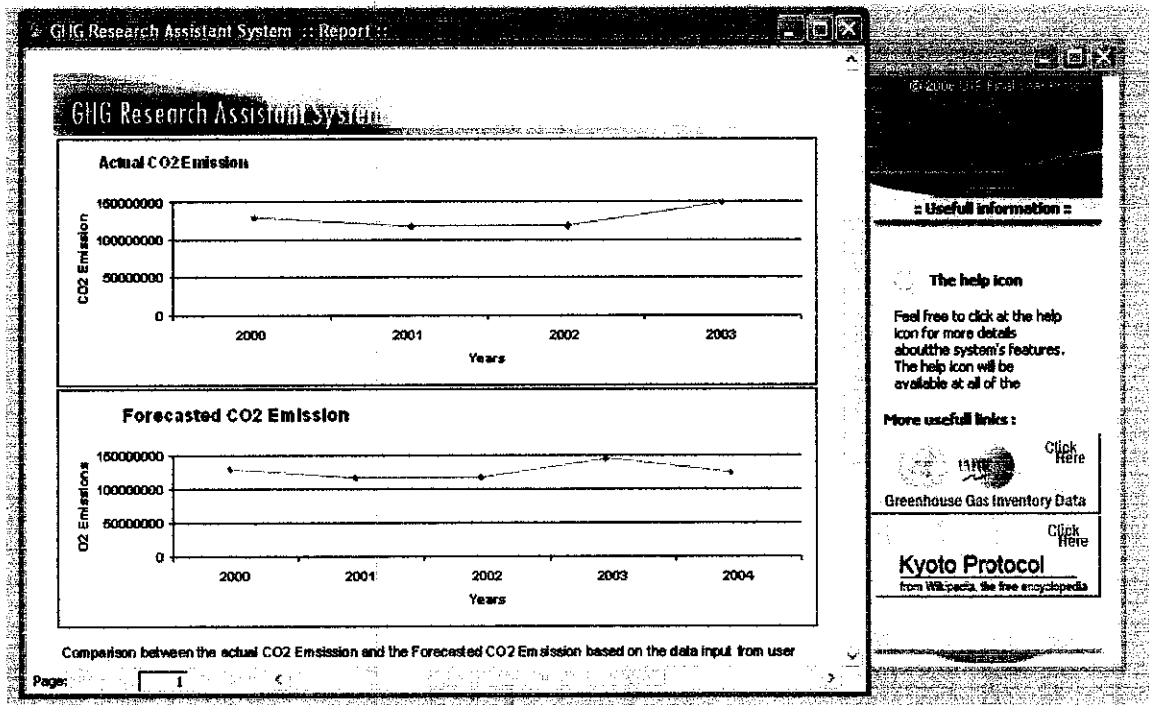


Figure 4.18: Comparison between the current data with the forecasted data.

After the development of the system was done, Usability testing, a questionnaire and a short interview were conducted again. The method was the same but a lot easier as the ROs have already tested the system in the Phase 2 development process.

The feedback was the systems have met the requirements. However, there a several errors in the system that they have pointed out. The errors have been fixed after getting the feedback and the system is now ready.

Phase 3 of the development process is the last phase and it has fulfilled the vital requirements. Now the system can get data input from the user, calculate the actual CO2 emission, generate reports and also guides the user in case the user is a non expert user. The Version 3 prototype is the final product which is the GHG Research Assistant Systems.

## **CHAPTER 5**

### **CONCLUSION AND RECOMMENDATION**

#### **5.1 Conclusion**

This study is to introduce a new system that can assist the ROs to do their GHG Inventory research and managing the data and information as the system can reduce the complexity of the process. The system will help the user to enter GHG Inventory data, produce the required reporting and also help the user in the data recording process by giving them related information and guidelines. The methodology being chosen to be used through out this study and the development of the application is known as the phased development. The development of the system subdivides the whole project into 3 phases. Each phase will release the first version of the system and the feature of the system will be added one by one along with the development process. The development of version 1 prototype is to complete the system that can store the data. Many findings have been made and new ideas are implemented to improve the system. The second version was completed by adding the reporting features. The third version is the final product and has a help feature and all features in the previous versions. Development task was planned carefully in the early stage of the development process and they were finished according to the time schedule given.

#### **5.2 Recommendations**

The system can also be implemented in a web based system. This can help the ROs to do their work even when they are not in their office. The systems' security feature can also be enhanced by creating a user account for the systems. Other concerns are to include data recovery features so that we can have a backup data if anything went wrong.



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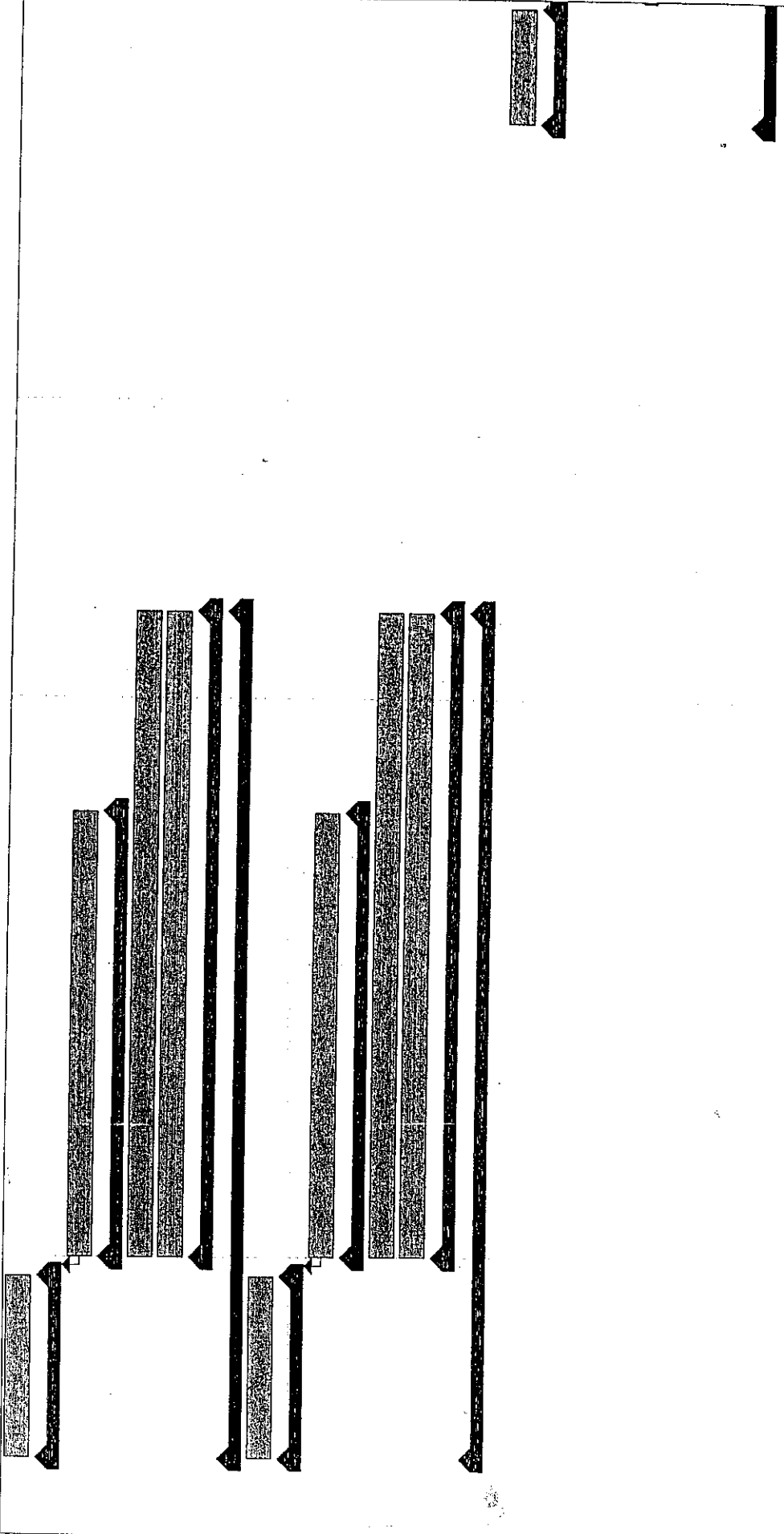
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## **APPENDIX I**

ID	Task Name	Sep '05							Oct '05							Nov '05		
		7	14	21	28	4	11	18	25	2	9	16	23	30	6	13		
1	Project Planning																	
2	System Version 1 - Storing data																	
3	Analysis on GHG Inventory Calculation																	
4	Research on the GHG Emission Calculation																	
5	User Requirements Data gathering																	
6	Design																	
7	Design the database																	
8	Design the Interface																	
9	Implementation																	
10	Test the system for implementation																	
11	System Version 2 - Produce Report and Analysis																	
12	Analysis on Producing Reports																	
13	Research on the reporting feature																	
14	User Requirements data Gathering																	
15	Design																	
16	Design the system and revising Version 1 system																	
17	Implementation																	
18	Test the system for implementation																	
19	System Version 3 - Include Info(References)																	
20	Analysis on help information System																	
21	Research on the help feature																	
22	User Requirement Data gathering																	
23	Design																	
24	Design the system and revising Version 1 and 2 system																	
25	Implementation																	
26	Test the system for implementation																	

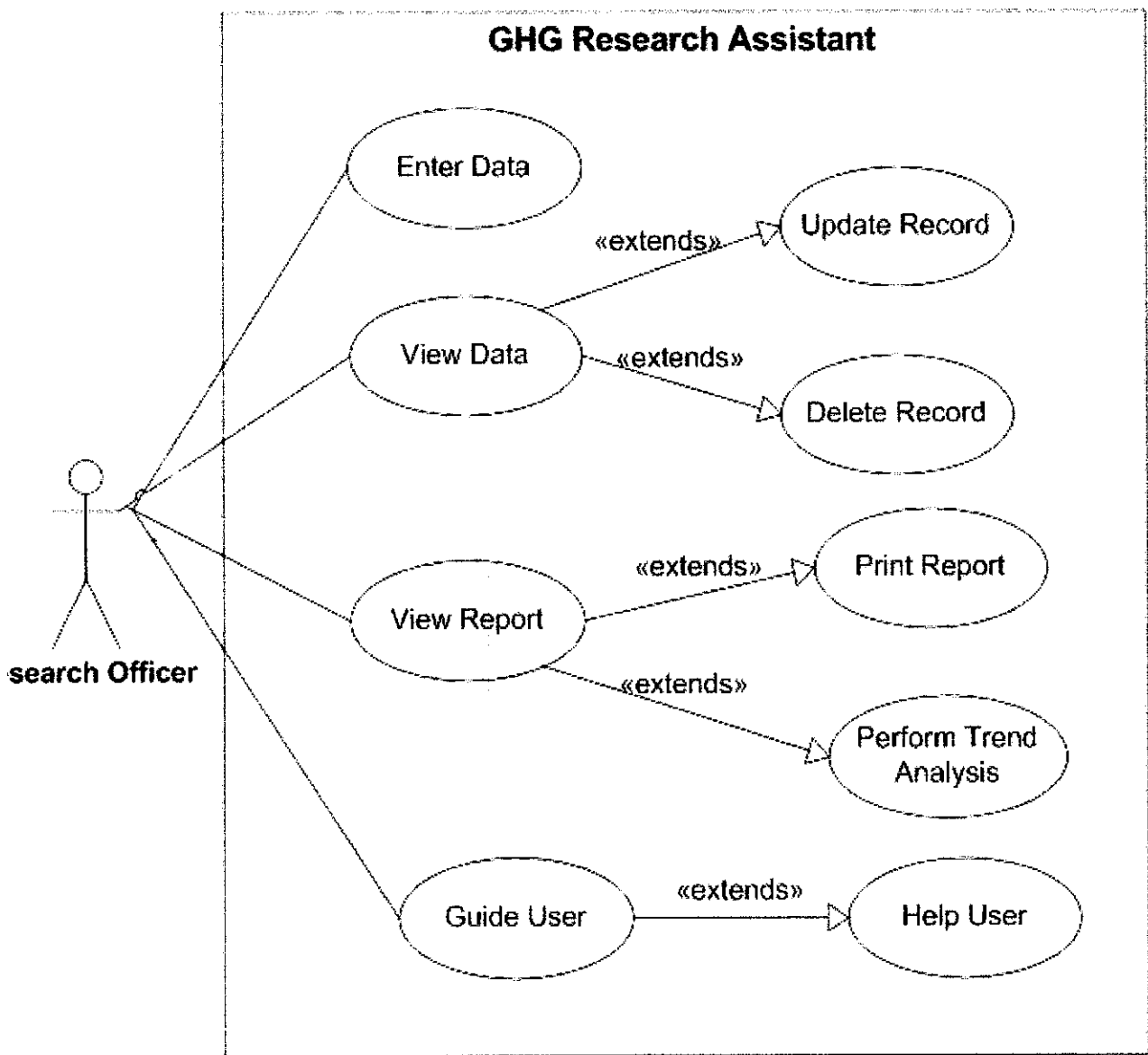
Dec '05							Jan '06							Feb '06							Mar '06							Apr '06						
20	27	4	11	18	25	1	8	15	22	29	5	12	19	26	5	12	19	26	2	9	16	23												



Task  Milestone  External Tasks 

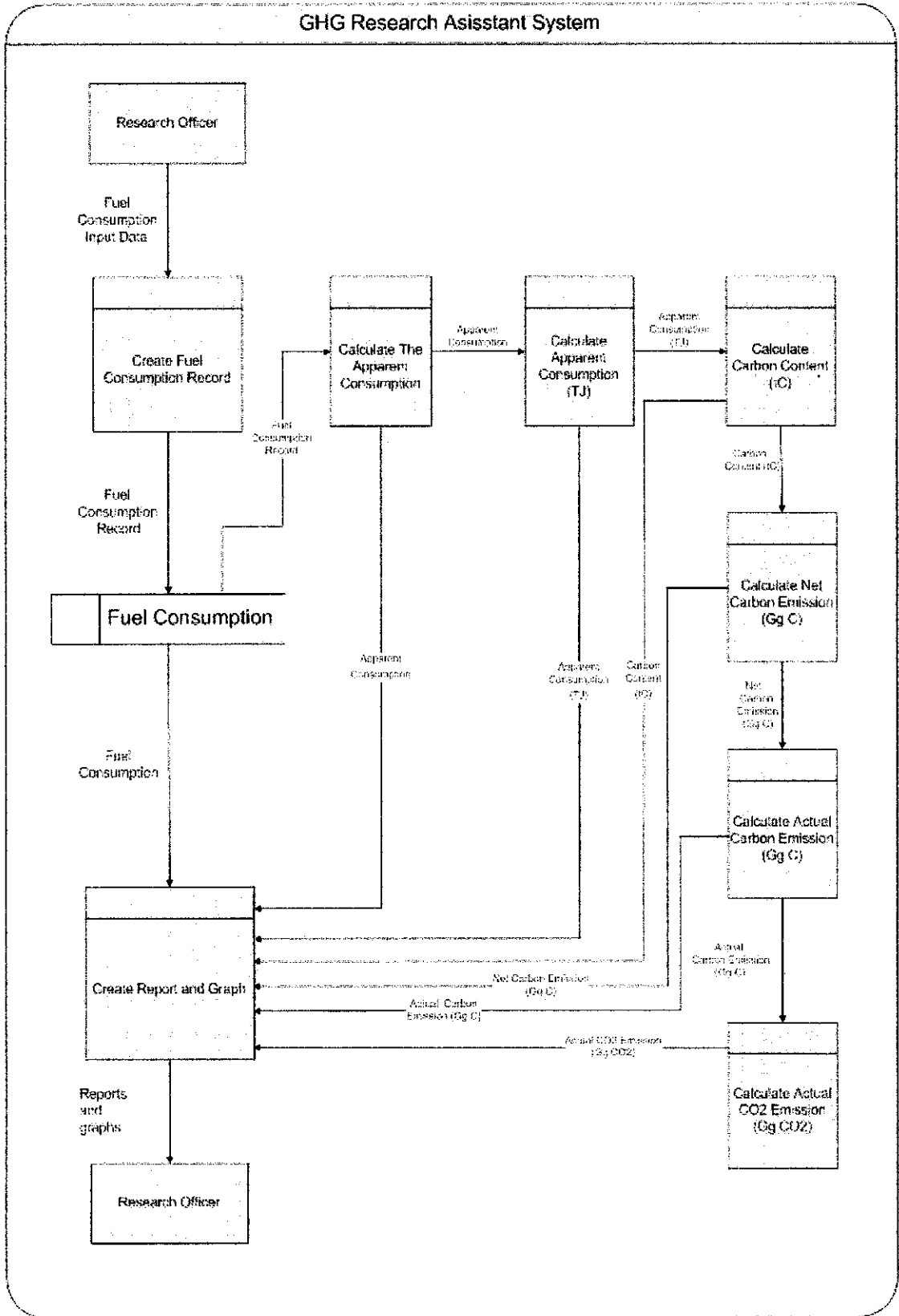


**APPENDIX III**



**GHG Research Assistant system use case diagram.**

# APPENDIX IV



Data Flow Diagram (DFD) for the GHG Research Assistant Systems