

GHG Inventory System for Energy Sector in Malaysia

by

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**Final Report submitted in partial fulfillment of
the requirements for the
Bachelor of Technology (Hons)
(Information Technology)**

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Universiti Teknologi PETRONAS

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CERTIFICATION OF APPROVAL

GHG Inventory System for Energy Sector in Malaysia

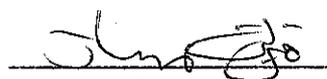
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Bushra Binti Tajuddin

A Final Report submitted to the
Information Technology Programme
Universiti Teknologi PETRONAS

in partial fulfillment of the requirement for the
BACHELOR OF TECHNOLOGY (Hons)
(INFORMATION TECHNOLOGY)

Approved by,



(Ms. Mazlina Mehat)

UNIVERSITI TEKNOLOGI PETRONAS
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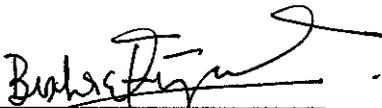
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CERTIFICATION OF ORIGINALITY

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.



BUSHRA BINTI TAJUDDIN

ABSTRACT

The GHG Inventory System for Energy Sector in Malaysia is developed to help the research officer in monitoring and analyzing the GHG emissions in Malaysia. It is done in an electronic environment where it enables better analysis of the information. Looking into the existing GHG Inventory System in Malaysia, they used the system that provided by IPCC Guideline which is not suitable for Malaysia usage. The scope of the study is focused more on how to represent the gases and fuel oil types in Sectoral Approach. The research officer will enter the value of the fuel oil that has been used in that year. The value will be used to calculate the GHG emissions in that year. Besides, the system also provides the save and print functions. The research officer can modify the value for many times and they can also print the reports of the GHG emission. The methodology used is the 'Waterfall' methodology that consists of five different stages which is analysis, design, development, testing and operation. The project was implemented within 1 year. The completed system featured user-friendly design which will aid the Research Officers in doing the analysis and monitoring the GHG emissions. Overall, the project has reaches its goals and ready to be used by the Research Officer.

ACKNOWLEDGEMENT

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LIST OF ABBREVIATIONS

1. GHG : Greenhouse Gas
2. CDM : Clean Development Mechanism
3. IPCC : Intergovernmental Panel on Climate Change
4. UN : United Nation
5. UNEP : United Nation Environment Program
6. WMO : World Meteorological Organization
7. UNFCCC : United Nations Framework Convention on Climate Change
8. AGGI : Annual Greenhouse Gas Index
9. EEA : European Environment Agency
10. NRE : Ministry of Natural Resources and Environment

CHAPTER 1

INTRODUCTION

1. OVERVIEW

Nowadays, our “mother-earth” is being threatened by global warming. Temperatures around the world are, on average, going up. The global temperature will rise if no steps taken. Currently, most countries in the world are going towards “Clean Development Mechanism”(CDM). This project is focused on the protection of the environment from pollution and global warming. One of the CDM projects is to record GHG emissions annually by using the GHG Inventory System.

1.1 Background of Study

The GHG Inventory System for energy sector in Malaysia is a system that will be used to record the GHG emissions from energy sector in Malaysia. There is a lot of sector that produced GHG emissions such as forestry sector, industrial sector, transportation sector and other sectors. But for this project, the focus is more on the energy sector from the Sectoral Approach. GHG consists of carbon dioxide, methane and nitrous oxide. Massive production of those gases might lead to the global warming. Currently, Malaysia is going towards “Clean Development Mechanism” which has the objective to protect our environment from pollution and global warming.

The existing GHG Inventory System in Malaysia is based on IPCC Guideline which is not suitable for Malaysia usage. Not all gases and fuel types that are listed in IPCC Guideline are applicable for Malaysia emissions analysis. Currently, the other

country such as Canada, Australia and Japan has move on with their own GHG Inventory System instead of using the system provided by IPCC Guideline as it helps them to analyze relevant gases and fuel types only. Their GHG Inventory System suits their country needs. Thus, it will be beneficial for Malaysia to have our own GHG Inventory System too.

In this system, there are two types of approaches that have to be considered, which consists of Reference Approach and Sectoral Approach. As for this project, the focus will be more on the Sectoral Approach. The Sectoral Approach consists of eight sub modules. Each sub module has its own gases and fuel types.

The following are the sub modules for the Sectoral Approach:

- Energy Industries
- Manufacturing Industries and Construction
- Transport Sector
- International Bunkers
- Commercial/Institutional Sector
- Agriculture/ Forestry/ Fishing
- Residential Sector
- Others

There are many sectors involved in the Sectoral Approach. The above listed sub modules are the sectors in the Sectoral Approach that being used in Malaysia which is suitable for Malaysia usage.

1.2 Problem Statement

1.2.1 Problem Identification

The problem with the current GHG Inventory activity is that the manual data entry increase the work load and working hours of a Research Officer. Other than that, when the research officers enter the data manually, there could be some mistakes

done where it increases amount of unreliable information. The current system can only enter the data for one specific year. So, there is a possibility of missing the information of any years. Besides, it is hard to find a specific data for each sub module. It also caused a delay in process, where the system failed to perform the analysis annually.

Now, since the world is moving towards paperless environment, there would be mountains of papers to handle manual activities. The existing GHG Inventory System in Malaysia is using the adopted system given by the IPCC Guideline. This current system was not suitable for Malaysia usage because it includes the unused gases and fuel types that will confuse the research officers who maintain the GHG Inventory in Malaysia.

1.2.2 Significant of the Project

The significant of the project is that the GHG Inventory System can be used to monitor the GHG emission in Malaysia. Besides, it also used to help the Research Officer in doing the analysis of GHG emission. The current system is provided by the IPCC Guideline. But the system is not suitable due to the problem that it confuse the research officer in entering the data for GHG emissions that could lead into some mistaken data. It is important for a country to record GHG emission. It is one of the ways to protect our environment by monitoring the GHG emission. Protecting our environment is a key element in ensuring sustainable livelihoods for today's and future generations. Mistaken data will lead to ineffective monitoring and the analysis of GHG emissions of the country.

The new GHG Inventory System will provide the list of gases and fuel types that is being used in Malaysia for the Sectoral Approach. The research officer has to choose the fuel types involved in Sectoral Approach before entering the data. Therefore, by having this system, it will help in reducing the complexity of the system.

1.3 Objectives and Scope of Project

1.3.1 Objectives

Several objectives have been outlined before starting with this project. The objective clearly shows the importance of conducting this project. The objectives are:

- To produce a more convenient GHG Inventory System that will increase the performance of the process.
- To provide a more efficient method in representing the results and analysis of GHG emissions.

1.3.2 Scope of Project

The scope of study for this project focuses on how to represent the gases and fuel oil types in Sectoral Approach. The research officer will enter the value of the fuel oil that has been used in that year. The value will be used to calculate the GHG emissions in that year. Besides, the system also provides the save and print functions. The research officer can modify the value for many times and they can also print the reports of the GHG emission. The GHG Inventory System has been design to help and guide the Research Officers to record data that is related to the Greenhouse Gas Emission. These data are collected and will be processed by the GHG Inventory system to produce information to control the emission of the Greenhouse Gas in Malaysia.

1.4 Relevancy of the Project

Basically the project is conducted to enhance the current GHG Inventory System which is done manually and not suitable to be used in Malaysia. This will provide benefit to research officers who have the responsibility to monitor and analyze the GHG emissions in Malaysia for each year.

1.5 Feasibility of the Project within the Scope and Time Frame

Basically, there are two constraints in completing a project which are scope and time. The project will focus on basic functionality of the system which are input the data, record the data, analyze the result, generate the report, and print the report. The period of time for completing the project is about one year and the project consists of several phase. (*Refer to Appendix*)

CHAPTER 2

LITERATURE REVIEW / THEORY

2. INTRODUCTION

Nowadays, our “mother-earth” is being threatened by global warming. Temperatures around the world are, on average, going up. As stated by David Hoffman, if no steps taken into action to stop this from happening, the global temperature will rise by about 1.4 to 5.8⁰C by the year 2100. This change would be much larger than any climate change experienced over at last 10,000 years. (2005)

The main cause of global warming is the emission of what are called “greenhouse gases”. Human activities change the natural composition of these GHGs. Carbon dioxides is produced when fossil fuels are used to generate energy and when forests are cut down and burned. Methane and nitrous oxide are emitted from agricultural activities, changes in land use, and other sources.

Rising levels of GHGs are already changing the climate. In general, the faster the climate changes the greater will be the risk of damage. As sea level rises, there will be flooding of low-lying areas and other damage. Other effects could include an increase in global precipitation and changes in the severity or frequency of extreme events. Climatic zones could shift poleward and vertically, disrupting forests, deserts, rangelands, and other unmanaged ecosystems. As a result, many will decline or fragment and individual species could become extinct.

2.1 The Kyoto Protocol

There are of course international actions and commitments. In 1997, the Kyoto Protocol was adopted. It called for stronger action in reducing GHG emission in the post-2000 period. Under the protocol, developed countries have a legally binding commitment to reduce their collective emissions of six greenhouse gases by at least 5% compared to 1990 levels by the period 2008-2012. The Protocol also establishes an emission trading regime including clean development mechanism to facilitate countries to fulfill their commitments.

In short, one of the ways 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 Inventory to protect our environment. The EEA reporting that protecting our environment is a key element in ensuring sustainable livelihoods for today's and future generations.

An annual index of climate forcing by long-lived greenhouse gases is important because it is not fraught with uncertainty. The AGGI is a readily understood measure of the climate forcing by long-lived greenhouse gases, which are of entirely anthropogenic origin or are largely influenced by human activities. It also shows changes in the relative importance of the various long-lived greenhouse gases. It will be the gauge of success or failure of future efforts to curb carbon dioxide in the atmosphere both by natural and human-engineered processes. As stated by Justin Blum, the data that has been collected and analyzed are important for IPCC assessments, climate modelers, and the media who inform the general public about climate change. In the future this information will provide decision-support in managing atmospheric greenhouse gases. (2005)

2.2 Intergovernmental Panel on Climate Change (IPCC)

IPCC has been established by WMO and UNEP to assess scientific, technical and socio- economic information relevant for the understanding of climate change, its potential impacts and options for adaptation and mitigation. It is open to all members of the UN and WMO.

The “*Revised 1996 IPCC Guideline*” is the standard guideline for recording the GHG Inventory and approved internationally and developed through an international process which has included:

- Wide dissemination of drafts and collection of comments from national experts;
- Testing of methods through development of preliminary inventories;
- Country studies which ensure that methods are tested in a wide variety of national contexts;
- Technical and regional workshops held in Africa, Asia, Latin America, Central Europe and Western Europe;
- Informal expert groups convened to recommend improvements on specific aspects of the methodology.

The *IPCC Guidelines* were first accepted in 1994 and published in 1995. UNFCCC COP3 held in 1997 in Kyoto reaffirmed that the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* should be used as "methodologies for estimating anthropogenic emissions by sources and removals by sinks of greenhouse gases" in calculation of legally-binding targets during the first commitment period.

The *Revised 1996 IPCC Guidelines* contain three volumes, each of which provides assistance to the analyst in the preparation of national GHG Inventories. However, the second Book, which is also known as the “workbook”, was the main reference material.

The “Workbook” contains suggestions about planning and getting started on a national inventory for participants who do not have a national inventory available already and are not experienced in producing such inventories. It also contains step-by-step instructions for calculating emissions of carbon dioxide (CO₂) and methane (CH₄), as well as some other trace gases, from six major emission source categories. It is intended to help experts in as many countries as possible to start developing inventories.

2.3 The existing GHG Inventory System

Currently, the other country such as Canada, Australia and Japan has make their move in developing their own GHG Inventory System instead of using the system provided by IPCC Guideline. Their GHG Inventory System is suitable for their countries. So, we have to take an effort to have our own GHG Inventory System.

The existing GHG Inventory System in Malaysia is developed by using the guidelines of the "Revised 1996 IPCC Guideline" provided by the IPCC as reference. The IPCC Guidelines were first accepted in 1994 and published in 1995. UNFCCC COP3 held in 1997 in Kyoto reaffirmed that the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories should be used as "methodologies for estimating anthropogenic emissions by sources and removals by sinks of greenhouse gases" in calculation of legally-binding targets during the first commitment period.

The system was created on the year 2000 and has been design to help the Research Officers to record data that is elated to the Greenhouse Gas Emission. The data collected will be entered to system. But, it was a long process where the Research Officer needs to calculate the emission manually. Besides, the current system is not efficient since it's a long process and did not meet the requirement, where the system is not helpful to produce the GHG Inventory annually.

2.4 Other GHG Inventory System available in the market

Through out the research activities, a system for calculating CO₂ emissions known as Emco2 Analyzer was discovered. The system application was created by AnaSoft Inc. The application provides data collection and emission calculation functions, department management, fuel type, unit and conversion factors (to CO₂ tones conversion). The application has indirect fuel related type, unit and conversion factors management that can export or import data entry in Excel spreadsheet form and emission calculation management. For the reporting part, it has reporting functions that will do the reporting department management, emission source types (buildings, equipment) management, emission intensity, emission models

management (grouping CO₂ generated emissions by departments and fuel types to provide business specific reports) and reporting year management (rolling or removing the reporting year).

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.

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.

Greenhouse gas reporting is mandatory in Alberta by 2004 (Bill 37, the Climate Change Emissions Management Act.). The application helps to generate GHG mandatory reports.

The application offers full and trial version. The trial version which is "Emco2 Analyzer" is a desktop application linked to local MS Access database. But the full version has option of multi-users using system connected to Oracle or MS SQL Server database in distributed environment. The application has multi-layered architecture so web-services implementation is feasible option.

CHAPTER 3

METHODOLOGY / PROJECT WORK

3. INTRODUCTION

This chapter will be focusing on the methodology that is going to be implemented along developing this project. The methodology used in this project is the “Waterfall model”. There are five stages or phases in the Waterfall model.

3.1 Procedure Identification

The waterfall model takes the fundamental process activities of specification, development, validation, and evolution and represents them as separate process phase such as requirements specification, software design, implementation, testing and maintenance. The system is developed during the design and development stage. Testing is run regularly to check whether the system runs as expected. Finally, conduct evaluation phase in order to analyze the system performance whether it is meet the user’s requirements. The methodology was adopted because it provides systematic and orderly approach in solving system problem.

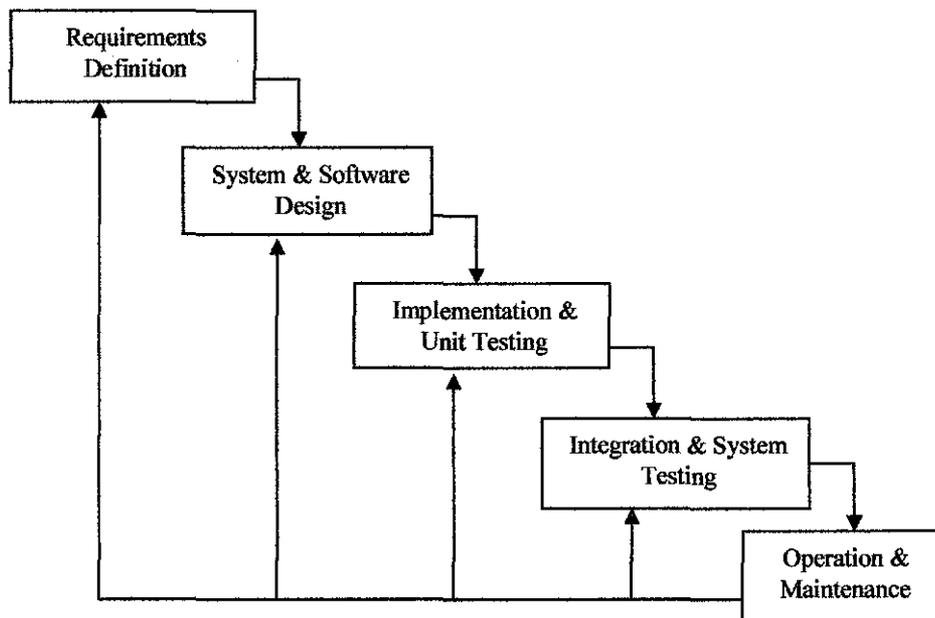


Figure 3.1 : Phases involved in creating the GHG Inventory System for Energy Sector in Malaysia.

3.1.1 Requirement Analysis and Definition

In this phase, the system's services, constraints and goals are established. Then, the detail is defined and served as a system specification.

Before developing the system or doing any modeling for the system, it is important to know about the basic knowledge of the data that is going to be recorded first. The first phase of developing the GHG Inventory System is "*Requirement Analysis and Definition*" of the system. The two important things that were being studied in details are how the GHG Inventory system works and any related knowledge about the data itself. In this phase, the main focus is to research what is the GHG Inventory. It is important to study the whole process of the GHG Inventory because it is helpful in developing the system later on.

After having a basic knowledge of the GHG Inventory, it is time to set the project planning. The project timeline was set through a Gantt chart and each task is being advocated within certain period.

The IPCC Guideline and the interview with the Research Officer were the main references for obtaining ideas and searching for information regarding the development of the system. By conducting the interview, developer identifies the user requirement. Besides, author's experiences of using the existing GHG Inventory System are also very helpful in the development of the system. Internet becomes the additional method in getting supporting and relevant information regarding the system.

3.1.2 System and Software Design

The second phase is the "*System and Software Design*". In this phase, the fundamental software system abstractions and its relationship is identified and described. Then, the overall of the system architecture has been established.

The things that have to be done in this phase are designing the use case (Figure 3.2), the data flow diagram (Figure 3.3 & 3.4) and the interface of the system. The designs of the process flow were based on the IPCC Guideline, as the main reference. The IPCC Worksheet for recording was also a great help in designing the system flow of the GHG Inventory system. The data flow diagram (DFD) explains on how the process will work in the system.

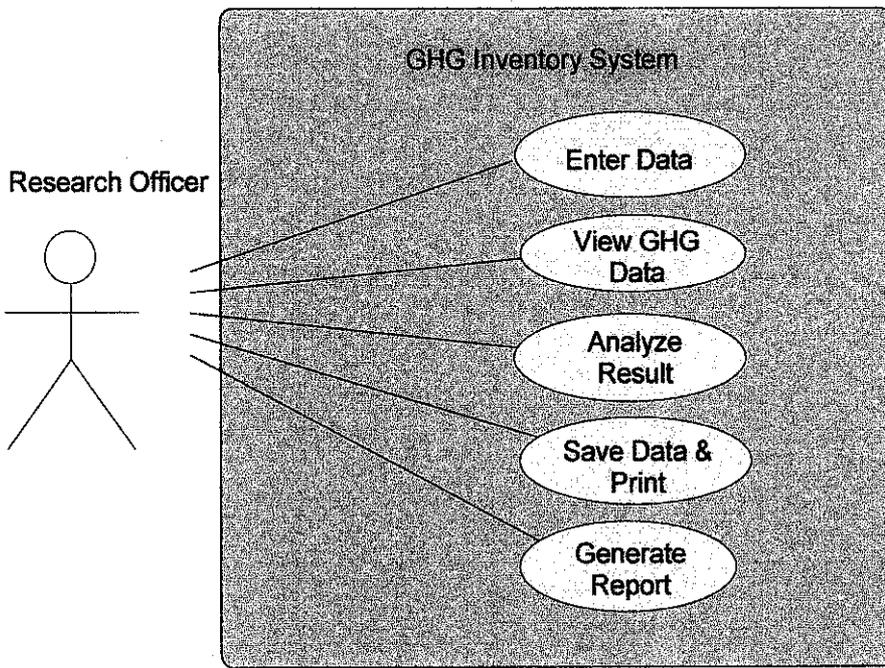


Figure 3.2 : Use Case Diagram

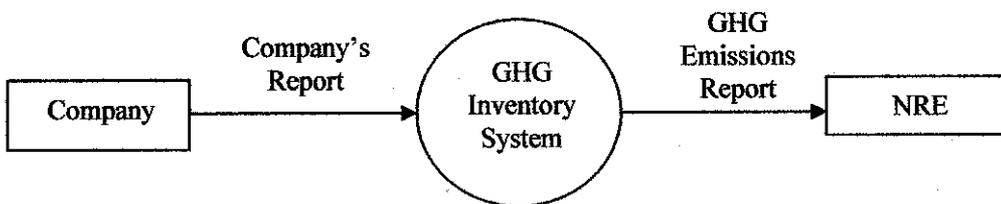


Figure 3.3 : Context Diagram

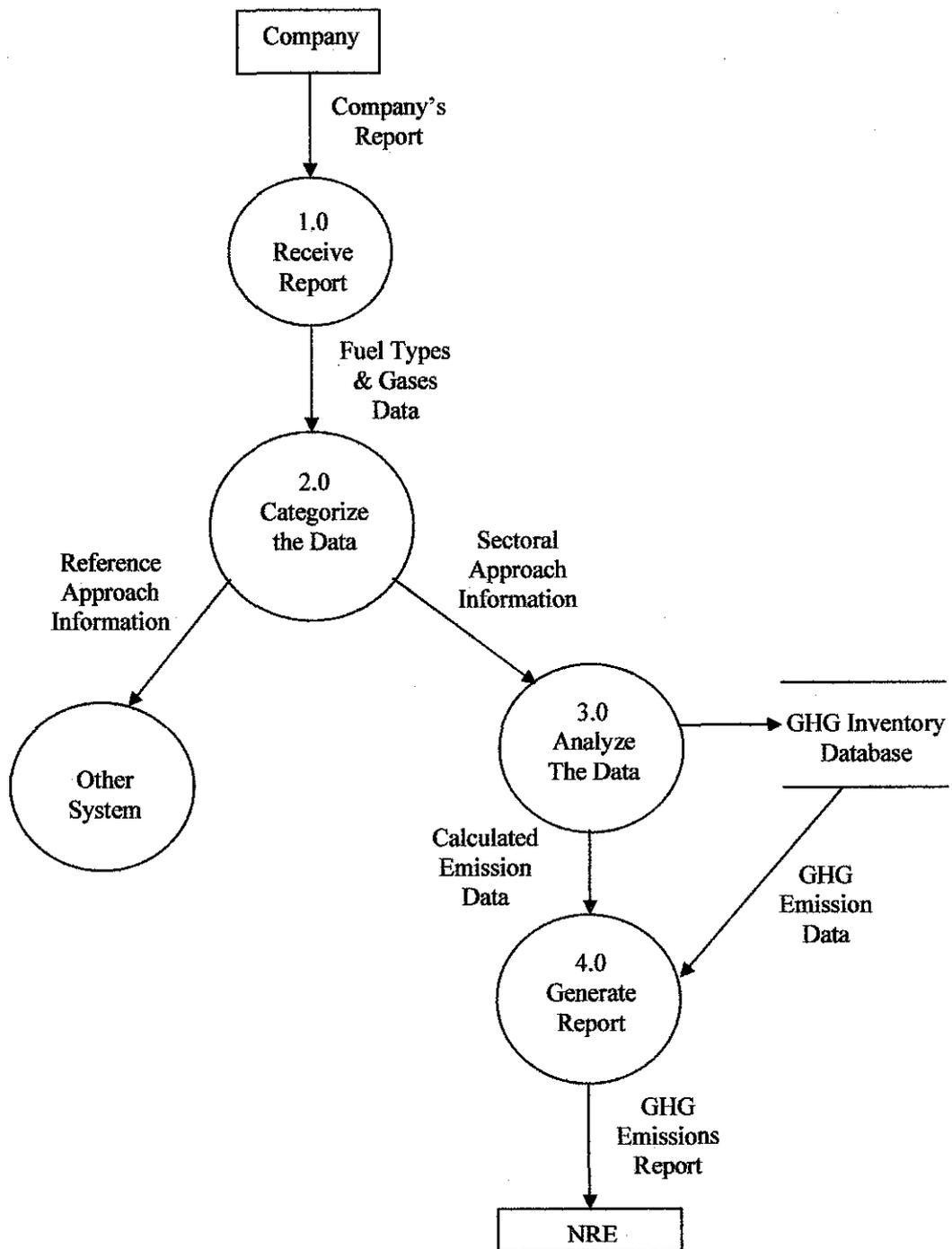
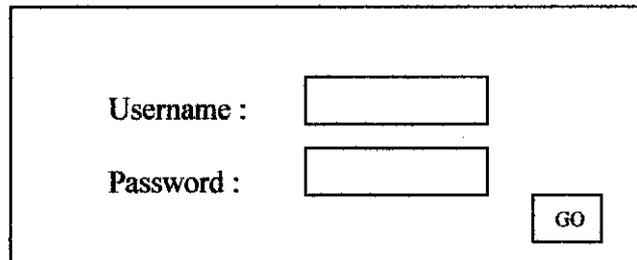


Figure 3.4 : DFD Level 0

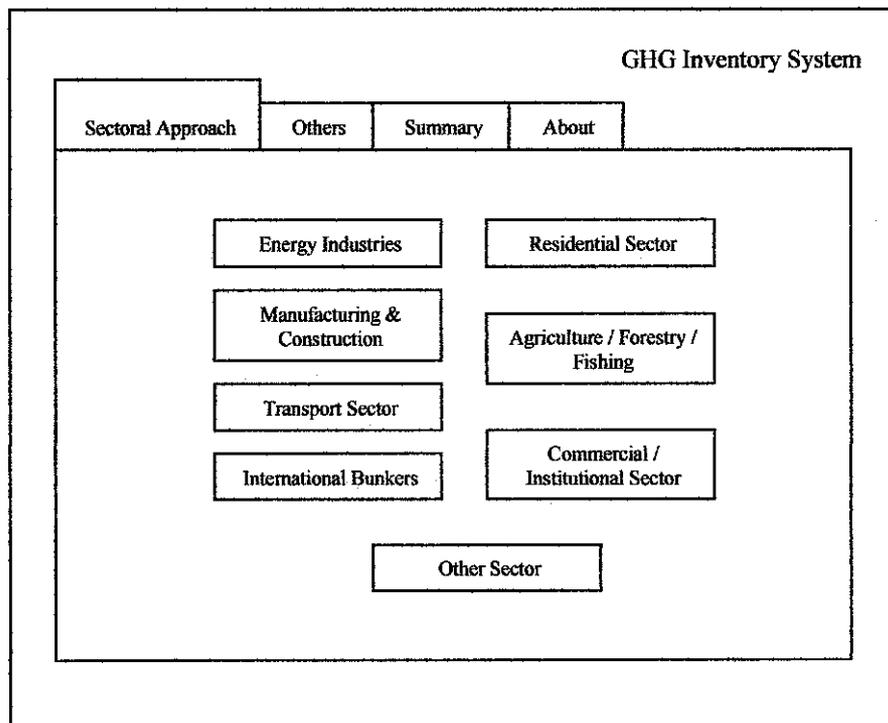
The storyboard of interface for the system was also has been done in this phase. This section shows the story board of the whole system. The system begins with the login form for the user in order to secure from any unauthorized access. Figure 3.5 shows the menu for logon form.



A rectangular box containing a login form. On the left, the text "Username :" is followed by a horizontal input field. Below it, the text "Password :" is followed by another horizontal input field. To the right of the password field is a small rectangular button with the text "GO" inside.

Figure 3.5 : Logon Form

After the user has successfully login, the main menu form will appear with all the tabs, so that the user can easily click the required form. Figure 3.6 are the main menu of the system begins with Sectoral Approach tab.



A window titled "GHG Inventory System" with a tabbed interface. The "Sectoral Approach" tab is selected. Below the tabs, there are several rectangular buttons arranged in two columns. The left column contains: "Energy Industries", "Manufacturing & Construction", "Transport Sector", and "International Bunkers". The right column contains: "Residential Sector", "Agriculture / Forestry / Fishing", and "Commercial / Institutional Sector". At the bottom center, there is a button labeled "Other Sector".

Figure 3.6 : Main Menu (Sectoral Approach)

Figure 3.7 are the menu for 'Others' tab where the user can input the data from Carbon Stored in products and emissions from International Bunkers.

GHG Inventory System

Sectoral Others Summary About

Auxiliary : Carbon Stored in

LPG Naphtha Natural Gas

Emissions from International

Diesel Fuel Oil

Figure 3.7 : Others Form

Figure 3.8 are the menu for 'Summary' tab where the user can view the data that has been entered. They also can view the report from the menu.

GHG Inventory System

Sectoral Others Summary About

Energy Industries Residential Sector

Manufacturing & Construction Agriculture / Forestry / Fishing

Transport Sector Commercial / Institutional Sector

International

Other Sector

Figure 3.8 : Summary Form

Figure 3.9 are the menu for 'About' tab. This menu was a brief explanation about the system.

Figure 3.9 : About Form

Figure 3.10 are the example menu of Sectoral Approach from Energy Industries. The user will go to this menu after they click on the Energy Industries at the Main Menu. The user can choose any of the gases or fuel types for the data entry.

Figure 3.10 : Example form of Sectoral Approach from Energy Industries

Figure 3.11 are the example menu of Diesel Oil from Energy Industries that has been chosen by the user from the previous menu. In this form, user need to enter the year and consumption data for that year.

Diesel Oil
Energy Industries

GHG Inventory System

Year :

Consumption :

Advanced >>

← Delete Add Save →

Figure 3.11: Example input form of Diesel Oil from Energy Industries

Figure 3.12 are the example of output menu of Diesel Oil from Energy Industries. The entered data or input will be showed at the left and the output or calculated data will be showed at the right.

Diesel Oil
Energy Industries

GHG Inventory System

Year :

Consumption :

Consumption :

Carbon Emission Factor :

Consumption :

Carbon Content (t C)

Carbon Content (Gg C) :

Carbon Stored :

Net Carbon Emission :

<< Simple

← Delete Add Save →

Figure 3.12: Example output form of Diesel Oil from Energy Industries

3.1.3 Implementation and Unit Testing

During this stage, the software has been developed according to the plan from the design phase. The designed system is realized as a set of program units. Unit testing involves verifying that each unit meets its specifications.

For this project, implementation and unit testing is involved during the development of the system. Normally, the developer of the system itself will conduct the unit testing and done at the developer site. During the testing, if any error or fault were found, that error or fault must be cleared before the development can proceed to the next stage.

3.1.4 Integration and System Testing

In this phase, the individual program units or programs are integrated and tested as a complete system to ensure that the software requirements have been met.

As for this project, before the system testing is conducted, the system will be integrated with the other system. As mentioned before, this project is focused on the Sectoral Approach part. To complete the system, it needs to be integrated with the other system that is focused on the Reference Approach. After the integration, system testing will be conducted.

Among of the tasks that would be carried on is reviewing, validating and testing the modules created in the system regularly in order to ensure the system runs as expected. Other than that, it would be best if the user try out the system and for see the weaknesses of the system that could be improved. Besides tested by the developer of the system, it is also needed to be tested by the potential user of the system. The potential users for this system are research officers of Pusat Tenaga Malaysia. The example of the testing part includes the functionality of the system, the interfaces, and the navigation. If the system does not meet the requirement, implementation will be conducted again. After the implementation and system testing is successful, the software system will be delivered to the user.

3.1.5 Operation and Maintenance

In the “*Operation and Maintenance*” phase, the system will be installed and put into practical use. After the system testing is successful, the software will be delivered to the user. The software will be installed at the user site. Then, the user will use and see the performance of the system.

Maintenance involves correcting errors which were not discovered in the earlier stages of the life cycle, improving the implementation of system units and enhancing the system’s services as new requirements are discovered.

Evaluation is the process of determining the value and effectiveness of the project. In this phase, evaluation is performed to the module of the system in order to define the performance of the whole system. The evaluation is done on the functionality of the system, security, the content, the interactivity and the user friendliness of the system. Basically, the final evaluation will be evaluated by the target audience as they are the one that will be using the system. As for this system, research officers of Pusat Tenaga Malaysia will do the final evaluation. The evaluation will be conducted informally whereby, the users clarified to the developer any problem, based on the system performance. The performance evaluation is based on :

- Fails to meet standards (the systems did not run)
- Adequate (meet the minimum user requirement)
- Meets all standards (perform well and satisfy the user needs)

3.2 Tools Required

The tools required in developing this system are as follows :

3.2.1 Hardware

1. *Processor Speed* : Intel Pentium 4, 2.4GHz
2. *Memory* : 256MB of RAM
3. *Disk Storage* : 30GB

3.2.2 Software

1. Windows XP Platform
2. Microsoft Access 2003

The minimum requirements for using this application are as follows:

1. *Processor Speed* : Intel Pentium 133 MHz or higher
2. *Memory* : 32MB of RAM
3. *Operating System* : Windows 95, Windows 98, Windows NT, Windows 2000, Windows XP.
4. *Software support* : Microsoft Access 97, 2000, 2003

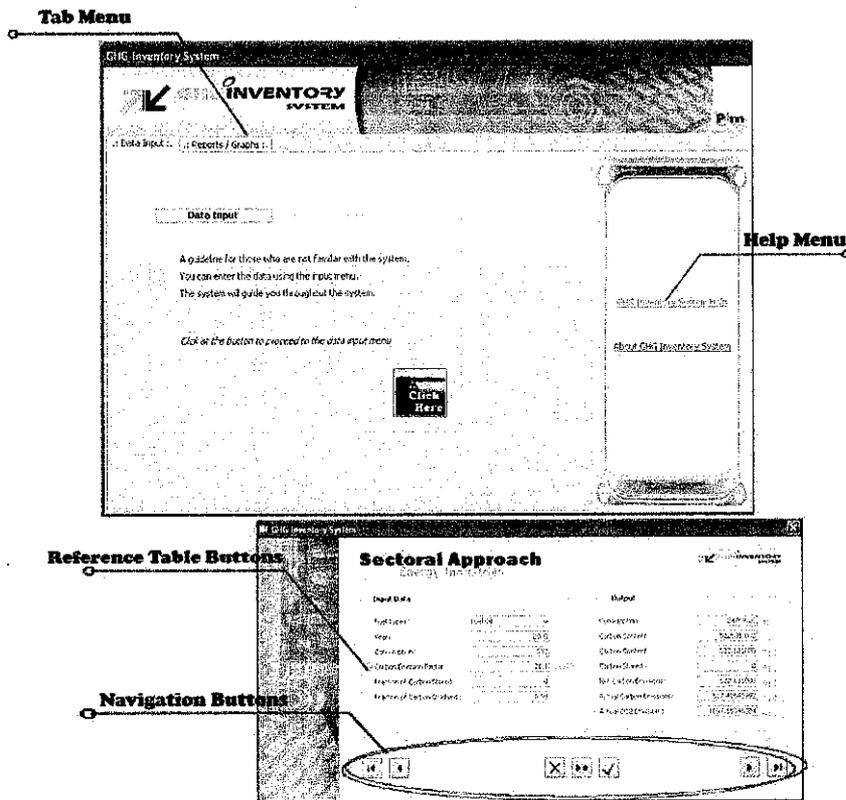
CHAPTER 4

RESULTS AND DISCUSSIONS

4.1 Results

4.1.1 Overview of the Features

This section will discuss about all of the basic features of the GHG Inventory System. The followings are the list of features and a brief description about each and one of them.



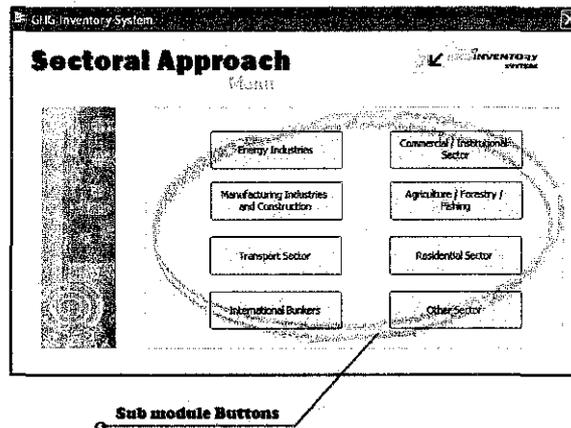


Figure 4.1: Overview of the Features

- ***Tab menu***
 The tab menu will help the user to go to the main menu of the main activities like data entry for “Sectoral Approach” and also viewing the results from the data entered. The tab menu are consist of 2 menus which are “Data Input” and “Reports / Graphs”

- ***Reference Table Buttons***
 These buttons is purposely to help user to get a reference table for some a few data that have default value provided by IPCC if there are no specific data to be entered. The user can click at the “f” button for Carbon Emission Factors table and “O” Button for Fraction of Carbon Oxidized table. (Optional) Both tables are just for reference.

- ***Navigation Buttons***
 These buttons are use for navigating the records in the system.

- ***Sub module Buttons***
 Clicking at the sub module button will bring user to the data input form for the selected sub module and fuel types.

4.1.2 Navigation Buttons

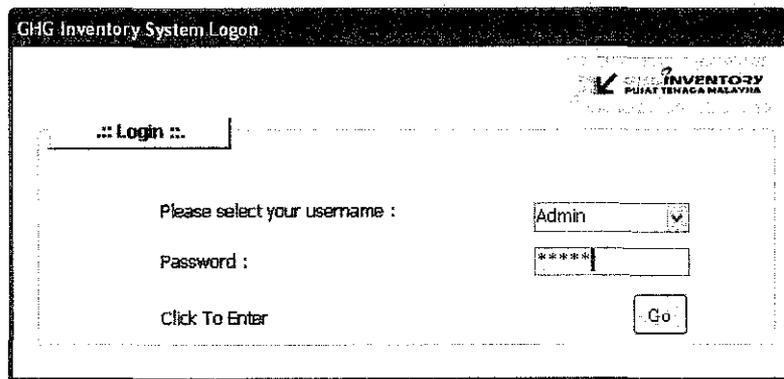
Navigation buttons are found at the data Input Forms. The followings are the list of navigation buttons and their usage:

Navigation Button	Name	Descriptions
	Add New Data	<ul style="list-style-type: none"> The user will click on this button when entering new data. All of the input Field will be clear from any data.
	Save	<ul style="list-style-type: none"> This button is clicked when saving the data. This button is clicked after entered new data This button is clicked when making any change or editing the data. <p><i>(Important: If this button is not clicked, any changes made would not be saved into the system)</i></p>
	Delete	<ul style="list-style-type: none"> This button is clicked when deleting the exiting data. A message box will appear after clicking the button for deleting confirmation. <p><i>(Important: Double check the data each time want to delete any record)</i></p>
	First Record	<ul style="list-style-type: none"> This button is clicked to go to the first record. <p><i>(Note: In this system, the first record would be the latest year to be entered.)</i></p>
	Last Record	<ul style="list-style-type: none"> This button is clicked to go to the last record. <p><i>(Note: In this system, the last record would be the earliest year to be entered.)</i></p>
	Next Record	<ul style="list-style-type: none"> This button is clicked to navigate the data entered into the system. Clicking this Button would go to the next record
	Previous Record	<ul style="list-style-type: none"> This button is clicked to navigate the data entered into the system. Clicking this Button would go to the previous record

Table 4.1 : Navigation buttons and its usage

4.1.3 Interfaces of the system

This section will show some example of the menu from the system. Since there are some changes made during the development phase, the interface of the system was no longer following the planned story board. The changes has been made depends on the situation and whether it is suitable or not. Followings are the example of menu from GHG Inventory System.



The screenshot shows a web browser window titled "GHG Inventory System Logon". The page has a header with the logo for "INVENTORY PIHAT TENAGA MALAYSIA". Below the header, there is a section titled ":: Login ::" enclosed in a dashed border. Inside this section, there are three labels: "Please select your username :", "Password :", and "Click To Enter". The "Please select your username :" label is followed by a dropdown menu showing "Admin". The "Password :" label is followed by a text input field containing "*****". The "Click To Enter" label is followed by a "Go" button.

Figure 4.2 : Login Form

The interfaces of the system begin with the login form of the user so that the system will be secure from any unauthorized access. Figure 4.2 shows the menu for logon form that has been designed.

After the user has successfully login, the form of main menu will appear. The tabs have been reduced to only two tabs, Data Input and Reports / Graphs because it is unnecessary to include others tabs. Figure 4.3 are the main menu of the system begins with Data Input tab. The user has to click on “Click Here” button to go to the next form for data entry.

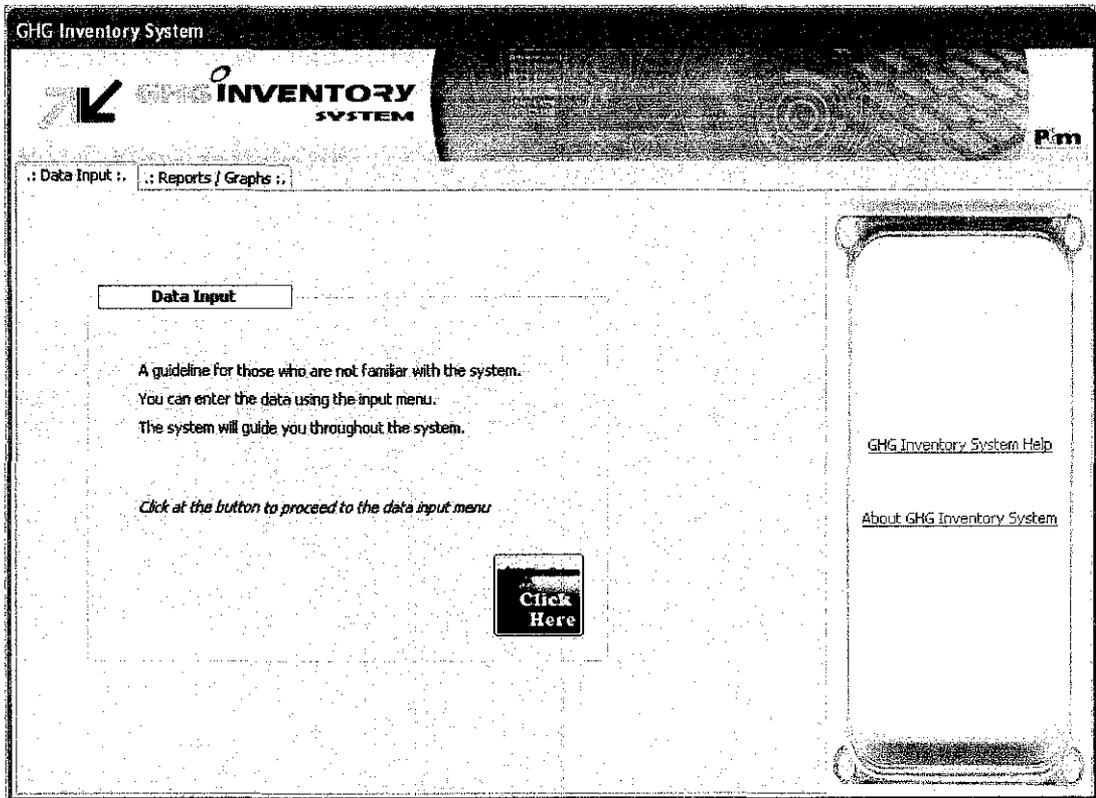


Figure 4.3 : Main Menu for Data Input

After the user has click on “Click Here” button at the previous menu, a form of Data Input menu for all sub modules will appear. The user can choose any of the sub modules that they may need to make a data entry. Figure 4.4 shows the Data Input Menu for all sub modules from the system.

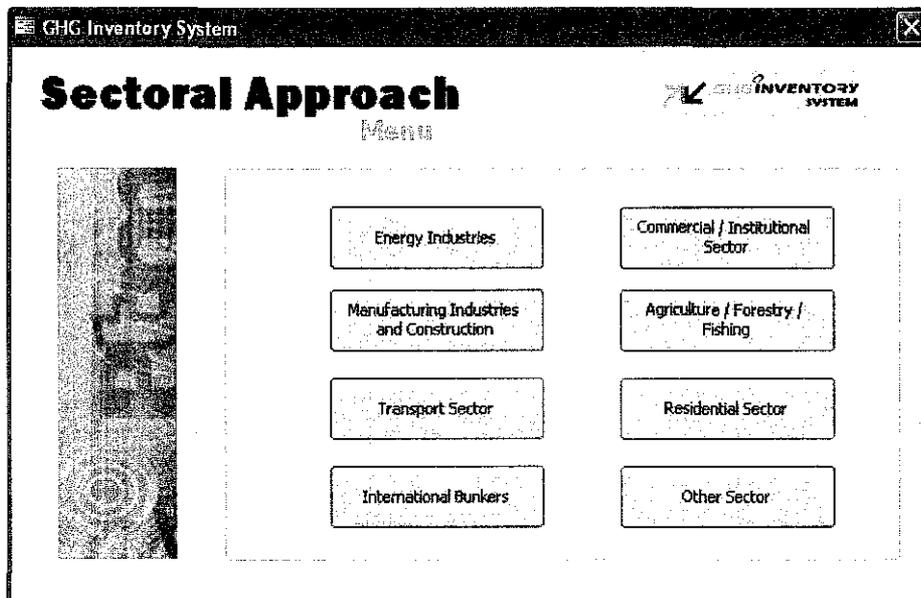


Figure 4.4 : Data Input Menu for all sub modules

When the user chooses the sub module, a form of Input Form will appear. The user may enter the data in this form at the Input Data column. When it is done, the calculated data will come out at the Output column. Figure 4.5 shows the Input Form for Energy Industries.

Input Data		Output	
Fuel Types:	Fuel Oil	Consumption:	24769.28 TJ
Year:	2000	Carbon Content:	522631.808 t C
Consumption:	592	Carbon Content:	522.631808 Gg C
Carbon Emission Factor :	21.1 t C/TJ	Carbon Stored :	0 Gg C
Fraction of Carbon Stored:	0	Net Carbon Emissions:	522.631808 Gg C
Fraction of Carbon Oxidised :	0.99	Actual Carbon Emissions:	517.40548992 Gg C
		Actual CO2 Emission :	1897.15346304 Gg C

Figure 4.5 : Example of Input Form for Energy Industries

After the data entry has been made. The user can view all the data and make a comparison from each year. To view all the data, they may view it using the report. Figure 4.6 are the Menu for reviewing the reports from all sub modules. The user can choose any specific sub module to view the report.

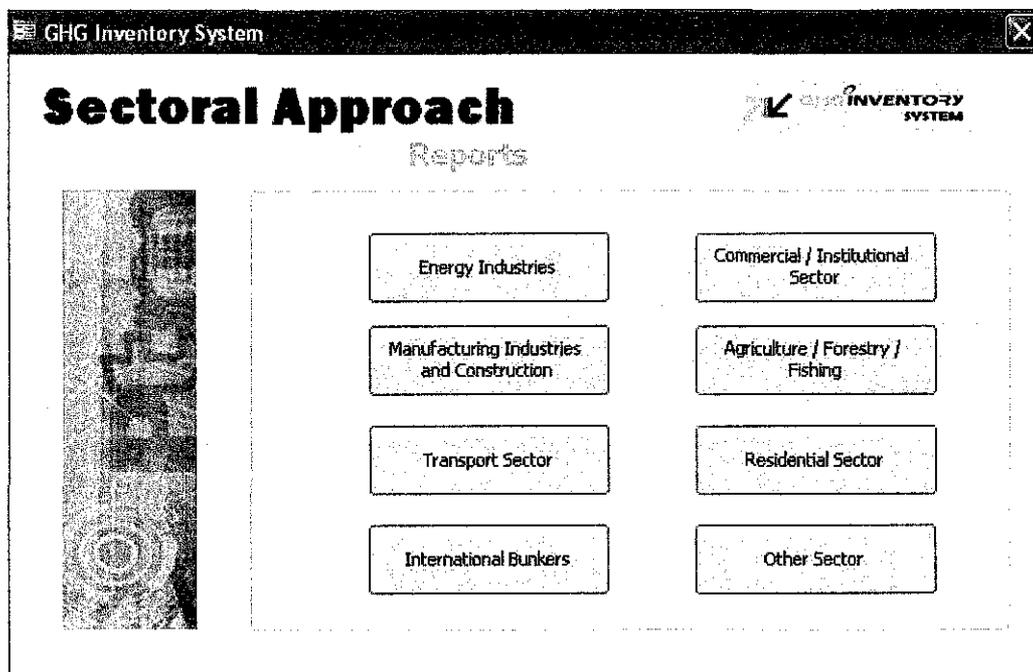


Figure 4.6 : Menu for reviewing the reports from all sub module

When the user clicks one of the sub modules, the report will appear. Figure 4.7 are the example of report for Energy Industries. All the data from gases and fuel types for Energy Industries that has been input can be viewed from the report. The report shows the sum of Consumption in unit TJ and the Actual CO₂ emissions that has been produced in a year. Besides, the user can also compare the Actual CO₂ emissions by each year.

GHG Inventory System - [GHG Inventory System]

File Edit View Tools Window Help Type a question for help

100% Close Setup

Energy Industries for Energy Sector in Malaysia

Year 2000

Fuel Type	Consumption	Carbon Emission Factor	Fraction of Carbon Shared	Carbon Shared	Fraction of Carbon Oxidized	Consumption (TJ)	Carbon Content (t-C)	Carbon Content (kg-C)	Net of Carbon Emissions	Actual Carbon Emissions	Actual CO ₂ Emissions
Solid Biomass	153	29.9	0	0	0.99	6011.52	191405.488	19140545	191405448	1894913235	694801782
Diesel	12110	15.3	0	0	0.995	506682.4	7752840.72	77522407	775224072	7713479516	2882275823
Other Biomass	1495	25.8	0	0	0.98	62530.8	1613810.64	16138106	161381064	1581534427	579895936
Fuel Oil	392	21.1	0	0	0.99	24769.28	522651.808	52263181	522621808	5174054839	1877153463
Sum						694814					3697367383

Year 2001

Fuel Type	Consumption	Carbon Emission Factor	Fraction of Carbon Shared	Carbon Shared	Fraction of Carbon Oxidized	Consumption (TJ)	Carbon Content (t-C)	Carbon Content (kg-C)	Net of Carbon Emissions	Actual Carbon Emissions	Actual CO ₂ Emissions
Solid Biomass	155	29.9	0	0	0.99	6485.2	193907.48	19390748	19391748	1919684352	7036841524
Diesel	13000	15.3	0	0	0.995	543920	8321976	8321976	8321976	828036612	3026134244
Other Biomass	390	25.8	0	0	0.98	41421.6	1068677.28	10686773	106867728	1047303734	3846113693
Fuel Oil	476	21.1	0	0	0.99	19915.84	420224.224	42022422	420224224	4160215818	1525413933
Sum						61174264					3641875422

Page: 1/1 Ready

Figure 4.7 : Example of Energy Industries Report generated by the system.

Beside the report, GHG Inventory System also provides the graph to enhance the comparison process. Figure 4.8 are the Menu for reviewing the graphs from all sub modules. The user can choose any specific sub module to view the graph.

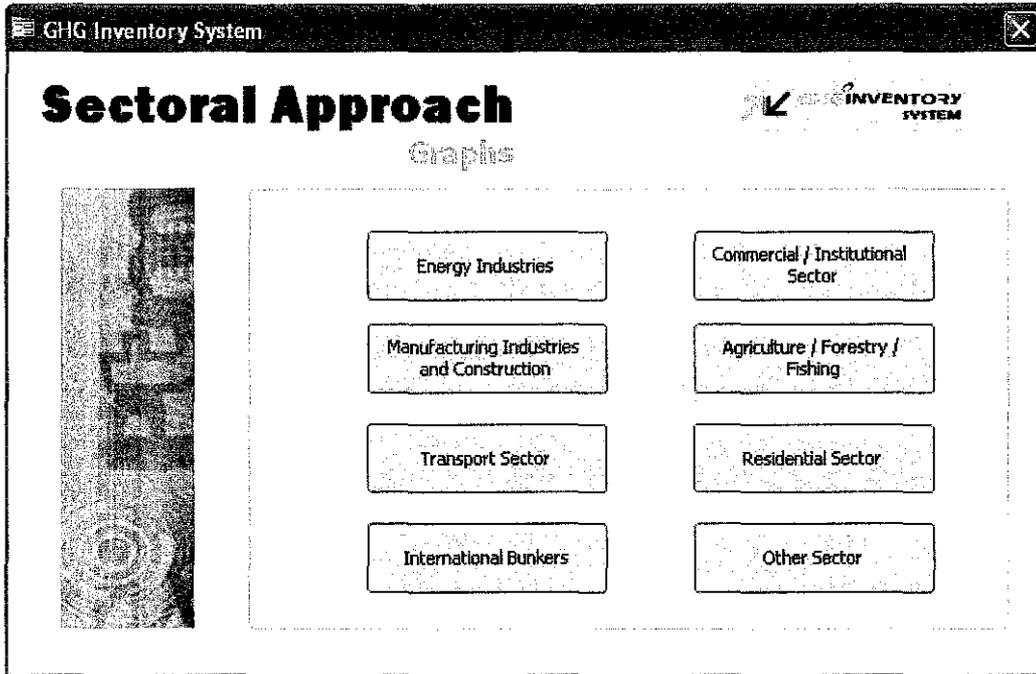


Figure 4.8 : Menu for reviewing the graphs from all sub module

When the user clicks one of the sub modules, the graph will appear. Figure 4.9 are the example of report for Energy Industries. The sum of the Actual CO₂ emissions for each year can be seen clearly from the graph. So, the user can make a comparison easily.

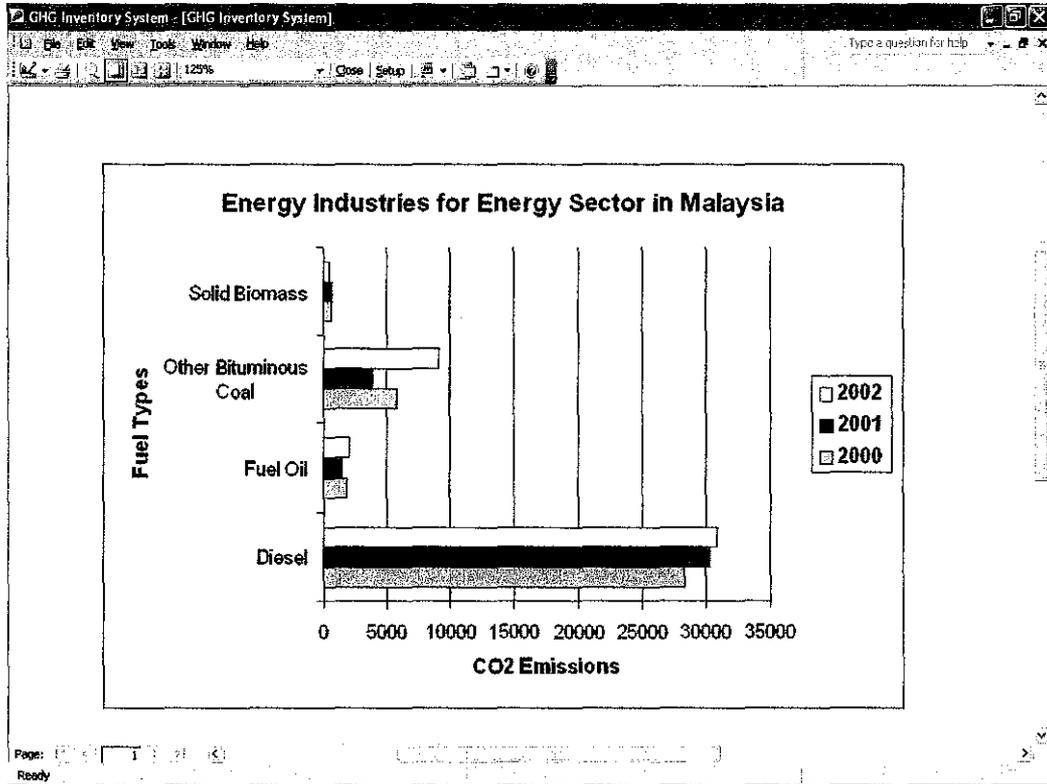


Figure 4.9 : Example of Energy Industries Graph generated by the system.

4.2 Discussions

The system testing has been done at the user's site which is located at Pusat Tenaga Malaysia, Seri Kembangan, Selangor. During the system testing of GHG Inventory System, the Research Officers which are the users of the system have tested the system in terms of the functionality of the system, the speed, the GUI, whether the system is user-friendly or not and also on the easiness of the system.

From the testing, it shows that the system has given a contribution to them where they are no longer need to work for long hours. Besides, it is useful for them because there is no confusion in entering the data. The GHG Inventory System offers to analyze all gases and fuel types used by Malaysia industry only. So, there are no more unused gases and fuel types that make them confused as before. The system can save the data for every year. Means that, there is no more missing of any specific year of data. They can just search to view any required data for any year they need at that time.

Using the GHG Inventory System also make their work smooth where there is no delay in the process of generating the reports. As mention before, the current system that they used caused a delay in process, where the system failed to perform the analysis annually. But by using the GHG Inventory System, they are able to perform the analysis annually since the system is easy to use and useful to them.

CHAPTER 5

CONCLUSION AND RECOMMENDATIONS

5.1 Conclusion

As a conclusion, this project is developed to help research officer to monitor and analyze the GHG emissions in Malaysia in an electronic environment where it enables better analysis of the information. By completing this project, the system user-friendliness will aid the Research Officers in doing their tasks. Besides, the analysis of the GHG emissions in Malaysia can be done efficiently annually. Therefore, GHG emissions can be monitored. The system has been tested in terms of the functionality of the system, the speed of the system, the GUI and also the easiness of the system. Based on the testing, the Research Officers have found that the GHG Inventory System is very helpful and useful as it has decreased their work loads. Thus, the project has reaches its goals and accepted by the users.

5.2 Limitation of the Project

Each program or application has its own limitation. Same goes to this system. The limitation for GHG Inventory System is that the system has limited database storage. Due to the usage of Microsoft Access, the database can only catered the data up to approximately 8 years. However, the GHG emissions need to be monitored annually.

5.3 Recommendations

Based on the limitation of the system, in future, when the system can no longer kept the data, the alternative that can be used is moving the data repositories to a database that provides better performance and reliability. As a suggestion, MySQL can promise flexibility and will be used as a data management platform, and continue to manipulate the data through Access as a front end.

The other alternative that can be implemented is by using a web-based application system. Web-based applications can indeed be utilized by multiple users at the same time. No more need to screen share or send a screenshot when multiple users can see and even edit the same document together. Besides, web-based applications have far more reasonable demands on end-user RAM memory than locally installed programs. By residing and running off a provider server, these web-based applications use in most cases the memory of the computers they run on, leaving more space for running multiple applications at the same time without incurring in frustrating performance hits.

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APPENDICES

APPENDIX A :

PROJECT TIMELINE

Table 1 : Project Timeline for the First Semester of 2 Semester Final Year Project

NO.	ACTIVITIES	WEEK NO/DATE															
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
1.	Selection of Project Topic	■	■														
	-Propose Topic																
	- Topic assigned to student																
2.	Data Analysis of Research and System Analysis		■	■													
	- Analysis on System Requirements																
3.	Preparation on Research			■	■												
	- Determine Scope of Study																
4.	Preliminary Research Work					■	■	■									
	- Introduction																
	- Objective																
	- List of references / literature																
	- Project planning																
5.	Submission of Preliminary Report								○								
6.	System Design									■	■	■	■	■			
	- Designing the flow of the system																
	- Storyboard and contents																
7.	Submission of Interim Report															○	
9.	Preparation for Oral Presentation															■	■
10.	Oral Presentation																○



○ Suggested milestone
 ■ Process

APPENDIX B :

**SAMPLE OF EVALUATION FORM FOR
SYSTEM TESTING**

GHG INVENTORY SYSTEM'S EVALUATION FORM

Instruction : Please select the option based on your evaluation.

- 1 : Strongly Disagree
- 2: Disagree
- 3: Neither Agree or Disagree
- 4: Agree
- 5: Strongly Agree

No.	Questions	1	2	3	4	5
1	Interface * Is the system user-friendly or not?					
	a) Input menu					
	* Do you think its easy to enter the data?					
	* Is it understandable?					
	b) Report					
	* Is it meet the standard?					
	* Is it understandable?					
	* Is it following the standard format?					
	c) Graph					
	* Is it meet the standard?					
	* Is it understandable?					
	* Is it following the standard format?					
	d) Buttons					
	* Is the navigation buttons helps you?					
	* Is the search button helps you?					
	* Is the Help function guide you?					
2	Speed of the processing					
3	Manuals * How the manuals guide you to use the system?					
4	Adaptation with the company environment					
	How you familiarize with the system?					
5	Objectivity					
	Is the system achieve the expectation?					

THE END
THANK YOU FOR YOUR TIME



APPENDIX C :

USER APPLICATION MANUAL



MALAYSIAN
 **GHGINVENTORY**
SYSTEM

FOR ENERGY SECTOR

USER APPLICATION MANUAL

GHG Inventory System for Energy Sector in Malaysia

User Application Manual

User Application Manual, 2006

**Pusat Tenaga Malaysia
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Selangor Darul Ehsan,
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CITATIONS

This report was prepared by

Bushra binti Tajuddin
Student of University Technology PETRONAS
for Pusat Tenaga Malaysia.

This report describes research by PTM.

DESCRIPTION

The GHG Inventory System was created on the year 2006 and has been design to help and guide the Research Officers to record data that is elated to the Greenhouse Gas Emission. These data are collected and will be processed by the GHG Inventory system to produce information to educe the emission of the Greenhouse Gas.

Description

The GHG Inventory System is developed using the guidelines of the "Revised 1996 IPCC Guideline" provided by the IPCC as reference. The IPCC Guidelines were first accepted in 1994 and published in 1995. UNFCCC COP3 held in 1997 in Kyoto reaffirmed that the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories should be used as "methodologies for estimating anthropogenic emissions by sources and removals by sinks of greenhouse gases" in calculation of legally-binding targets during the first commitment period.

Benefits and Value

- The user interface designed easily according to the end user needs. The end users are also familiar with Microsoft's Interface and this will eventually help them to use the application.
- The Application could be enhanced in the future. This includes using them as a back end in a VB.net Applications, merging the database with other database, can be uploaded to the Internet, and can be integrated with several other software like Microsoft Excel and Word.

Platform Requirements

The minimum requirement for using this application are :

- Processor Speed : Pentium 133 MHz or higher
- Memory : 48MB of RAM
- Operating System : Windows 95, Windows 98, Windows NT, Windows 2000, Windows XP.
- Microsoft Access 2000

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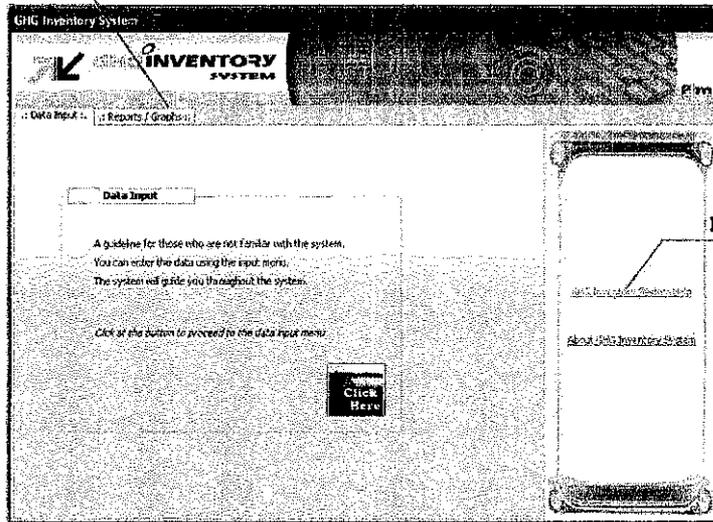
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1 OVERVIEW OF THE FEATURES

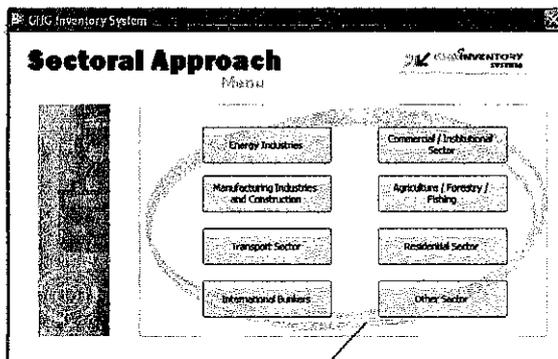
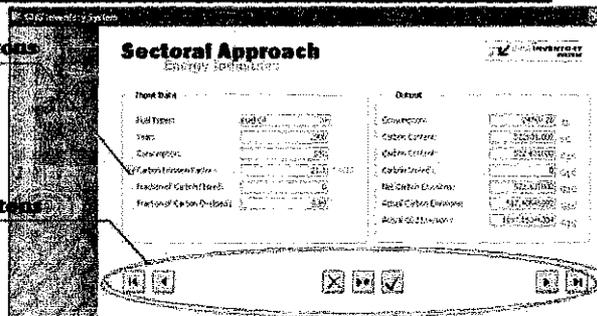
This section will discuss about all of the basic features of the GHG Inventory System. The followings are the list of features and a brief description about each and one of them.

Tab Menu



Reference Table Buttons

Navigation Buttons



Sub module Buttons

Figure 1 : Overview of the features

1. Tab menu

The tab menu will help the user to go to the main menu of the main activities like data entry for "Sectoral Approach" and also viewing the results from the data entered. The tab menu are consist of 2 menus which are "Data Input" and "Reports / Graphs"

2. Sub module Buttons

Clicking at the sub module button will bring user to the data input form for the selected sub module and fuel types.

3. Help Menu

Clicking at the help menu will bring user to the help form where the user can retrieve the solution for the problem occurred.

4. Reference Table Buttons

These buttons is purposely to help user to get a reference table for some a few data that have default value provided by IPCC if there are no specific data to be entered. The user can click at the "f" button for Carbon Emission Factors table and "O" Button for Fraction of Carbon Oxidised table. (Optional) Both tables are just for reference.

5. Navigation Buttons

These buttons are use for navigating the records in the system. Please refer to the "Navigation Buttons" Section in this Guide.

2

NAVIGATION BUTTONS

Navigation buttons are found at the Data Input Forms. The followings are the list of navigation buttons and their usage:

Navigation Button	Name	Descriptions
	Add New Data	<ul style="list-style-type: none"> Click this button when you want to enter new data. All of the input Field will be clear from any data.
	Save	<ul style="list-style-type: none"> Click this button when you want to save data. Click this button after you have enter new data Click this button when you change or edit any data. <p><i>(Important: If you do not click this button, any changes made would not be saved into the database)</i></p>
	Delete	<ul style="list-style-type: none"> Click this button when you want to delete the exiting data. A message box will appear after clicking the button for deleting confirmation <p><i>(Important: Please double check your data each time you want to delete any record)</i></p>
	First Record	<ul style="list-style-type: none"> Click this button to go to the first record. <p><i>(Note: In this database, the first record would be the latest year to be entered.)</i></p>
	Last Record	<ul style="list-style-type: none"> Click this button to go to the last record. <p><i>(Note: In this database, the last record would be the earliest year to be entered.)</i></p>
	Next Record	<ul style="list-style-type: none"> Click this button to navigate the data entered into the database. Clicking this Button would go to the next record
	Previous Record	<ul style="list-style-type: none"> Click this button to navigate the data entered into the database. Clicking this Button would go to the previous record

Table 1 : Navigation buttons and its usage

3

DATA ENTRY FOR SECTORAL APPROACH

1. Click at the "Data Input" menu tab. The tab menu can be found on the top of the main menu. (Note: The default Main menu will be the "Data Input" main menu.)



Figure 2 : The Data Input menu tab

2. Click on the button "Click Here".



Figure 3 : "Click Here" Button

3. Choose the Sub-modules related to your data. Click at the Button that has your chosen Sub Module. For This example, we are going to use the Energy Industries" Sub-Module.

(Note: There are 8 Sub-module for the Sectoral Approach; Energy Industries, Manufacturing Industries and Constructions, Transport Sector, International Bunkers, Commercial/International Sectors, Agriculture / Forestry / Fishing, Residential Sector, Others)

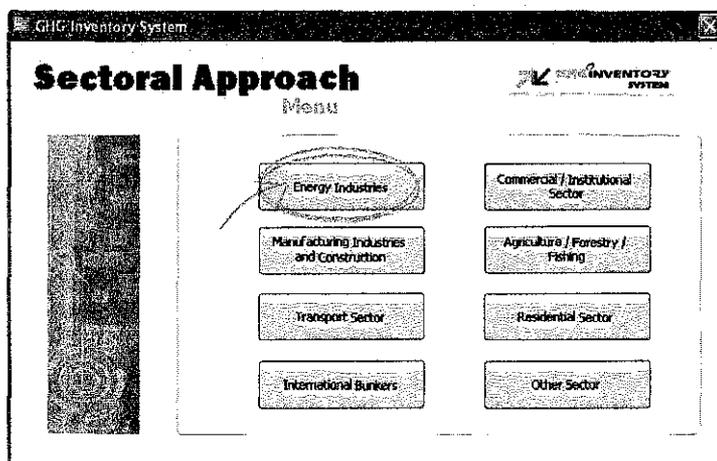


Figure 4 : The Sub module in the Sectoral Approach menu

- An Energy Industries Data Input form will appear.

Figure 5 : The input data form for Sectoral Approach in Energy Industries sector

- Click at the "New data" Button
(Note: Please refer to the "Navigation Button" Section in this guide)

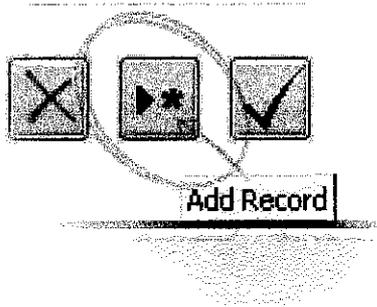


Figure 6 : Add new record button

- You can always click at the "f" button for Carbon Emission Factors table and "O" Button for Fraction of Carbon Oxidised table. (Optional) Both tables are just for reference.

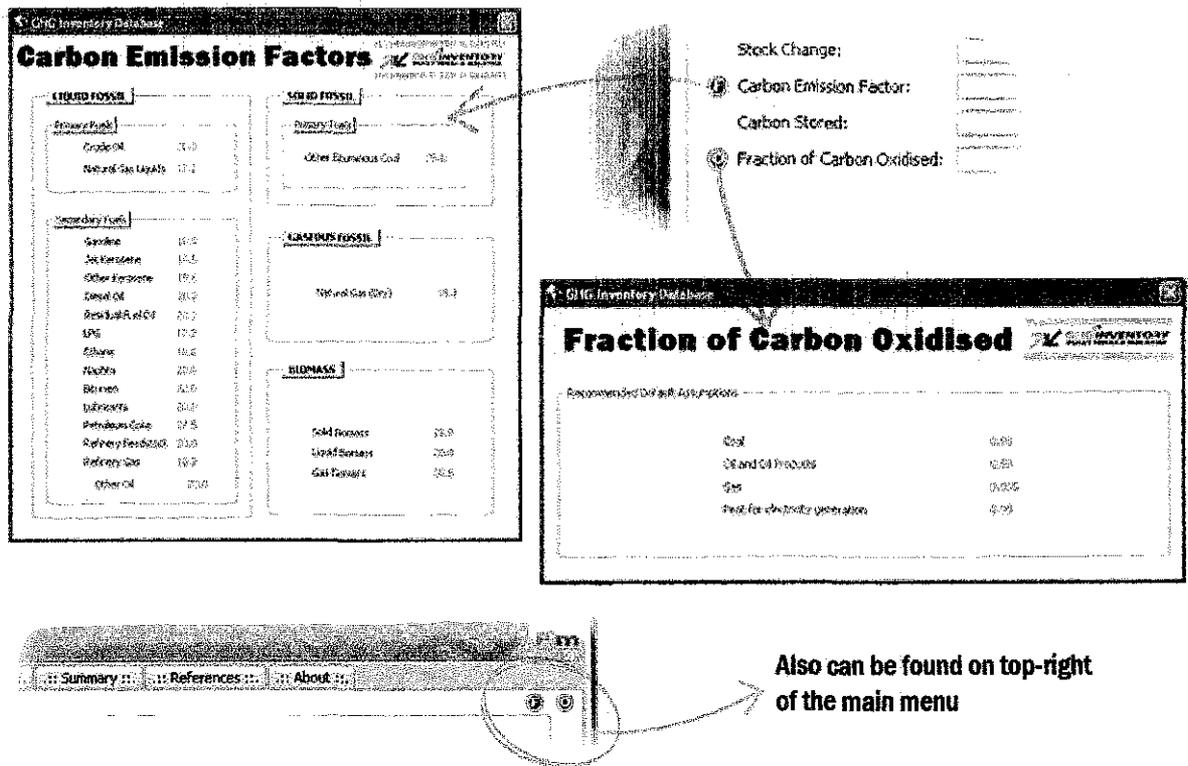


Figure 7 : Reference for Carbon Emission Factor and Fraction of Carbon Oxidised

6. Enter related data and click the "Save Button".
7. You can always navigate the Data that you have entered in the past using the navigation buttons. (See "Navigation Buttons" in this guide)

Viewing Calculation for the entered data for Sectoral Approach

8. Do step 1 until 6.
9. Click at the "Advance" Button on the lower right of the fuel type Data Input Form.

The "Advance" Button. Clicking on it will bring the user to another form

the calculated data

GHG Inventory Database

Diesel Oil

Energy Industries

::: Fuel Type : Liquid Fossil > Secondary Fuels :::

Year:

Consumption:

Consumption (TJ): TJ

Carbon Emission Factor: t C

Carbon Content (t C): t C

Carbon Content (Gg C): Gg C

Fraction of Carbon Stored:

Carbon Stored:

Net Carbon Emissions (Gg C): Gg C

Fraction of Carbon Oxidised:

Actual Carbon Emissions (Gg C): Gg C

Actual CO2 Emissions (Gg C): Gg C

"Simple" Button

<< Simple

Figure 8 : The user can view the calculated data after click on the "Advanced" button

10. A new form providing the data calculated will appear. Notice that the data that you have the input is on the left of the form where as the Calculate data is on the right.
(Note: You can neither enter data nor edit the data in this form. This is just to look at the result from the data that you have entered. If you want to change the data, Please change it in the Input form)
11. Click at the "Simple" button to go back to the simple view/Data Input Form.
(Note: You can now change data in this form just in case there were errors in the last data entry activities)

4

USING REPORTS TO VIEW THE RESULTS

The Report is use for viewing total results. Use the following step-by-step guide to view a sample report.

1. Click at the "Reports / Graphs" tab menu.
(Note: The default Main menu will be the "Data Input" main menu.)



Figure 9 : Click on the Reports / Graphs tab menu

2. Click on the button "Click Here"

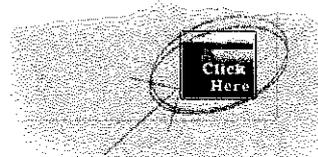


Figure 10 : "Click Here" button

5

USING GRAPH TO VIEW THE RESULTS

The Graph is use for comparing the total results. Use the following step-by-step guide to view a sample graphs.

1. Click at the "Reports / Graphs" tab menu.
(Note: The default Main menu will be the "Data Input" main menu.)

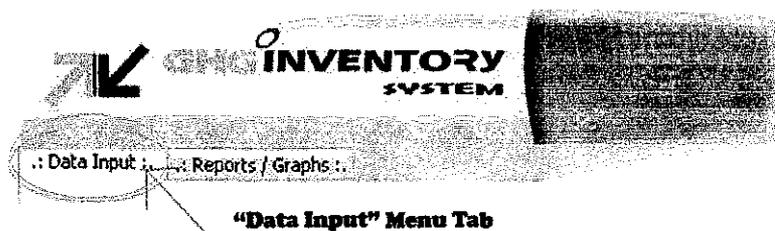


Figure 13 : Click on the Reports / Graphs tab menu

2. Click on the button "Click Here"



Figure 14 : "Click Here" button

- In this menu, the graphs are grouped according to their sub modules. Click on the required sub module to view the generated graphs. E.g : Energy Industries graph.

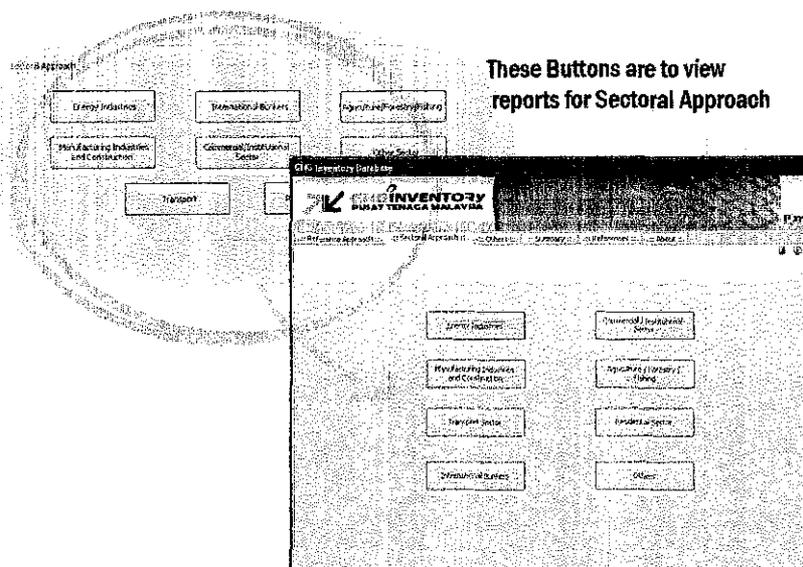


Figure 15 : The Energy Industries button in the Reports / Graphs will view the total graphs of the Energy Industries sector

- Just click the category buttons to view the results. In this Example, we are using "Energy Industries", one of the sub-modules from the Sectoral Approach.

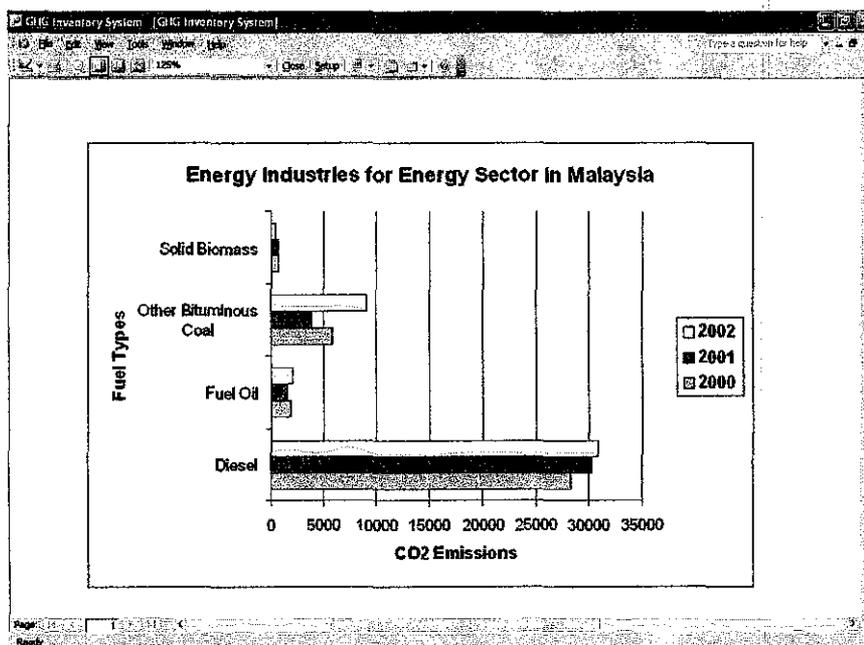


Figure 16 : Example of the graph of the Energy Industries from the Sectoral Approach

6

UPDATING EXISTING DATA

User can also update the existing data. The Existing data can be edited using the same steps in all sub modules.

The followings are the step-by-step guide on how to update an existing data:

Changing the Existing Data

1. To update the existing data, let us use the Energy Industries Input Form as an example. (Note: Please refer to chapter 3 for opening the Input data form)
2. Choose the particular Year of the data that you want to update. This can be done by using the navigation buttons (Refer to Chapter 2) to navigate the records in the database. Click at the "Next" or the "previous" buttons to search your data.

Sectoral Approach
Energy Industries

Choose the fuel types and year

Input Data:

Fuel Types:	Fuel Oil
Year:	2000
Consumption:	592
Carbon Emission Factor :	21.1 tC/TJ
Fraction of Carbon Stored:	0
Fraction of Carbon Oxidised :	0.99

Output:

Consumption:	24769.28	TJ
Carbon Content:	522631.808	tC
Carbon Content:	522.631808	Gg C
Carbon Stored :	0	Gg C
Net Carbon Emissions:	522.631808	Gg C
Actual Carbon Emissions:	517.40540992	Gg C
Actual CO2 Emission :	1897.15346304	Gg C

Navigate the records using navigation buttons

Figure 17 : Updating the data

3. Choose the data that you want to update and click at the field. In this example, we will update the "Year" for Fuel Oil in the Energy Industries form.



Figure 18 : Key in the required data

- 4. Type in the data that you want to update.
- 5. Click at the "Save" Button

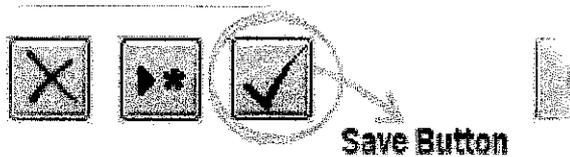


Figure 19 : Click "save" button to save the changes

- 6. Now, the data have been changed.

Deleting the Existing data

1. To update the existing data, let us use the Energy Industries Input Form as an example. (Note: Please refer to chapter 3 for opening the Input data form)
2. Chose the particular Year of the data that you want to delete. This can be done by using the navigation buttons (Refer to Chapter 2) to navigate the Records in the database. Click at the "Next" or the "previous" buttons to search your data.

Sectoral Approach
Energy Industries

Choose the fuel types and year

Input Data

Fuel Types: Fuel Oil

Year: 2000

Consumption: 592

Carbon Emission Factor : 21.1 t C/TJ

Fraction of Carbon Stored: 0

Fraction of Carbon Oxidised : 0.99

Output:

Consumption: 24769.28 TJ

Carbon Content: 522631.808 t C

Carbon Content: 522.631808 Gg C

Carbon Stored : 0 t C

Net Carbon Emissions: 522.631808 Gg C

Actual Carbon Emissions: 517.40548992 Gg C

Actual CO2 Emission : 1897.15346304 Gg C

Navigate the records using navigation buttons

Delete Record

Figure 20 : Choose the data that want to remove

3. Click at the "Delete" button.

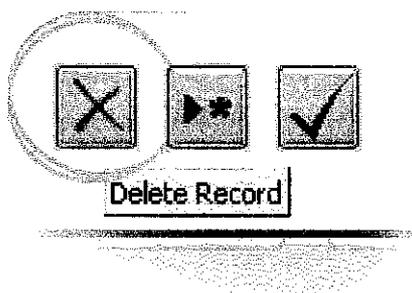


Figure 21 : Click the "delete" button

4. A dialog box asking for confirmation will appear.
5. If you are confirm that you want to delete the data, Click "OK".

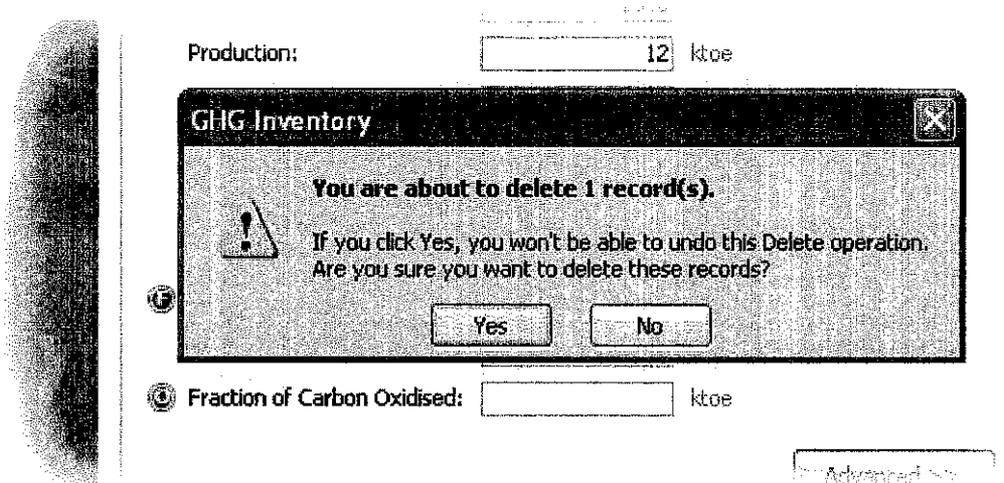


Figure 22 : A confirmation dialog box will appear.

6. Clicking cancel will not delete any data and will bring the user back to the Input Form.

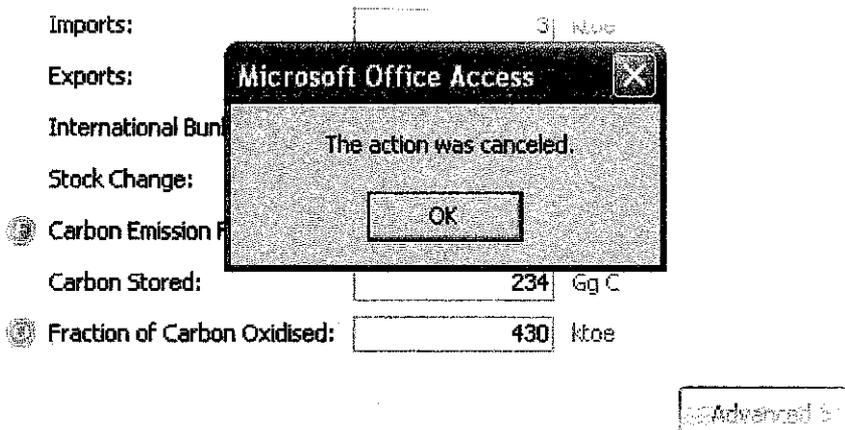


Figure 23: Confirm the dialog box

7

NOTES
