Central Institute for Economic Management (CIEM)

Final Report

"Green GDP index: Research for Methodology Framework Development"

Submitted to British Embassy in Vietnam

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Ha Noi, March 2012

List of abbreviations and acronyms

CIEM : Central Institute for Economic Management

GDP : Gross Domestic Products

GSO : General Statistics Office

I.O.T : Input-Output table

PSO : Province Statistic Office

SAM : Social Accounting Matrix

SEEA : System of integrated Environmental and Economic Accounts

SNA : The System of National Accounts

SNAD : The System of National Accounts Department

SUT : Supply and Use table

WRI : World Resources Institute

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Acknowledgments

This draft report is jointly prepared by the Central Institute for Economic Management - CIEM and SNA Department of Vietnam's General Statistic Office - GSO within a research project funded by Prosperity Fund (UK). The research team consists of Ms. Vu Xuan Nguyet Hong (team leader), Dr. Nguyen Manh Hai, Ho Cong Hoa (CIEM), Bui Trinh, Nguyen Viet Phong, Duong Manh Hung, (GSO).

The team members have been benefited from the great contribution of Jean-Louis Weber (EEA) who made valuable comments to the draft report, shared the international experience on developing a methodology framework of green accounting and provided a presentation in training workshop on "Green" national accounting: Development of Environmental-Economic Accounts at the International Level" organized in February 2012.

Special gratitude are given to Dr. Pham Van Ha, Financial Strategic Research Institute and Dr. Le Ha Thanh (Department on Environmental Economics and Urbanization, the National Economic University) who made relevant comments and suggestions to the first draft report which was presented at the workshop held on March 21, 2012.

This research project has been carried out with close collaboration between the research team and other related organizations from different ministries like MPI, MONRE, MOIT, MARD. The team members wish to thank all participants represented these organizations who attended and provided their views and comments through several consultation rounds organized during the project period from September 2011 to March 2012. Their contributions have been highly appreciated and helped the team to improve this final report.

Last but not least, the authors wish to express the tremendous gratitude to Le Thi Ngoc Bich, an officer of British Embassy in Vietnam, who has continuously supported and collaborated with the research team along the whole research project period.

The proposed methodology framework expressed in this draft final report is entirely that of the team members and should be considered as an initial step for further works and discussions with relevant stakeholders and practitioners before it will be officially applied in practice by GSO. Because of data limitation, the data used in this report should be seen for demonstration purpose to the proposed methodology framework only and does not necessary represent the actual situation of Vietnam in the reality.

1. Introduction

1.1.The Context

Over the last two and half decades, the economy of Vietnam has experienced relatively high growths at about 7% on average. However, that is not the whole story given the fact that the Gross Domestic Product which is used as the most important index to measure economic growth does not fully reflect natural resource depletion and the costs of environment pollutions occurred along with economic and residential activities. It was also argued that Vietnam's economic growth over the last decades has been heavily relied on intensive natural resource extraction, the growth of relatively polluting industries and energy use intensity is higher than other countries in the region.

Recently, Vietnamese government was fully been aware of the importance of shaping the economy towards more sustainable development by a large range of policies and regulations such as the Law on Environment Protection (2005), 2011-2020 socio-economic Development Strategy and 2011-2015 socio-economic Development Plan. Currently, the government is in process to formulate green growth strategy until 2020 and vision to 2030. One of the important attempts included in these strategic documents was to set up a green national accounting system in Vietnam. As it was stipulated in the Prime Minister's Decision No. 43/2010/QD-TTg dated June 2, 2010, the government of Vietnam plans to introduce so called "green GDP indicator" in the overall national socio-economic indicator system from 2014[1].

However, green national accounting currently is still new topic in Vietnam, particularly for policymakers and statistical practitioners. There have been so far some initial studies and initiatives to put this topic in academic discussions rather in operational manner[2]. In order to put the mentioned policy on green national accounting into practice, several preparatory steps should be conducted, including: i) developing a methodological framework for constructing green national accounts; ii) preparation of data information on natural resource and environment consistent to the green accounts; iii) human resource development for carrying out the green accounts.

The project on "Research for Methodology Framework Development " was initiated by the Central Institute for Economic Management (CIEM) and funded by the Foreign and Commonwealth Office (UK) through a small grant of Prosperity Fund. The project tries to formulate a solid and tailored-

[1] *See National Statistical Indicator System, GSO and UNDP, Hanoi 2011, page: 25.*

[2] *Further reference on green accounting in Viet nam can be seen in: Vu Xuan Nguyet Hong, "Environmental accounting in the national account system"(2004) ; UNDP, "The possibility and scope on environmental accounting in Vietnam" (2006)...*

made methodology for conducting national green accounts in Vietnam. The proposed methodology should be based on the standard green national accounting methodology which has been used in other countries and on the international practices, but adjusted in Vietnam's particular case.

1.2. Introduction to The Research Project

Objective

This research project aims at collaborating with GSO and related organizations to develop a methodological framework for conducting green national accounting in Vietnam. In the end, the project will help GSO in calculating Green GDP Indicator as stipulated in Prime Minister's decision and contribute to ensuring green growth path by informing the policymakers about environmental sustainability of the country's growth over the years.

It important to note that the overall methodological framework of green national accounting already exist and was published by the UN in its publication: "System of Integrated Environmental and Economic Accounting – SEEA" (2003)[3]. The project therefore does not attempt to develop a new methodology rather to formulate a relevant methodological framework to apply SEEA in practical manner for Vietnam.

Project activities

The proposed project was carried out in participatory manner. It has involved a broad range of people, including national academics, environmentalists, economists, statisticians, practitioners and international experts. During the project period, the following activities were carried out:

- Desk study to review of current methodology of Green GDP measurement published by UN, international experiences. The output of this activity was a report prepared by the team summarizing SEEA framework and application of green accounting in other countries in the world. This report was presented at the first workshop held in September 2011 in Hanoi.

- Based on the discussion with related experts and organizations to propose a applicable methodology framework to be used for Vietnam. CIEM and GSO teams have worked with relevant experts from different organization from line ministries like MPI, MOIT, MARD, MOF, etc. on the availability of information required for introducing green national accounting in Vietnam. Then, the team proposed a methodological approach to be used in the project.

[3] *See more information in: UN 2003, "System of Integrated Environmental and Economic Accounting – SEEA"*

- The proposed methodology was then consulted with related stakeholders through consultative meetings and discussions (including input of international experts). 3 workshops were organized during the project period.

- Develop selective templates and software for applying proposed methodology framework. This activity was undertaken by a GSO experet team.

- Organize 4 days training workshop for GSO staff and related organizations on green national accounting and proposed green accounts templates and software. The activity involved CIEM, GSO and an international experts from (EEA, UK) who played a role as resource persons.

Outputs of the project

The research project is expected to produce following outputs:

- A report on methodology for measuring green national accounts for Vietnam

- Templates for selected green accounts (at least two)

- The results of research as mentioned above are disseminated in a final workshop.

1.3. Structure of this report

This report serves as one of the project's outputs as listed above. It mainly focuses on describing the proposed methodology framework of green national accounting to be applied for Vietnam and propose further works to be done.

A part from the introduction above, the current report consists of the following sections:

Section two introduces the concept of green national accounting and the System of Integrated Environmental and Economic Accounting – SEEA developed by the UN before it focuses on the proposed methodological framework to be used for introducing green national accounting in Vietnam.

Section three of the report is to illustrate how the proposed methodology framework can be operated in practice by conducting empirical estimation for selected natural resource accounts and environmental costs account. A tailor-made spreadsheet was designed and utilised for this purpose. The section also describes the data availability situation for applying the methodology and proposes possibility to obtain the missing data.

Finally, section four concludes the report with recommendations to follow up the research and steps should be conducted in the future for applying green national accounting in practice.

2. Methodology Framework

2.1. Concept of Green National Accounting

The concept of green national accounting

Green National Accounting (Green GDP Accounting for short) refers to an accounting system deducting natural resources depletion costs and environmental degradation costs, so as to assess the quality of sustainable development in a real sense. The rational for introducing this concept is because the traditional GDP accounting system does not reflect sufficiently and precisely the nature of the economic growth since it neglects the environmental costs and resource depletion resulting from economic activities.

In the 70s, many developed countries like Norway, Canada, France and Netherlands put great efforts to formulate a mechanism of integrating the environmental damage and resource degradation into the national economic accounting. However, only until 1993, United Nations and the World Bank jointly produced methodology for developing the natural and environmental accounts and published a manual on "System of Integrated Environmental and Economic Accounting – SEEA" 1993. This was then amended in 2003 (SEEA 2003), and now become a standard methodological framework for environmental accounting and has been applied in many countries in the world.

Basically, SEEA 2003 is a system of accounts developed based on the system of national account (SNA). Therefore, the contribution of the natural resources to economic growth is highlighted as well as the environmental expenditure is separated and the pollution costs, environmental damages and resource degradation are accounted. This approach is seen as green national accounting and enables us to calculate the so-called "green GDP".

By its nature, green GDP reflects the quality of growth and sustainable development of the economy. In general, green GDP can be summarized in the following formula:

GDP_{green} = $GDP_{traditional}$ – Depletion of Natural Resource – Cost of Pollution/Climate Change

Of which:

- Depletion of Natural Resource: decreases in the products/quality and areas of forest, production land, reserve land, faunas and floras, gene sources, biological system, and mineral resources, etc.

- Cost of Pollution/climate change: public health, water supply, crops, fishery, drought, natural disaster...as a result of environmental degradation.

Introduction to SEEA

System of Environmental and Economic Accounting – SEEA was developed based on the existing SNA to integrate the environmental statistics to the economic ones. The system enables to collect the environmental statistics in conjunction with the economic statistics at the same period. This can provides the information on the environmental sustainability of the production and consumption and the economic impacts of the environmental policies.

The environmental pollution is accounted based on the principle that the value of the product or service is the expenditure or income from that product or activity. If the polluters are not charged for damaging the environment, the costs are not deducted from the national income, therefore the damage is not deducted from the labor income or corporation share, and hence the household consumption is not reduced. In other words, exemption from the fee using the environmental facilities such as the sea does not increase the national income.

The accounts of the SEEA can be measured either in physical or monetary terms or both of them. The accounts measured in physical terms can be presented in the international standardized available units on length, volume, areas, such as meters, litre, hectare or kilogram. In short, all of them are called “physical accounts". Monetary accounts are measured in the value term.

There are 4 types of accounts in the SEEA, including:

- Physical and hybrid flow accounts.
- Economic accounts and environmental transactions.
- Asset accounts in physical and monetary terms.
- Extending SNA aggregates to account for depletion, defensive expenditure and degradation.

From the international experience, it is important to emphasize that because of its complexity and measurement methodology issues of SEEA, no countries in the world that have applied green national accounting can capture all aspects of natural resource depletion and environmental costs. It is because there are still areas in this SEEA manual need to be further considered in term of measuring methodology. Most of these countries usually chose to include selected natural resource and environmental costs into account only.

2.2. Types of accounts in the SEEA

2.2.1. Physical and hybrid flow accounts:

The data on environmental inputs and resources are collected in physical accounts and arrange along the structure of the SNA. The hybrid accounts combine the environmental data with the accounts of the SNA. In these accounts, the physical environmental accounts hybridize with the economic accounts.

These accounts show the dependency of the economy on the environmental inputs as well as the sensitivity of the environment to the economic activities.

The environmental accounts are developed based on the common categorization of the economic activities so that filling the gap in the traditional accounting and highlighting the inconsistency of the data.

Physical flow accounts:

The accounts consider the physical flows of materials and energy relating to the goods and services produced in the economy. For example, the life cycle analysis of wood and timber products and total material flow analysis. The account system of the SNA measures the flows of goods and services in the economy and illustrates their uses in production, investment, final consumption and import or export.

The environmental inputs are classified into two groups, natural resources (such as mineral and biological resources) and ecosystem inputs (such as water and air). The flows from the economy to the environment consist of gaseous, liquid and solid wastes. The materials measured in physical units and presented as a physical supply and use table, which is used as a basis for material flow analysis.

There are four important concepts relating to physical flow accounts. They are products, natural resources, ecosystem inputs and residuals.

- Products: goods and services produced and used in the economy, including those for domestic production and consumption and for export.

- Natural resources: consists of energy and minerals, and biological resources.

- Ecosystem inputs: consists of the environmental inputs such as water, air and land (for example, O_2 is necessary for plants).

- Residuals: the flows from the economy to the environment, which uses the environment as a disposal sink.

Hybrid flow accounts

These are presented in a hybrid supply and use table, where the columns contain values of products plus the cost of labour and capital and adding the physical inputs of natural resources and ecosystem inputs while the rows contain values of products and physical measures of residuals.

In the economy, the industries make more than one product and some products are made by more than one type of industry. This is captured by the supply and use tables, classified the supply by industry and the use by products. Covering the format of these tables to show either the supply of and use of products or the supply by and use by industries is analytically useful.

We can calculate the total environmental input of all products if we know the environmental inputs into a product, and we know who uses the product. For example, we can calculate the environmental input into iron and steel, into various chemical products, into types, etc. and therefore can find the total environmental inputs of a car. In some case, the direct demands on the environment made by the economy fall when in fact the demands are met via another economy. A case in point is that a country may not produce electricity but import it from a country, which generates it by burning fossil fuels. Therefore, the independence of the former on fossil fuels is more apparent than real. Analysis of input-output tables for two countries can give more precise picture on the issue.

2.2.2. Economic accounts and environmental transactions:

Based on the SNA, transactions relating to the environmental management and the impacts of environmental change on that transactions can be identified more clearly if environmental transactions are separated from the existing economic accounting, for example the accounts on education and health expenditure. The environmental expenditure can be spent by firms, government and households.

On the one hand, environment provides input to the economy. On the other hand, more and more economic activities are undertaken and products are made in a way to relieve the negative impacts on the environment. For instant, more and more firms show their commitment to the environmental protection by reducing pollution, saving energy, etc. As a result, hybrid accounting helps to see the

environmental impacts of the economic activities and identify which measures should be applies to reduce the impacts.

Increasing the environmental expenditure is one of the important policies. In addition, economic instruments can be used to promote the environmental friendly behaviors. For example, imposing tax on the natural resources can reduce the resource use and increase its efficiency; and many other policies such as reducing or abolishing the subsidy on fuel fossils, trading the environmental certification and emission licenses.

The close relation among economic and environmental accounts helps measure the sustainability indirectly. For example, it is clear that the increase in spending on environmental protection may release the negative impacts on the environment. However, this is not totally ensured because there are many other economic transactions related to the above spending. In order to know exactly the impact, it is necessary to investigate the relation of that expenditure on many related accounts in the system. This provided important information for financial sustainable analysis.

Some issues are worth to consider here:

- Examine the environmental expenditure, which can be clearly identified in the SNA to define the policies, influencing that expenditure and promoting the voluntary environmental spending.

- Study the efforts on environmental protection through several indicators/activities such as the investment in clean technology, pollution treatment, reuse, production and supply of environmental goods and services, reservation, natural resource management, environmental investment in the relation to total investment in the economy.

- The supply and use tables present the relationship between producers and consumers on environmental products and services, production inputs (labor, capital) and production outputs (for market or domestic consumption).

2.2.3. Asset accounts in physical and monetary terms:

Environmental resources are considered in both physical and monetary terms. When natural resources are used in a production process, they are embodied in the final good or services produced. The price charged for the product contains an element which implicitly covers the value of the natural resource. Establishing this implicit element is at the heart of valuing the stock of the resource and seeing the full role of the resource in the production activity of extracting the resource and making it available to other units in the economy.

The asset accounts of the SEEA are highly relevant to the measurement of sustainable development from the capital perspective. Natural resources, land and ecosystems represent the stocks that provide the many environmental inputs required to support economic activity.

To builds the accounts in both physical and monetary units, it is necessary to classify the environmental assets into several types for example the natural resources accounts, land and ecosystem, renewable and non-renewable resources, economic assets belong or not to the SNA, differentiate the assets consumed in the economy (such as underground assets and biological resources) and the assets are not consumed such as land and surface water.

It is necessary to clarify the principles behind physical asset accounts, which is, getting from opening stock levels to closing stock levels. A distinction is drawn between changes in quantity and changes in quality and/or the classification of the asset. It then relates the stocks and flows in physical terms to the transactions and accounting entries of the SNA. It also discusses to what extent a pure environmental classification can be used in monetary terms and how far some compromise with economic classifications is inevitable when valuation is involved.

For monetary accounts, the principle of economic valuation is an important issue. This relates to the theory of the provision of capital services to the production process by fixed assets. The application of this theory to environmental assets which are currently regarded as "free" gifts of nature is discussed as the basis for reaching a valuation of the stock of these assets.

2.2.4. Extending SNA aggregates to account for depletion, defensive expenditure and degradation:

This deals with the issue how to adjust the existing SNA to account for the impacts of the economy on environment relating to pollution costs, natural capital depletion and degradation, and defensive expenditures, as well as the impacts of the environment on the economy by using the economic instruments to account the values of reducing and increasing natural resources in monetary terms..

In the SEEA, this covers not only the depreciation of manufactured/fixed (non-natural) assets as SNA, but also the depreciation of natural assets, the monetary transactions related to the environment, especially the economic instruments used in natural resource management, such as environmental tax, natural resource ownership permits and license. The accounts are arranged into a matrix, including the tax revenue and the payments to the users, similar with the SAM. They are also considered as a hybrid table including physical and monetary terms of environmental inputs and outputs in the flow accounts of SNA.

2.3. Proposed The Methodological Approach for Building Pilot "Green" Accounts for Vietnam

2.3.1. Approaches to application of green national accounting in Vietnam

The application of green GDP with a comprehensive integration of "green" accounts into existing national economic accounts would be very complicated and difficult. Until now, the countries in the world which have tried this work do not intend to include all aspects of SEEA in their green GDP assessment. Most of them apply SEEA in a partial manner, i.e. focusing only on building green accounts which are considered to be the most important for their economy and then, integrate them into the existing national economic account. This work is undertaken on an annual basis in some developed countries like Denmark, Australia, but less regular (once after 2-3 or even 5 years time) in the other. For developing countries, building green accounts is still seen as a pilot stage. Moreover, the initiative on building the green accounts and integrate them to existing national account system is voluntary rather than being institutionalized and should be compulsory applied for a country. Even though, construction of green accounts in the way to ensure their structure to be consistent with the existing national account setup would have an important policy implication for the policymakers. This would provide useful information for them to consider the growth pattern of the economy toward sustainable development. In short, the policy implications of the application of "green" GDP are not only drawn when GDP has been adjusted after the environmental and resource aspects have been taken into account but also be drawn when building the green accounts - the input information to the green GDP indicator. The integration of the "green" accounts into the SNA enables us to see the relationship between the economic growth and the environment, or the impacts of economic policies on the environment and vice versa, the impacts of the environmental protection policies on the economy.

The flexibility of green accounting applications under the SEEA framework of many countries implies that Vietnam can do the same although there will be some challenges at the beginning. Developing the "green" accounts integrated into the SNA provides several important policy implications. *First*, compiling the "green" accounts will assist General Statistics Office in implementing the Decision No.43 of the Prime Minister on statistical indicator system of Vietnam. Under this Decision, green GDP is considered as the indicator under the group B (the priority classification in application, of which group A is given the highest priority and group B is followed) and will be applied in 2013. This means that Vietnam has 2 years to prepare for this application.

Second, Vietnam is in a process to develop the green development strategy. Building "green" accounts shows a practical commitment in implementing the strategy. It also provides useful information to state management organizations, especially those related in this field such as Ministry of Planning and Investment, Ministry of Natural Resources and Environment, Ministry of Agriculture and Rural Development, Ministry of Industry and Trade, Ministry of Finance, to supervise the implementation of the strategy in the future.

2.3.2. Selection criteria and recommendations on green accounts to be developed for Vietnam

Based on the international experience, in particular those of developing countries presented in section 2 of the report, the selection of the green accounts to be developed for Vietnam is based on the following criteria:

a. *Focusing on the "green" accounts, which are important to the economy*. For example, for the natural resources accounts, the accounts important to the economy such as mineral resources, water, forestry, land, etc. could be selected. Similarly, regarding to pollution, the accounts related to some emerging environmental problems at present time such as water pollution, air pollution (especially CO_2 emission), solid waste could be selected. In addition, the expenditure on environment should be separated from the other expenditure of the system of national accounts in order to analyze the role and the responsibility of the state, firms and households in the environmental protection.

b. Initially focusing on the accounts, whose input information is either available or can be collected in the future. The current statistics system of Vietnam can provide basic input information to some green accounts such as mineral resources accounts, public environmental expenditure account, etc. although the information is probably scattered and inconsistent. The selection of "green" accounts to be developed based on this principle will help Vietnam (especially the statistics office) make use of the available information on the one hand and actively establish the input information sources on the other. That is the most important factor in developing successfully the "green" accounts for Vietnam.

c. *Developing the accounts whose methodology is clear and unanimous*. According to the SEEA manual of the United Nations as well as the experience of many countries, the approach to developing the green accounts and integrating them to the SNA is clear but there are some problems with measurement method and its applicability in reality. In some cases, it is based on a number of

abstract assumptions. For Vietnam, the accounts, whose measurement methods are clear, should be selected to avoid unnecessary discussion latter on.

d. *The selected "green" accounts should be developed in both physical and monetary terms*. The selected "green" accounts must be built in monetary term in order to integrate into the existing system of national accounts. However, the experience of many countries on applying the green accounting show that analyzing the "green" accounts in physical term in many cases provide more meaningful policy recommendations than that in monetary term. Moreover, the accounts in physical term can be used to measure the natural resource use efficiency or emission intensity – the indicators recommended by several international organizations[4].

Up to now, there are several studies relating to "green" accounting in Vietnam, which provide recommendations on which "green" accounts should be compiled for Vietnam. Some of them are as follows:

- A study by Vu Xuan Nguyet Hong (2004) [5] on "Environmental accounting in the national account system" proposes some accounts to be built such as resources accounts (land, mineral (underground), forest, aquatic resources, water); pollution; environmental expenditure.

- A study of the UNDP's experts (2006) [6] on "The possibility and scope on environmental accounting in Vietnam". Based on the interviews with experts from related organizations of Vietnam, the team proposed a list of green accounts that Vietnam can develop such as resources accounts (forest, coastal resources, biological diversity), pollution (water, urban solid waste, transportation emission), public expenditure for environment.

- In addition, in the training workshop on environmental accounting organized by Central Institute for Economic Management (CIEM) and CIEM-DANIDA project in 2010 with the participation of the experts from Australian Bureau of Statistics, after the discussion, the participants agreed that Vietnam should focus on building some accounts such as resources accounts (water, aquatic resources, non-renewable energy, forest); pollution (water, air), environmental expenditure.

The above recommendations show consensus to some extents. However, all of them seem to be based only on the first principle presented above, i.e. the importance of the resources and the role of the related environmental factor on the economy. The availability of the input information have yet

[4] *See UNCTAD: Manual for Preparers and Users of Eco-efficiency Indicators. UN New York and Geneva, 2004 and*
[5] *Vu Xuan Nguyet Hong (2004)*
[6] *See UNDP (2004).*

taken into account. Under the framework of this project, therefore, the research team selected the following accounts to be developed for Vietnam (see Table 1):

Table 1: Recommended green accounts to be developed for Vietnam in the framework of the current project and selection criteria

Selected accounts	Important to the economy?	Methodology clarity?	Data availability?	In physical (P) or monetary terms (M)?
Resources accounts:				
Crude oil	Yes	Clear	Yes	M
Coal	Yes	Clear	Yes	M
Gas	Yes (No at the moment)	Clear	Yes	M
Pollution:				
Emissions to air (CO2)	Yes	Clear	Yes/No	P

Source: Own authors.

- *On the resources asset accounts:* We are going to select the mineral resource accounts to be built, focusing on the non-renewable energy namely crude oil, coal, and gas. This is because non-renewable resources play an important role in the economy of Vietnam, serving both the domestic production demand and those for exports. The output value of these three resources accounted up to 90% of total output of the mining industry in 2009. Annually, Vietnam exports millions tons of crude oil and coal, accounting for about 12-14% of the total export value and therefore contribute to approximately 14-18% total state budget revenue. Recently, there is a lively discussion in the public on the fact that Vietnam will become an importer of coal in the near future if coal continues to be exported intensively. At the same time, Vietnam could face a big challenge on the fossil fuel supply for domestic production in the future. The input information for these accounts is relatively rich and sufficient under the current statistics system.

- *On pollution accounts*: The research team plans to compile the green accounts on air emission and will focus on CO_2. According to the Environment Report 2010 of Ministry of Natural Resources and

Environment, the selected pollution is an emerging issue presently[7]. On the input information, Vietnam has not yet measured the annual water and air emissions from production and household activities. However, this information can be collected from the current statistics system on economic activities. In addition, Vietnam is implementing a program on releasing GHG emission data based on the inventory from different sources of information. This project is being conducted by the Ministry of Natural Resources and Environment. There are, in fact, other air pollutants in Vietnam. However, for the purpose of methodological illustration of this study, CO_2 can be used as a good example for estimation. In addition, other air pollutants can be converted to CO2 equivalent figures and thus the examination for the case of CO_2 can be applied for them.

2.4. Methodological framework for building the selected "green" accounts in Vietnam

2.4.1. The resource account for non-renewable energies

The building for selected accounts in this project is mainly based on the SEEA developed by the United Nation. In addition, the research team also consults the experience on building the green accounts of the regional countries such as Australia, China, and Japan, etc. in order to accommodate the framework to a developing country like Vietnam.

In principle, energy accounts can be presented in both physical and monetary terms and both of them have their own useful meanings and policy implications. To set up the accounts in respective forms requires different set of information as well.

Regarding the physical terms, an energy resource account provides detailed physical information on energy stocks, production, conversion and consumption. Once energy accounts are well constructed, air emission flow accounts can also be developed. Following SEEA 2003 format, the data requirements for setting up energy account are shown in Table 2 bellow. It is important in terms of valuing natural resource use that the information on the annual depletion of non-renewable resources (in physical term) should be revealed. It is based on the residual between the opening and closing stock levels.

[7] *Ministry of Natural Resources and Environment, National Report on Environment 2010*.

Table 2: Information of selected physical energy resource accounts

Items	***Coal*** (physical unit such as ton)	***Crude Oil*** (physical unit such as ton)	***Natural Gas*** (physical unit such as ton)
A. Opening stock level:			
B. Increases in stocks + Due to economic activities (such as importing); + Due to natural processes (such as discoveries)			
C. Decreases in stocks + Due to economic activity (exploitation) + Due to natural processes (natural disaster, earthquake)			
D. Closing stock level = (A + B – C)			

Source: Summarised from SEEA 2003.

Another representation of a natural resource (including energies) can be seen in T-form account as bellow:

Energy Resource Account (Coal, Oil, Gas)	
Resource (in nature) **New reserve**	**Used** 1. For production 2. For final demand + Consumption + Change in inventories + Export
Import **Total resource**	**Total use** **Balance (remaining resource)**

The left-hand side of the resource T-account interprets the resources of a country (examples here are coal, oil and gas). In this T-account, supply and use aspects are more emphasised. The resources put into this account shall be construed as reserves of natural resources, the new mine detection and imports by type of resource. The right-hand side of the account reflects the use of resources which includes the use for production, final demand as consumption, reserve and export. The resource balance is the difference between total resource and total resource used or the remaining reserves by the end of the accounting period.

Regarding the monetary accounts for natural resources: These accounts are, in principle, transformations of the corresponding physical accounts into value terms. Anyway, during this process, two value-related items should be added to those in Table 2. They are: i) upwards reappraisals for the case of item of "Increae in stocks" or downwards appraisals for the case of "Decrease in stocks"; and ii) Reclassifications for either case. (SEEA 2012).

According to (SEEA 2012), there are few transactions in mineral and energy resources, the valuation of these assets requires the use of Net Present Value (NPV) approach. As earlier presented in SEEA 2003 manual, the value of a stock of a natural resource can be calculated as the NPV of the strem of future resource rents the resource will yield until it is exhausted.

The value of resources at time t is measured as follows: $RVt = \Sigma\ RRt / (1+ r)^t$ (summation by years from 1 to n)

Of which, RVt is the valuation of resources at time t; RRt is a resource rent at time t; r is a discount rate, n is the life-length of the resource.

The value of resource depletion in the accounting period is measured by the following formula:

$$\Delta RVt = RRt – r\ RVt$$

Where ΔRVt is the valuation of resources depletion in the accounting period t;

However, if we use the physical resource accounts in the above formula, resource depreciation (the valuation of resource depletion) at time t equals the net change in the resources in the accounting period t, or as follows:

$$dt = Vt\text{-}1 – Vt = RRt – rVt,$$

of which: d is a resource extraction, rVt is a profit due to resources used, RR is a resource rent, and r is a discount rate. The resource rent is often estimated based on information about the income and

operating costs for the extraction industry. It is noted that the above methodology can be applied to both renewable and non-renewable resources. Therefore, this method can be applied to the other accounts such as forest, water, etc.

In Vietnam, not all data requirements for estimating energy accounts are available. Specifically, there is no reliable data on nature resources (stocks) of coal, oil and gas. It has fortunately data on import of coal, oil and gas from GSO report and those on coal, oil and gas for production and final demand was estimated from Input – Output table (the most recent I-O table of Vietnam was estimated for 2007). From these data, the value of resource depletion or resource used can be estimated. However, it is not possible to estimate the physical energy accounts as there have been different prices applied in the economy.

Although there are difficulties in setting up full energy resource accounts, the estimation of "green GDP" (or real GDP) is still possible as long as an approximation of natural resource consumption value in an accounting period can be computed. The "partial" green GDP which takes into account, at first, natural resource used can be presented by the following formula[8]:

$$Y^G = Y - R$$

Of which:

Y^G is green GDP;

Y is conventional GDP; and

R: Resource depletion/used value

R in this study include the costs of coal, crude oil and gas. It is therefore noted that this is just a "partial" green GDP formula as there are still many other components of green GDP as presented in the general formula in sub-section 2.1.

2.4.2. Designed methodology to develop pollution accounts:

Emissions to air are gaseous and particulate substances released to the atmosphere by establishments and households as a result of production, consumption and accumulation process. The SEEA air emission account records the generation of air emissions by resident economic units by type of substance.[9] The SEEA air emission account is, therefore, a physical account and can be presented in Table 3. It is noted that a complete air emissions account is not demanding as it is difficult to have

[8] *According to Yusuf & Alisjahbana (2003)*
[9] *According to SEEA 2012*

all such data. Instead, the focus is often only on the generation and release of residuals which serve well for compiling with corresponding economic accounts.

Table 3: Air emissions account

Type of substance	***Supply table for air emissions***				***Use table for air emissions***	
	Generation of emissions		Accumulation	Total supply of emissions	Flows to the environment	Total use of emissions
	Industries	Households	Emissions from landfill		Emissions released to the environment	
Carbon dioxide						
Methane						
Dinitrogen oxide						
Nitrous oxides						
Hydroflourocarbons						
Perflourocarbons						
Etc…						

Source: Adapted and summarized from SEEA 2012

From this PSUT table, we can have information about generation of emissions by industry (column 2 can be disaggregated). The air emissions can also be disaggregated by purpose of use such as transport, heating etc… Part of gaseous and particulate substances generated through economic activity may be captured for use in other production processes and thus this is recorded in the Use Table.

On the physical term, due to the fact that Vietnam has yet measured the emissions to water and air therefore within the framework of this project, the research team intends to do so based on the available statistics on economic activities (in physical terms) in the SNA. For example, we base on the input-output table (I-O) 2007 or the supply and use table (SUT) 2007 to measure the emissions (such as CO_2) of the different economic industries. Based on the estimated emissions (in physical term), the research team will evaluate the emissions as the cost of pollution.

The green GDP formula taking into account both the cost of natural resource depletion and air pollution therefore is:

$$Y^G = Y - R - P_{air} \quad (1)$$

Where P_{air} is the cost of air pollution.

The cost of air pollution is often proxied by pollution damage to human health.

In fact, there are a number of issues concerning the measurement of air emissions. These issues were metioned in SEEA 2012 such as economic, environmental and other boundaries of air emissions. For example, some air emissions would occur when a national economic unit undertakes activity in another country or vice-versa, the account may exclude emissions released by non-residents within the national territory. Due to the nature of airs, they can be "run" from a country to another through atmosphere etc… These are challenges for air pollution accounting to some extent.

In this study, we estimate emissions in terms of CO2 applying Input - Output relationship induced by final demand. The basic equation for the estimation reflecting the relationship between GDP growth and emissions growth is:

$$E = e.(I-A)^{-1}.Y \quad (2)$$

or $$\Delta E = e.(I-A)^{-1}.\Delta Y$$

Where: e is the emission coefficient matrix from production;

E is the total of air emissions generated from production;

$(I-A)^{-1}$ is the inverse Leontief matrix (A is technical coefficient matrix);

Y is the final demand matrix.

In the case of Vietnam, the availability of input data for the model estimation is again an issue. Up to present, the data information available include: i) The input - output table (not every year); ii) Government expenditure for abating pollution; iii) Gross value added by times at constant price (with benchmark year is year that we have input-output table). Thus, the information about matrix e is still lacking and that is where the information from international literature is extracted to help the estimation in this study.

2.4.3. The Linkage Model

The linkage model is used to integrate economic and environmental accounts considering both forward and backward linkages. The used approach is adopted from Bui Trinh et. al (2012).

Let V^* be a matrix of direct residual coefficients of production on environmental pollution and coefficients of direct impact on natural resources. V^* is a (m*n) matrix, with m = 2 corresponding to two kinds of selected green accounts and n is number of economic activities.

The following economic and social indicators are used as proxies for each of the impact variables:

1) Environmental pollution impact can be represented by amounts of pollutants discharged into the environment (BOD, COD, DO, DIN, DIP, CO_2, SO_2, NO_x, …).
2) Impact on natural resources can be represented by amounts of exploited mineral (coal, crude oil…).

V^* is then decomposed into its components as follows:

1) V^*_{kj} (k=1), determined as the amount of pollutants generated per (currency) unit of output of each sector.
2) V^*_{kj} (k=2) determined as the amount of natural resources exploited per unit of output of exploitation sectors;

Thus, the total impacts on pollution and natural resources are given by:

$$V = V^*.X \qquad (3)$$

Or

$$V = V^*.(I - A)^{-1}.Y \qquad (4)$$

Each element in matrix V is the total impact in terms of residuals generated per (currency) unit of final demand.

V^**1 is the matrix of direct residuals coefficient generated by abating activities

Changes in impact variables due to a change in final demand can be found by using:

$$dV = V^*.(I - A)^{-1}.dY \qquad (5)$$

Substituting equation (3) into equation (5):

$$dV = V^{*}.dX \qquad (6)$$

Equation (5) may be used to estimate changes in pollution and depletion of natural resources due to changes in final demands. Equation (6) may be used in the case of projected changes in gross outputs.

Estimation of Feedback Effects:

Let ϕ^{1} be the (n*m) feedback matrix, with n sectors; m determined as in V^{*} and $\phi^{1}_{ij} = \Omega_{ij} / W_{j}$

Ω_{ij}: expenditure *essential* of sector i for abating the residual j;

W_{j}: total residual j, including residuals from both production and non-production activities; The part of W is amount pollutant that need to abate the residuals

1) In the case j =1$\rightarrow$ m1: $\Omega_{ij:}$ expenditure for abating the pollutant j in sector i; W_{j}: total amount of pollutant j.

2) In the case j=m1+1; Ω_{ij}: output of exploitation sectors; W_{j}: total mineral reserves;

From the above definitions and relations, the system, to some extent, can be considered as the most parsimonious in terms of the way it extends the familiar input - output formulation. Thus, we can put forward the general equation as:

$$\begin{pmatrix} X \\ W \end{pmatrix} - \begin{pmatrix} A\Phi_{1} \\ V^{*}V_{1}^{*} \end{pmatrix} \begin{pmatrix} X \\ W \end{pmatrix} = \begin{pmatrix} Y_{1} \\ \Phi^{2} + g \end{pmatrix} \qquad (7)$$

$$\begin{pmatrix} (I - A) & -\phi^{1} \\ -V^{*} & (I - V1^{*}) \end{pmatrix} \cdot \begin{pmatrix} X \\ W \end{pmatrix} = \begin{pmatrix} Y \\ \phi^{2} + gY \end{pmatrix} \qquad (8)$$

Where: ϕ^{2} is the (m x 1) vector impact from other resources and

g is the (m x n) direct pollution coefficient matrix of final uses, which shows the amount of residuals (in physical units) generated per unit of product (monetary units) consumed by households.

From equation (7), we have:

$$(I - A).X - \phi^1.W = Y_1 \quad (9)$$

$$W = V^*.X + \phi^2 + g.Y + V_1*.W \quad (10)$$

where:

$V^*.X$ is the total impact of production on residuals;

ϕ^2 is the total amount of residuals from other sources;

gY is the total amount of residuals generated from household consumption.

$V_1*.W$ is the amount of residual generated from abating activities.

The 2007 input – output table of Vietnam was used in this study

2.4.4. Green or real GDP:

From equation (8), we can further express following terms:

$$Y = X - AX - \Omega$$

$$Y = X - AX - \phi^1.(V^*.X + \phi^2 + g.Y + V1*.W) \quad (11)$$

Equation (11) becomes the measure of real GDP when we consider all production impacts that are not usually reflected in calculating the value of conventional GDP. It is equal to net supply of production (i.e. GDP based on the production approach), minus the total cost of production for abating residuals (including: expenditure for abating pollution, output of exploitation sector), and minus the total expenditure for abating residuals from other sources and from household consumption.

Substituting for GDP, we put forward the idea of "Real Gross Domestic Product (RGDP)" as:

$$RGDP = GDP - \Omega \quad (12)$$

With:

$$\Omega = \sum \Omega_i$$

$$\Omega_i = \sum \Omega_{ij}$$

From equation (12), RGDP can be interpreted as the real development of the economy. The inverse of the expanded IO-based coefficient matrix is thus defined as:

$$C = \begin{pmatrix} (I - A) & -\phi_1 \\ -V^* & (I - V1^*) \end{pmatrix}^{-1} \quad (13)$$

Matrix C is thus used to substitute for standard Leontief inverse matrix $(I - A)^{-1}$.

The implication of feedback effects: Besides providing the measure of the real GDP, the scale of feedback effects also implies that each economy should set up ***residual-abatement funds***, including fund for abatement of environmental pollutants.

The analysis of model linkage framework multipliers[10].

From the balance viewpoint of equation (8), the final term (Y) can be expressed as following differential equation.

$$\Delta X = (I\text{-}A)^{-1}\Phi_1.\Delta Y. \quad (15)$$

The multiplicative term $(I\text{-}A)^{-1}\Phi_1$ in equation (9) (now denoted as P1), is the matrix multiplier for endogenous production propagation impacted by abating activities. In another words, it is the matrix multiplier due to change in volume of pollution.

From sub-matrix multipliers, the external matrix multipliers reflecting the relationship between Economic and Pollution factors can be derived as follows:

$$\theta_1 = (I - (I\text{-}A)^{-1}. \Phi_1.(I\text{-}V_1^*)^{-}1.V^*)^{-1}$$

$$\theta_2 = (I - (I\text{-}V_1^*)^{-1}.V^* .(I\text{-}A)^{-1}. \Phi_1)^{-1}$$

θ_1 is external matrix multiplier of production caused by pollution and other factors.

θ_2 is external matrix multiplier of pollution and other caused by Economic activities.

The equation (7) can be further elaborated with reference to Schur (Schur,1917; Sonis and Hewings, 1993) as follows:

[10] Bui Trinh et. al (2012)

$E_1 = (I-A-\Phi_1.(I-V_1*)^{-1}.V*)^{-1}$

The enlarged Leontief inverse E_1 contains elements, which are larger than those of the standard Leontief inverse $(I-A)^{-1}$ due to the fact that they include extra output required to meet feedback (abating activities induced output effects).

Using an explicit hierarchical order among the blocks with this matrix decomposition technique, Sonis and Hewings (1993) identified the following multiplicative structure of Leontief inverse and Miyazawa partition:

$$C = \begin{pmatrix} \theta_1 I \\ I\theta_2 \end{pmatrix} \begin{pmatrix} IV_1 \\ V * I \end{pmatrix} \begin{pmatrix} (I-A)^{-1} 0 \\ 0(I-V_1*)^{-1} \end{pmatrix}$$

And: $E1= \theta_1.(I-A)^{-1}$

In the case where only capital and labour are the impact variables, θ_1 and θ_2 could be straightforwardly estimated..

3. Empirical estimations

The empirical estimations were conducted for Resources energy account and air pollution account (for CO_2) based on the Vietnam statistics database up to 2010. As Vietnam does not have data on direct residual coefficient matrix, we adopted those for CO_2 from a project of the World Resource Institute namely EarthTrend[11]. To make estimations consistent, Vietnamese economy is also disaggregated into 6 sectors as analysed in the WRI's project. The sectors include Power, other energy, industry and construction, transportation, state management and "other" sectors.

From 2007 I-O table, the economy is aggregated into 6 above sectors and thus a new I-O derived table was established. The energy natural resources including coal, crude oil and gas were estimated directly from the derived I-O table. For other years (2008-2011), the accounts were also estimated by adjusting for increased final demand corresponding to growth rates of individual final demand components. Two coefficient matrices of natural energy resources (k) and air pollution (e) were also set up for the estimation. The energy use and air (CO2) emissions induced by final demand can be presented respectively as follows:

[11] http://earthtrends.wri.org/pdf_library/data_tables/cli2_2005.pdf.

For natural energy used: $\Delta \mathbf{K = k * (I - A)^{-1} * \Delta Y}$

For CO2 emission: $\Delta \mathbf{E = e * (I - A)^{-1} * \Delta Y}$

The primary estimated results can be seen in the following tables by utilizing the team designed software (presented in the Appendix)

3.1. For energy resources.

The estimated results for energy resource values can be first seen in Table 4.

Table 4: Values of energy resources (coal, crude oil, gas) use induced by final demand, 2007-2011 *(Unit: VND billions, 2007 price)*

		Power	Other energy	Industry and Construction	Transportation	State Management	Others	Total
2007	Consumption	2,950.0	2,141.6	7,690.8	137.6	0.6	790.0	13,710.5
	Gross Capital Formation	1,061.9	295.0	7,180.6	62.1	0.0	361.5	8,961.1
	Export	1,429.6	2,635.5	9,060.7	83.4	0.0	490.3	13,699.6
	Total	5,441.5	5,072.1	23,932.2	283.1	0.6	1,641.8	36,371.2
2008	Consumption	3,141.7	2,280.8	8,190.7	146.5	0.6	841.3	14,601.7
	Gross Capital Formation	1,072.5	297.9	7,252.4	62.7	0.0	365.2	9,050.7
	Export	1,523.0	2,807.6	9,652.4	88.9	0.0	522.3	14,594.2
	Total	5,737.2	5,386.3	25,095.6	298.1	0.6	1,728.8	38,246.6
2009	Consumption	3,487.3	2,531.7	9,091.7	162.7	0.7	933.8	16,207.9
	Gross Capital Formation	1,162.8	323.0	7,863.1	68.0	0.0	395.9	9,812.8
	Export	1,523.0	2,807.6	9,652.4	88.9	0.0	522.3	14,594.2
	Total	6,173.1	5,662.3	26,607.2	319.5	0.7	1,852.1	40,614.9
2010	Consumption	3,931.9	2,854.5	10,250.9	183.4	0.8	1,052.9	18,274.4
	Gross Capital Formation	1,225.0	340.3	8,283.8	71.6	0.0	417.1	10,337.8
	Export	1,732.4	3,193.7	10,979.6	101.1	0.0	594.2	16,600.9
	Total	6,889.3	6,388.4	29,514.3	356.1	0.8	2,064.2	45,213.1
2011	Consumption	4,116.7	2,988.6	10,732.7	192.0	0.8	1,102.4	19,133.3
	Gross Capital Formation	1,225.0	340.3	8,283.8	71.6	0.0	417.1	10,337.8
	Export	1,926.4	3,551.4	12,209.3	112.4	0.0	660.7	18,460.2
	Total	7,268.2	6,880.3	31,225.8	376.1	0.8	2,180.2	47,931.3

Source: Estimated results

These estimated results show that substantial resource values have been depleted due to the use of coal, oil and gas in the economy of Vietnam. In 2007, it is VND 36,371 billion, while the

corresponding figures for 2010 and 2011 are VND 45,213 billion and VND 47,931 billion respectively (all in 2007 price). Only for the last 4 years, the energy resource consumption value increased already by 32%.

It is clearer when the structure of these energy uses is analysed and this structure is shown in Table 5.

Table 5: Structure of energy use by final demand and by sector of Vietnamese economy, 2007-2011 (%)

Sectoral share		Power	Other energy	Industry and Construction	Transportation	State Management	Others	Total
2007	Consumption	21.52	15.62	56.09	1.00	0.00	5.76	100.00
	Gross Capital Formation	11.85	3.29	80.13	0.69	0.00	4.03	100.00
	Export	10.44	19.24	66.14	0.61	0.00	3.58	100.00
	Total	14.96	13.95	65.80	0.78	0.00	4.51	100.00
2008	Consumption	21.52	15.62	56.09	1.00	0.00	5.76	100.00
	Gross Capital Formation	11.85	3.29	80.13	0.69	0.00	4.03	100.00
	Export	10.44	19.24	66.14	0.61	0.00	3.58	100.00
	Total	15.00	14.08	65.62	0.78	0.00	4.52	100.00
2009	Consumption	21.52	15.62	56.09	1.00	0.00	5.76	100.00
	Gross Capital Formation	11.85	3.29	80.13	0.69	0.00	4.03	100.00
	Export	10.44	19.24	66.14	0.61	0.00	3.58	100.00
	Total	15.20	13.94	65.51	0.79	0.00	4.56	100.00
2010	Consumption	21.52	15.62	56.09	1.00	0.00	5.76	100.00
	Gross Capital Formation	11.85	3.29	80.13	0.69	0.00	4.03	100.00
	Export	10.44	19.24	66.14	0.61	0.00	3.58	100.00
	Total	15.24	14.13	65.28	0.79	0.00	4.57	100.00
2011	Consumption	21.52	15.62	56.09	1.00	0.00	5.76	100.00
	Gross Capital Formation	11.85	3.29	80.13	0.69	0.00	4.03	100.00

	Export	10.44	19.24	66.14	0.61	0.00	3.58	100.00
	Total	15.16	14.35	65.15	0.78	0.00	4.55	100.00
Final demand use share								
2007	Consumption	54.21	42.22	32.14	48.60	99.61	48.11	37.70
	Gross Capital Formation	19.51	5.82	30.00	21.93	0.18	22.02	24.64
	Export	26.27	51.96	37.86	29.47	0.23	29.86	37.67
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2008	Consumption	54.76	42.34	32.64	49.15	99.60	48.66	38.18
	Gross Capital Formation	18.69	5.53	28.90	21.03	0.17	21.12	23.66
	Export	26.55	52.12	38.46	29.81	0.23	30.21	38.16
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2009	Consumption	56.49	44.71	34.17	50.91	99.63	50.42	39.91
	Gross Capital Formation	18.84	5.70	29.55	21.28	0.16	21.38	24.16
	Export	24.67	49.58	36.28	27.82	0.21	28.20	35.93
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2010	Consumption	57.07	44.68	34.73	51.50	99.63	51.01	40.42
	Gross Capital Formation	17.78	5.33	28.07	20.11	0.16	20.21	22.86
	Export	25.15	49.99	37.20	28.39	0.21	28.79	36.72
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00
2011	Consumption	56.64	43.44	34.37	51.06	99.63	50.56	39.92
	Gross Capital Formation	16.85	4.95	26.53	19.04	0.15	19.13	21.57
	Export	26.50	51.62	39.10	29.90	0.23	30.31	38.51
	Total	100.00	100.00	100.00	100.00	100.00	100.00	100.00

Source: Estimated results.

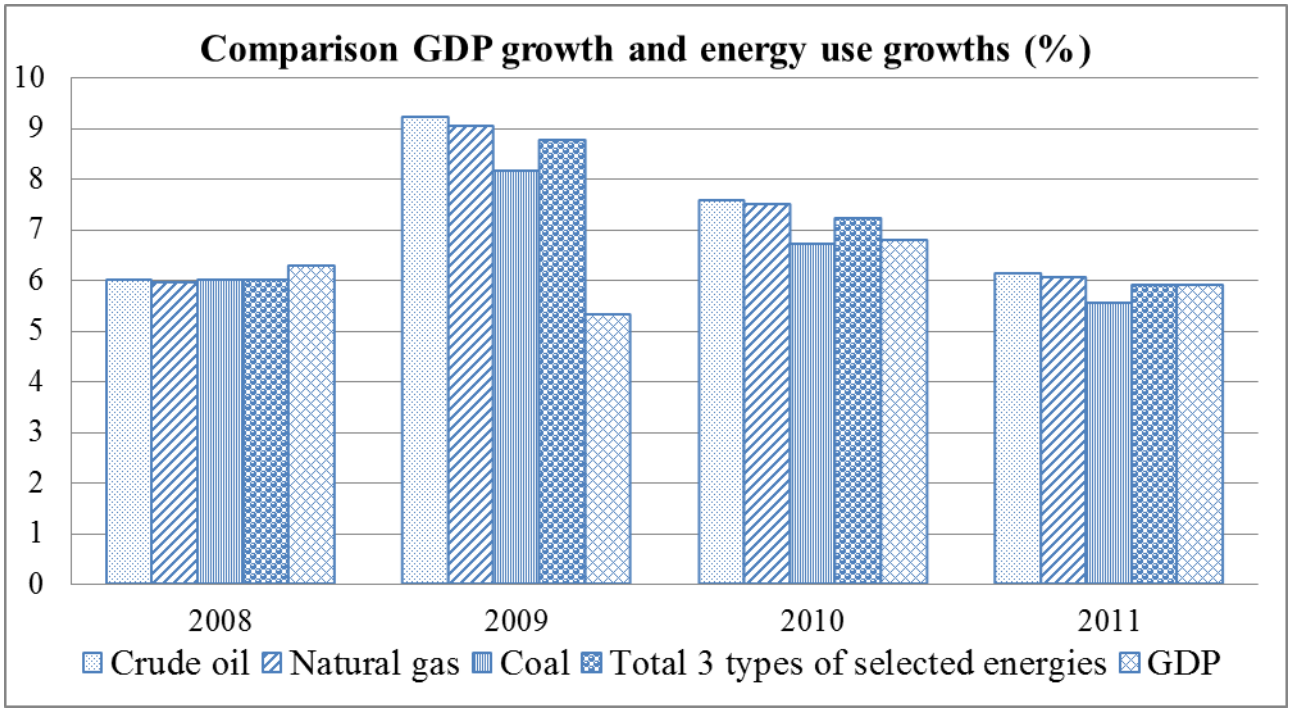
By sector (or industry), it is clearly that Industry and Construction accounts for major shares of energy resource used in terms of all consumption, gross capital formation and export. Power and

other energy sectors are also the large ones in this aspect. One of the main reasons for that is Vietnam exported substantial output of crude oil. Taking 2007 as examples, 66.1% of the export of selected energies was of Industry and Construction sector and this figure has been stable for the whole 2007-2011 period. The natural energy use of transportation sector is minor due to the fact that the sector consumed basically a larger share of imported energies rather than domestic natural energy resources.

By the final uses, consumptions by households and government for the energies account for the largest share in almost all economic sectors such as power, other energy, industry and construction etc… Energy exports account for the significant shares in "other energies" and Industry and Construction sector with 51.6% and 39.1% respectively for these two sectors. For the economy as a whole, energy consumption by households and government is at the same level with that of energy export accounting for 35-40% total of natural resource energy use of the economy.

The model results also help to estimate the growths of energy resource use of the economy by type of energies and this is presented in Figure 1. It is meaningful to compare these growths with economic growth of Vietnam.

Figure 1: Comparison GDP growth and energy use growths (%)



Source: Estimated results

It can be seen from Figure 1 that energy use growths seems to have a tendency to overtake that of corresponding GDP. Of course, it is noted that these non-renewable energy resources do not include total energy used in the economy. This is due to the fact, as stated earlier, that Vietnam imports fuels from the rest of the world as well.

3.2. For CO2 pollution

First, the estimated results for **CO_2** emissions were obtained from the software and they are presented in Table 6.

Table 6: Vietnam's CO_2 emissions by industry, 2007-2011 (Unit: Million ton)

		Power	Other energy	Industry and Construction	Transportation	State Management	Others	Total
2007	Consumption	15.8	0.3	15.3	17.2	0.0	8.0	56.5
	Gross Capital Formation	5.7	0.0	14.2	7.7	0.0	3.7	31.2
	Export	7.8	0.4	18.0	10.5	0.0	5.0	41.6
	Total	29.2	0.7	47.4	35.3	0.0	16.7	129.3
2008	Consumption	17.3	0.3	16.7	18.7	0.0	8.8	61.7
	Gross Capital Formation	6.0	0.1	15.0	8.1	0.0	3.9	33.0
	Export	10.0	0.5	23.2	13.5	0.0	6.4	53.6
	Total	33.3	0.8	54.8	40.4	0.0	19.1	148.4
2009	Consumption	17.9	0.3	17.2	19.4	0.0	9.1	63.9
	Gross Capital Formation	6.2	0.1	15.5	8.5	0.0	4.0	34.3
	Export	9.1	0.4	21.1	12.3	0.0	5.9	48.9
	Total	33.2	0.8	53.9	40.2	0.0	18.9	147.0
2010	Consumption	19.7	0.4	19.0	21.4	0.0	10.0	70.4
	Gross Capital Formation	6.8	0.1	17.0	9.3	0.0	4.4	37.5
	Export	11.5	0.5	26.7	15.6	0.0	7.4	61.8
	Total	38.1	1.0	62.7	46.2	0.0	21.8	169.7
2011	Consumption	19.7	0.4	19.0	21.4	0.0	10.0	70.4

	Gross Capital Formation	6.8	0.1	17.0	9.3	0.0	4.4	37.5
	Export	11.5	0.5	26.7	15.6	0.0	7.4	61.8
	Total	38.1	1.0	62.7	46.2	0.0	21.8	169.7

Source: Estimated results

The table shows that the total CO2 emissions in 2007 was estimated at ton 129.3 million. In 2011, the corresponding figure already increased to ton 169.7 million showing an 31.2% increase only for 4 years period. It reflects the fact that Vietnamese economy has been dependent more and more on national exploited energy and their emissions grew relatively fast. The CO2 emission potentially caused by the export of raw energy resources such as crude oil also went up significantly reaching tons 41.6 million in 2007, tons 48.9 million in 2009 while approaching tons 61.8 million in 2011.

Table 7: Structure of CO2 emissions by final demand and by sector of Vietnamese economy, 2007-2011 (%)

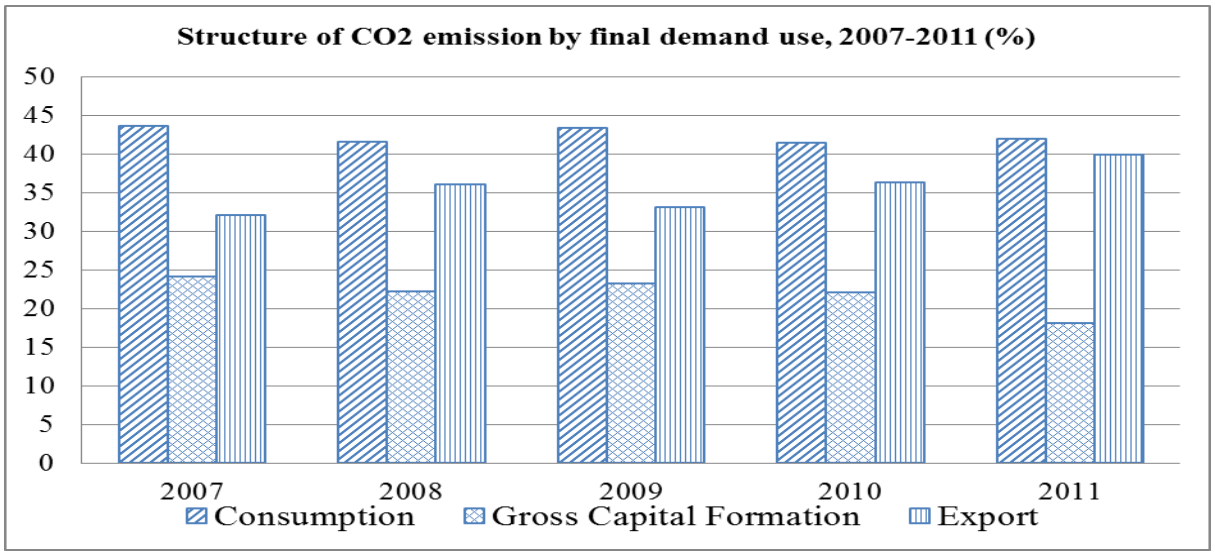
Sectoral share		Power	Other energy	Industry and Construction	Transportation	State Management	Others	Total
2007	Consumption	27.97	0.52	26.98	30.35	0.00	14.18	100
	Gross Capital Formation	18.12	0.13	45.37	24.68	0.00	11.71	100
	Export	18.69	0.86	43.25	25.18	0.00	12.01	100
	Total	22.61	0.54	36.65	27.32	0.00	12.89	100
2008	Consumption	27.97	0.52	26.98	30.35	0.00	14.18	100
	Gross Capital Formation	18.14	0.15	45.33	24.67	0.00	11.71	100
	Export	18.69	0.86	43.25	25.19	0.00	12.01	100
	Total	22.43	0.56	36.95	27.22	0.00	12.84	100
2009	Consumption	27.97	0.52	26.98	30.35	0.00	14.18	100
	Gross Capital Formation	18.15	0.17	45.3	24.67	0.00	11.7	100
	Export	18.69	0.87	43.25	25.18	0.00	12.01	100
	Total	22.59	0.55	36.66	27.31	0.00	12.88	100
2010	Consumption	27.97	0.52	26.98	30.35	0.00	14.18	100
	Gross Capital Formation	18.18	0.21	45.25	24.67	0.00	11.69	100
	Export	18.69	0.86	43.25	25.19	0.00	12.01	100
	Total	22.43	0.57	36.94	27.21	0.00	12.84	100
2011	Consumption	27.97	0.52	26.98	30.35	0.00	14.18	100
	Gross Capital Formation	18.18	0.21	45.25	24.67	0.00	11.69	100
	Export	18.69	0.86	43.25	25.19	0.00	12.01	100

	Total	22.43	0.57	36.94	27.21	0.00	12.84	100
Final demand use share								
2007	Consumption	54.08	42.2	32.18	48.56	0.00	48.09	43.71
	Gross Capital Formation	19.36	5.78	29.9	21.82	0.00	21.96	24.16
	Export	26.56	51.88	37.92	29.62	0.00	29.95	32.13
	Total	100	100	100	100	0.00	100	100
2008	Consumption	51.88	38.25	30.38	46.38	0.00	45.92	41.6
	Gross Capital Formation	17.99	6.12	27.29	20.16	0.00	20.27	22.24
	Export	30.13	55.64	42.33	33.46	0.00	33.82	36.16
	Total	100	100	100	100	0.00	100	100
2009	Consumption	53.78	40.64	31.98	48.29	0.00	47.83	43.45
	Gross Capital Formation	18.73	7.27	28.81	21.06	0.00	21.18	23.31
	Export	27.49	52.09	39.21	30.65	0.00	30.99	33.24
	Total	100	100	100	100	0.00	100	100
2010	Consumption	51.74	37.33	30.3	46.27	0.00	45.81	41.49
	Gross Capital Formation	17.93	7.9	27.09	20.05	0.00	20.14	22.12
	Export	30.33	54.77	42.61	33.68	0.00	34.05	36.4
	Total	100	100	100	100	0.00	100	100
2011	Consumption	51.74	37.33	30.3	46.27	0.00	45.81	41.49
	Gross Capital Formation	17.93	7.9	27.09	20.05	0.00	20.14	22.12
	Export	30.33	54.77	42.61	33.68	0.00	34.05	36.4
	Total	100	100	100	100	0.00	100	100

Source: Estimated results

It can be seen from Table 8 that the power sector together with industry and construction, and transportation sectors are three major causes of CO2 emissions in Vietnam. The shares of these sectors in terms of released pollution are relatively stable. In 2011, the shares of these sectors in terms of CO2 pollution are 22.4%, 34.9% and 27.2% respectively. These percentages are not much different from those of 2007 and it is understandable that industry and construction is always the largest sector in terms of producing CO2 emissions to the environment. In terms of the emission structure by final demand use, there are differences across sectors of the economy. In power or electricity sector, household and government consumptions account for the dominant shares of emission with about 50% or more. The situation is somewhat opposite in "other energies" and industry & construction sectors where the emission originating from export activities were the highest especially in recent years. This is shown in Figure 2 bellow.

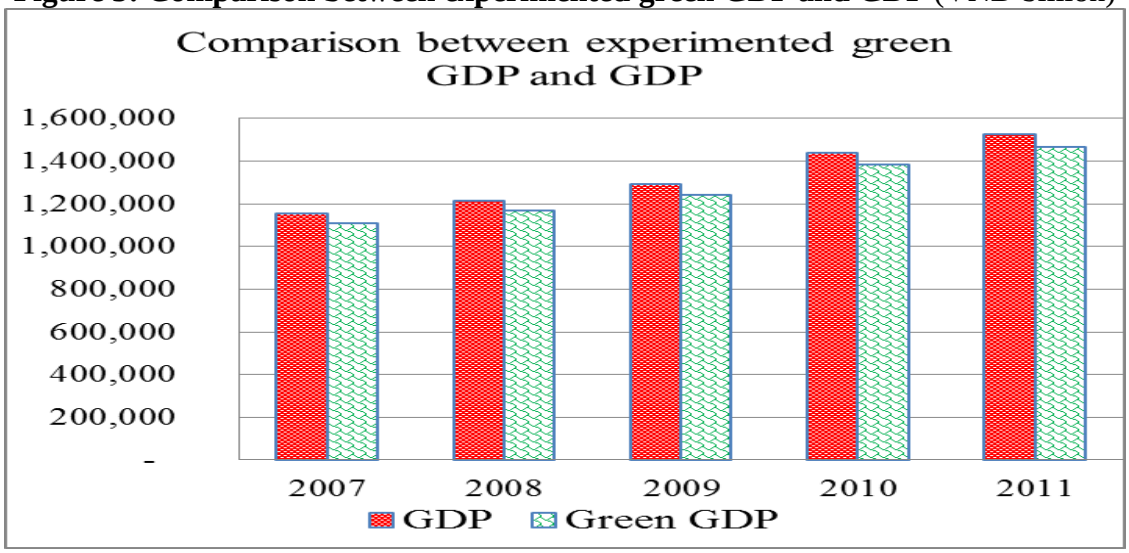
Figure 2: Structure of CO2 emission by final demand use, 2007-2011



Source: Estimated results

The cost of CO2 emission was then estimated from the physical emission table that was already presented above. The price of CO2 was incorporated from the WB (various years). Based on the resulted natural resource (for coal, oil and gas) and CO2 costs, the green GDP figures were then estimated making use of the formula (1). In the team designed software, the green GDP figures were automatically estimated. This is due to the fact that more complicated formulas have already been established inside the software. The results for green GDP are presented in Figure 3 bellow.

Figure 3: Comparison between experimented green GDP and GDP (VND billion)



Source: Estimated results

It is noted that the results of green GDP here aim at illustrating for methodology only. Taking this into account, green GDP figures show considerable lowers. According to the model results, the

green, GDP growth was almost similar to the conventional GDP . It is noted that these figures of "green GDP" have just taken into account factors of two environmental accounts namely energy resource accounts and air-emission (CO2) account meaning that it does not include "everything". Therefore, improvements of these figures will certainly be needed in the future.

4. Conclusion and recommendations for the next steps

Vietnam can apply international environmental accounting framework and at first focus on the most important accounts of natural resources and pollutions. It is needed to have all three following factors for successful completion of this task: i) Methodology; ii) Data required; and iii) Qualified human resources. The methodological framework for "green accounting" in general and for "green GDP" in particular was somehow made clear in this study following guidelines of SEEA framework. Of course, the more "green accounts" are set up, the better we can get for measuring real or green GDP.

It is therefore reasonable to say that constant efforts should be made and built up to obtain realiable estimations of natural resources and environmental accounts. In order to estimate "green GDP indicator" by 2014, data preparation steps should be conducted from now on.

The revealed data gaps or difficulties in compiling environmental accounts are:

i) There is still estimation gap between GDP estimated from supply side to that from demand side. Efforts are needed to make them consistent to each other by improving data quality. This makes it difficult to select which GDP is suitable for the basic or conventional GDP in estimation process. As long as this gap is narrowed, the comparison between conventional and green GDP figures would be more meaningful.

ii) In order to estimate environmental accounts, price should be converted to the base year which is the most recent year with I-O table. Currently, 1994's price is used as fixed base year price for comparison between two different years and this price, of course, is already out of date in the sense that it does not reflect recent economic structural changes in Vietnam. The most recent I-O table of Vietnam is for 2007 and thus it would be ideal if this year (or a new year for the next I-O table) can be considered as the base year.

iii)The industry disaggregation of current I-O Table does not fully meet requirements for constructing hybrid I-O: There is no industry representing the costs for waste recycling

iv) Lacking direct residual coefficient matrix and natural resource stocks in Vietnam. In this study, we had to adopt these coefficients from another study (Earthtrend project of WRI) with limitation of industry disaggregation due to this information gap.

v) Lacking treatment cost coefficients by wastes. This makes it difficult to estimate corresponding abatement costs by type of waste and by industry. Consequently, the estimation of corresponding environmental accounts is not feasible.

vi) GSO needs to include forward and backward impact indicators (between economic activities and environment) to regular surveys

vii) It is needed to, at first, construct direct emission to the air coefficient matrix and the cost for treatment of a unit of air emission (by air pollutants)

viii) Data is scattered among Vietnamese institutions and coordination among these institutions in terms of data management is still very weak.

It is necessary to raise awareness of environmental accounting and at the same time to build-up capacity to complete this task.

Ideally, if all the above works are completed, a green GDP to some extent, can be derived by 2014. Otherwise, a goal of applying principles of "green accounting" may be more important and more realistic.

From our team points of views, there are two options to pursuit in the next 2-3 years.:

Option 1: is the case when we move towards the goal of releasing green GDP by 2014. In this case, Vietnam should start immediately with data collection and human resource training. The data requirements which are listed above should be fulfilled from a number of specific surveys. A road map for completing all these tasks (corresponding to gaps and difficulties mentioned above). In addition, methodologies for some other green accounts (rather than two accounts analysed in this study) should be examined more closely to put it in practice. The commitment of GSO and relating ministries in completing the tasks (gaps and difficulties) is essential.

Option 2: This option is more feasible and even more meaningful than option 1 from our points of view. In this option, Vietnam should construct important environmental accounts for Vietnam in the coming years such as energy and pollution accounts (to be completed as this is just an illustration for the methodology in this study), land and forest accounts, water, urban solid waste and public expenditure for environmental accounts without the ambition to produce a green GDP figure by

2014. In this option, the first step is to priotise the environmental accounts and then in the next step to construct the chosen accounts. In this step, “three factors/tasks” (methodology, data and human resources) should be parallel conducted for successfully setting-up every chosen account.

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Appendix 1: Input-output framework expanded for pollutions

		Sector	**Pollutions**	**final demand**			**Pollutions**		**Output**
		1.....n	**1.....m**	**Consumption**	**Capital Formation**	**net export**			
Sectors	1 . . . n	A.X	Φ_1.W	Y_1^1	Y_1^2	Y_1^3		Y_1	X
Pollutions	1 . . . m	V_1^*.X	V_2^*.W	$g_1Y_1^1\Phi_2$	$g_2Y_1^2$	$g_3Y_1^3$	Φ_2	g + Φ_2	W
Value added	1 2 3 4	VA_1	VA_2						

$Y_1^1 + Y_1^2 + Y_1^3 = Y_1$ is vector of Final demand

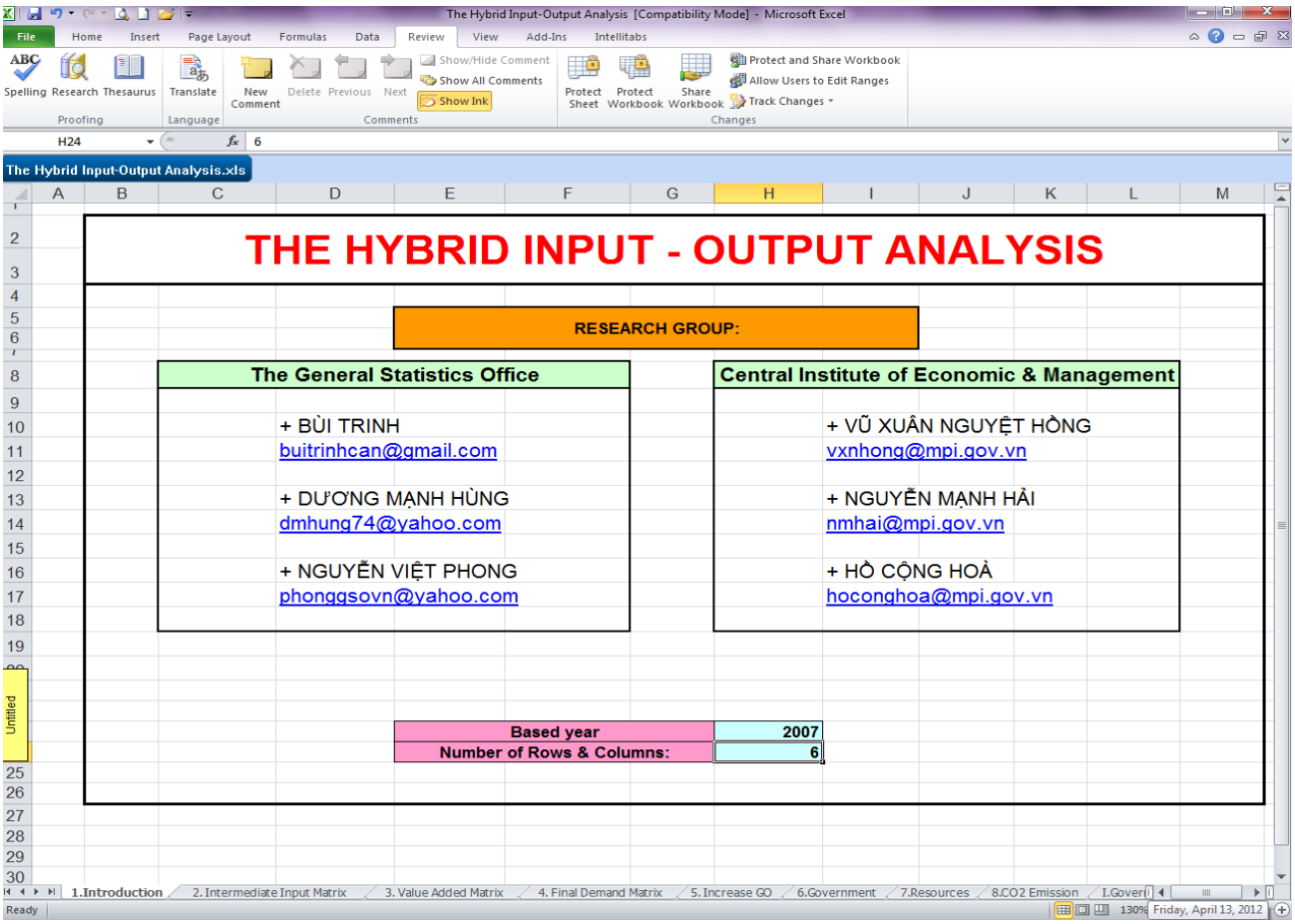
$g_1Y_1^1 + g_2 Y_1^2 + g_3 Y_1^3 = g$ is vector of residuals generated by Final demand

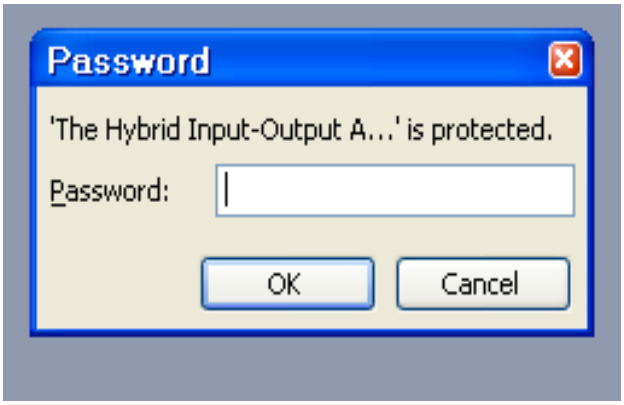
Appendix 2: Software Introduction:

The software is built on Microsoft Office Excel 2007.

The maximum Row & Columns number is 50 for inputting the Intermediate Consumption Matrix, Value Added Matrix and Final Demand Matrix.

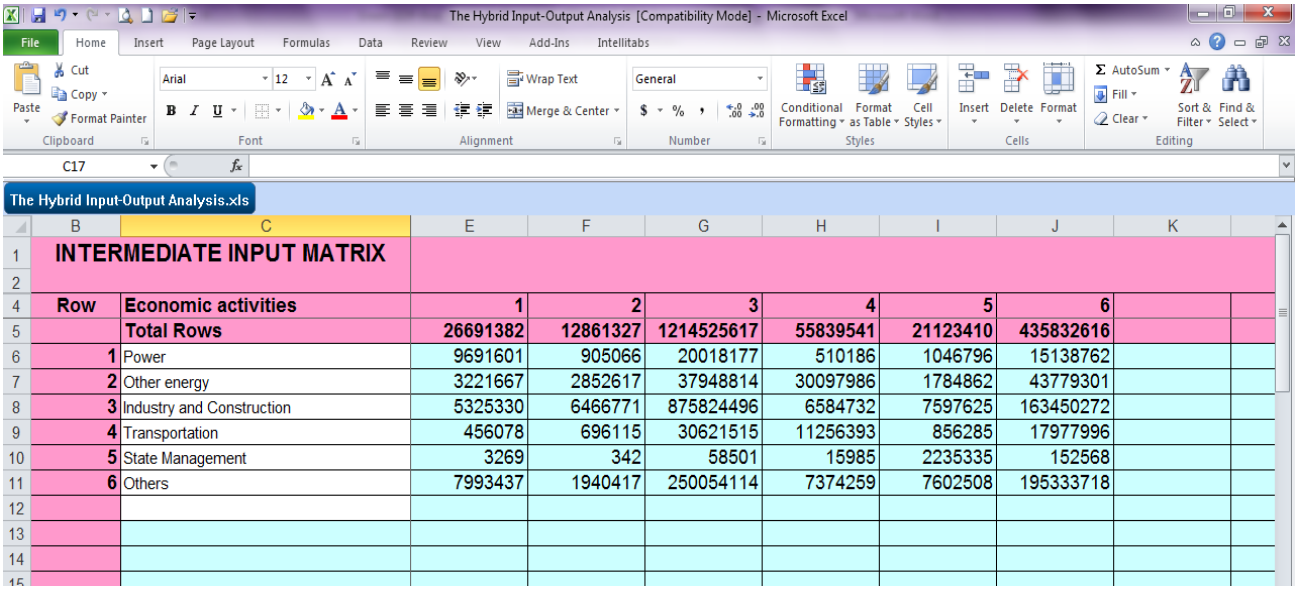
First of all, users have to input the **password** to open the software: **IO**





The 1st step is to input the Based year and the number of Rows & Columns:

The 2nd step: input the name of economic activities and Intermediate Input Matrix (6 Rows & 6 Columns)



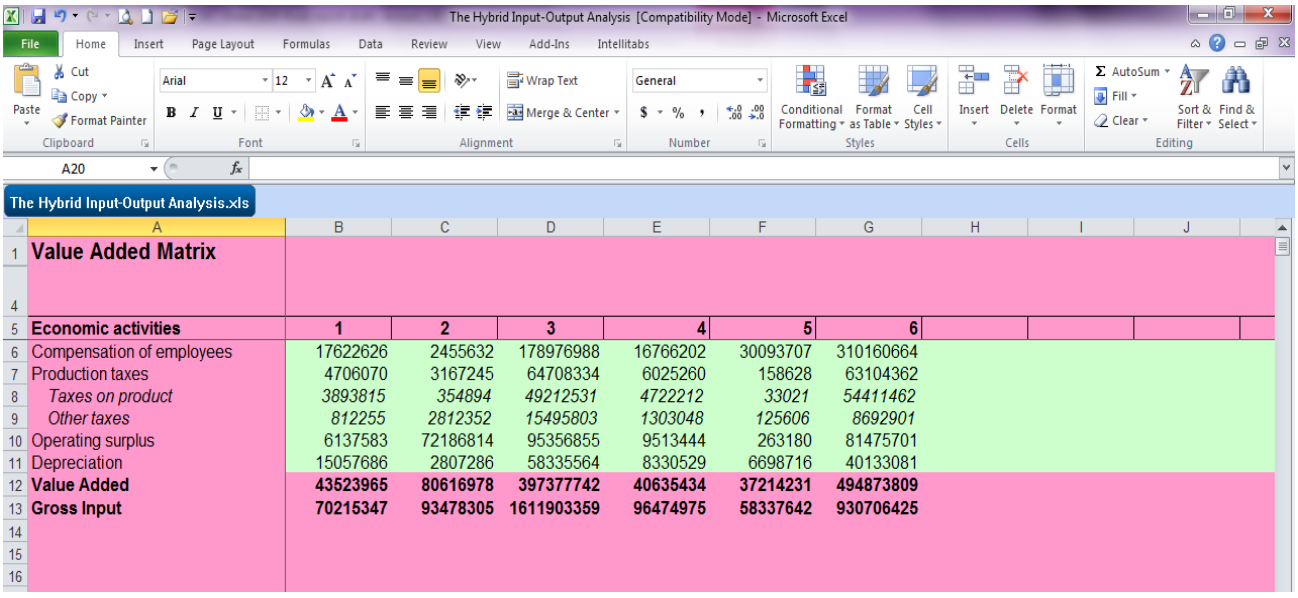
The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

The Hybrid Input-Output Analysis.xls

INTERMEDIATE INPUT MATRIX

Row	Economic activities	1	2	3	4	5	6
	Total Rows	**26691382**	**12861327**	**1214525617**	**55839541**	**21123410**	**435832616**
1	Power	9691601	905066	20018177	510186	1046796	15138762
2	Other energy	3221667	2852617	37948814	30097986	1784862	43779301
3	Industry and Construction	5325330	6466771	875824496	6584732	7597625	163450272
4	Transportation	456078	696115	30621515	11256393	856285	17977996
5	State Management	3269	342	58501	15985	2235335	152568
6	Others	7993437	1940417	250054114	7374259	7602508	195333718

The 3rd step: input the Value Added Matrix (6 Rows & 6 Columns).



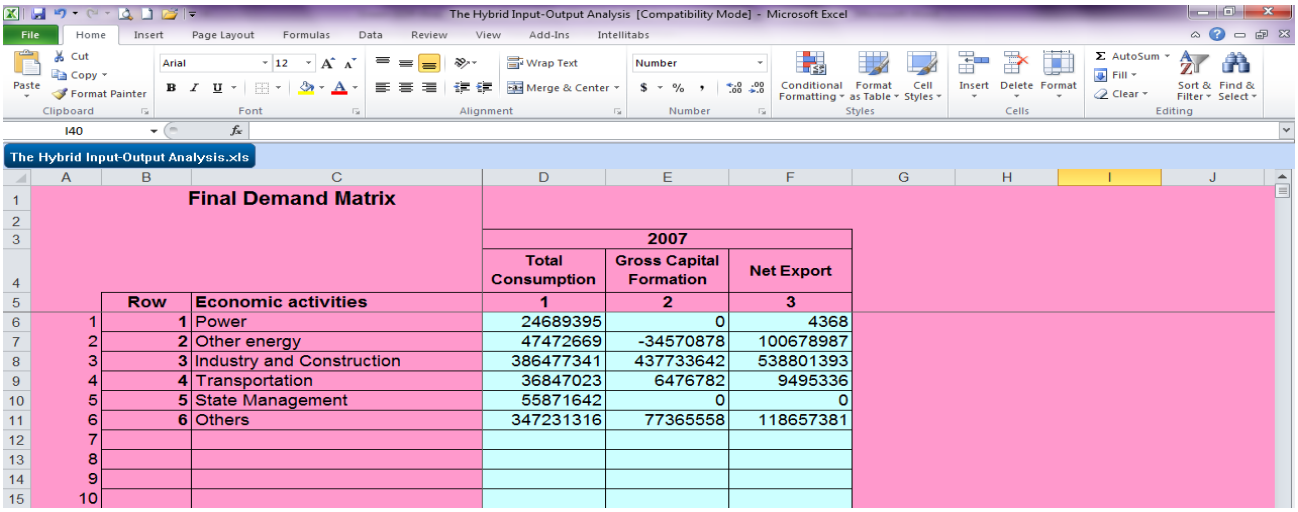
The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

The Hybrid Input-Output Analysis.xls

Value Added Matrix

Economic activities	1	2	3	4	5	6
Compensation of employees	17622626	2455632	178976988	16766202	30093707	310160664
Production taxes	4706070	3167245	64708334	6025260	158628	63104362
Taxes on product	*3893815*	*354894*	*49212531*	*4722212*	*33021*	*54411462*
Other taxes	*812255*	*2812352*	*15495803*	*1303048*	*125606*	*8692901*
Operating surplus	6137583	72186814	95356855	9513444	263180	81475701
Depreciation	15057686	2807286	58335564	8330529	6698716	40133081
Value Added	**43523965**	**80616978**	**397377742**	**40635434**	**37214231**	**494873809**
Gross Input	**70215347**	**93478305**	**1611903359**	**96474975**	**58337642**	**930706425**

The 4th step: Input the Final Demand Matrix (including Total Consumption, Gross Capital Formation, and Net Export).

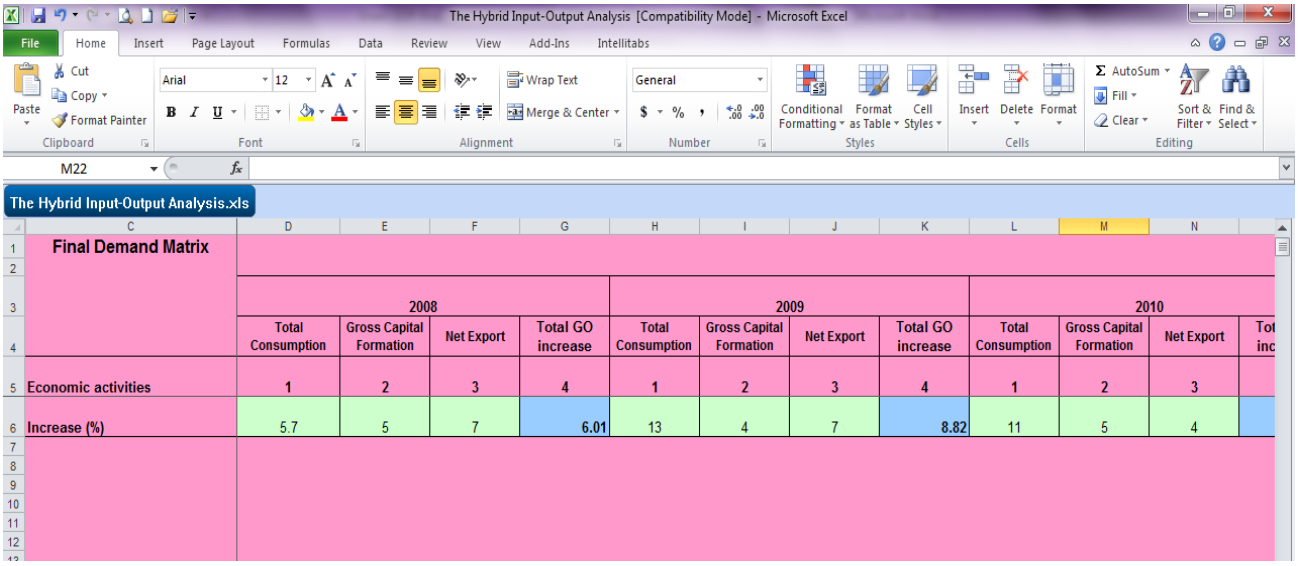


The Hybrid Input-Output Analysis.xls

Final Demand Matrix

Row	Economic activities	2007 Total Consumption	2007 Gross Capital Formation	2007 Net Export
		1	2	3
1	Power	24689395	0	4368
2	Other energy	47472669	-34570878	100678987
3	Industry and Construction	386477341	437733642	538801393
4	Transportation	36847023	6476782	9495336
5	State Management	55871642	0	0
6	Others	347231316	77365558	118657381
7				
8				
9				
10				

The 5th step: Input the effects for Total Consumption, Gross Capital Formation, Net Export (in percentage %) in each year. The purpose in this step is to estimate the Total Valued (GDP) in each year.



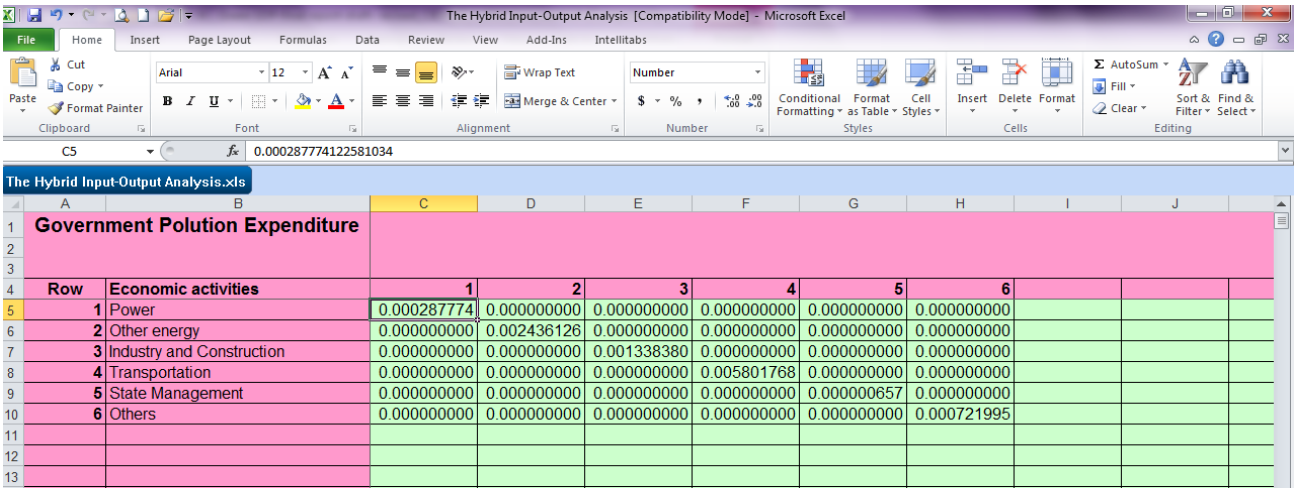
The Hybrid Input-Output Analysis.xls

Final Demand Matrix

	2008 Total Consumption	2008 Gross Capital Formation	2008 Net Export	2008 Total GO increase	2009 Total Consumption	2009 Gross Capital Formation	2009 Net Export	2009 Total GO increase	2010 Total Consumption	2010 Gross Capital Formation	2010 Net Export	2010 Tot inc
Economic activities	1	2	3	4	1	2	3	4	1	2	3	
Increase (%)	5.7	5	7	6.01	13	4	7	8.82	11	5	4	

In the case of the year 2008, Total Consumption increased 5.5%; Gross Capital Formation increased 5.0%; Net Export increased 7.0%.

The 6th step: Input the Government Expenditure Matrix for environment.



The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

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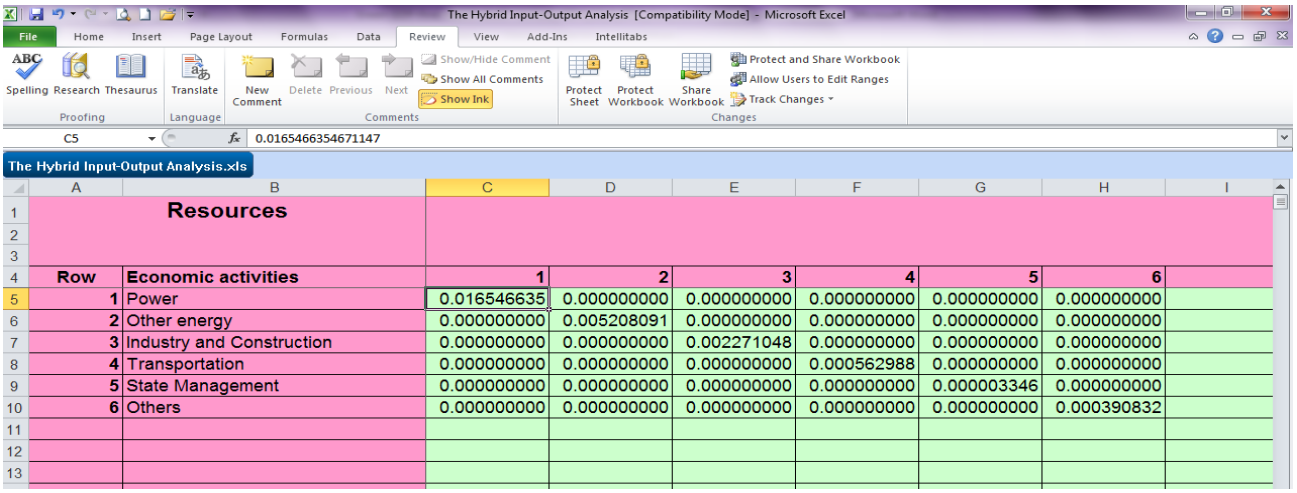
The Hybrid Input-Output Analysis.xls

	A	B	C	D	E	F	G	H	I	J
1	**Government Polution Expenditure**									
2										
3										
4	**Row**	**Economic activities**	**1**	**2**	**3**	**4**	**5**	**6**		
5	1	Power	0.000287774	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000		
6	2	Other energy	0.000000000	0.002436126	0.000000000	0.000000000	0.000000000	0.000000000		
7	3	Industry and Construction	0.000000000	0.000000000	0.001338380	0.000000000	0.000000000	0.000000000		
8	4	Transportation	0.000000000	0.000000000	0.000000000	0.005801768	0.000000000	0.000000000		
9	5	State Management	0.000000000	0.000000000	0.000000000	0.000000000	0.000000657	0.000000000		
10	6	Others	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000721995		
11										
12										
13										

The 7th step: Input the Resources Matrix.



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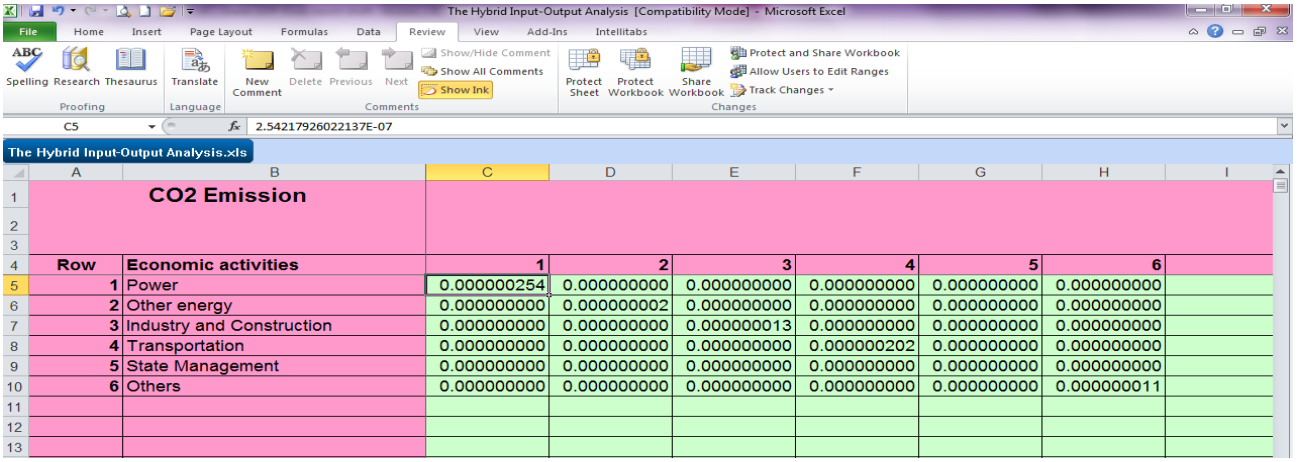
	A	B	C	D	E	F	G	H	I
1	**Resources**								
2									
3									
4	**Row**	**Economic activities**	**1**	**2**	**3**	**4**	**5**	**6**	
5	1	Power	0.016546635	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	
6	2	Other energy	0.000000000	0.005208091	0.000000000	0.000000000	0.000000000	0.000000000	
7	3	Industry and Construction	0.000000000	0.000000000	0.002271048	0.000000000	0.000000000	0.000000000	
8	4	Transportation	0.000000000	0.000000000	0.000000000	0.000562988	0.000000000	0.000000000	
9	5	State Management	0.000000000	0.000000000	0.000000000	0.000000000	0.000003346	0.000000000	
10	6	Others	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000390832	
11									
12									
13									

The 8th step: Input the CO2 Emission Matrix



The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

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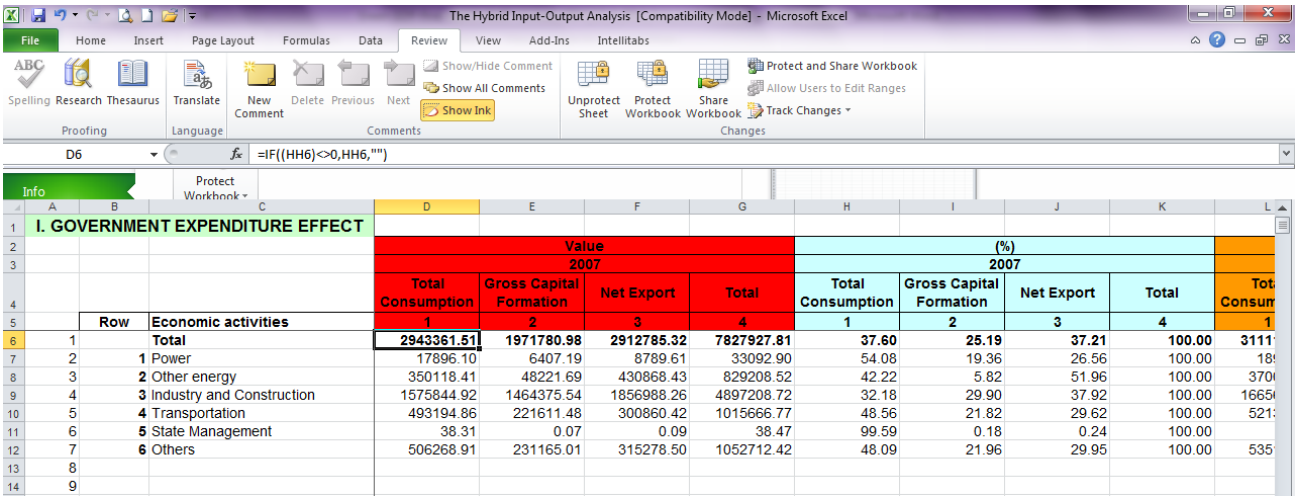
The Hybrid Input-Output Analysis.xls

	A	B	C	D	E	F	G	H	I
1	**CO2 Emission**								
2									
3									
4	**Row**	**Economic activities**	**1**	**2**	**3**	**4**	**5**	**6**	
5	1	Power	0.000000254	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	
6	2	Other energy	0.000000000	0.000000002	0.000000000	0.000000000	0.000000000	0.000000000	
7	3	Industry and Construction	0.000000000	0.000000000	0.000000013	0.000000000	0.000000000	0.000000000	
8	4	Transportation	0.000000000	0.000000000	0.000000000	0.000000202	0.000000000	0.000000000	
9	5	State Management	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	
10	6	Others	0.000000000	0.000000000	0.000000000	0.000000000	0.000000000	0.000000011	
11									
12									
13									

All the reported results are made in the remaining sheets automatically.

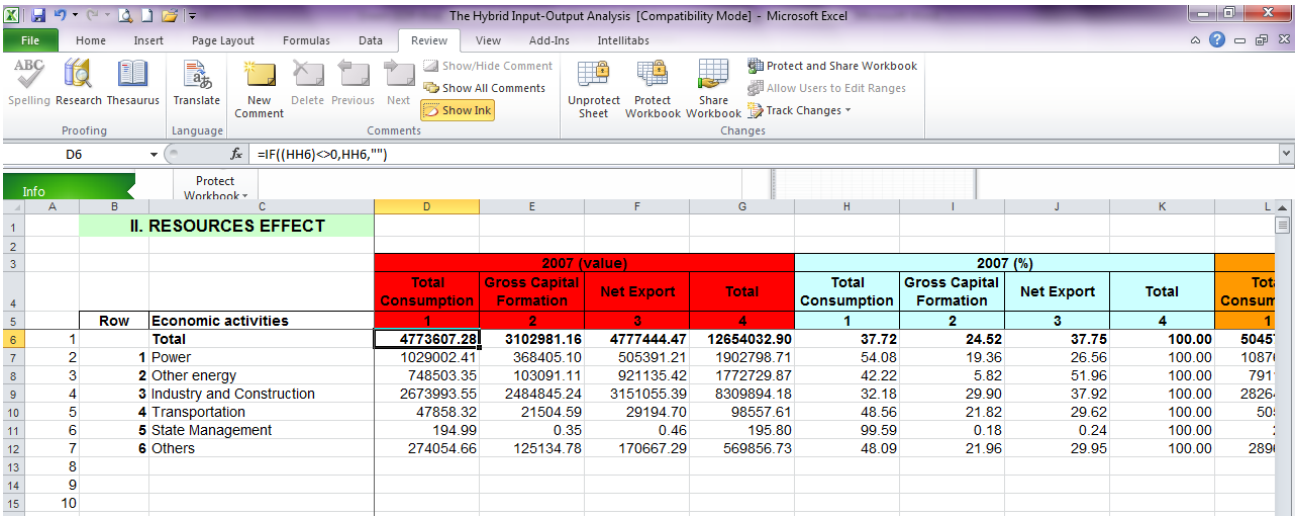


The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

D6 =IF((HH6)<>0,HH6,"")

I. GOVERNMENT EXPENDITURE EFFECT

			Value 2007				(%) 2007				
Row	Economic activities		Total Consumption	Gross Capital Formation	Net Export	Total	Total Consumption	Gross Capital Formation	Net Export	Total	Tot Consum
			1	2	3	4	1	2	3	4	1
1	Total		2943361.51	1971780.98	2912785.32	7827927.81	37.60	25.19	37.21	100.00	3111
2	1	Power	17896.10	6407.19	8789.61	33092.90	54.08	19.36	26.56	100.00	18
3	2	Other energy	350118.41	48221.69	430868.43	829208.52	42.22	5.82	51.96	100.00	370
4	3	Industry and Construction	1575844.92	1464375.54	1856988.26	4897208.72	32.18	29.90	37.92	100.00	1665
5	4	Transportation	493194.86	221611.48	300860.42	1015666.77	48.56	21.82	29.62	100.00	521
6	5	State Management	38.31	0.07	0.09	38.47	99.59	0.18	0.24	100.00	
7	6	Others	506268.91	231165.01	315278.50	1052712.42	48.09	21.96	29.95	100.00	535
8											
9											

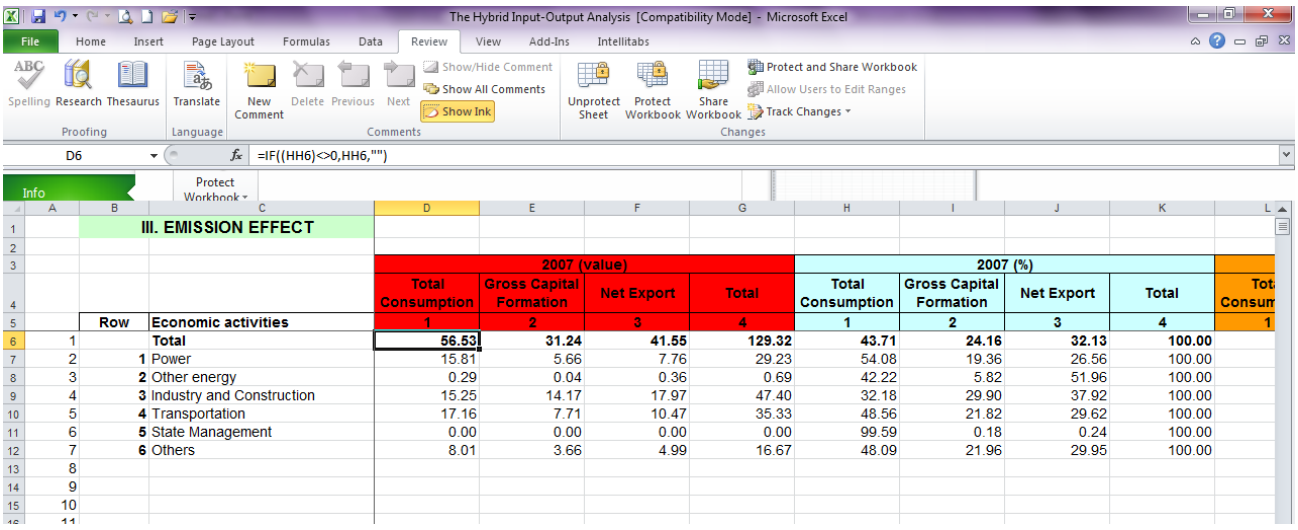


The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

D6 =IF((HH6)<>0,HH6,"")

II. RESOURCES EFFECT

			2007 (value)				2007 (%)				
Row	Economic activities		Total Consumption	Gross Capital Formation	Net Export	Total	Total Consumption	Gross Capital Formation	Net Export	Total	Tot Consum
			1	2	3	4	1	2	3	4	1
1	Total		4773607.28	3102981.16	4777444.47	12654032.90	37.72	24.52	37.75	100.00	5045
2	1	Power	1029002.41	368405.10	505391.21	1902798.71	54.08	19.36	26.56	100.00	1087
3	2	Other energy	748503.35	103091.11	921135.42	1772729.87	42.22	5.82	51.96	100.00	791
4	3	Industry and Construction	2673993.55	2484845.24	3151055.39	8309894.18	32.18	29.90	37.92	100.00	2826
5	4	Transportation	47858.32	21504.59	29194.70	98557.61	48.56	21.82	29.62	100.00	50
6	5	State Management	194.99	0.35	0.46	195.80	99.59	0.18	0.24	100.00	
7	6	Others	274054.66	125134.78	170667.29	569856.73	48.09	21.96	29.95	100.00	289
8											
9											
10											

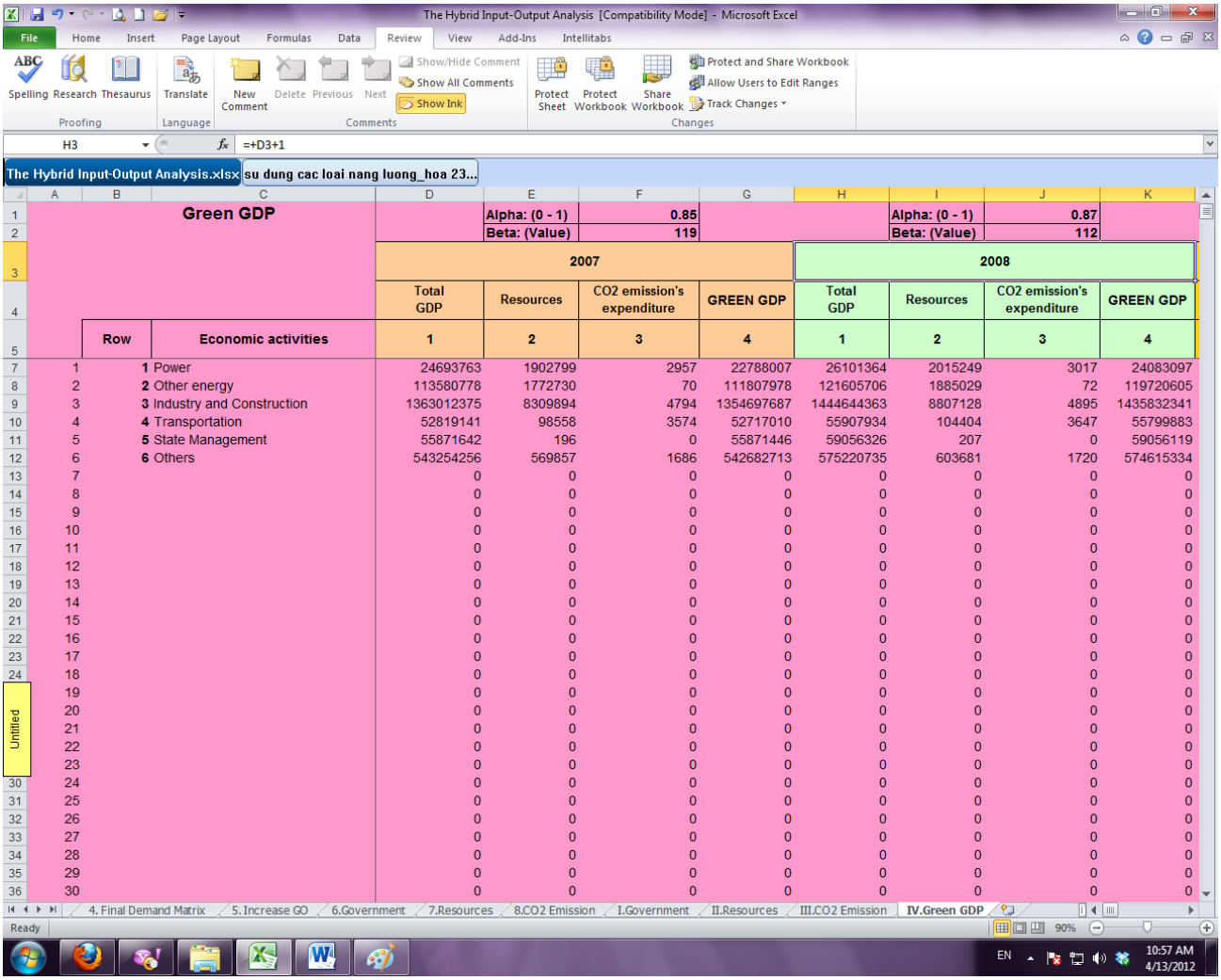


The Hybrid Input-Output Analysis [Compatibility Mode] - Microsoft Excel

D6 =IF((HH6)<>0,HH6,"")

III. EMISSION EFFECT

			2007 (value)				2007 (%)				
Row	Economic activities		Total Consumption	Gross Capital Formation	Net Export	Total	Total Consumption	Gross Capital Formation	Net Export	Total	Tot Consum
			1	2	3	4	1	2	3	4	1
1	Total		56.53	31.24	41.55	129.32	43.71	24.16	32.13	100.00	
2	1	Power	15.81	5.66	7.76	29.23	54.08	19.36	26.56	100.00	
3	2	Other energy	0.29	0.04	0.36	0.69	42.22	5.82	51.96	100.00	
4	3	Industry and Construction	15.25	14.17	17.97	47.40	32.18	29.90	37.92	100.00	
5	4	Transportation	17.16	7.71	10.47	35.33	48.56	21.82	29.62	100.00	
6	5	State Management	0.00	0.00	0.00	0.00	99.59	0.18	0.24	100.00	
7	6	Others	8.01	3.66	4.99	16.67	48.09	21.96	29.95	100.00	
8											
9											
10											
11											



	Row	Economic activities	2007 Total GDP	2007 Resources	2007 CO2 emission's expenditure	2007 GREEN GDP	2008 Total GDP	2008 Resources	2008 CO2 emission's expenditure	2008 GREEN GDP
			1	2	3	4	1	2	3	4
1	1	1 Power	24693763	1902799	2957	22788007	26101364	2015249	3017	24083097
2	2	2 Other energy	113580778	1772730	70	111807978	121605706	1885029	72	119720605
3	3	3 Industry and Construction	1363012375	8309894	4794	1354697687	1444644363	8807128	4895	1435832341
4	4	4 Transportation	52819141	98558	3574	52717010	55907934	104404	3647	55799883
5	5	5 State Management	55871642	196	0	55871446	59056326	207	0	59056119
6	6	6 Others	543254256	569857	1686	542682713	575220735	603681	1720	574615334
7	7		0	0	0	0	0	0	0	0
8	8		0	0	0	0	0	0	0	0
9	9		0	0	0	0	0	0	0	0
10	10		0	0	0	0	0	0	0	0
11	11		0	0	0	0	0	0	0	0
12	12		0	0	0	0	0	0	0	0
13	13		0	0	0	0	0	0	0	0
14	14		0	0	0	0	0	0	0	0
15	15		0	0	0	0	0	0	0	0
16	16		0	0	0	0	0	0	0	0
17	17		0	0	0	0	0	0	0	0
18	18		0	0	0	0	0	0	0	0
19	19		0	0	0	0	0	0	0	0
20	20		0	0	0	0	0	0	0	0
21	21		0	0	0	0	0	0	0	0
22	22		0	0	0	0	0	0	0	0
23	23		0	0	0	0	0	0	0	0
24	24		0	0	0	0	0	0	0	0
25	25		0	0	0	0	0	0	0	0
26	26		0	0	0	0	0	0	0	0
27	27		0	0	0	0	0	0	0	0
28	28		0	0	0	0	0	0	0	0
29	29		0	0	0	0	0	0	0	0
30	30		0	0	0	0	0	0	0	0