Preliminary study on

SUSTAINABLE LOW-CARBON DEVELOPMENT TOWARDS 2030 IN

VIETNAM

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Preface

This report is completed by Kyoto University researchers along with the collaboration of National Institute for Environmental Studies (NIES), Japan.

The objective of designing Asian Low Carbon Societies (LCS) is to avoid dangers by global climate change. Up to now, we have approached this problem with integrated assessment methodology, in which we proposed a systematic design methodology of future LCS towards the designed future by the tool namely, Extend Snapshot Tool (ExSS). We prepared this Low Carbon Society (LCS) report which aims to show the possibility of developing Vietnam into Low Carbon society.

This pamphlet is also intended to (i) introduce the preliminary study on LCS in Vietnam towards 2030 by using ExSS tool, and (ii) expect the collaboration with related experts, researchers, authorities and community to contribute building a LCS in Vietnam

This preliminary results, we hope, not only will give the readers an idea of a LCS scenario in general and Vietnam in particular, but also would guide effective transition towards a LCS in Vietnam.

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Executive summary

This study, towards a low carbon society for Vietnam, is carried out for the following main sectors, namely: residential, commercial, industrial, passenger and freight transport sectors.

The methodology involves (i) deducing the inventory of socio-economic, energy and Green House Gases (GHGs) emission in CO_2 equivalent of Vietnam in baseline year 2005, and (ii) quantifying socio-economic activity level in 2030 according to national development objectives.

Most of energy information used in this estimation were referred from IEA[1].

Based on the projection of development, Extended Snapshot Tool (ExSS) estimates the amount of GHG emissions in two scenario (1) 2030 BaU (Business as Usual-without mitigation measures) and (2) 2030 CM (With Counter Mitigation measures) assumptions of employed innovation technologies as well as other low-carbon measures available by 2030 to reduce the GHG emissions.

In the base year, 2005, per capita CO_2 emission from energy consumption in Vietnam is 0.97 t-CO_2. In 2030, this number will increase to 4.5 t-CO_2 under the BaU scenario.

Currently, the total GHG emission is approximately 80.9 million t-CO_2 (2005). Under the 2030 BaU scenario GHGs emission increase to 446 million t-CO_2 or about 5.5 times higher than 2005. In which, GHGs emission from residential sector was 53.9 million t-CO_2, occupied 12.1% of total national emission, commercial sector: 47.8 million t-CO_2, occupied 10.7%, industry: 210.3 million t-CO_2, occupied 47.1%, passenger and freight transportation: 59.7 million t-CO_2 and 74.7 million t-CO_2, occupied 13.4% and 16.7% respectively.

However, in 2030 CM scenario, by adopting the mitigation options available by 2030, the emissions can be decreased approximately 45% and suppressed to 250 million t-CO_2, and 2.5 t-CO_2 per capita. A box of countermeasures are shown in Figure 1.

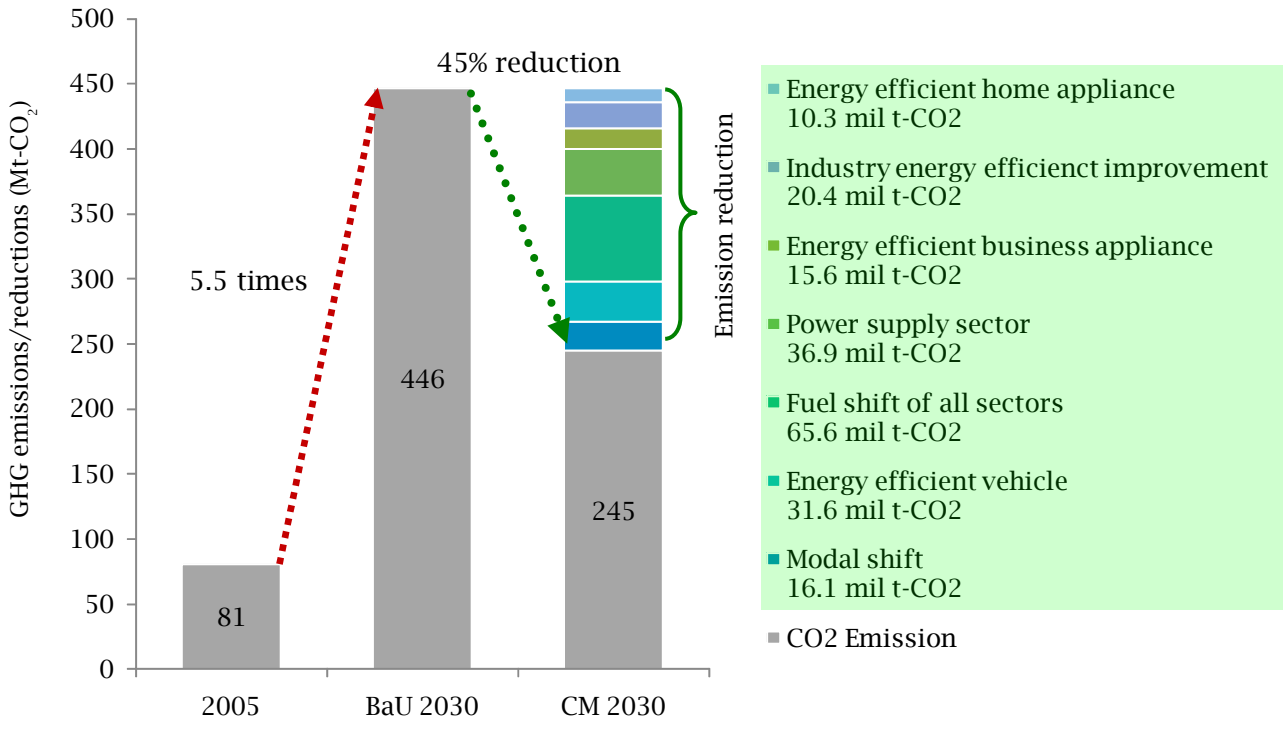

Figure 1. GHG emissions and mitigations by countermeasures.

IEA[1].International Energy Agencies

To develop a low carbon society for Vietnam, a package of green growth policies is formulated based on National Development Plan, Nation Target Programme to Respond to Climate Change and Energy Efficiency Programme, Renewable Energy Programme as well (Figure 2). This policy package encompasses several optimal solutions such as fuel switch of the fossil fuel, promotion of renewable energy, improvement of energy efficiency of energy using equipments and building, increasing use of public transport and developing traffic management system, improvement of power supply sector, promotion of Clean Development Mechanism (CDM) projects.

Table 1. Estimated socio-economic indicators in 2030 in Vietnam

	2005	2030	2030/2005
Population (million people)	83,1	99,3	1.2
No. of households (million)	25,2	33,1	1.3
GDP (trillion VND)	818.5	4,182.5	5.1
Gross output (trillion VND)	1,933.6	10,404.8	5.4
Primary industry (trillion VND)	261.0	1,068.9	4.1
Secondary industry (trillion VND)	1,176.0	6,675.4	5.7
Tertiary industry (trillion VND)	496.6	2,660,561	5.4
Passenger transport demand (mil p-km)	57,696	518,785	9.0
Freight transport demand (mil t-km)	100,728	1,085,643	10.8

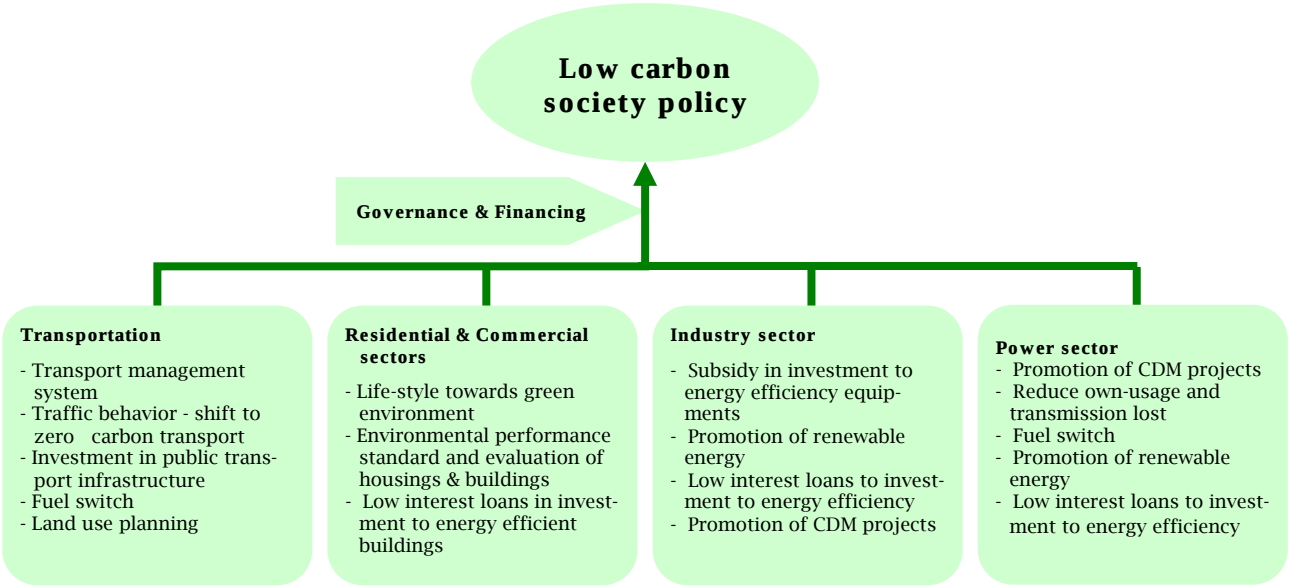

Figure 2. Policy package for Low Carbon Society

About Vietnam

General information

Vietnam is located in Southeast Asia with a total land area of 331,690 km^2 consisting of thousands of islands and a coast line of approximately 3,260 km. Vietnam climate is under the influence of tropical monsoon.

Vietnam is known as one of the most populous nations in Southeast Asia and one of the most densely populated nations in the world. Currently total population is 86.5 million people, growing at a rate of 1.1%. As economic activities become more vigorous, more people continue to flow into cities, lead to the urbanization rate is around 30.5%.

Figure 3. Traffic in Hanoi city

Macro-economic

Among the N-11 economies[1], Vietnam stands out as having achieved the highest economic growth in recent years. Vietnam has experienced satisfactory economic growth despite its economic difficulties during the past decade. In 2005, the GDP grew by over 8.4%. In which, primary sector contributed 20.7%, secondary and tertiary sector contributed 40.2% and 39.1%, respectively. The service sector is becoming an important economic area for Vietnam. While this economic prospect offers great opportunities for development of the energy sector in Vietnam, it also raises concerns over the protection of the environment. Vietnam's GDP reached 838 trillion dong ($53 billion), bringing per capita income to $636 per year, in 2005. According to the Trade Promotion Department (under the Ministry of Trade), foreign direct investment (FDI) rose $5.72 billion, an increase of 25% compared to 2004.

Transportation

Current transportation infrastructure is inadequate to meet Vietnam's rapidly growing needs. To meet the target of industrialization and modernization of the country, Vietnam determines that transportation is extremely important and should go ahead of other sectors.

Road transport is the most advanced in terms of privatization and handles the largest volume about 65% (2005) of domestic passenger and freight transports. Road transport mainly serves the domestic market, while international road transport account for an insignificant share.

Inland waterway transport is very developed due to the natural endowment of dense river and canal network, and rank the second which accounting for 25-30% of total domestic transported volume. Other transportations are contributed by maritime transportation, air transport and railway transport which accounting for 20% of total transport volume.

Figure 4. Road transport in sub-urban of Hanoi

[1] The Next 11 (N-11) economics including these countries: Bangladesh, Indonesia, Iran, Korea, Mexico, Nigeria, Pakistan, Philippines, Turkey and Vietnam.

Energy

In the last few years, Vietnam had rich fossil energy resource such as oil, gas and coal which are non-renewable energy and also well-endowed with renewable in the form of hydropower, biomass and solar energy which can satisfy the basic needs of energy for the internal socio-economy development as well as partially export to other countries. Energy demand in Vietnam has the average growth rate of 15% for many years in the past, and annual growth rates of approximately 18% have been predicted for the period of 2010-2030 by the Vietnam Institute of Energy.

Currently, energy is explored, transformed, transported and used with low efficiency while the self-usage and losses rates are high. Investments in the energy sector can have a substantial impact on water quality, air quality and human health, as experiences show. It is becoming increasingly important to address the potential environmental impacts of energy use and policies.

Electricity consumption in Vietnam grew at 15.3% over 2000-2005. The electricity consumption per capita in 2005 was 538 kWh per year, and is expected to increase up to about 2350 kWh per year by 2020 and over 3096 kWh per year by 2030 (Electricity of Vietnam, 2006a, 2008a; Institute of Energy, 2006a, 2006b, 2008b).

Total electricity generation capacity in Vietnam in 2007 was 12948 MW, of which Electricity of Vietnam (EVN) facilities accounted for about 72%, followed by local and foreign independent power producers (24%) and 4% of power was imported.

Industry and Land use

Most of the industrial zones in Vietnam are concentrated in three key economic regions, the North, the Central and the South of Vietnam. By the end of 2008, these three key economic regions had 149 industrial zones with the total natural land areas of 49,232 hectares, accounting for 68 percent of the total number of industrial zones, and 81 percent of their total natural land areas

The major industries of the country are food processing, garments, machine building, fertilizer, shoes, glass, tires, oil, coal, steel, cement and paper.

Industry and construction make the largest contribution (over 40%) to the aggregate a GDP growth rate.

In 2005, export value reached $32.23 billion, while import value rose to $36.88 billion. Vietnam's main exports are crude oil, textiles, garments, footwear and aquatic products. Main imports are machinery, equipment, parts and petroleum products.

Figure 5. Song Da concrete enterprise

Figure 6. Residential area in Hanoi city

Concept of "Low Carbon Society"

What is a "Low Carbon Society" (LCS)?

A low-carbon society (LCS) is a sustainably developed or developing society on the basic of close, reasonable and harmonious coordination of economic and social development and environmental protection. On that society, environmental protection will be given the same level of attention as other socio-economic development issue.

The concept of a low-carbon society has the following attributes:

1. Take actions that are compatible with the principles of sustainable development, ensuring that the development needs of all groups within society are met.
2. Make an equitable contribution towards the global effort to stabilize the atmospheric concentration of CO_2 and other greenhouse gases at a level that will avoid dangerous climate change, through deep cuts in global emissions.
3. Demonstrate a high level of energy efficiency and use low-carbon energy sources and production technologies.
4. Adopt patterns of consumption and behavior that are consistent with low levels of greenhouse gas emissions.

A low-carbon society framework has not merely GHGs emission reduction. It also helps in achieving national development targets especially effective and sustainable development.

Climate change activities in Vietnam and Why we need LCS?

Vietnam, is one of the poor countries would be the most seriously affected by climate change, especially in sea level rise. IPCC (2007)[2] anticipated that the sea level will rise from 30cm to 1m over the next 100 years (2100). Climate change could not only increase Vietnam's exposure to extreme weather but also could cause a yearly capital loss in Vietnam of up to 17 billion USD (according to World Bank 2008).

Being aware of this danger, Vietnam Government signed the UNFCCC in June 1992 and ratified it on 16 November 1994. Vietnam ratified Kyoto Protocol on 25 September 2002. On 17 October 2005, the Vietnamese Prime Minister has issued a Directive on the implementation of Kyoto Protocol to UNFCCC, which instructs various ministries and government agencies, as well as provincial/municipal People's Committee, to effectively implement the Clean Development Mechanism (CDM) of the Kyoto Protocol. Article 12 of the Kyoto Protocol created CDM to assist developing countries including Viet Nam in achieving sustainable development. CDM projects in Viet Nam play an important role in sustainable socio-economic development, improvement of people living conditions and poverty reduction through income and employment generation together with environmental protection in the country.

Currently, Vietnam is not obligatorily committed to reduce CO_2 emissions but it have to achieve sustainable socio-economic development. In the view of long term development, if it does not have any intervention of abatement countermeasures, Vietnam will contribute a significant of CO_2 emission which will make global warming worsen. These changes have direct impact on environment, growth and human in Vietnam. In order to prevent this peril, socio-economic development in Vietnam must go hand in hand with low-carbon society's development.

[2] IPCC—Intergovernmental Panel on Climate Change
[3] UNFCCC—United Nation Framework Conventional on Climate Change

Energy Policy and Sustainable Development In Vietnam

Box 1.

National Energy Policy

The national energy development strategies for the development of socio-economy are as follows: "*Rationally and efficiently exploit and use national energy resources; ensure sufficient energy supply with continuously increasing quality, rational price for the socio -economic development, diversify the investment and business types in the energy sector, gradually form energy market in Vietnam; promptly, efficiently and stably develop the energy sector, development goes together with the improvement in social equity and environmental protection*". These strategies are included:

- Strategies for and policies of the Oil and Gas industry (by Petroleum Law on 9th June 2000 together with Decrees No. 48/2000/NDCP dated 12 September 2000, Decree No. 34/2001/NDCP dated 6 July 2001 of the Government)
- Strategies and policies of the coal industry
- The Development Strategies of power sector and Vietnam Electricity Law in the period 2004-2010, oriented to 2020 (approved by Government on 5th October 2004)

Sustainable development point of view in the Vietnam energy policies and strategies

The assessment of the impacts of the Vietnam energy policies and strategies in term of sustainable development at national level should follow the "Vietnam Agenda 21" approved by the State on August, 2004. Essential points of sustainability understanding are:

8 principles for sustainability development

1. Human being is the centre of sustainable development.
2. Economic development is considered as the central task in the coming development period.
3. Protection and improvement of environment quality are to be considered as an inseparable factor from the development process.
4. The development process must equally satisfy the needs of the current generations without causing obstacles for the life of future generations.
5. Science and technology is the foundation and the momentum for the country's industrialization, modernization, quick, strong and sustainable development.
6. Sustainable development is the cause of the whole Party, authorities at all levels, the ministries, sectors and localities, agencies, businesses, social organizations, population communities and the whole people.
7. The establishment of an independent and autonomous economy is tightly attached to the international economic integration on basis of self initiative.
8. Social-economic development, environmental protection should be closely combined with guarantee of national defense and security as well as social safety and order.

5 priorities for sustainable energy development

1. Strengthening of legal base and energy management
2. Selection of appropriate exploration and utilization
3. Research and development of transfer and application of clean energy technology
4. Proposal of technological and management solutions for energy types
5. International co-operation in energy.

The viewpoint on National Energy Security

Energy security is one of the issues that should come first on the list of priorities in national energy policy. It is necessary to combine the exploitation and utilization of home energy resources with the import of energy from stable sources of energy supply, and with the reduction of the dependence on imported energy of highest sensitivity level, especially oil products.

Reference: Vietnam Agenda 21 and Report on "Impact on current energy policies ans energy development in Vietnam from sustainability point of view", at Greening the Business and Making Environment a Business Opportunity Conference, Bangkok, Thailand 2007

Socio-Economic Assumption in 2030

The study considers two scenarios. The BaU (Business as usual) scenario and CM (counter measure) scenario. The scenario stories span the period till 2030.

Based on the current socio-economic development, the future economic development in 2030 is estimated. The future picture about economy, society, commercial, energy and transport in Vietnam in 2030 is depicted as follows.

Population and number of household

Population projections are based on UN Population low variant, 2030 for Vietnam. The Vietnam population will reach over 99.3 million people in 2030. Number of household will rise from 25.2 million (2005) to 33.1 million (2030), and average household size will decrease from 3.3 (2005) to 3.0 (2030).

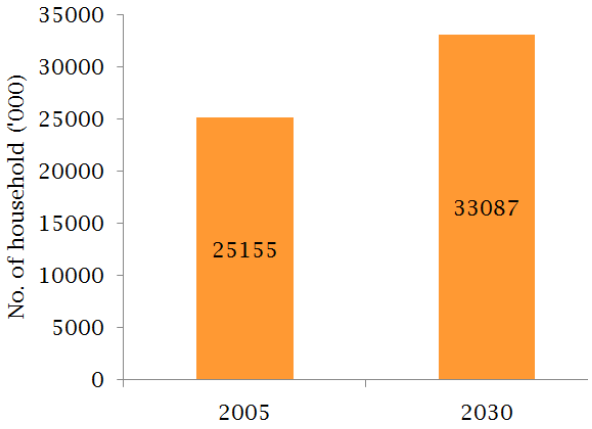

Figure 7. Number of household

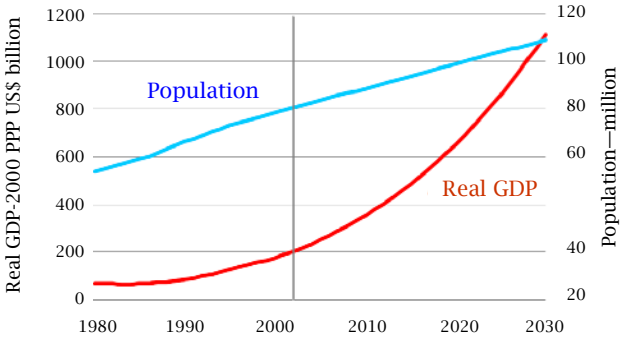

Figure 8. Population and GDP
(Source: Global Insight—2005)

Table 2. Quantitative socio-economic assumption in 2030

Indicator	Set Value (2030)	2030 Tendency
Population	Estimated by UN Population low variant, 2030 for Vietnam	Growth rate still at 1.2 per annum
Demographic composition	[Male] 0-14: 8%, 15-64: 35.9%, 65 and over: 5.8% [Female] 0-14: 7.7%, 15-64: 35.2%, 65 and over: 7.4%	Number of male births are higher than female births
Population distribution	Urbanization rate is 45% (22.3% in 2005)	Large quantity of rural-lived people move to cites causes asynchronous infrastructure development
Average number of persons per household	3 (3.15 in 2005)	Slight decrease in average size of household
Employment rate	Increasing 20-30%	Economic development leads to increasing the need of labour
Structure of employed population	[Agriculture, Fishery, Forestry]: 30% (58% in 2005) [Industry, Construction]: 30% (18% in 2005) [Service]: 40% (24% in 2005)	Primary industry sectoral share has a decrease trend, whilst secondary industry still has an increasing trend.
Modal share	[Train] 10%, [Bus]30%, [Waterway]11.6%, [Motorcar & motorbike]35.3%, [Walk]7%, [Bicycle]5%	Increasing of public transport, more people respond to walk and use bicycle
Gross output	[Primary industry]: 4.1 times higher than 2005 [Secondary industry]: 5.7 times [Tertiary industry]: 5.4 times	Vietnam is on an increasing economic growth trajectory and has priorities in meeting the development needs.

Industry

It is projected that Vietnam annual average real Gross Domestic Product (GDP) to grow at 7% per annum for period 2005-2030. The real GDP of Vietnam in 2030 is estimated to be approximately 4,183 trill.VND (5.1 times of the performance in 2005).

An input-output framework has been used to determine the future structure of economy. Currently, the agriculture sector has its relative importance in the total GDP of the Vietnam economy. However, in coming time, the percentage share of the agriculture sector in the total GDP has followed a declining trend. While, the industry sector is making well in the economy from last 10 years and it is expected to contribute more to GDP in the future.

Modeling result shows that economic sectoral structure in GDP in 2030 will be as follows: share of the primary industry will decrease from 13.5% (2005) to 10.3% (2030) whereas the share of secondary industry will increase by 4% from 60.1% (2005) to 64.1% (2030) . In addition, the share of the tertiary industry still remain as in 2005 about 25.6% (2030).

Table 3. Macro-economic indicators (trillion VND)

Indicator	2005	2030	2030/ 2005
GDP	818.5	4,182.5	5.1
GDP/capita (mil VND)	9.8	42.1	4.3
Private consumption	585.3	296.9	5.1
Government consumption	8.9	44.9	5.1
Fixed capital formation	30.7	155.6	5.1
Exports	56.2	285.1	5.1
Imports	644.4	323.8	5.0

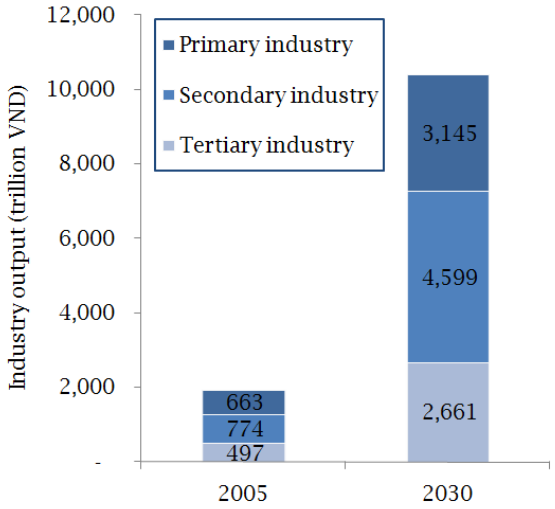

Figure 9. Production by industry

Transportation

Passenger transport demand will increase from 57 billion passengers-kilometers (2005) to 519 billion passengers-kilometers (2030) or 9 times higher than 2005.

Due to the growth of output of the manufacturing industries, the corresponding freight transport demand will increase over 10 times, from 101 billion tone-kilometers (2005) to 1085 billion tone-kilometers (2030).

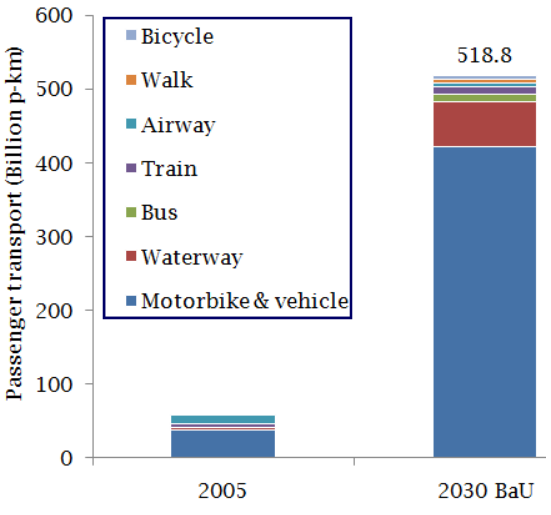

Figure 10. Passenger transport demand

Energy demand and GHG emissions

Estimation of energy demand and corresponding GHGs emission in 2030 is based on bottom-up type energy demand and supply model.

Finding results related to energy demand and GHGs emission are shown in Figure 11 to Figure 14.

The model result shows that the total energy demand of Vietnam is projected to increase about 3.3 times from 44.4 million toe (toe: tone oil equivalent) in 2005 to 144.7 million toe in 2030 BaU scenario. As can be seen from figure 13 energy demand of passenger transport and freight transport have rapidly increase of 5.7 times and 6.9 times, respectively. However, energy demand of industry is estimated to increase 5.2 times and still will maintain the largest share of 36% (52 million toe), followed by transport (42 million toe, 29%), residential (39 million toe, 27%), and commercial (11 million toe, 8%) in 2030 BaU.

This study shows that by 2030 BaU the energy system of the country would rely more on oil than biomass (fuel wood) this corresponds to the increasing of oil products of supply from the domestic refinery. By 2030 BaU, the share of oil in the TPES (total primary energy supply) would rise to about 34% (as compared to 24% in 2005), followed by natural gas (24%), coal (19%), renewable (15%) and hydropower (8%).

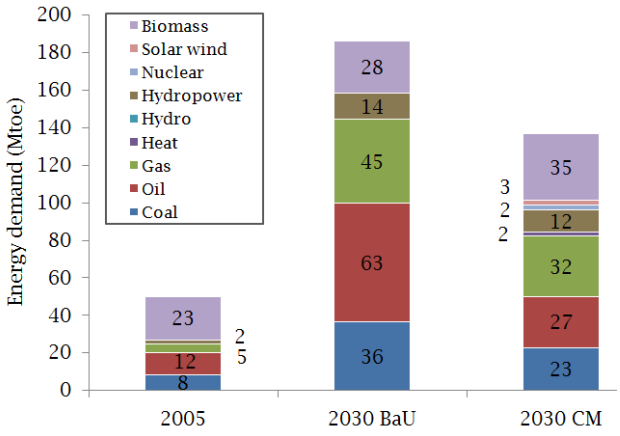

Figure 11. Energy demand by primary energy

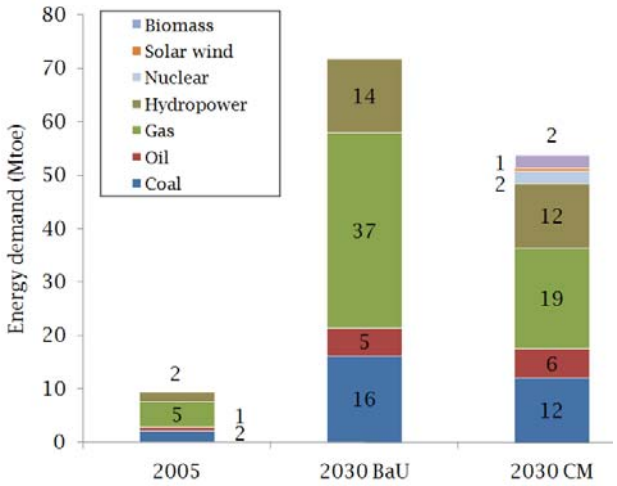

Figure 12. Fuel demand for power generation

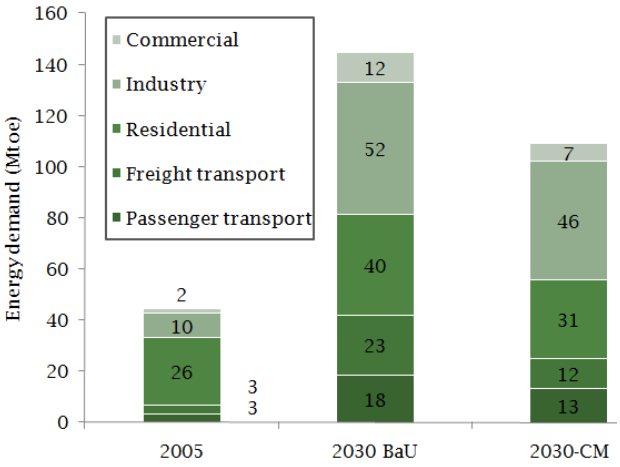

Figure 13. Final energy demand by sector

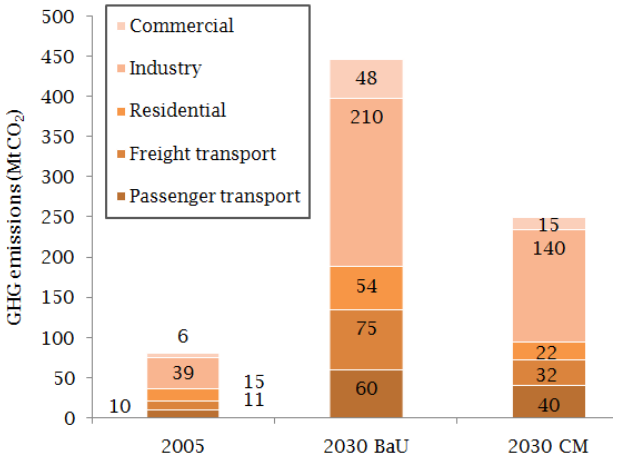

Figure 14. GHG emissions by sector

The finding from the modeling shows that the total GHG emissions in Vietnam are projected to increase from approximately 80.9 million t-CO_2 (2005) to 446.3 million t-CO_2 (2030 BaU) or 5.5 times higher than 2005. It can be illustrated from Figure 14 that GHG emission from industry will be about 210 million t-CO_2 and the share will be around 47% of total GHG emission. GHG emissions from passenger transport and freight transport are found to be about around 6 times the amount in 2005.

From Figure 15, GHG per capita will increase from 0.97 tones of CO_2 per capita in 2005 to 4.5 of CO_2 per capita in 2030 BaU scenario.

Based on the assumption, fuel sources for power generation are dominated by natural gas, accounting for 1845 ktoe of the total capacity in 2005 which has the largest share of about 50%, followed by coal (22.5%), hydropower (19.5%) and oil (7%). This share still remain in 2030 BaU scenario.

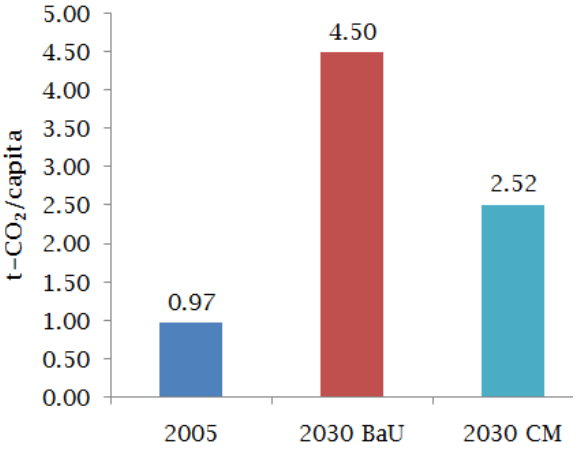

Figure 15. Per capita GHG emissions

Box 2.
Key elements of **"National Energy Policy of Vietnam."**

1. Developing energy infrastructure and ensuring adequate, stable and long-term energy supplies for development;
2. Developing energy, taking into account environmental considerations and sustainable development;
3. Encouraging the economical and efficient use of energy by: (i) taking steps to replace low-efficient
equipment and facilities, (ii) encouraging domestic manufacture of end-use equipment and facilities that meet energy efficiency standards, (iii) carrying out measures to improve energy conservation in large buildings, and (iv) applying the principles of demand side and energy supply management;
4. Developing new and renewable energy resources, such as small hydro, wind power, solar energy, and geothermal;
5. Promoting rural energy policy by ensuring adequate energy supply for the sustainable development of remote populations, achieving rural access for all by 2010;
6. Enhancing international cooperation in energy3; and
7. Improving legal frameworks and market-oriented reforms, especially in the power sector (APERC, 2005).

Laws governing the Energy sector

- **Electricity Law:** Provides roadmap and assigns responsibilities for reform and liberalization of the power sector (2004-2005)
- **Petroleum Law:** Sets the overall framework for exploration and development of on-shore and off-shore oil and gas resources, including the nature of FDI allowed and types of contracts to be entered into with IOCs—International Oil Companies (1993-Amended 2000)
- **Law on Environmental Protection:** Creates the statutory basis for regulating public and private activities to protect the
environment and establishes the Ministry of Natural Resources and Environment.

Potential Mitigation of Vietnam in 2030

The amount of CO_2 emission in Vietnam will be reduced from 446 million t-CO_2 in the 2030 BaU scenario to 250 million t-CO_2 in 2030 CM by adoption of counter measures for mitigating GHG in 2030. Based on the model simulation, the reduction of GHG emissions by types of countermeasures contributed by several measures (Figure 16).

Energy efficiency improvement accounts for the largest CO_2 emission reduction of 40% of total reduction, distributed as 31.6 million t-CO_2 (16%) in transport, 20.4 million t-CO_2 (10%) in industry, 15.6 million t-CO_2 (8%) and 10.3 million t-CO_2 (5%) in commercial and residential, respectively.

Fuel switch of all sectors make up the second largest CO_2 emission reduction of 65.5 million t-CO_2 (33%). The next big potential comes from power supply sector by 36.8 million t-CO_2 emission reduction (19%). The last potential reduction is from increasing the use of public transport (8% of total CO_2 reduction).

Portfolio of energy efficiency improvement includes (i) industry sector: improvement of low-efficiency coal-fired boilers to higher efficiency one, improvement of low-efficiency oil-fired boilers to higher efficiency one, and more efficient industrial equipments and motors; (ii) residential and commercial sectors: replace existing coal-cooking stoves and existing LPG (Liquefied petroleum gases) - cooking stoves to BAT (best available technology)-cooking stoves, replace incandescent light bulbs by compact fluorescent lamps.

However, in order to realize a low carbon society, Vietnam has to have new and bold policies to encourage and promote businesses and citizens to take these countermeasures.

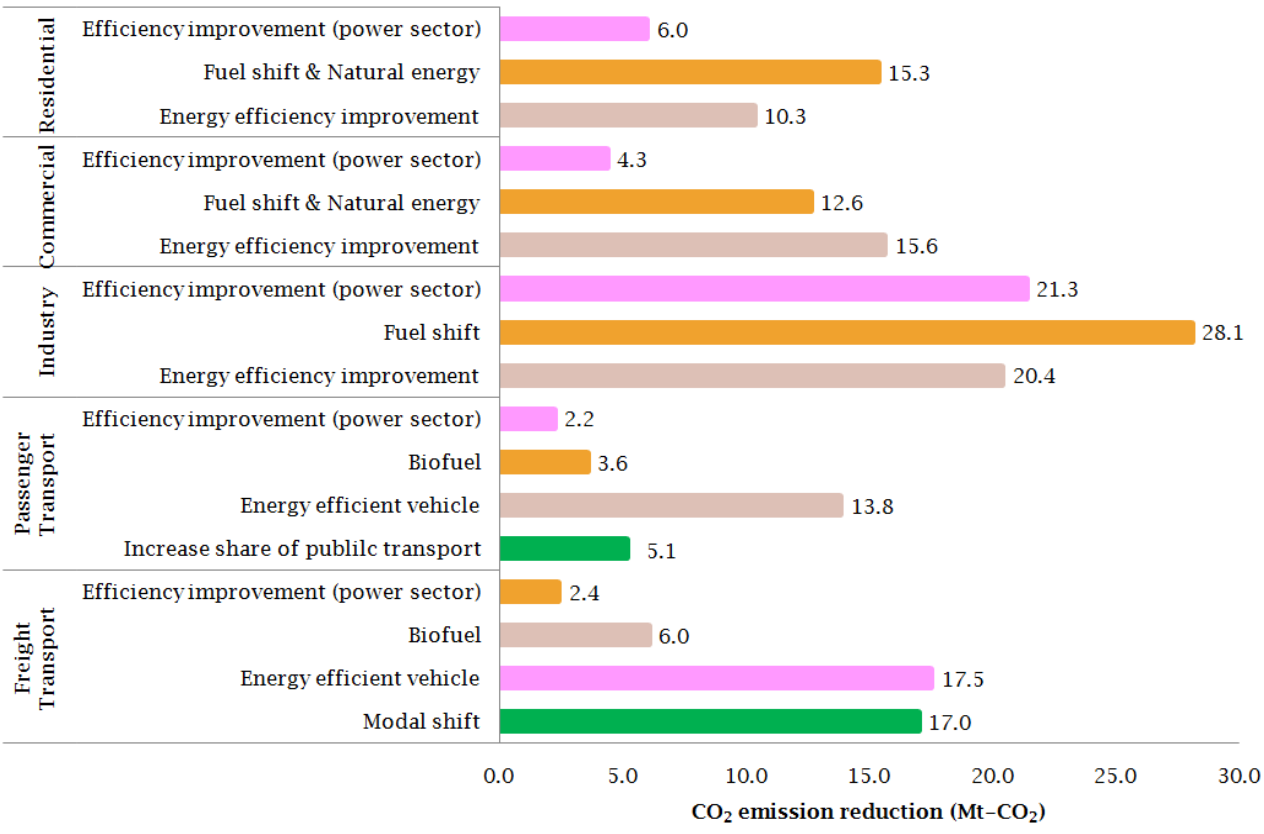

Figure 16. Contribution of each countermeasure to reduce CO_2 emission

Five "Actions" towards LCS

Based on the socio-economic assumption and for reducing GHG emissions to achieve sustainable development, we carried out the combination of measures (Figure 16). Due to these several numbers of measures, we divide them into five actions (Figure 17).

Action 1. Convenient Transport

Using of public transportation and bicycle will increase level of convenience in travel, which has lead to decline in usage of automobiles and it has results in a safe and comfortable transportation environment. Instead of cargo transportation by trucks, convenient and comfortable large scale transportation by train and by ship is increasingly used. Promoting the use of biofuel in automobile also brings about benefit in cutting down CO_2 emission.

Action 2. Green Building

Buildings have intelligent structures by utilizing of natural energy resources such as photovoltaic energy. Households have increase the application of renewable energy in daily life such as cooking activities.

Action 3. Energy Efficiency (EE) Improvement

This action could not only enhance EE in all sectors but also strengthen state management on EE by developing a management system for energy saving and strengthen public awareness to promote EE as well as environmental protection.

Action 4: Fuel switch of Industry

The action aims to switching from coal to gas and other renewable energies. A large amount of financial commitments would be required in not only technology but also in associated infrastructure.

Action 5: Smart Power Plants

A Smart Power Plant could not only be environmental friendly but also could be understood as the sufficient, continuous supply of energy required for the social and economic development of the whole country. Leveraging to achieve it is the benefits of energy efficiency, utilizing nuclear energy and renewable energy.

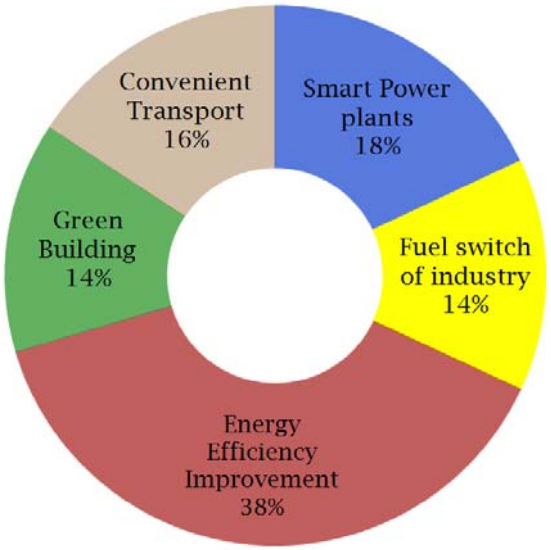

Figure 17. Five actions to reduce GHG emission

Table 4 . Potential of CO_2 emission reduction from "Five Actions"

No.	Action name	Potential of CO_2 reduction (Mt-CO_2)
Action 1	Convenient Transport	31.7
Action 2	Green Building	27.9
Action 3	Energy Efficiency Improvement	77.7
Action 4	Fuel switch of industry	28.1
Action 5	Smart Power plants	36.3

Action 1: Convenient transport

The action on **Convenient transport** primarily comprises of a shift from private vehicles to **public transportation** (such as bus and train) by traffic management system and increased penetration of **fuel switch** (fuel switch from gasoline and diesel to electricity and gas).

GHG reductions from modal shift is 22.1 Mt-CO_2. Promoting fuel switch could reduce 9.6 Mt-CO_2. Total CO2 emission reduction from this action contribute to 16% of total CO_2 emission reduction.

Because of population and economic growth in 2030, the passenger transport demand is projected to be 517.8 billion passenger-km. The share of walk and bicycle are very small compare to the share of motorbike in 2005 and 2030 (see Figure 20). Motorbike is overwhelmingly the most popular mode of transport in Vietnam, correspondingly cause traffic congestion frequently and contribute to faster increasing of CO_2 emission. As usual economic growth without any interference of mitigations, energy demand and CO_2 emission of this sector will increase to 18.4 million toe and 60 million t-CO_2 in 2030 BaU, respectively. However, in 2030 with countermeasure, the final energy consumption reduces to 13.2 million toe. Accordingly, CO_2 emissions decrease to 40 million t-CO_2.

Currently, Vietnam has paid due attention to transport demand management which including transport infrastructure development (focusing investment on road network development, building new and upgrading key national highways), investment to public vehicles, and bold policy to control and reduce the use of motorbikes.

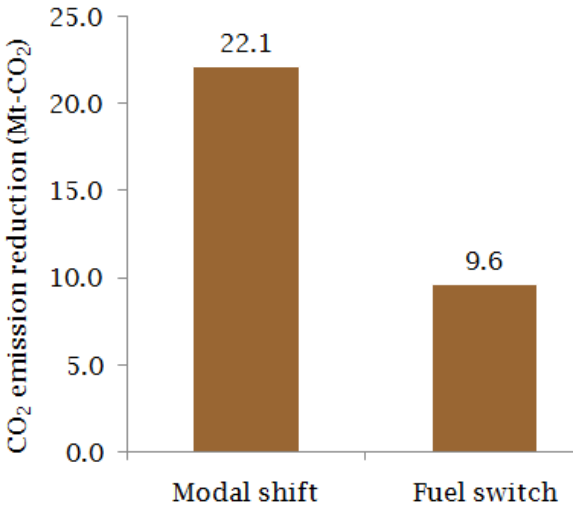

Figure 18. CO_2 emission reduction by action 1

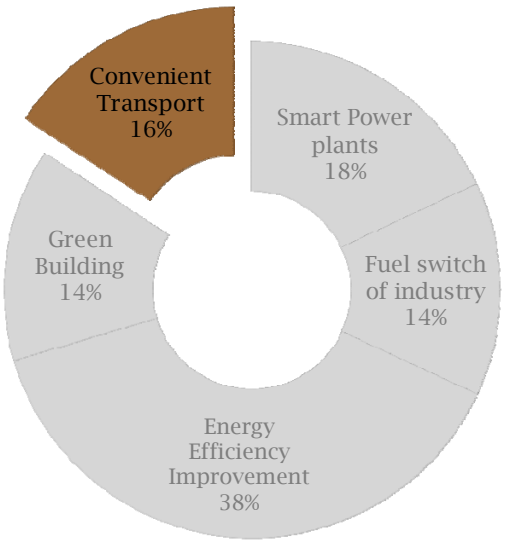

Figure 19. Potential CO_2 mitigation by Action 1

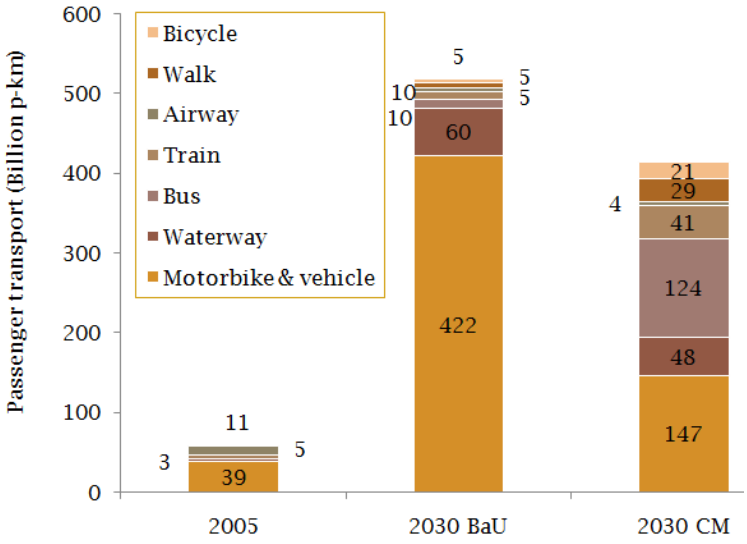

Figure 20. Passenger transport volume

The freight demand increase due to the growth of output of the manufacturing industries. With the natural endowment of dense river and canal network, waterway transport is very developed with the share of nearly 35% of total domestic transported volume. The energy demand from this sector increases significantly in 2030 BaU to 23.5 million toe. With energy efficiency improvement of shifting fuel to biomass/bio-fuel and travel demand management in 2030 CM, the energy demand and CO_2 emission reduce considerably to 11.8 million toe and 31.8 million t-CO_2, respectively.

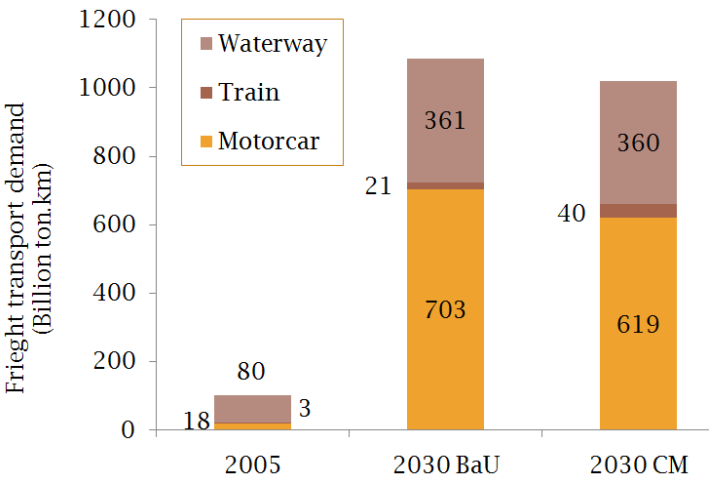

Figure 21. Freight transport volume

Figure 22. A future public transportation system

Box 3.
Electric Vehicles (EV)

In an electric vehicle (EV), a battery or other energy storage device is used to store the electricity that powers the motor. EV batteries must be replenished by plugging in the vehicle to a power source. Some electric vehicles have onboard chargers; others plug into a charger located outside the vehicle. Both types, however, use electricity that comes from the power grid. Although electricity production may contribute to air pollution, EVs are considered zero-emission vehicles because their motors produce no exhaust or emissions.

Ref.Alternative Fuel and Advanced Vehicle Center

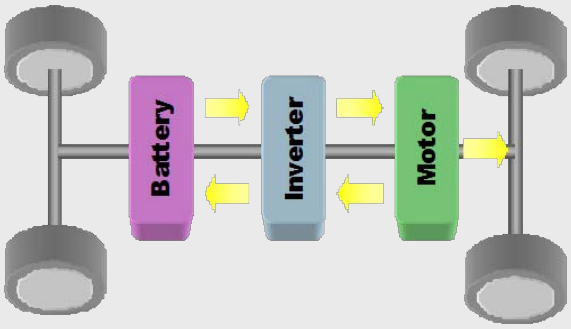

Figure 23. A electric vehicles (http://www.mitsubishi-motors.co.jp)

Action 2: Green Building

The "Green Building" action focuses on measures of fuel shifting and natural energy utilization of two sectors (residential and commercial). This action is targeted to reduce CO_2 emissions in 2030 by 12.6 million t -CO_2 and 15.3 million t-CO_2 or 6% and 8% (total 14%) compared to total CO_2 emission reduction in the two sectors: commercial and residential, respectively.

Fuel shifting and natural energy utilization comprise following measures such as: biomass heating, solar heating, photovoltaic power and solar water heater.

In order to achieve this action, it should be deploying policies concerning (i) subsidy to introduce natural energy system (solar and wind energy, photovoltaic power), (ii) low interest loan in investment to building using renewable energy, (iii) environmental performance standard and evaluation of housing and buildings.

Figure 24. "Green space" in Hanoi

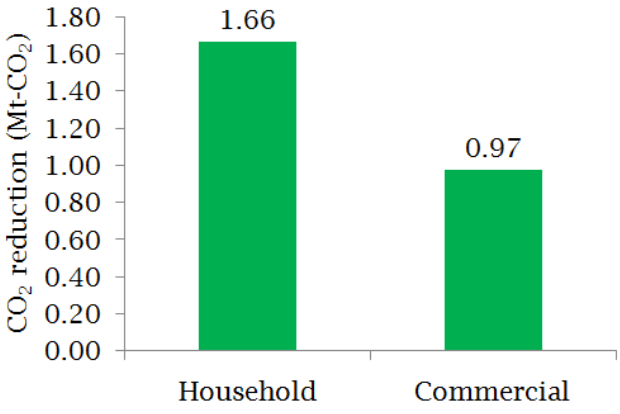

Figure 25. CO_2 reduction contributed by solar & wind in residential and commercial sectors

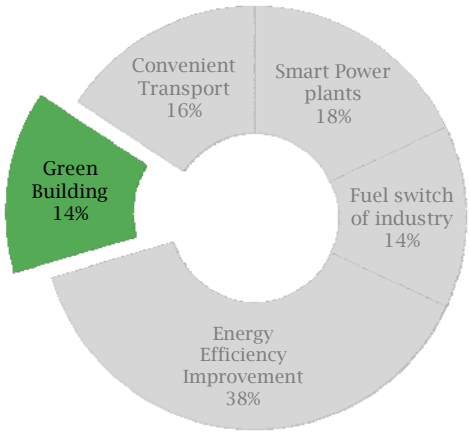

Figure 26. Potential CO_2 mitigation by Action 2 "Green Building"

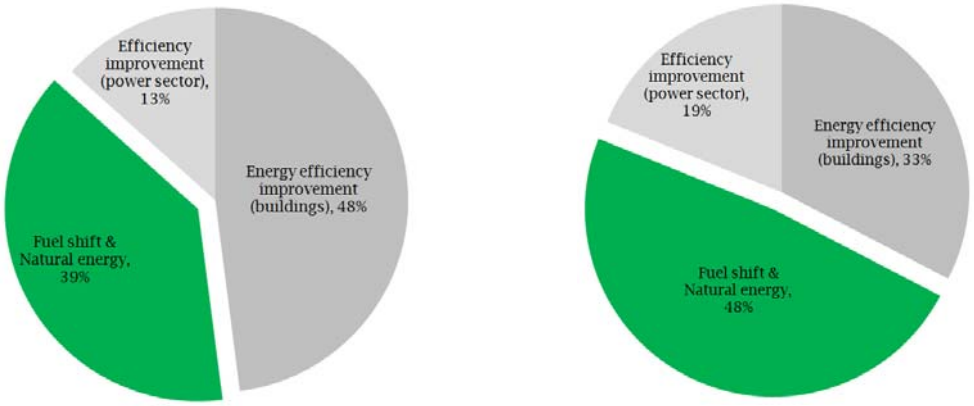

Figure 27. Breakdown of emission mitigation by means in commercial (left) and in residential (right)

Action 3: Energy Efficiency Improvement

The "Energy Efficiency Improvement" action is able to reduce CO_2 emissions in all sectors in 2030 by 77.7 million t-CO_2, accounting for about 38% compared to total CO_2 emission reduction. In the graph below, the highest amount of CO_2 emission reduction accounts for transport sector by 31.6 $MtCO_2$, following by industry, commercial and residential sectors with respectively amount of CO_2 reductions are 20.4, 15.6 and 10.3 $MtCO_2$.

This action is used to turn the existing or low-efficiency device, equipment, motors or vehicles into "best available technology" models in all sector. "Nation Strategic Program on Energy Saving and Effective Use" is used in order to implement this action.

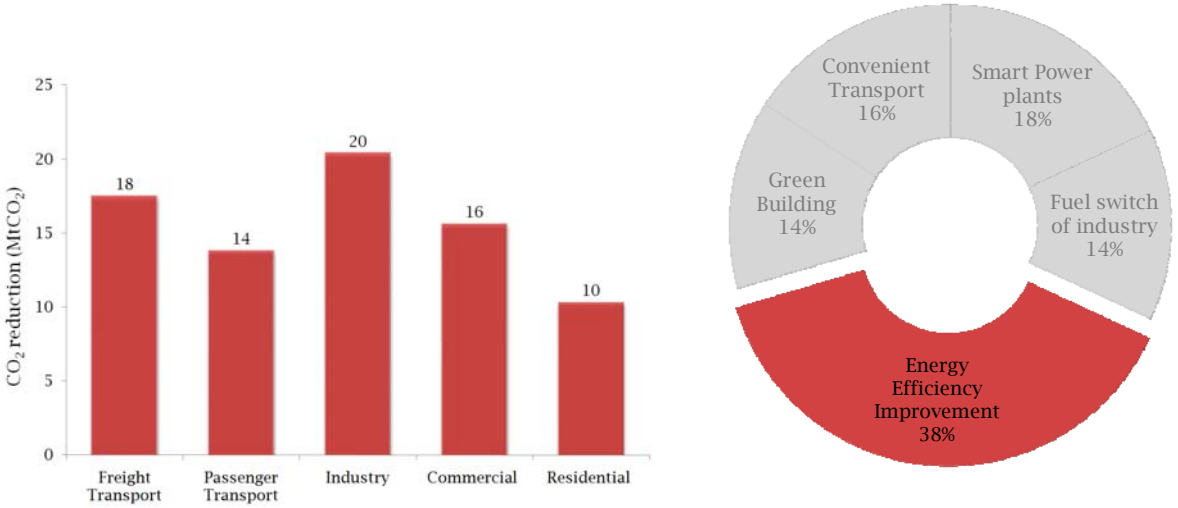

Figure 28. Potential CO_2 mitigation by Action 3 "Energy Efficiency Improvement"

Box 4.

National Strategic Program on Energy Saving and Effective Use

The energy efficiency and conservation goal is a 5-8% cut in cumulative energy consumption between 2011—2015.This target is in line with the long-term objective of reducing the elasticity factor (growth rate of energy demand/growth rate of GDP) from the historical level of 1.46 to 1.0 by 2015, and further to 0.9 by 2020 and 0.8 in subsequent years.

The government decrees, circulars and decisions that address energy efficiency and conservation are listed in below table.

Legislation (type)	Promulgator	Issuance date	Date Effective
Energy Saving and Efficient Use of Energy (Decree)	National Government	3 September 2003	September 2003
Guiding the Saving and Efficient Use of Energy by Production Establishments (Circular)	Ministry of Industry	2 July 2004	July 2004
Approving the 2006-2010 Electricity Saving Program (Decision)	Prime Minister	14 April 2006	May 2006
Approving the National Target Program on Saving and Efficient Use of Energy (Decision)	Prime Minister	14 April 2006	May 2006
Establishing the Energy Efficiency and Conservation Office at the Ministry of Industry (Decision)	Ministry of Industry	7 April 2006	7 April 2006
Establishing the Steering Committee of the National Target Program on Savings and Efficient Use of Energy (Decision)	Ministry of Industry	18 May 2006	18 May 2006
Promulgating the Regulations on Selection of the Organizations, Individuals to Preside over the Implementation of National Target Program on Saving and Efficient Use of Energy projects (Decision)	Steering Committee of the National Target Program	20 September 2006	20 September 2006
Guiding the Order and Procedures for Energy Efficiency Labeling for Energy Consuming Products (Decision)	Ministry of Industry	16 November 2006	December 2006

Source: EVN,2006c

Reference: Vietnam country report: From ideas to action: Clean Energy solutions for Asia to address climate change by USAID/ASIA

Action 4: Fuel Switch in Industry

The action "Fuel Switch in Industry" is targeted to reduce CO_2 emission in 2030 by 28062 kt-CO_2 or 14% of total CO_2 emission. In which, largest potential reduction is accounted for steam boiler by 17779 kt-CO_2, followed by direct heating (furnace) by 8549 kt-CO_2, and other activities by 1734 kt-CO_2.

Fuel uses in industry sector, will be able to shift from high carbon intensity to lower ones. For instance, fuel switch from coal and oil to natural gas.

To promote mitigation measures of industry sector, incentive to investment in fuel switch is essentially important. Policies for this sector should be focus on tax, subsidy and low interest loans.

Table 5. Energy demand by service by fuel in industry

	Coal	Oil	Gas	Biomass	Electricity
2005	2352	631	38	0	173
Furnace	1968	1623	49	0	0
Boiler	0	0	0	0	1497
Motor	480	717	13	0	249
Others	4799	2971	100	0	1919
Total	49%	30%	1%	0%	20%
Share	2352	631	38	0	173
2030 BaU					
Furnace	9630	1619	3846	0	2755
Boiler	4821	4474	3057	0	7844
Motor	0	0	0	0	8365
Others	1816	1952	1140	0	316
Total	16267	8046	8043	0	19280
Share	32%	16%	16%	0%	37%
2030 CM					
Furnace	3262	567	4475	1800	3071
Boiler	4412	982	6106	2726	4255
Motor	0	0	0	0	6760
Others	1803	549	2494	1279	1875
Total	9477	2097	13075	5804	15961
Share	20%	5%	28%	13%	34%

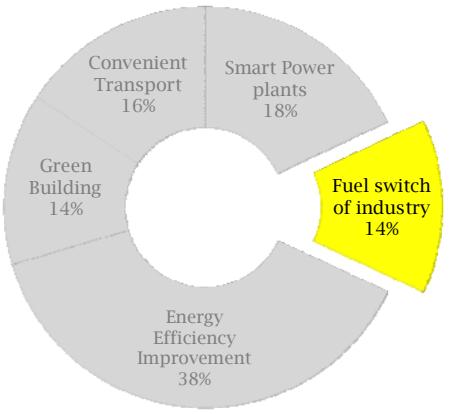

Figure 29. Potential CO_2 mitigation by Action 4

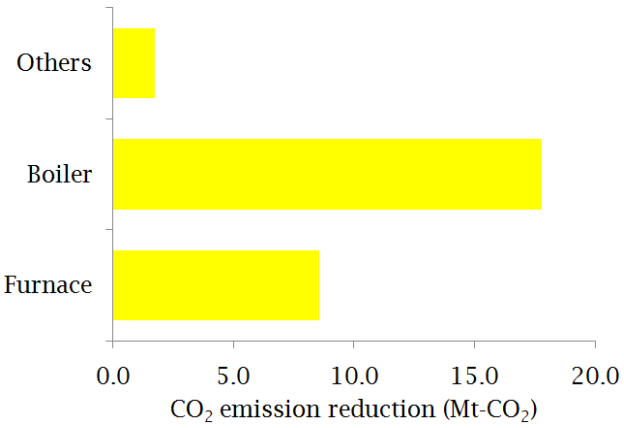

Figure 30. CO_2 emission reduction by service

Box 5.

Renewable Energy potential in Vietnam

According to Institute of Energy (IOE) of Electricity of Viet Nam (2005):

1. Hydropower: The total hydropower potential is estimated at 80,000 GWh/year. Around 20% of this total (16,000 GWh/year) is small hydro (under 10 MW).

2. Biomass potential ranges from 43 to 46 million TOE per annum, of which, fuel wood shares 60% (26 to 27 million TOE) while agricultural residues share 40% (17 to 19 mill TOE);

3. Wind power potential ranges from 860-1,410 kWh per m^2 per year on the islands, 800-1,000 kWh per m^2 per year in coastal regions and 500-800 kWh per m^2 per year in some inland areas.

4. Biogas shares 10% (0.4 million TOE)

5. Solar energy: In winter, it would see about 3-4.5 KWh per m^2 per day of solar radiation and this increases to 6.5 KWh per m^2 in the summer. Vietnam has up to 2,000-2,500 hours of sunshine a year.

Action 5: Smart Power Plants

The action "Smart Power Plants" is calculated to reduce CO_2 emission in 2030 by 26853 kt-CO_2 or 18% of total CO_2 emission. This action comprises of 4 main measures; namely, utilizing economically efficient domestic energy resources, promoting the use of renewable energies, reducing transmission and distribution loss, and developing nuclear power plant.

The finding results are shown in Table 6. As can be seen from the table, the share of high carbon intensity fuel decreased and replaced by lower carbon intensity fuel and renewable energies such as solar & wind and biomass.

The transmission loss in 2005 was 11.3% and this number will reduce to 9% in 2030 BaU case and 7.5% in 2030 CM. This trend is made according to EVN's goal for 2025 (see Box 6).

The model results show that nuclear is required to contribute 8% to generate power in 2030 CM case.

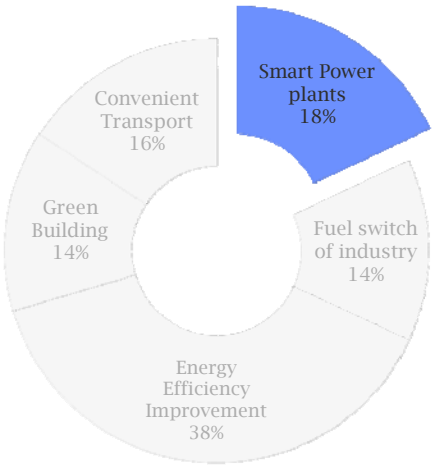

Figure 31. Potential CO_2 mitigation by Action 4

Table 6. Power supply sector in 2005, 2030 BaU and 2030 CM (Unit: ktoe)

	Coal	Oil	Gas	Hydro	Nuclear	Solar wind	Biomass	Total
2005								
Fuel	2132 (17%)	679 (4.6%)	4812 (39%)	1845 (4%)	0	0	0	9467
Generation	769	213	1770	1845	0	0	0	4597
Own-use (2.7%)	21	6	49	51	0	0	0	126
Transmission loss (11.3%)	84	23	194	203	0	0	0	505
Distribution	663	184	1527	1592	0	0	0	3966
2030 BaU								
Fuel	16186 (17%)	5155 (4.6%)	36540 (39%)	14007 (4%)	0	0	0	71888
Generation	5838	1621	13441	14007	0	0	0	34906
Own-use (2.7%)	160	44	368	384	0	0	0	957
Transmission loss (9%)	511	142	1177	1226	0	0	0	3055
Distribution	5167	1434	11896	12397	0	0	0	30894
2030 CM								
Fuel	11991 (15%)	5503 (6%)	18811 (24%)	12109 (42%)	2306 (8%)	721 (2.5%)	2403 (2.5%)	53843
Generation	4325	1730	6919	12109	2306	721	721	28831
Own-use (2.7%)	119	47	190	332	63	20	20	790
Transmission loss (7.5%)	315	126	505	883	168	53	53	2103
Distribution	3891	1556	6225	10894	2075	648	648	25937

Box 6.
Current targets for **Power Development in Vietnam**

1. The electricity consumption per capita in 2005 was 538 kWh/yr, and is expected to increase up to 2058-2350 kWh/yr by 2020 and 3096-3752 kWh/yr by 2030 (Electricity of Vietnam, 2006a, 2008a; Institute of Energy, 2006a, 2006b, 2008b)
2. Transmission and distribution loss in Vietnam in 2025 will reduce to less than 8%(Institute of Energy, 2006a, 2006b, 2008a, 2008b)
3. According to current and the sixth National Power Development Master Plan of 2006-2015 with prospects to 2025 (Decision No. 110/2007/QD-TTg dated 18 july 2007), the electricity demand is projected to increase by 15% - 18% per annum over the period 2010-2030.
3. Strategy to apply nuclear energy for peaceful purposes by 2020 (Decision No.01/2006/QD-TTg): The investment report for construction of the first nuclear power plant will be approved by 2010. By 2020 Vietnam will complete construction and commissioning of the first nuclear power plant. At the same time, the country has to prepare the infrastructure for development of a long-term nuclear power programme.

Methodology

A procedure to create LCS scenarios

In order to create a local low-carbon society scenario, We developed a method based on the idea of "back casting", which sets a desirable goal first, and then seek the way to achieve it. Figure 31 shows overview of the method.

(1) Setting framework

Framework of a LCS scenario includes; target area, base year, target year, environmental target, number of scenarios. Among them, the base year is compared with target year. The target year should be far enough to realize required change, and near enough to image the vision for the people in the region. In this study, we set the target year of Vietnam, 2030. This is also a suitable time span for a LCS study for the reasons above. As an environmental target, we targeted CO_2 from energy use because it will be a main source of GHG emissions from Vietnam in 2030.

(2)Assumptions of socio-economic situations

Before conducting quantitative estimation, qualitative future image should be written. It is an image of lifestyle, economy and industry, land use and so on.

(3)Quantification of socio-economic assumptions

To estimate Snapshot based on future image of (2), values of exogenous variables and parameters are set. Using those input, ExSS calculates socio-economic indices of the target year such as population, GDP, output by industry, transport demand, and so on.

(4)Collection of low-carbon measures

To collect counter measures which are thought to be available in the target year. For example, high energy-efficiency devices, transport structure change such as public transport, use of renewable energy, energy saving behavior and carbon sink. Technical data is required to estimate their effect to reduce GHG emissions. In this research we employed the measure showed in preceding study (Japan's study)

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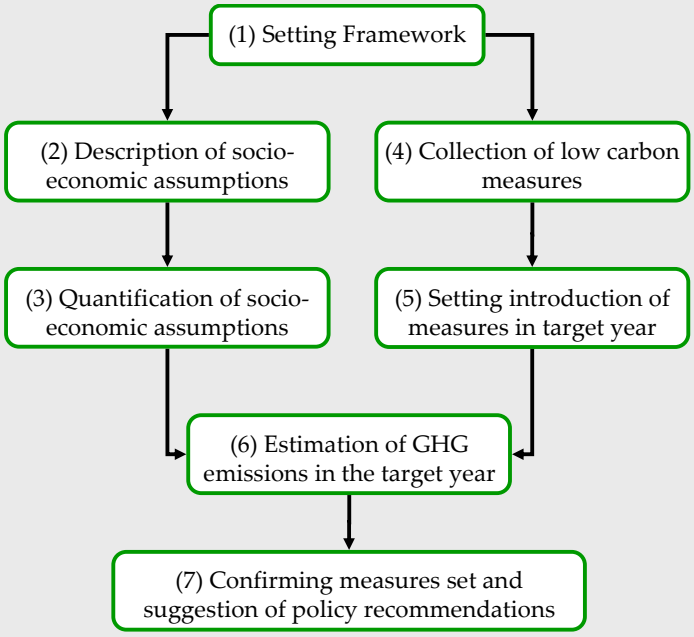

Figure 32. Procedure to create LCS scenarios

(5)Setting introduction of counter measures

Technological parameters related to energy demand and CO_2 emissions, in short energy efficiency, are defined. Since there can be various portfolios of the measures, one must choose appropriate criteria. For example, cost minimization, acceptance to the stakeholders, or probability of technological development.

(6)Estimation of GHG emission in the target year

Based on socio-economic indices and assumption of measures' introduction, GHG emissions are calculated.

(7)Proposal of policies

Propose policy set to introduce the measures defined. Available policies depend on the situation of the country. ExSS can calculate emission reduction of each counter measure.

Therefore, it can show reduction potential of measures which especially needs local policy. It can also identify measures which have high reduction potential and therefore important.

Quantitative estimation tool "Extended Snapshot Tool"

Figure 33 shows the structure of the Extended Snapshot Tool (ExSS); seven blocks with input parameters, exogenous variables and variables between modules. ExSS is a system of simultaneous equations. Given a set of exogenous variables and parameters, solution is uniquely defined. In this simulation model, only CO_2 emission from energy consumption is calculated, even though, ESS can be used to estimate other GHG and environmental loads such as air quality. In many LCS scenarios, exogenously fixed population data are used. However, people migrate more easily, when the target region is relatively a smaller area such as a state, district, city or town. Population is decided by demand from outside of the region, labor participation ratio, demographic composition and relationship of commuting with outside of the region. To determine output of industries, input-output approach is applied.

For future estimation, assumption of export value is especially important if the target region is thought to (or, desired to) develop led by particular industry, such as automotive manufacturing or sight seeing.

Passenger transport demand is estimated from the population and freight transport demand whereby it is a function of output by manufacturing industries. Floor area of commerce is determined from output of tertiary industries. Other than driving force, activity level of each sector, energy demand by fuels determined with three parameters. One is energy service demand per driving force, energy efficiency and fuel share. Diffusion of counter measures changes the value of these parameters, and so GHG emissions.

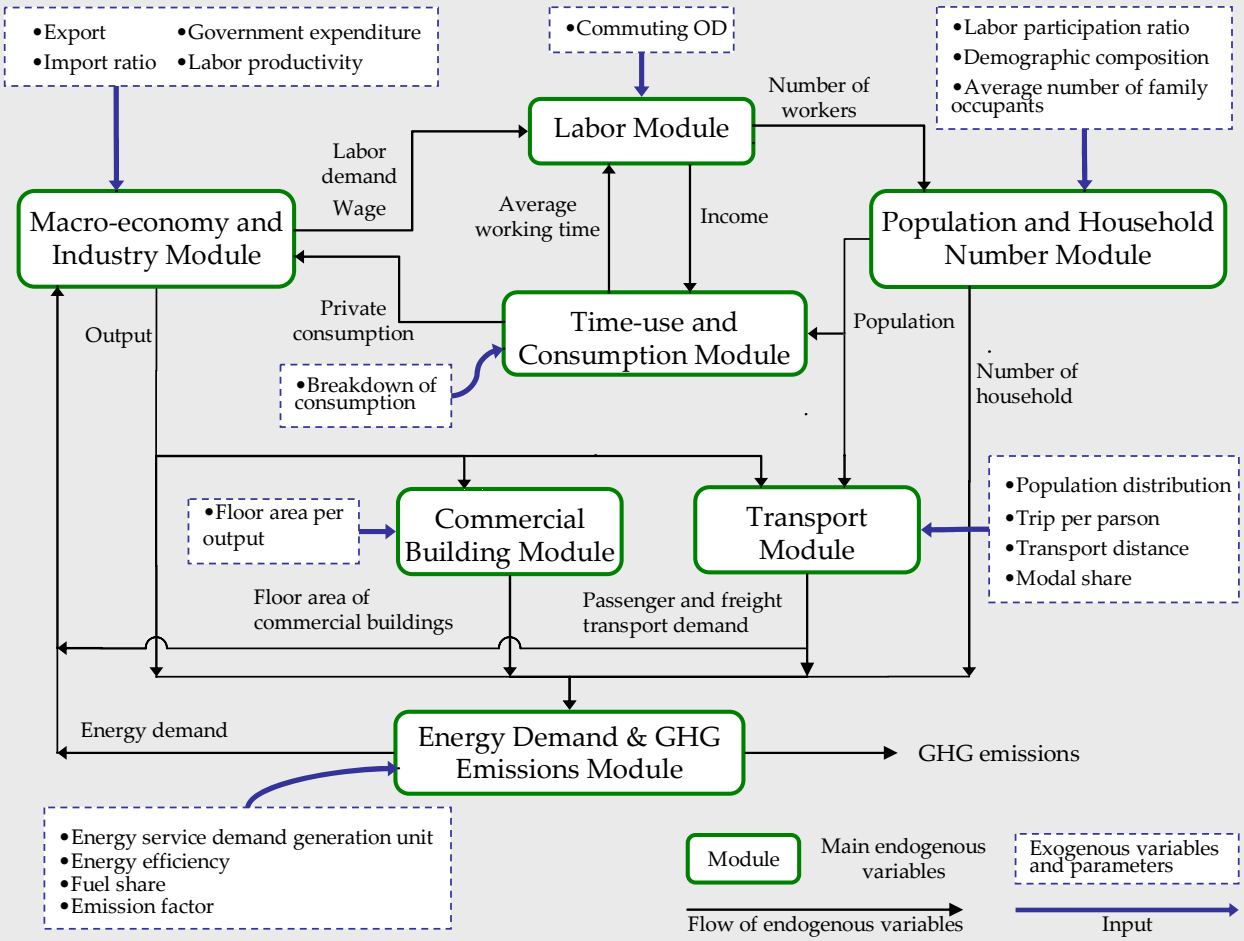

Figure 33. Overview of calculation system of Extended Snapshot Tool

Table 7. Input-output table of Vietnam in 2005 (Unit: Trillion VND)

No.	Description	01	02	03	04	05	06	07	08	**Total intermediate consumption**	Private consumption	Government consumption	Fixed capital formation	Export	Import	**Total gross output**
01	Agriculture-Fishery-Forestry	30	0	112	11	1	0	0	4	**159**	83	0	4	32	-17	**261**
02	Mining and quarrying	0	3	3	1	10	0	5	3	**26**	1	0	0	127	-11	**143**
03	Food, beverage & tobaco manufactu	9	0	44	0	0	0	0	9	**62**	143	0	13	72	-30	**259**
04	Other consumer goods	3	1	10	160	7	5	8	16	**209**	35	0	-4	160	-115	**285**
05	Industrial materials	29	9	15	38	97	28	78	53	**348**	37	0	36	42	-282	**182**
06	Capital goods	3	5	3	4	5	58	26	37	**141**	33	0	41	48	-135	**127**
07	Construction	0	0	0	0	0	0	0	0	**0**	0	0	179	0	0	**179**
08	Private & government services and o	11	24	12	20	16	7	9	71	**170**	254	9	37	81	-54	**497**
	Total intermediate input	**85**	**42**	**200**	**235**	**137**	**99**	**126**	**193**	**1115**	**585**	**9**	**307**	**562**	**-644**	**1934**
	Gross value added	176	101	59	50	45	29	53	304	**818**						
	Total gross output	**261**	**143**	**259**	**285**	**182**	**127**	**179**	**497**	**1934**						

Table 8. Input-output table of Vietnam in 2030 (Unit: Trillion VND)

No.	Description	01	02	03	04	05	06	07	08	**Total intermediate consumption**	Private consumption	Government consumption	Fixed capital formation	Export	Import	**Total gross output**
01	Agriculture-Fishery-Forestry	124	1	590	83	6	0	1	20	**826**	208	0	21	164	-151	**1069**
02	Mining and quarrying	0	16	15	11	50	1	26	14	**133**	5	0	2	647	-73	**713**
03	Food, beverage & tobaco manufactu	35	0	229	3	2	0	1	47	**318**	831	0	65	363	-215	**1363**
04	Other consumer goods	11	3	55	1228	33	25	39	85	**1479**	324	0	-20	810	-411	**2182**
05	Industrial materials	120	46	77	293	485	132	394	285	**1833**	70	0	183	215	-1395	**907**
06	Capital goods	11	25	18	27	26	274	130	201	**713**	47	0	207	242	-608	**601**
07	Construction	0	0	0	0	0	0	0	0	**0**	0	0	910	0	0	**910**
08	Private & government services	45	118	64	154	79	32	48	381	**921**	1484	45	187	409	-386	**2661**
	Total intermediate input	**347**	**209**	**1050**	**1799**	**681**	**465**	**640**	**1032**	**6222**	**2969**	**45**	**1556**	**2851**	**-3238**	**10405**
	Gross value added	722	504	313	383	226	136	270	1628	**4183**						
	Total gross output	**1069**	**713**	**1363**	**2182**	**907**	**601**	**910**	**2661**	**10405**						

Table 9. Energy Consumption by fuel (Unit: ktoe)

	Coal	Oil	Gas	Heat	Hydro	Solar wind	Biomass	Electricity	Total
2005									
Residential	861	726					23129	1674	26390
Commercial	333	958						338	1629
Industry	4799	2971	100					1919	9789
Passenger Transport		3182						33	3215
Freight Transport		3386						2	3388
Total	**5993**	**11223**	**100**	**0**	**0**	**0**	**23129**	**3966**	**44411**
Share	**13%**	**25%**	**0%**	**0%**	**0%**	**0%**	**52%**	**9%**	**100%**
2030 BaU									
Residential	2606	2758					27580	6574	39518
Commercial	1327	5760						4557	11644
Industry	16267	8046	8043					19280	51636
Passenger Transport		17952						467	18420
Freight Transport		23439						16	23455
Total	**20200**	**57955**	**8043**	**0**	**0**	**0**	**27580**	**30894**	**144673**
Share	**14%**	**40%**	**6%**	**0%**	**0%**	**0%**	**19%**	**21%**	**100%**
2030 CM									
Residential	833	987		1274		1522	22316	3819	30751
Commercial	309	1280	271	689		279	1658	2235	6720
Industry	9477	2097	13075				5804	15961	46413
Passenger Transport		9190					1454	2598	13243
Freight Transport		8255			455		1742	1324	11777
Total	**10618**	**21809**	**13346**	**1963**	**455**	**1801**	**32975**	**25937**	**108904**
Share	**10%**	**20%**	**12%**	**2%**	**0%**	**2%**	**30%**	**24%**	**100%**

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