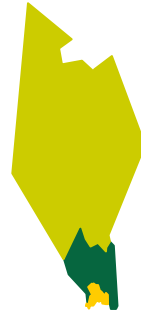


# LOW-CARBON CITY 2025

# SUSTAINABLE

# ISKANDAR

# MALAYSIA



Universiti Teknologi Malaysia  
Kyoto University  
Okayama University  
Ritsumeikan University



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THE PLANNING OF URBAN ENERGY AND ENVIRONMENTAL SYSTEMS (GROUP VII)

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# Preface

This project is one of the research outcomes of Group 7 of Vice Chancellor Council- Japan Society Promotion Science (VCC-JSPS) The main universities involved in this collaboration work are Universiti Teknologi Malaysia and Kyoto University, Japan. Other partners involved in related research work from the same group are Toyohashi University of Technology and Ritsumeikan University, Okayama University.

We take this opportunity to thank the Johor State government, Iskandar Malaysia Development Authority and relevant local authorities for their support in providing relevant data and information for the modeling of the project.

In line with Malaysian government effort in supporting UNEP program to integrate climate change responses into the development processes, this research findings hope to contribute by modeling and facilitating a transition of ISKANDAR MALAYSIA, one of the fastest growing regions in Malaysia towards low carbon society.



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# Executive Summary

This report aims to show the possibility of developing Iskandar Malaysia (IM) into Low-Carbon Region. The methodology involves (i) develop the current inventory of GHG emissions of IM, and (ii) quantify socio-economic activity level in 2025 according to IM Comprehensive Development Plan 2025.

According to the proposed development, the amount of GHG emissions increase is estimated based on (1) 2025 BaU (Business as Usual—without mitigation measures) and (2) 2025 CM (With Counter Mitigation measures) assumptions of employed technologies as well as the potential to reduce the GHG emissions by low-carbon measures available by 2025. The Main findings are as follows.

1. Current annual greenhouse gas (GHG) emissions of IM are approximately 12.6 million t-CO<sub>2</sub>.
2. Under the scenario of Without mitigation measures, the GHG emissions will increase to 45.5 million t-CO<sub>2</sub>, or 3.6 times higher than 2005.
3. By adopting the mitigation options available by 2025, the emissions can be decreased approximately 60% and suppressed to 19.6 million t-CO<sub>2</sub>.

The current per capita emission for IM area is 9.3 t-CO<sub>2</sub> (2005). This current per capita emission in IM is greater than national average of Malaysia (5.0 t). In 2025 it will increase to 15.1 t-CO<sub>2</sub>/year and 6.5 t-CO<sub>2</sub>/year without and with countermeasures, respectively.

In order to mitigate the emission to lower level, several measures such as diffusion of low-carbon technologies, energy efficient buildings and increased use of public transport and renewable energy should be introduced.

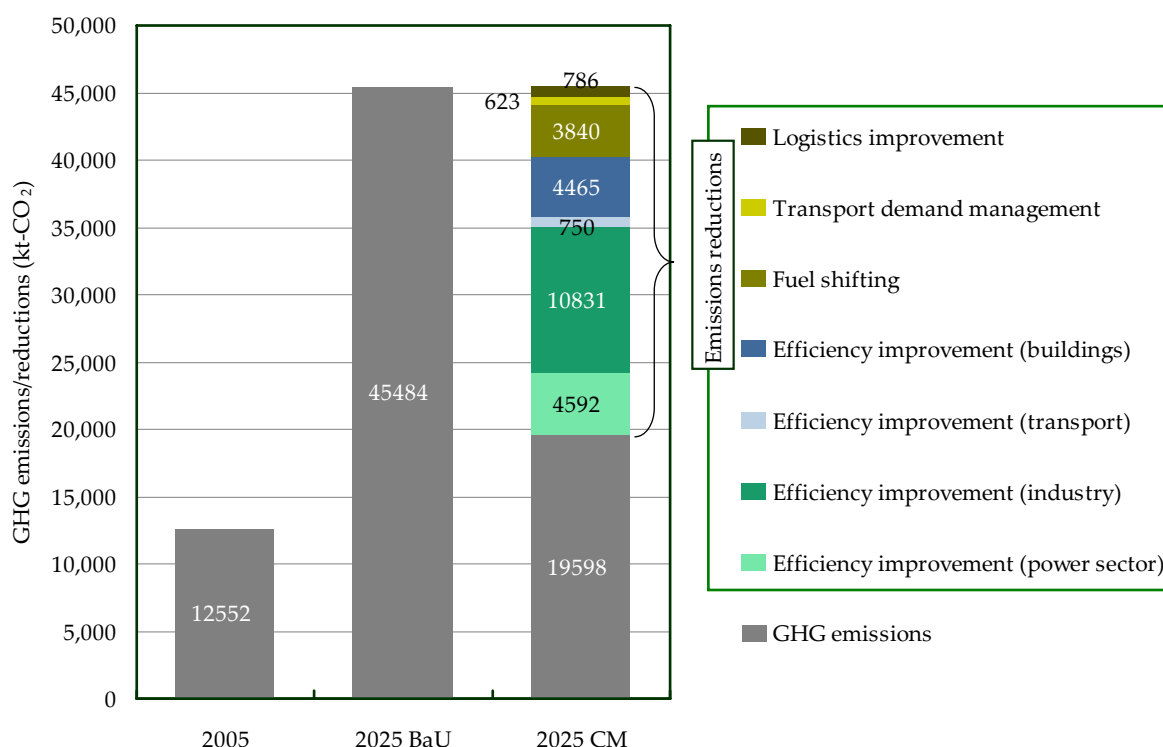


Figure 1. GHG emissions and mitigations by means. “efficiency improvement” means improvement of energy efficiency of energy using equipments or buildings.

A comprehensive policy to lead the implementation of the measures is also required. Figure 2 shows recommended policies and related mitigation options.

If those policies are planned from the early stage, IM will be able to develop not only as a premier growth centre but also as a model for Low-Carbon Region.

Table 1. Estimated socio-economic indicators in 2025 in IM.

	2005	2025	2025/2005
Population	1,353,202	3,005,815	2.2
No. of households	317,762	751,454	2.4
GDP (mil RM)	37,641	176,224	4.7
GDP per capita (RM/capita)	27,817	58,628	2.1
Gross output (mil RM)	121,431	474,129	3.9
Floor space for commercial (mil m <sup>2</sup> )	6.8	19.3	2.8
Passenger transport demand (mil p-km)	3,816	8,677	2.3
Freight transport demand (mil t-km)	1,652	5,204	3.1

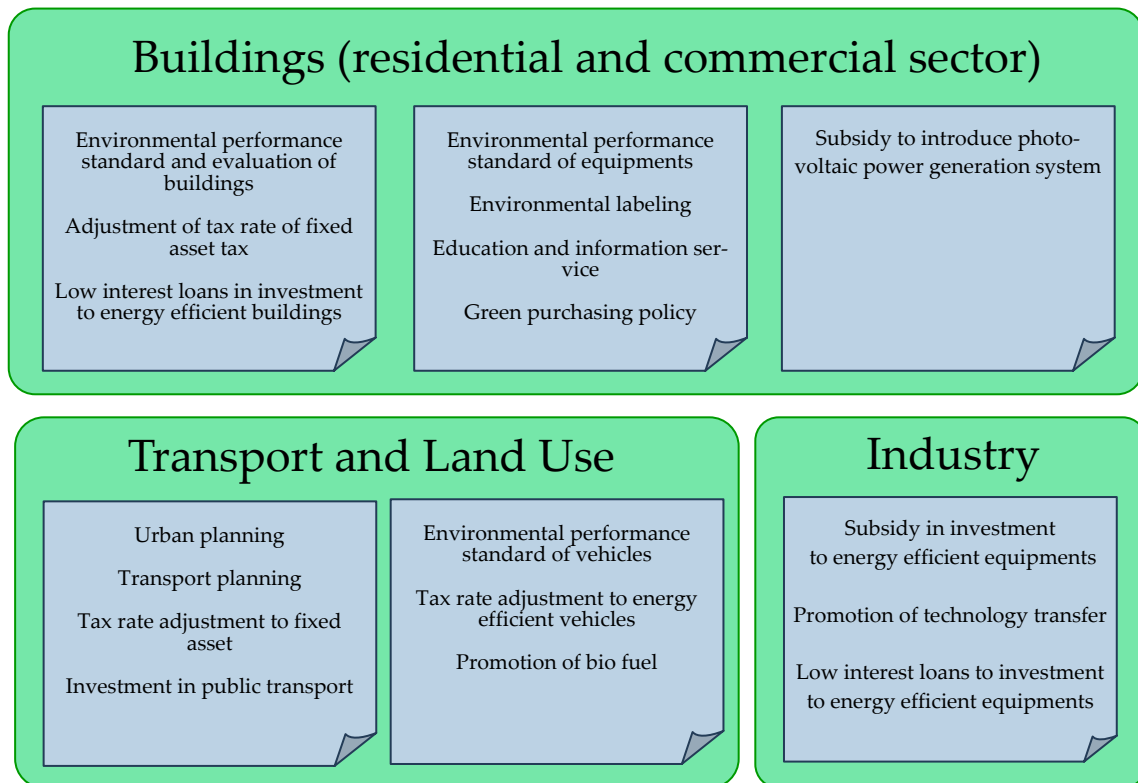


Figure 2. Policy package for Low-Carbon Region

# About Iskandar Malaysia

## Iskandar Malaysia

In order to plan for a low-carbon society (LCS) in Malaysia, it is more effective to look into the urban areas as they are engines of economic growth as well as main contributors to CO<sub>2</sub> emission. In the case of Malaysia, the natural resource management through spatial planning approach integrates environmentally sustainable development concepts. These strategies are incorporated into the National Physical Plan and then translated into structure plans. These plans also identify and manage environmentally sensitive areas (ESAs) including forest and green lung reserves. Major urban conurbations are identified and three economic growth areas are demarcated in Peninsular Malaysia as regions or sub-regions where it will develop to be globally competitive. The South Johor Economic Region (SJER), which commonly known as the Iskandar Malaysia (IM), is one of these economic growth centers to be developed as an integrated global node that encompasses Singapore and Indonesia (cf. Figure 1)

The Iskandar Malaysia covers an area of about 2,216.3 km<sup>2</sup>, about 3 times the size of Singapore and two times the size of Seoul Metropolitan Area. IM covers the entire district of Johor Bahru, and several sub-districts (mukim) of Pontian (cf. Figure 2). The Planning Area falls under the jurisdiction of five local planning authorities, namely Johor Bahru City Council, Johor Bahru Tengah Municipal Council, Pasir Gudang Local Authority, Kulai Municipal Council and Pontian District Council.

As shown in Figure 3, there are a total of five flagship zones proposed as key focal points for developments:

a) Flagship Zone A: Johor Bahru City Centre (new financial district, central business dis-



Figure 1: Iskandar Malaysia and the surrounding region – Singapore and Riau of Indonesia

trict, Danga Bay integrated waterfront city, Tebrau Plentong mixed development, causeway)

- b) Flagship Zone B: Nusajaya (Johor state administrative centre, medical hub, educity, international destination resort and southern industrial logistic cluster )
- c) Flagship Zone C: Western Gate Development (Port of Tanjung Pelepas (PTP), 2nd Link (Malaysia/Singapore), Free Trade Zone, RAMSAR World Heritage Park and Tanjung Piai)
- d) Flagship Zone D: Eastern Gate Development (Pasir Gudang Port and industrial zone, Tanjung Langsat Port and Technology Park and Kim-Kim regional distribution centre)
- e) Flagship Zone E: Senai-Skudai (Senai International Airport and Senai cargo hub)

Each of these flagships has a major urban centre. Among these urban centers are Johor Bahru City (financial district), proposed Nusajaya urban centre (new State administrative centre), Pasir Gudang/Tg. Langsat (port and industrial township) and Senai-Skudai/Kulai (transport and cargo hub). Four of the focal points will be located in the Nusajaya-Johor Bahru-Pasir Gudang

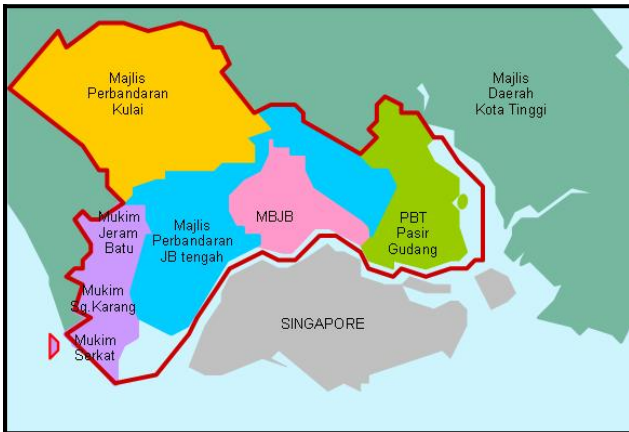


Figure 2: Local planning authorities in IM

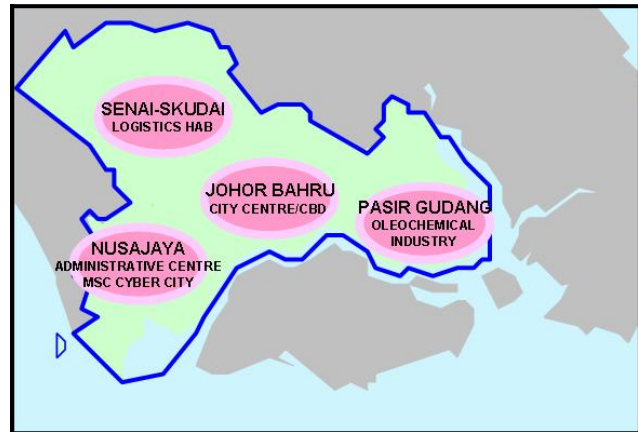


Figure 3: Flagship zones and compact cities development in IM

## Necessity of development as Low-Carbon Region for IM

Since Malaysia gained independence in 1957, concerted efforts have been taken by the government to improve the quality of life of the people. Mainly through commercial agricultural programs in the 1960 and 1970s; industrial development programs in the 1980 and 1990s and value added and ICT industrial development programs in the 2000s. Rapid urbanization and industrialization in the last few decades have contributed to the affluence lifestyle change in Malaysia. The rapid development tempo has contributed to marked increase in the demand for urban land use; sea, land and air transportation demand and other urban infrastructure and utility development to meet the demand for better quality of life of urban residents. These changes have direct impact on climate change in the form of environmental hazards and disasters which are evident in recent years with more frequent occurrences of flooding, landslides and forest fire in Malaysia.

The State of Johor is undergoing a rapid industrialization process and has huge investments in manufacturing and infrastructure development and hence has high demand for energy consumption. The rapid economic growth places a heavy demand and stress on resources means that a continued dependence on energy, in particular on fossil fuel is important to propel further growth. Although the Johor State has been blessed with relatively large tracts of natural tropical forests, (almost 60% of its total land area), some of the forest areas may be converted into agriculture and other urban use to generate job opportunities for the growing population. The pressure for more forested land and peat land to be converted into plantations is becoming more serious with escalating crude palm oil (CPO) prices and the hype over bio fuel, oil palm ventures. The fact remains that peat and forest are vital carbon sinks and that disturbed peat or forest will be a significant source of carbon emissions.

# Background

## What is a “Low Carbon Society” ?

In simple terms, a low-carbon society is a society that consumes sustainable and relatively low-carbon energy as compared with our present day practice to avoid adverse climate change. Hence conscious efforts need to be taken by community, industry, institution and government to change their behavior towards energy consumption and supply. The Society will adopt a lifestyle that make more use of alternative renewable energy, less dependence on fossil fuel and practice 3Rs (reduce, reuse and recycle) in their everyday life.

The working definition for policy research and action of a low-carbon society (National Institute for Environmental Studies, 2006) should have the following attributes:

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

In order for Malaysia, is fast developing nation to achieve LCS it would involve a holistic balance socio- economic and ecological conservation with the widely use of low-carbon technologies and changes to lifestyles and institutions.

## Principles for a Low-Carbon Society

Under the initiatives of the UK-Japan Low-Carbon Society movement and the recent Bali meeting in February 2008, the world needs to cooperate to make concerted efforts to establish a low-carbon society by “reducing global emissions by half from the current level by 2050.”

Under the principle of common but differentiated responsibility, developed nations will take the lead on climate change mitigation and developing countries will adopt the necessary technology and expertise to reduce the often inefficient and carbon intensive development path of the

pasts.

All countries, organizations, and entities have to take action based on the following philosophies.

### 1) Carbon Minimization In All Sectors

“A low-carbon society” in the ultimate sense would be a society that emits greenhouse gases only in an amount which can be absorbed by nature (Carbon Neutral Society). To achieve this goal, we have to have a social system where all sectors, such as industries, governments, and citizens, will naturally or automatically give special



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consideration to their selection and decisions in order to minimize carbon-dioxide emissions (carbon minimization).

## **2) Toward a simpler life style that realize richer quality of life**

People would need to forgo the mass-consumption society, mainly formed by developed countries, and build a new society in which value is placed on family or community ties, health, interactions with mother nature and the “Mottainai” spirit to improve the quality of life. This type of consumer choice would lead to a revolution in the social system, moving toward a low-carbon and rich society.

## **3 ) Coexistence with Nature**

We recognize human and its society as a part of the global ecosystem. In order to secure the CO<sub>2</sub> absorption essential for a low-carbon society and to adapt to the avoidable global warming, it is important to maintain and restore rich, diverse natural environments, such as forests. To achieve this symbiosis, local communities should place importance on harmony and coexistence with nature, and promote “nature-friendly technologies,” such as utilization of biomass.

## **Objectives of this study**

The objectives of this study are,

- a) To prepare a summary of a quantitative scenario study on the establishment of a sustainable low-carbon society in Iskandar Malaysia
- b) To create awareness among local authorities, the State government, stakeholders and the community urgent and decisive actions to be taken to realize a robust growth and low-carbon Malaysia.

# Socio-Economic Scenario in 2025

## Assumptions of the future society

In the urban and energy demand modeling on GHG emissions of Iskandar Malaysia in the year 2025, several quantitative assumptions have to be made (Table 4).

Table 4. Quantitative assumption in 2025

Average no. of people per household	4.00 per household
Labour participation ratio	[Male] 5-64: 90%, 65+: 30% [Female]15-64: 60%, 65+: 20%
Demographic composition	[Male] 0-14: 12.0%, 15-64: 33.9%, 65+: 4.5%
	[Female] 0-14: 11.6%, 15-64: 33.0%, 65+: 5.4%
Exports	Primary industry: approximately 1.0% p.a increase
	Secondary industry: approximately 6.5% p.a increase
	Tertiary industry: approximately 13.2% p.a increase
Labour productivity	113,808 RM per labour force from CDP
Private consumption	10% p.a increase
Government consumption	10% p.a increase
Fixed capital formation	155,172 mil RM per 5 years (2021-2025) from CDP
Modal share	[Railway]10%, [Bus]20%,
	[Motorcar]40%, [Motorcycle]15%,
	[Walk]10%, [Bicycle] 5%

## Scenario quantification

The future socio-economic indicators in 2025 based on the scenario description are estimated by using a macroeconomic model. The following are our estimated results about economy, establishments, and transport.

**Economy:** Modelling results based on a macroeconomic model shows that Gross Domestic Product (GDP) (real) of Iskandar Malaysia in 2025 is expected to be approximately RM 176 billion (4.7 times of the performance in 2005). An input-output analysis based on final demands in the macro economy is used to estimate the future industrial structure in IM. The findings showed the share of the primary industry will decrease from 3% (2005) to 2% (2025). In addition, the

share of the secondary industry will decrease from 51% (2005) to 33% (2025). On the other hand, the share of the tertiary industry will increase from 46% (2005) to 65% (2025). Labour participation ratio of productive-age women will increase from 46 % (2005) to 60 % (2025), and the ratio of aged population will increase by 5 % from 2005 to 2025.

**Establishments:** Number of households in IM will increase from 318 thousand (2005) to 751 thousand (2025), and average household size IM will decrease from 4.26 (2005) to 4.00 (2025). The total floor space of commercial buildings in IM will increase from 6.8 million square meters (2005) to 19.3 million square meters (2025).

**Transport:** Passenger transport demand in IM will increase from 3.8 billion passenger-kilometres (2005) to 7.8 billion passenger-kilometres (2025). On the other hand, freight

transport demand in IM will increase from 1.7 billion tonne-kilometres (2005) to 5.3 billion tonne-kilometres (2025).

Table 5. Estimation result of scenario quantification in 2025, IM

	2005	2025	2025/2005
Population	1,353,200	3,005,815	2.2
No. of households	317,762	751,454	2.4
GDP (mil RM)	37,641	176,224	4.7
GDP per capita (RM/capita)	27,817	58,628	2.1
Gross output (mil RM)	121,431	474,129	3.9
Primary industry (mil RM)	1,860	5,375	2.9
Secondary industry (mil RM)	83,502	263,444	3.2
Tertiary industry (mil RM)	36,069	205,309	5.7
Floor space for commercial (mil m <sup>2</sup> )	6.8	19.3	2.8
Offices	1.3	1.7	2.9
Shops	5.7	16.3	2.9
Hospitals & Schools	0.6	1.2	2.1
Passenger transport demand (mil p-km)	3,816	8,677	2.3
Freight transport demand (mil t-km)	1,652	5,303	3.1

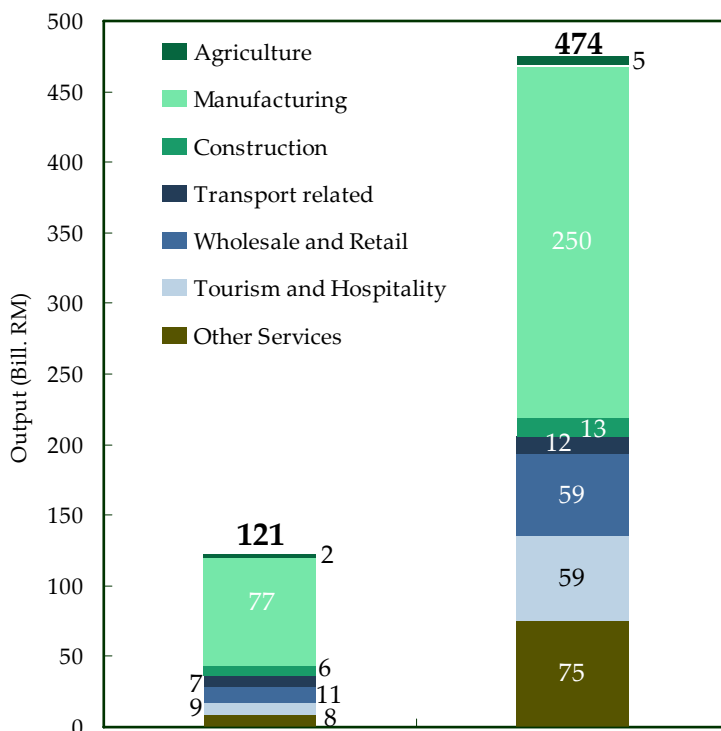


Figure 5. Output by industry

# GHG Emissions in 2025

## Energy demand and GHG emissions of IM

The macro-economic model is used to estimate future energy demand and GHG emissions for the year 2025 based on the scenario quantification. The estimated results about energy demand and GHG emissions are shown in Figure 6, Figure 7 and Figure 8.

Energy demand in IM is projected to increase from 3.3 million toe (toe: tonne oil equivalent) in 2005 to 10.9 million toe in 2025 for the BaU case (BaU: business as usual). Energy demand of in-

dustry is expected to be 6.6 million toe and will maintain the largest share of 61%, followed by transport (2.2 million toe; 20%), and residential and commercial (2.1 million toe; 19%) in 2025.

Energy demand by energy sources (Figure 7) showed that In 2025, there will be a total of 5.0 million toe (toe: tonne oil equivalent) of petroleum consumed in the BaU scenario. In addition, there will be also a marked increase in demand for natural gas i.e. 3.9 million toe or 3.2 times the

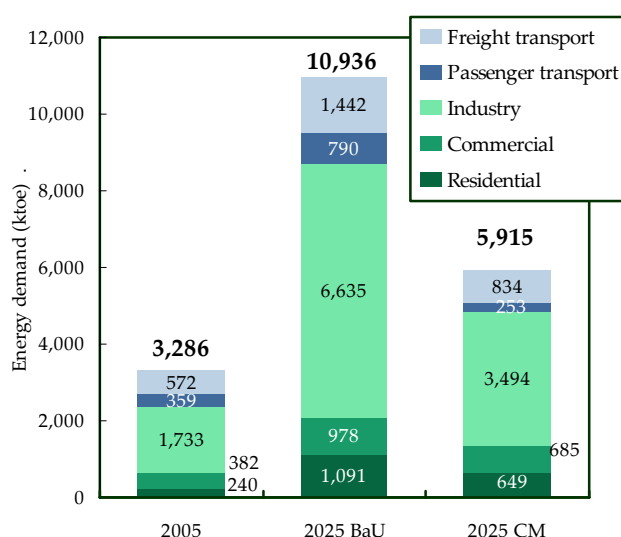


Figure 6. Final energy demand by sector

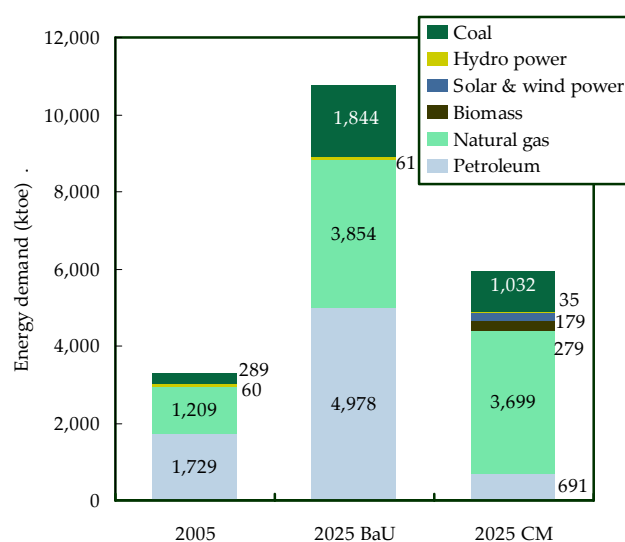


Figure 7. Energy demand by primary energy

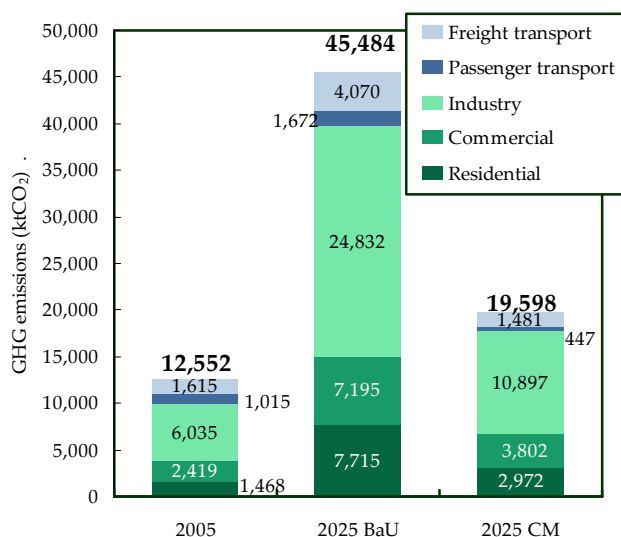


Figure 8. GHG emissions by sector

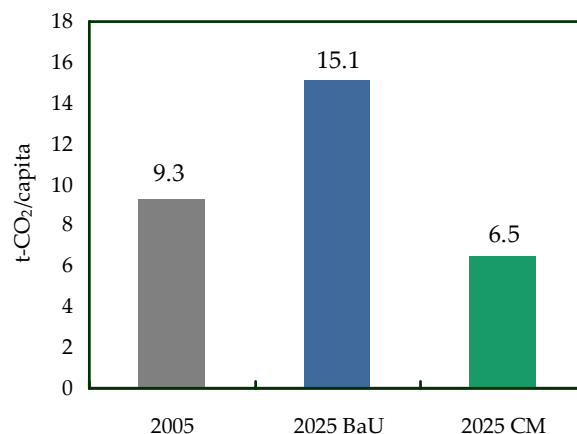


Figure 9. Per capita GHG emissions

consumption in 2005. On the other hand, biomass, solar power, and wind power will be newly introduced for primary energy in 2025 CM case (CM: countermeasure). The share of renewable energy is expected to be 8% of the total energy demand.

Based on the energy demand by source, the GHG emissions in IM are projected to increase from 12.6 million tonnes of CO<sub>2</sub> in 2005 to 45.5 million tonnes of CO<sub>2</sub> under the BaU scenario. The modelling results also showed GHG emis-

sions from industry will be about 4.1 times the total as compared with year 2005 and the share will be around 54% of the total GHG emissions. GHG emissions from passenger transport are also found to be about 1.6 times the amount in 2005 and the share will be 4% of the total GHG emissions. GHG emissions per capita will increase from 9.3 tonnes of CO<sub>2</sub> per capita in 2005 to 15.1 tonnes of CO<sub>2</sub> per capita in 2025 BaU scenario.

Table 6. Final energy demand by sector (unit: ktoe) : 2030BaU is a modeling result without any measures to improve energy efficiency or CO<sub>2</sub> intensity. In 2030CM, higher energy efficiency and fuel shift to less CO<sub>2</sub> intensive fuel is assumed. Detailed energy demand and supply table is shown in page 28 to 30.

	Coal	Petroleum	Natural gas	Biomass	Solar & Wind	Electricity	Total
<b>2005</b>							
Residential	0	47	0	0	0	193	240
Commercial	0	53	2	0	0	328	382
Industry	50	679	623	0	0	381	1,733
Passenger Transport	0	357	2	0	0	0	359
Freight Transport	0	568	4	0	0	0	572
<b>Total</b>	<b>50</b>	<b>1,704</b>	<b>632</b>	<b>0</b>	<b>0</b>	<b>901</b>	<b>3,286</b>
<b>Share</b>	<b>2%</b>	<b>52%</b>	<b>19%</b>	<b>0%</b>	<b>0%</b>	<b>27%</b>	<b>100%</b>
<b>2030BaU</b>							
Residential	0	213	1	0	0	877	1,091
Commercial	0	135	4	0	0	839	978
Industry	228	2,594	2,367	0	0	1,446	6,635
Passenger Transport	0	585	4	200	0	1	790
Freight Transport	0	1,432	10	0	0	0	1,442
<b>Total</b>	<b>228</b>	<b>4,960</b>	<b>2,386</b>	<b>200</b>	<b>0</b>	<b>3,163</b>	<b>10,936</b>
<b>Share</b>	<b>2%</b>	<b>45%</b>	<b>22%</b>	<b>2%</b>	<b>0%</b>	<b>29%</b>	<b>100%</b>
<b>2030CM</b>							
Residential	0	16	52	0	130	452	649
Commercial	0	18	25	0	49	592	685
Industry	100	346	2,275	0	0	774	3,494
Passenger Transport	0	70	116	65	0	2	253
Freight Transport	0	230	384	213	0	6	834
<b>Total</b>	<b>100</b>	<b>680</b>	<b>2,852</b>	<b>279</b>	<b>179</b>	<b>1,825</b>	<b>5,915</b>
<b>Share</b>	<b>2%</b>	<b>11%</b>	<b>48%</b>	<b>5%</b>	<b>3%</b>	<b>31%</b>	<b>100%</b>

## Mitigation potential of IM in 2025

The model results estimated that total GHG emissions in IM is to be reduced from 45.5 million tonnes CO<sub>2</sub> in the BaU case to 19.6 million tonnes CO<sub>2</sub> in the CM case by adoption of countermeasures for mitigating GHG emissions in 2025. Based on the model simulation, the reductions of GHG emissions by types of countermeasures contributed by several measures.

Among the measures, efficiency improvement for industry accounts for the largest proportion, 43.2% of the total reductions, followed by efficiency improvement for efficiency improvement for power sector (18.3%), efficiency improvement

for buildings (17.8%), fuel shifting (15.3%), logistics improvement (3.1%), energy efficiency for transport (3.0%) and transport demand management (2.5%).

Among the categories of countermeasures, local governments should take effective measures in transport demand management, and penetration of renewable energy. In order to realize a low carbon society, IM has to have new and bold policies to encourage and promote businesses and citizens to take these countermeasures.

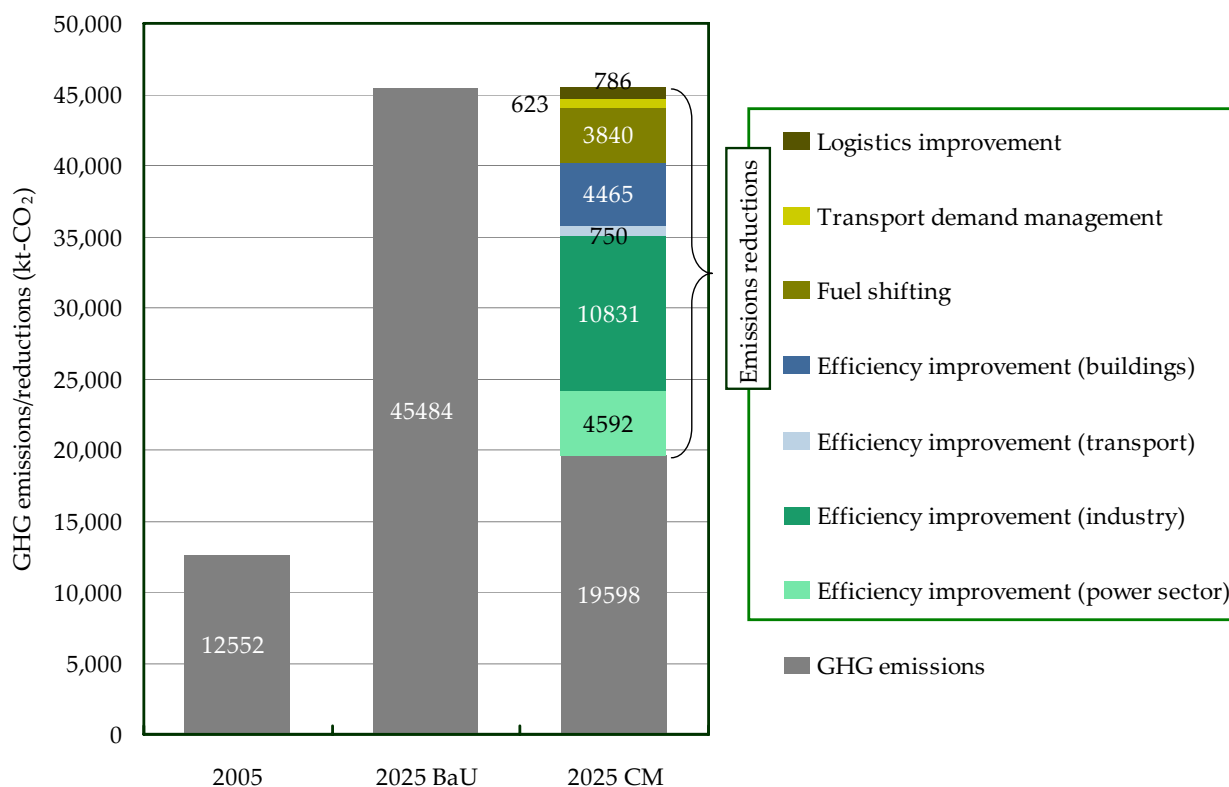


Figure 10. Breakdown of emissions reduction potential

# Environmental & Energy Policies in Malaysia (1)

## Climate Change Policy in Malaysia

The Climate Change policy in Malaysia has been in the pipe line of being constructed for a long period of time now. Datuk Douglas Uggah Embas, the Minister of Natural Resources and Environment Malaysia, said that this is because Malaysia wants to ensure a broad-based support, during the United Nations (UN) climate summit in Poland in December 2008. The Climate Change Performance Index, a report issued annually by German Watch and Climate Action Network Europe, ranked Malaysia in the bottom 10 of the list. It was in the company of big greenhouse gas polluters like the United States, Australia, Canada and Saudi Arabia. Malaysia a developing nation should take more initiative towards making changes to lessen the effects of climate change.

## Energy and Environment

Energy and the environment are interrelated issues and it must be addressed together. They are fast becoming the focus of widespread attention as a global priority issues. It is increasingly important for the public to control their usage of energy resources from the perspective of environmental preservation and to increase their efficiency of energy consumption. Energy production and consumption, however, puts undeniable pressure on the environment, which leads towards the alarming issue of Climate Change.

## Principal Energy Objectives

National energy policies ensure that adequate and available supplies are reasonably priced to support national economic development objectives. These measures place a priority on oil and gas resources serving the needs of the nation, while taking into account the need for conservation and environmental protection.

Guiding these policies are three principal energy objectives that are instrumental for future energy sector development:

- **The Supply Objective:** To ensure the provision of adequate, secure, and cost-effective energy supplies through developing indigenous energy re-

sources both non-renewable and renewable energy resources using the least cost options and diversification of supply sources both from within and outside the country;

- **The Utilization Objective:** To promote the efficient utilization of energy and to discourage wasteful and non-productive patterns of energy consumption; and
- **The Environmental Objective:** To minimize the negative impacts of energy production, transportation, conversion, utilization and consumption on the environment.

Government strategies at achieving national energy objectives include the following:

- **Secure supply** - Diversification of fuel type and sources, technology, maximize use of indigenous energy resources, adequate reserve capacity to cater for contingencies [adequate reserve margin for generation, upgrading transmission and distribution networks and distributed generation (islanding);
- **Sufficient supply** - Forecast demand, right energy pricing and formulate plans to meet demand.
- **Efficient supply** - Promote competition in the electricity supply industry.
- **Cost-effective supply** - Promote competition and provide indicative supply plan to meet demand based on least cost approach using power computer software such as WASP;
- **Sustainable supply** - Promote the development of renewable and co-generation as much as possible.
- **Quality supply** (low harmonics, no surges and spikes, minimal variation in voltage) - Match quality with customer demand with variable tariffs;
- **Efficient utilization of energy** - Bench marking, auditing, financial and fiscal incentives, technology development, promotion of ESCOs, Labelling, Ratings, correct pricing, energy managers; and
- **Minimizing Negative Environmental Impacts** - Monitor the impacts, improve efficiency of utilization and conversion and promote renewable.

( Continue to page 21)

# Buildings (residential & commercial sector)

## Residential sector

According to the South Johor Economic Region Comprehensive Development Plan 2006-2025, population of the region in 2005 is 3 million. Since energy demand of residential sector is thought to be determined based on number of household rather than population, we assumed average occupants of a household in 2025 by using the assumptions of household size in 2025 (four members per household), then the number of households will increase to 751,454 in 2025 from 317,762 in 2005. In the BaU case, energy consumption increases to 1,091 ktoe and GHG emissions 7,715 kt-CO<sub>2</sub>, 4.5 times and 5.3 times greater than 2005, respectively. The emissions

can be mitigated in the CM case, 4,743 kt-CO<sub>2</sub> or 61% lower than BaU case. The largest mitigation potential is found in efficiency improvement (buildings) (54%).

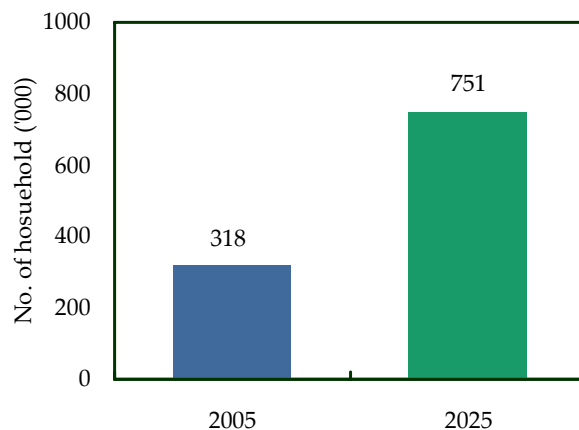


Figure 11. Number of households

## Commercial sector

Energy demand of commercial sector is estimated based on the floor space of the buildings. Driven by growth of tertiary industry, in 2025, it will increase 2.8 times greater than 2005. In the BaU case, energy consumption increases to 978 ktoe and GHG emissions 7,195 kt-CO<sub>2</sub>, 2.6 times and 3.0 times greater than 2005, respectively. The emissions can be mitigated in the CM case, 3,802 kt-CO<sub>2</sub> or 47% lower than BaU case. The largest mitigation potential is found in efficiency improvement (buildings) (56%).

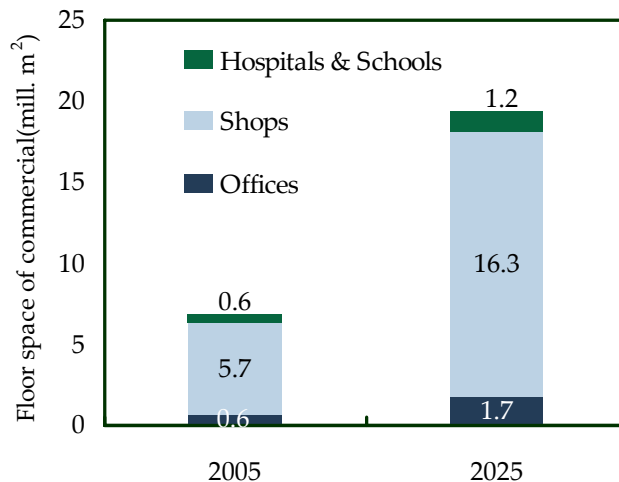


Figure 12. Floor space of commercial

## Policy promoting mitigation measures of buildings and construction

In order to promote mitigation measures of the building and construction sector, required policies related to building design, energy efficient equipment and use of renewable energy should be explored. Figure 14 shows the example of the policies; performance standard or guidelines of buildings, tax rate adjustment, subsidy,

labeling and green purchasing policy of the government itself. In addition, it is equally important for financial and funding companies to have the corporate social responsibilities to promote investments that bring about energy efficiency improvement and promote the use of renewable energy.



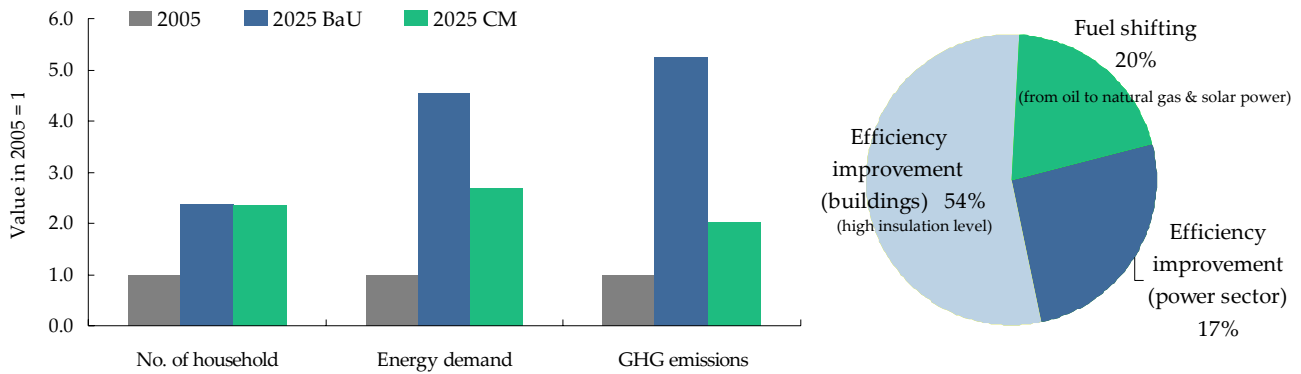


Figure 13. Changes from base year (left) and breakdown of emission mitigation by means (right) in residential sector

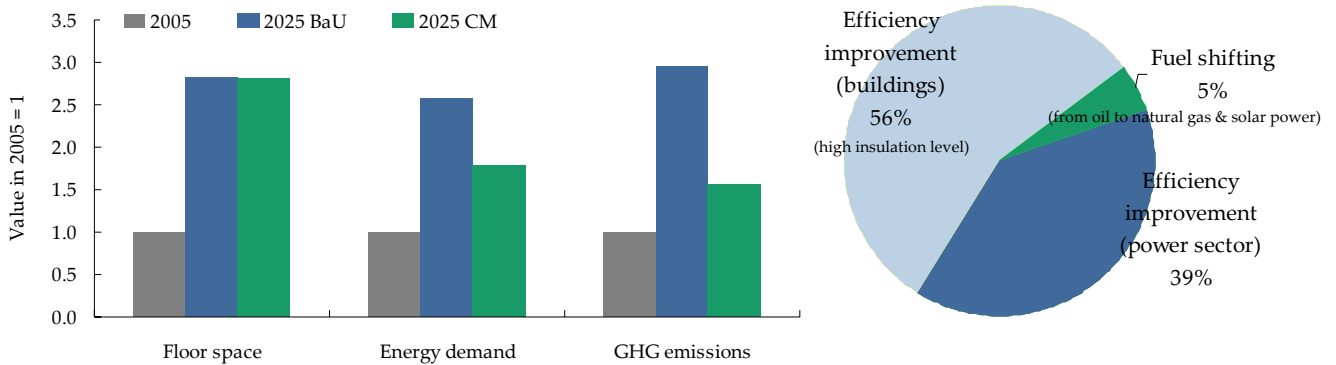


Figure 14. Changes from base year (left) and breakdown of emission mitigation by means (right) in commercial sector

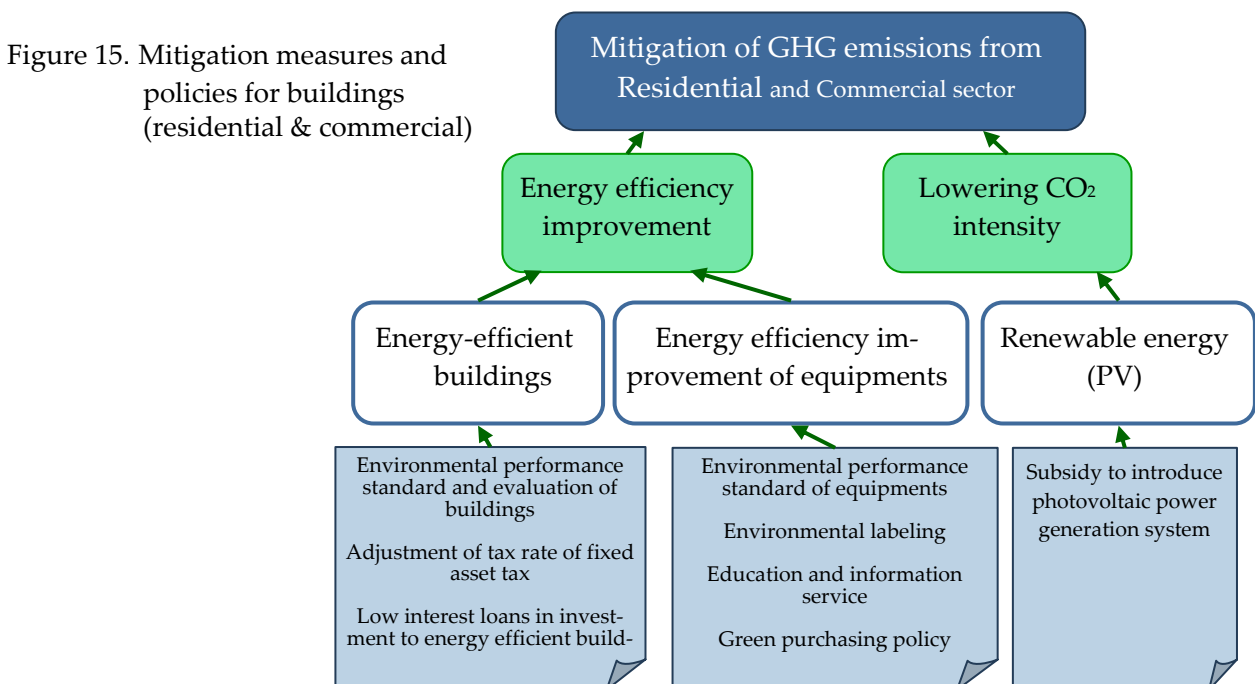


Figure 15. Mitigation measures and policies for buildings (residential & commercial)

# Transport (passenger & freight)

## Passenger transport sector

In 2025, passenger transport demand will increase to 8,677 passenger-km or 2.3 times greater than 2005 due to population growth. Currently, other than non motorist transport such as walk or bicycle, motorized vehicle is the main mode of mobility. If modal share does not change, energy demand and GHG emissions of this sector will increase to 790 ktoe and 1,672kt-CO<sub>2</sub> in 2025, respectively. However in the countermeasure case, energy efficiency improvement of the vehicles can mitigate the emissions at around 13% and transport demand management (compact urban structure and using public transport, which are shown in the Comprehensive Development Plan 2005-2025), can have savings of 51%.

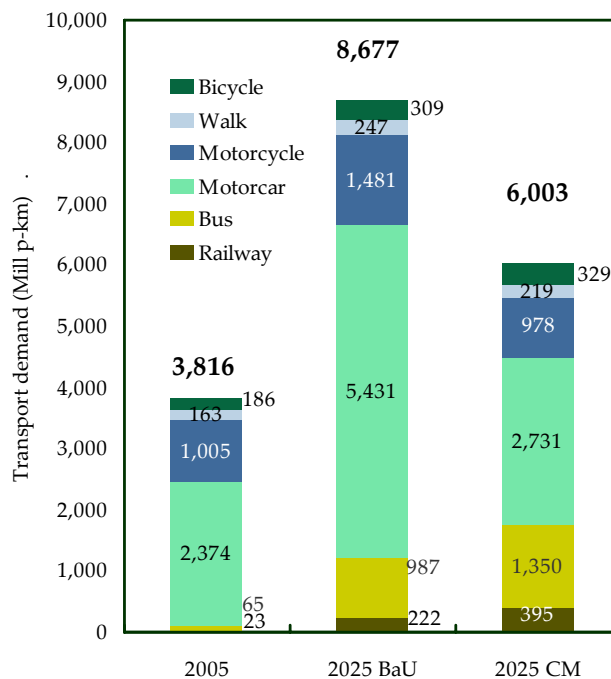


Figure 16. Passenger transport demand

## Freight transport sector

Due to the growth of output of the manufacturing industries, freight transport demand will increase to 5,204 tonne-km or 3.2 times greater than 2005. Without mitigation measures, energy demand will increase proportionally, and so GHG emissions. Energy efficiency improvement of the vehicles and shifting fuel to biomass/biofuel can mitigate the emissions at around 69%.

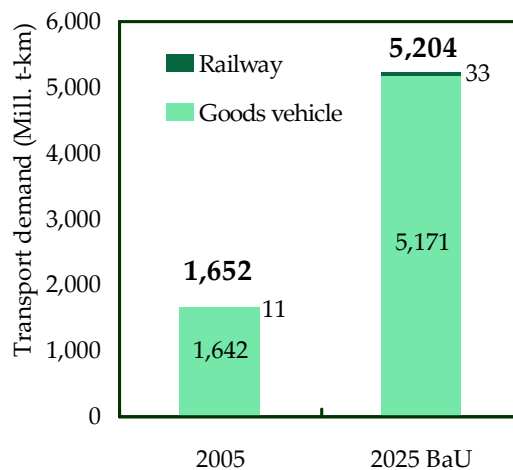


Figure 17. Freight transport demand

## Policy promoting mitigation measures of transport sector

One important aspect of the emission mitigation of this sector is transport demand management, including land use policy and investment to public transport. However those are already shown in the CDP, those policies should be as-

sessed also from the view point of low carbon city. Energy efficiency improvement of vehicles and diffusion of biomass fuel will need incentives such as tax or subsidy.

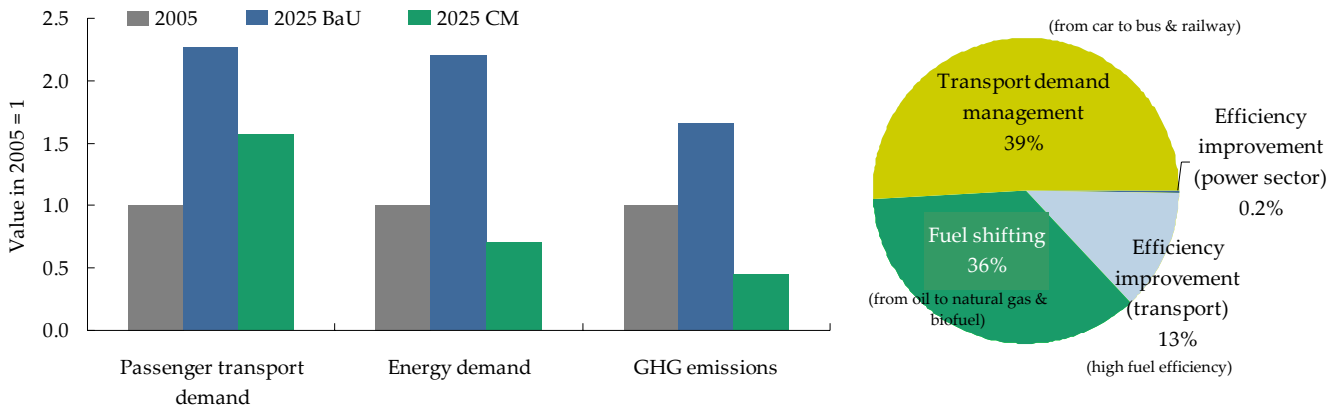


Figure 18. Changes from base year (left) and breakdown of emission mitigation amount by means (right, kt-

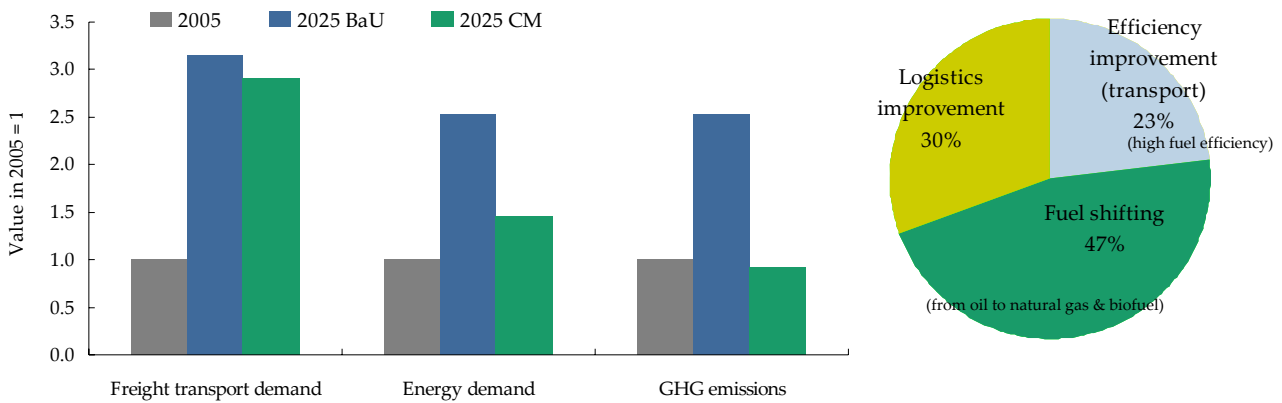
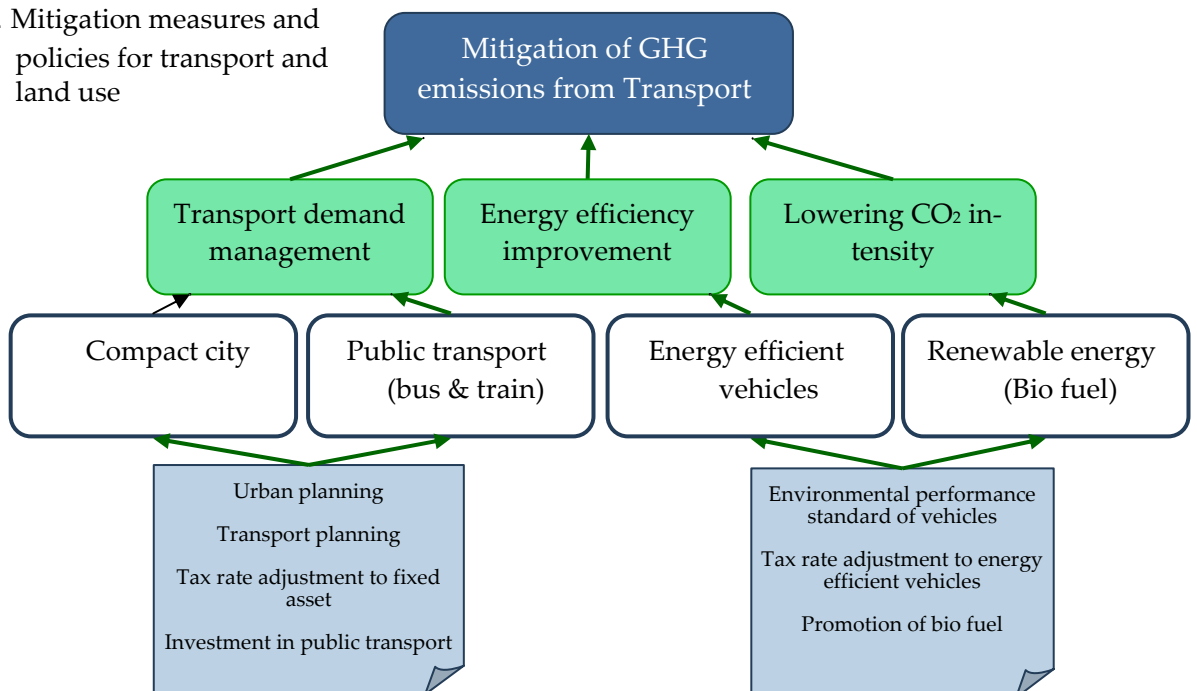


Figure 19. Changes from base year (left) and breakdown of emission mitigation amount by means (right, kt-CO<sub>2</sub>) in freight transport sector

Figure 20. Mitigation measures and policies for transport and land use



# Industry & Power sector

## Growth of industries and a policy set to induce measures

In this report, "Industry sector" as an energy consuming sector means primary and secondary industries. Assuming GDP increase of 8.0% per year, which is shown in the CDP, output of those industries will increase to RM 474,129 million or 3.9 times greater than 2005 in 2025. Without energy efficiency improvement (BaU case), energy demand and GHG emissions will increase to 2.0 times and 1.8 times from 2005, respectively. In the CM case, energy efficiency improvement of this sector can reduce the emissions 10,831 kt-

CO<sub>2</sub>. Including mitigation effects of fuel shifting and efficiency improvement of power sector, the reduced GHG emissions add up to 3,104 kt-CO<sub>2</sub> or 13% of BaU case emissions.

To promote mitigation measures of industries, incentive to investment in energy efficiency improvement is essentially important. Tax, subsidy and low interest loans will be central policies for this sector. Promotion of technology transfer from abroad is also effective.

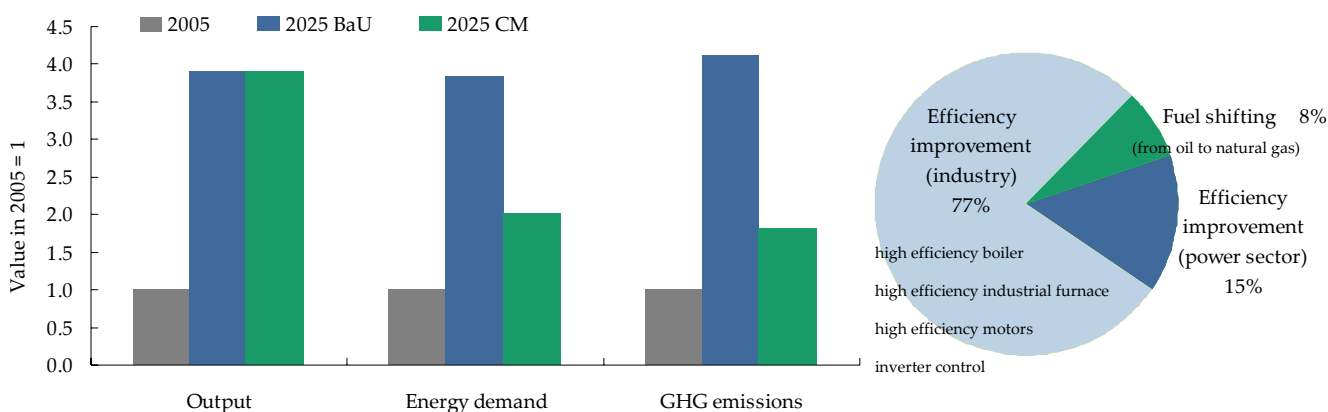


Figure 22. Changes from base year (left) and breakdown of emission mitigation amount by means

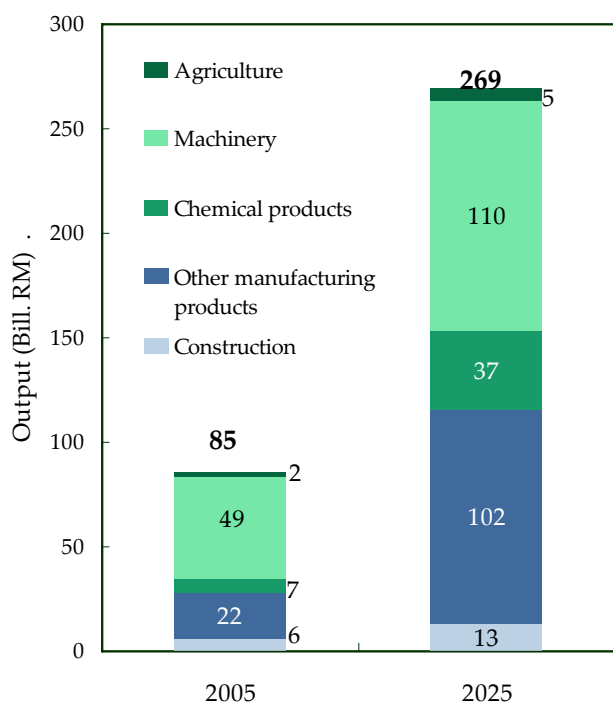


Figure 21. Output by industry

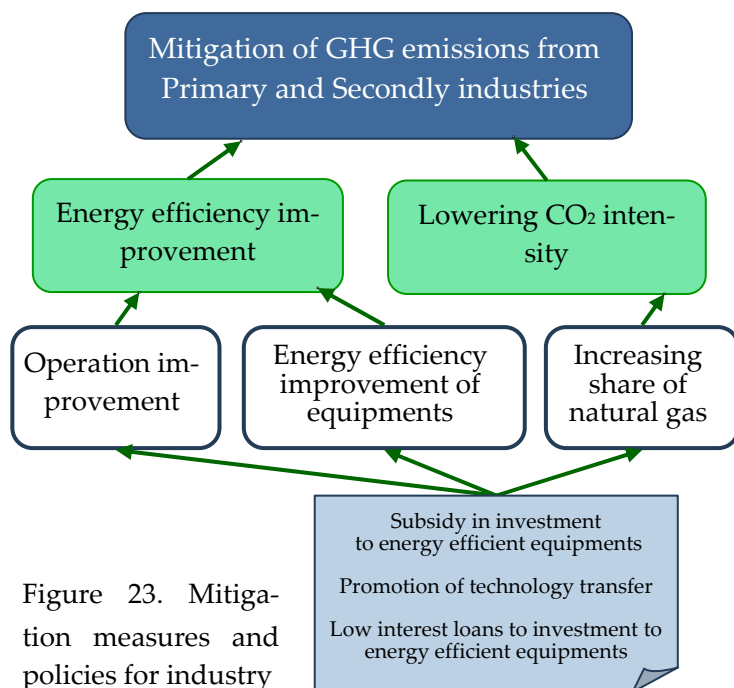


Figure 23. Mitigation measures and policies for industry

## Power generation and renewable energy

In this report, mitigation amount due to efficiency improvement of power generation has been computed in sectors consuming electricity. Sum of those are 4,592 kt-CO<sub>2</sub>, or 18.3% of the whole mitigation potential. However power generation is a state-level strategy rather than city-level energy policy, it cannot be ignored also from the view point of the low carbon city. If GHG emissions from the power sector per elec-

tricity generation is lower, burden of mitigation measures of a region can also be lowered. This time we assumed only fuel efficiency improvement. Using fuel with less CO<sub>2</sub> emissions or carbon capture and storage are other options, for example.

Promotion of technology transfer  
Promotion of investment to improve energy efficiency

## Environmental & Energy Policies in Malaysia (2)

(Continue from page 15)

The key policies guiding energy-related activities in Malaysia are:

- **Petroleum Development Act 1974** – Established Petronas as the national oil company and vested it with the responsibility for exploration, development, refining, processing, manufacturing, marketing and distribution of petroleum products.
- **National Energy Policy 1979** – Set the overall energy policy with broad guidelines on long-term energy objectives and strategies to ensure efficient, secure and environmentally sustainable supplies of energy.
- **National Depletion Policy 1980** – Introduced to safeguard the exploitation of natural oil reserves because of the rapid increase in the production of crude oil.
- **Four Fuel Diversification Policy 1981** – Designed to prevent over-dependence on oil as the main energy resource, its aim was to ensure reliability and security of the energy supply by focusing on four primary energy resources: oil, gas, hydro-power and coal.
- **Fifth Fuel Policy (Eighth Malaysia Plan 2001-2005)** – In the Eighth Malaysian Plan, Renewable Energy was announced as the fifth fuel in the energy supply mix. Renewable Energy is being tar-

geted to be a significant contributor to the country's total electricity supply. With this objective in mind, greater efforts are being undertaken to encourage the utilization of renewable resources, such as biomass, biogas, solar and mini-hydro, for energy generation.

- **Energy Efficiency and Renewable Energy (Ninth Malaysia Plan 2006-2010)** - The Ninth Plan strengthens the initiatives for energy efficiency and renewable energy put forth in the Eighth Malaysia Plan that focused on better utilization of energy resources. An emphasis to further reduce the dependency on petroleum provides for more efforts to integrate alternative fuels.

The implementation of energy efficiency measures can lead to a reduction of Malaysia's current GHG emissions. Thus, the potential viability of energy efficiency and renewable energy needs to be seriously looked into as a way of achieving cost, energy and environmental savings for the nation.

### Reference

ENERGY EFFICIENCY POLICY, PROGRAMS AND INDICATORS IN MALAYSIA, Energy Efficiency Indicator Workshop Moscow 12-15 Sep 05  
Malaysia To Address Climate Adaptation Measures Sep 06, 2007, UNDP Malaysia  
Pusat Tenaga Malaysia, <http://www.ptm.org.my/>

# Policy package for Low-Carbon

## A policy package towards low-carbon Iskandar Malaysia

Comprehensive policy, plan or action is necessary to realize Low-Carbon Region. Figure 24 shows the policies aforementioned in the mitigation measures of each sector. It takes decades to create a low-carbon city because energy consumption has strong inertia and it is needed to construct infrastructure and renew the stock to

change the current status. Therefore, it is important to consider creating Low-Carbon Region in the goals of development at earlier stage. Hence it is imperative to set a GHG emissions target as one of the goals of Iskandar Malaysia development.

## Needs for further research

In this preliminary report, simple modeling method is adopted due to the constraints of data and information availability. Based on this report, more concrete and detail research to investigate strategy to realize Low-Carbon Region on IM is desired.

Pertinent research information required for more sophisticated modeling work includes; more detailed and disaggregated information

especially energy consumption from transport demand, availability of renewable energy resources in Iskandar Malaysia and the Johor State and GHG emissions from land use and land use change. With this information, it will be possible to show more valid estimation of GHG emissions and reductions, which enables the assessment of each mitigation measures and priority of the policies being carried out.



# Region

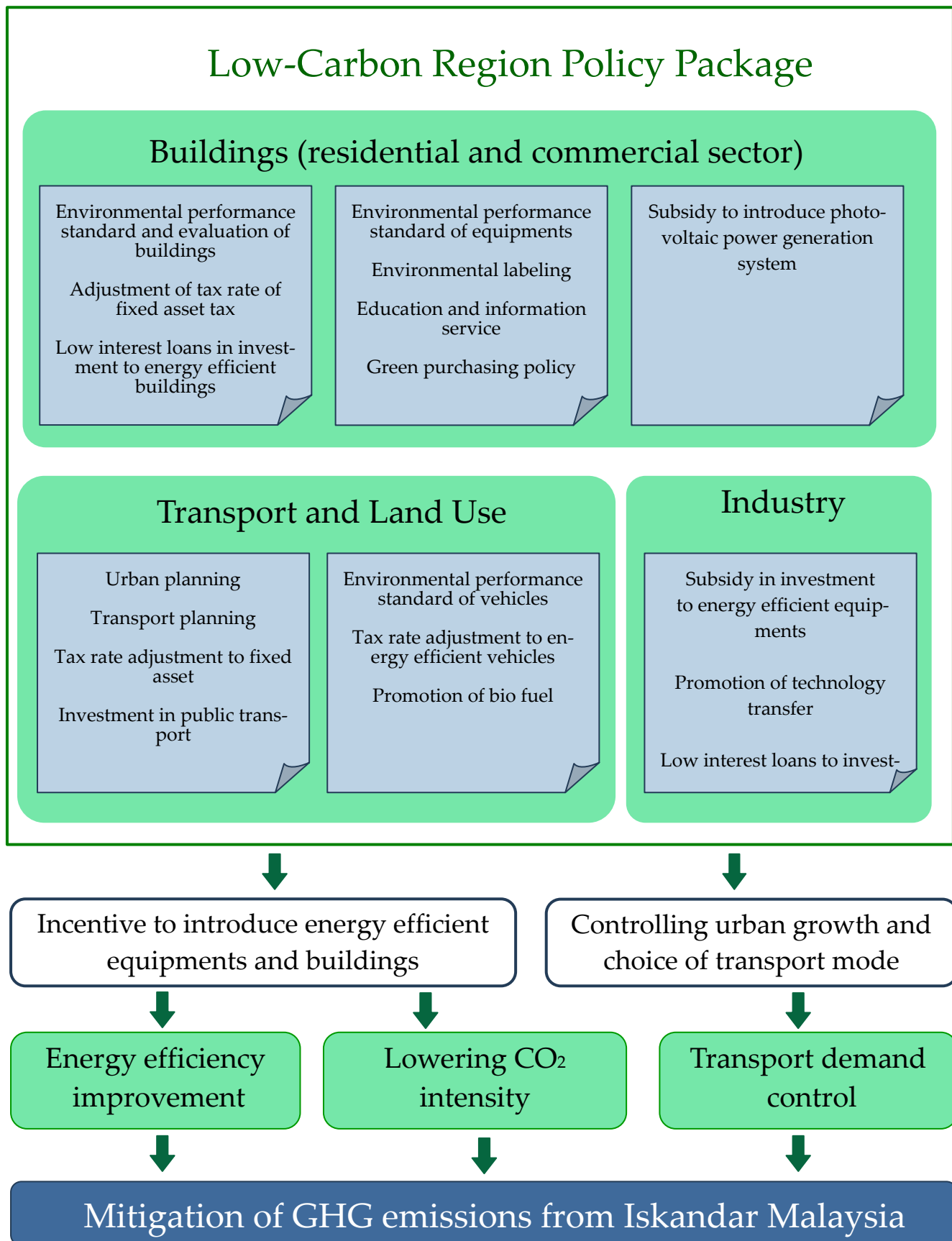


Figure 24. Policy package for Low-Carbon Region

# Methodology

## A Procedure to create a local LCS scenario

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 25 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 IM, 2025. This is also a suitable time span for a LCS study for the reasons above. As an environmental target, we targeted CO<sub>2</sub> from energy use because it will be a main source of GHG emissions from IM in 2025.

### (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. We could use the assumptions showed in the CDP.

### (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 in the Shiga prefecture, Japan because of information availability and similarity of industrial structure and population size of Shiga and IM region.

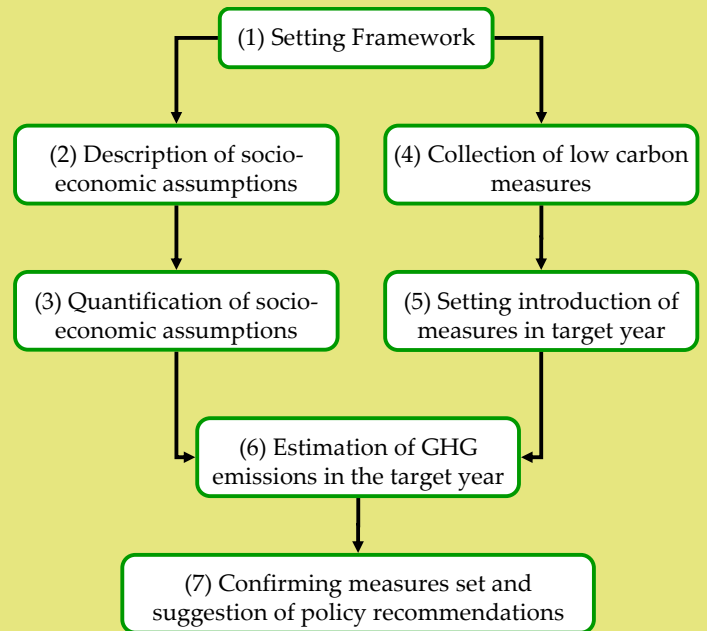


Figure 25. Procedure to create a local LCS scenario

### (5) Setting introduction of counter measures

Technological parameters related to energy demand and CO<sub>2</sub> 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 municipality or the country which it belongs. 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 26 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<sub>2</sub> 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 with “export-base approach” is combined in line with the theory of regional economics.

Industries producing export goods are called "basic industry". Production of basic industries induces other industries i.e. non-basic industries, through demand

of intermediate input and consumption of their employees. Number of workers must fulfill labor demand of those productions. Given assumptions of where those workers live and labor participation ratio, population living in the region is computed. This model enables us to consider viewpoints of regional economic development to estimate energy demand and CO<sub>2</sub> emissions. 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.

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.

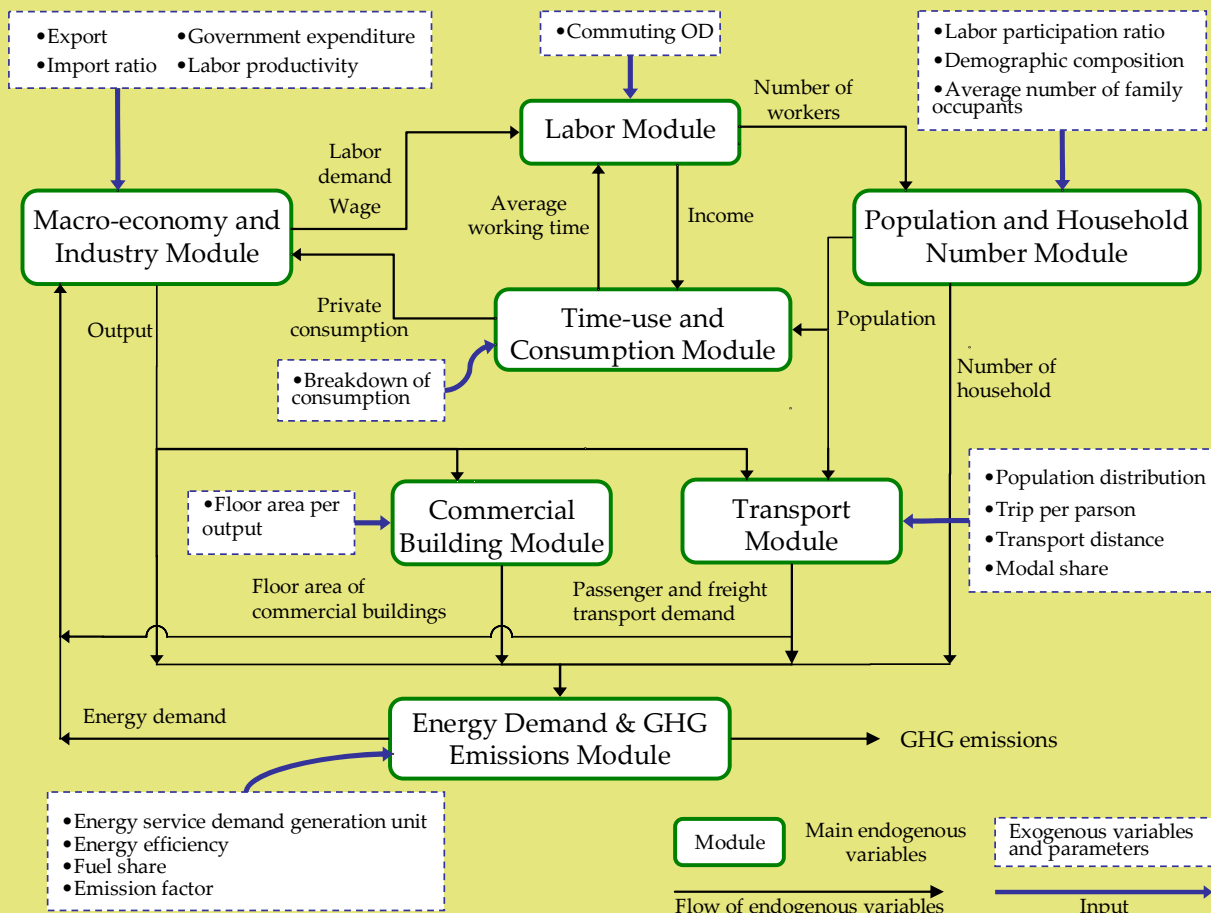


Figure 26. Overview of calculation system of Extended Snapshot Tool

# Collection and estimation of information

The estimated results of the future socio-economic indicators and energy demand in 2025 are based on the modelling of the socio-economic variables and energy balance table in 2025. Most of the socio-economic indicators and energy balance table on Iskandar Malaysia are obtained from published statis-

tics and secondary sources. Assumptions are used where information for macroeconomic analysis is not available for the Iskandar Malaysia region.

The followings are the procedures for estimating socio-economic indicators and energy balance table (final demand sector).

SECTOR	PROCEDURE TO MAKE IM ENERGY BALANCE TABLE	REFERENCES
<b>Energy Supply Sector</b>		
Indigenous Production Imports Exports Error term		Ministry of Energy, Water and Communications, Malaysia: National Energy Balance 2005 Malaysia
<b>Energy Demand Sector</b>		
<b>Transformation Sector</b>		
Utility generation Refineries Losses & own use Statistical Discrepancy		Ministry of Energy, Water and Communications, Malaysia: National Energy Balance 2005 Malaysia
<b>Industry Sector</b>		
Agriculture Mining Food Products and Beverages Chemicals and Chemical Products Electric and Electronic Products and Machinery Fabricated Metal Products and Machinery Other Non-Metallic Rubber and Plastics Products Construction	Energy consumption for each industry in IM = Energy consumption for each industry in Malaysia * Value of gross output for each sector in IM / Value of gross output for each sector in Malaysia	Ministry of Energy, Water and Communications, Malaysia: National Energy Balance 2005 Malaysia, Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
<b>Residential &amp; Commercial Sector</b>		
Residential Sector	Energy consumption for residential sector in IM = Average energy consumption per household in IM * No. of households in IM	Ministry of Energy, Water and Communications, Malaysia(2005): National Energy Balance 2005 Malaysia, IDR Master Plan(2005), Dept. of Statistics, Malaysia(2006): State/District Data Bank 2006
Commercial Sector	Energy consumption for commercial sector in IM (excl. electricity) = Energy consumption for commercial sector in Malaysia * No. of employed people for services in IM / No. of employed people for services in Malaysia Energy consumption for commercial sector in IM (electricity) = Energy consumption for commercial sector in Malaysia * No. of employed people for services in IM / No. of employed people for services in Malaysia * Energy consumption for residential sector in IM / Energy consumption for residential sector in Malaysia * No. of household in IM / No. of households in Malaysia	IDR Master Plan(2005), Dept. of Statistics, Malaysia (2006): State/District Data Bank 2006
<b>Transport Sector</b>		
<b>Passenger transport</b>		
Motorcar	Energy consumption for motorcars in IM = Energy consumption for motorcars in Malaysia * No. of motorcars in IM / No. of motorcars in Malaysia	Dept. of Statistics, Malaysia(2006): State/District Data Bank 2006
Motorcycle	Energy consumption for motorcycles in IM = Energy consumption for motorcycles in Malaysia * No. of motorcycles in IM / No. of motorcycles in Malaysia	Dept. of Statistics, Malaysia(2006): State/District Data Bank 2006
Bus	Energy consumption for buses in IM = Energy consumption for buses in Malaysia * No. of buses in IM / No. of buses in Malaysia	Dept. of Statistics, Malaysia(2006): State/District Data Bank 2006
Railways	Energy consumption for railways in IM = Energy consumption for railways in Malaysia * Passenger traffic volume of railways in IM / Passenger traffic volume of railways in Malaysia	Dept. of Statistics, Malaysia(2006): Year Book of Statistics, Malaysia 2006
Ship	Unconsidered	
Aviation	Unconsidered	
<b>Freight transport</b>		
Goods vehicle	Energy consumption for goods vehicles in IM = Energy consumption for goods vehicles in Malaysia * No. of goods vehicles in IM / No. of goods vehicles in Malaysia	Dept. of Statistics, Malaysia(2006): State/District Data Bank 2006
Railways	Energy consumption for railways in IM = Energy consumption for railways in Malaysia * Freight traffic volume of railways in IM / Freight traffic volume of railways in Malaysia	Dept. of Statistics, Malaysia(2006): Year Book of Statistics Malaysia 2006
Ship	Unconsidered	
Aviation	Unconsidered	

SOCIO-ECONOMIC INDICATOR	UNIT	PROCEDURE TO ESTIMATE IM SOCIO-ECONOMIC INDICATORS 2005	REFERENCES
Population	person	Population in IM is cited from Comprehensive Development Plan for South Johor Economic Region 2006-2025. Population by age cohort and sex in IM = Population in IM * age cohort ratio * Sex ratio Age cohort ratio: [0-14] 30.5%, [15-64]66.4%, [65+]3.1%, Sex ratio: [male]50.5%, [female]49.5%	Dept. of Statistics, Malaysia(2006): Malaysia Economic Statistics - Time Series 2005, Dept. of Statistics, Malaysia(2006): State/ District Data Bank 2006, Khazanah Nasional(2006): Comprehensive Development Plan for South Johor Economic Region 2006-2025
Labour participation ratio	%	Labour participation ratio in IM = Labour participation ratio in Johor	Dept. of Statistics, Malaysia(2006): State/ District Data Bank 2006
No. of employed people	person	No. of employed people in IM = Population by sex in IM (15+) * Labour participation ratio by sex in IM No. of employed people by industry in IM =No. of employed people by each industry in Malaysia * Paid wage of each industry in IM / Paid wage of total industry in IM	Dept. of Statistics, Malaysia(2006): State/ District Data Bank 2006
Commuting origin-destination (OD) matrix	%	Commuting OD matrix in IM is cited from researchers' estimation adjusted by CS Ho 1992 studies.	CS Ho 1992 studies
No. of households	household	No. of households in IM 2000 is cited from Population & Housing Census of Malaysia 2000; Population Distribution by Local Authority Areas and Mukims No. of households in IM 2005 = No. of households in IM 2000 * No. of places of residence in IM 2005 / No. of places of residence in IM 2000	Dept. of Statistics, Malaysia(2001): Population & Housing Census of Malaysia 2000; Population Distribution by Local Authority Areas and Mukims
Place of residence	residence	No. of places of residence in IM 2000 is cited from Population & Housing Census of Malaysia 2000; Population Distribution by Local Authority Areas and Mukims No. of places of residence in IM 2005 is estimated from year 2000 based on Property Market Report 2005.	Dept. of Statistics, Malaysia(2001): Population & Housing Census of Malaysia 2000; Population Distribution by Local Authority Areas and Mukims, Valuation and Property Services Department, Ministry of Finance, Malaysia(2006): Property Market Report 2005
Gross Regional Domestic Product (GRDP)	RM (current price)	Percentage of GRDP by industry in IM is cited from IDR Master Plan.	Dept. of Statistics, Malaysia(2006): Malaysia Economic Statistics - Time Series 2005, Johor State Economic Planning Unit(2006), IDR Master Plan(2005)
Value of gross output	RM (current price)	Value of gross output for manufacturing industry in IM is cited from IDR Master Plan(2005). Value of gross output by industry in IM (except manufacturing industry) = Intermediate input by industry in IM + Value added by industry in IM	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000, Johor State Economic Planning Unit(2006), IDR Master Plan(2005)
Intermediate input	RM (current price)	Intermediate input of manufacturing industry in IM = Intermediate input of manufacturing industry in Johor * 0.606 Intermediate input by industry in IM (except manufacturing industry) = Intermediate Input by industry in Malaysia * Value added by industry in IM / Value added by industry in Malaysia	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000, Johor State Economic Planning Unit(2006)
Value added	RM (current price)	Value added of manufacturing industry in IM = Value added of manufacturing industry in Johor * 0.606 Total value added of industries in IM = Value added of manufacturing industry in IM / Percentage of regional GDP of manufacturing industry in IM Value added by industry in IM (except manufacturing industry) = Total value added of industries in IM * Percentage of regional GDP by industry in IM	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
Paid wage	RM (current price)	Paid wage of manufacturing industry in IM = Paid wage of manufacturing industry in Johor * 0.606 Paid wage by industry in IM (except manufacturing industry) = Paid wage by industry in Malaysia * Value added by industry in IM / Value added by industry in Malaysia	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
Private consumption expenditure	RM (current price)	Private consumption expenditure in IM = Private consumption expenditure in Malaysia * Population in IM / Population in Malaysia	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
Government consumption expenditure	RM (current price)	Government consumption expenditure in IM = Government consumption expenditure in Malaysia * Population in IM / Population in Malaysia	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
Gross fixed capital formation	RM (current price)	Gross fixed capital formation in IM = Private investment expenditure in IM + Government investment expenditure in IM	Dept. of Statistics, Malaysia(2005): Input-Output tables, Malaysia 2000
Private investment expenditure	RM (current price)	Private investment expenditure in IM = Private investment expenditure in Malaysia * Population in IM / Population in Malaysia	Johor State Economic Planning Unit(2006)
Government investment expenditure	RM (current price)	Government investment expenditure in IM = Government investment expenditure in Malaysia * Population in IM / Population in Malaysia	Johor State Economic Planning Unit(2006)
Floor space of building stocks	m <sup>2</sup>	Floor space of building stocks by building type is cited from Property Market Report 2005.	Valuation and Property Services Department, Ministry of Finance, Malaysia(2006): Property Market Report 2005
No. of vehicles	vehicle	No. of vehicles in IM = No. of vehicles in Malaysia * No. of households in IM / No. of households in Malaysia	Dept. of Statistics, Malaysia(2006): State/ District Data Bank 2006
Trip per person per day	trip/person/day	Trip per person per day = 2.25	
Modal share in passenger	%	Modal share in passenger in IM is estimated from JICA and Malaysia Traffic Survey.	JICA(1997): A Study on Integrated Urban Transportation Strategies for Environmental Improvement in Kuala Lumpur, Ministry of Work, Malaysia(2006): Road Traffic Volume Malaysia 2006
Average trip distance	km	Average trip distance in IM is estimated from JICA(1997).	JICA(1997): A Study on Integrated Urban Transportation Strategies for Environmental Improvement in Kuala Lumpur
Passenger transport volume: Passenger vehicles (motorcar, motorcycle, bus)	passenger-km	Passenger transport demand of passenger vehicles in IM (passenger-km) = Population in IM * Trip per person per day * 365 * Average trip distance	
Passenger transport volume: Railways	passenger-km	Passenger transport demand of railways in IM (passenger-km) = Passenger transport demand of goods vehicles in IM (passenger-km) * main stations of KTM in IM / main stations of KTM in Malaysia	Dept. of Statistics, Malaysia(2006): Year Book of Statistics Malaysia 2006, Keretapi Tanah Melayu (KTM)
Modal share in freight	%	Modal share in freight is estimated from freight transport demand.	
Freight transport volume: Goods vehicles	tonne-km	Freight transport demand of goods vehicles in IM (vehicle-km) = No. of goods vehicles in IM * Average travel distance per goods vehicle per year (km) in Fulton and Eads(2004) Freight transport demand of vehicles in IM (tonne-km) = Freight transport demand of goods vehicles in IM (vehicle-km) * Average load (tonne per vehicle) in Fulton and Eads(2004)	Fulton, L. and G. Eads(2004): IEA-SMP Model Documentation and Reference Case Projection
Freight transport volume: Railways	tonne-km	Freight transport demand of railways in IM (tonne-km) = Freight transport demand of railways in Malaysia (tonne-km) * main stations of KTM in IM / main stations of KTM in Malaysia	Dept. of Statistics, Malaysia(2006): Year Book of Statistics, Malaysia 2006, Keretapi Tanah Melayu (KTM)
CO <sub>2</sub> emission factor	kt-C/ktoe	CO <sub>2</sub> emission factor by energy (except electricity) is cited from Ministry of the Environment, Japan. CO <sub>2</sub> emission factor of electricity in IM is based on National Energy Balance 2005 Malaysia.	Ministry of Energy, Water and Communications, Malaysia(2005): National Energy Balance 2005 Malaysia

IM 10 table 2005 (Unit: mill.RM)

	Agriculture	Mining	Food Products and Beverages	Chemicals and Machinery	Electric and Electronic Products	Other Non-Metallic	Fabricated Metal Products and Machinery	Rubber and Plastics Products	Construction	Transport related	Wholesale and Retail	Tourism and Hospitality	Professional and Business	Medical and Education	Other Services	Public administration	Total intermediate input	Private consumption	Government consumption	Fixed capital formation	Export	Import	Total final demand	Total use (domestic production)
Agriculture	175	0	1686	232	5	14	561	472	7	2	0	9	1059	5	1	11	0	797	0	65	443	-3684	-2379	1860
Mining	0	0	139	518	2	107	83	2531	214	0	0	1	0	3	0	2	0	5	0	154	0	-3233	-3074	0
Food Products and Beverages	105	0	3673	518	6	2	2	3	1	1	7	2283	5	39	4	10	6665	958	0	0	3743	-2138	2563	9228
Chemicals and Machinery	74	0	250	2063	833	506	291	910	54	13	19	53	9	104	9	2	5191	181	0	0	4327	-3046	1461	6651
Electric and Electronic Products	11	0	0	14343	7548	297	132	306	35	15	30	23	8	147	4	109	12426	1017	0	441	22503	-19329	4082	26803
Fabricated Metal Products and Machinery	43	0	166	196	2963	6442	97	100	1302	429	119	73	65	53	109	1426	1618	1093	0	71	17719	-10749	9606	22032
Other Non-Metallic	17	0	247	116	653	331	1282	79	1214	17	121	99	62	25	39	4413	1093	0	0	3445	-3644	965	5378	
Rubber and Plastics Products	135	0	544	469	236	332	390	746	103	824	174	95	21	14	69	15	4187	811	0	4069	-1972	2908	7095	
Construction	17	0	36	124	61	116	44	67	243	51	147	82	31	42	39	39	1129	33	0	2098	3168	-113	5185	
Transport related	14	0	120	79	186	205	91	43	109	2127	239	138	31	42	30	16	3444	530	0	9	4693	-1449	3782	
Wholesale and Retail	61	0	288	325	187	1776	231	306	335	172	47	297	30	36	39	39	5770	157	0	129	5303	0	5588	
Tourism and Hospitality	2	0	12	18	49	41	16	14	35	418	400	156	26	19	11	18	1235	1043	0	0	6984	0	8027	
Professional and Business	12	0	77	136	190	268	69	54	388	355	1195	926	57	170	185	106	4707	2173	82	5	4796	-820	9261	
Medical and Education	54	0	112	124	151	147	35	116	55	109	462	202	82	41	65	1	1756	100	875	0	14	-906	83	
Other Services	10	0	244	197	231	319	118	132	64	170	394	546	134	76	132	42	2807	832	73	0	133	-2140	1705	
Public administration	0	0	3	0	0	0	0	0	0	1	0	0	0	0	1	20	26	0	1810	0	0	-1044	766	
Total intermediate input	731	0	7458	4738	21729	18173	3567	5715	4433	4723	3340	6099	1139	691	823	432	83790	10195	2840	4590	78259	-58243	154127	237916
Compensation of Employee	202	0	471	386	1489	1042	722	258	1227	1122	1695	1183	641	1073	168	344	12023							
Operating Surplus	924	0	1271	1482	3542	2685	1057	1097	609	1342	6228	1921	2042	68	696	8	24975							
Other value added	3	0	29	45	44	132	31	26	46	39	94	58	64	7	17	8	644							
Total value added	1129	0	1771	1913	5075	3859	1811	1381	1882	2503	8018	3162	2748	1148	882	360	37641							
Total input (domestic production)	1860	0	9228	6651	26803	22032	5378	7095	6315	7226	11358	9261	3887	1840	1705	793	121431							

Energy balance table of IM in 2005 (final demand sector) (Unit: ktoe)

Industry	Petroleum Products (total)														Natural gas				LNG		Renewables		Electricity	Ratio of All Sector		
	Coal	Gasoline	Naphtha	Jet Fuel	Kerosene	Diesel Oil	Heavy Oil	Lubricating Oil	LPG	Petrol. Hydro	Petrol. Coke	Natural gas	LNG	Renewables	Electricity	Total	Ratio of All Sector									
Non-manufacturing	0.0	3.0	0.1	0.0	0.0	3.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3.0	0%		
Manufacturing	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2%	
Transport	0.0	31.8	0.1	0.0	0.2	20.4	2.8	0.0	1.3	0.1	0.1	23.2	0.0	0.0	14.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	16%	
Construction	0.0	158.4	0.4	0.0	0.0	0.9	101.3	48.8	0.0	6.4	0.3	0.0	0.0	0.0	136.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	57.4	
Wholesale and Retail	0.0	147.3	0.4	0.0	0.0	0.8	94.4	45.4	0.0	6.0	0.3	0.0	0.0	0.0	51.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	229.6	
Tourism and Hospitality	0.0	22.6	0.1	0.0	0.0	0.1	14.5	7.0	0.0	0.9	0.0	0.0	0.0	0.0	76.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	228.0	
Professional and Business	0.0	39.4	0.1	0.0	0.2	25.2	12.1	1.6	0.0	1.6	0.1	0.0	0.0	0.0	54.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	33.2	
Medical and Education	497	34.2	0.1	0.0	0.2	21.9	10.5	0.0	1.4	0.1	0.0	0.0	0.0	0.0	125.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	15.8	
Other Services	0.0	242.4	0.7	0.0	0.0	1.4	153.4	74.7	0.0	9.8	0.4	0.0	0.0	0.0	230.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	456.3	
Total	497	679.0	1.9	0.0	0.0	3.8	436.2	208.4	0.0	27.4	1.2	0.0	0.0	0.0	980.7	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1732.9	
Residential	0.0	46.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	192.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	240.0	
Commercial	0.0	52.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	327.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	381.9	
Transport	0.0	322.8	200.0	0.0	0.0	122.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	325.0	
Construction	0.0	287.6	178.2	0.0	0.0	109.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	289.6	
Wholesale and Retail	0.0	35.2	21.8	0.0	0.0	13.4	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	35.4	
Tourism and Hospitality	0.0	33.9	21.0	0.0	0.0	12.9	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	34.1	
Professional and Business	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Medical and Education	0.0	565.3	352.1	0.0	0.0	216.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	572.1	
Other Services	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	
Total	0.0	925.0	573.1	0.0	0.0	351.8	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	931.4	
All Sector	497	1705.6	575.0	0.0	0.0	3.8	788.1	227.1	0.0	108.3	1.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	3286.2	
Ratio of All Sector																										100%



Energy balance table of IM in 2025 CM ( final demand sector ) (Unit: ktoe)

Industry	Petrolium Products (total)														Total	Ratio of All Sector		
	Coal	Gasoline	Naphtha	Jet Fuel	Kerosene	Diese Oil	Heavy Oil	Lubricating Oil	LPG	Petrol. Hydro	Petrol. Coke	Natural gas	LNG	Renewables			Electricity	
Non-manufacturing	Agriculture	0.0	1.1	0.0	0.0	0.0	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	4.2	0%
	Mining	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%
	Construction	0.0	7.4	0.0	0.0	0.0	4.7	2.3	0.0	0.3	0.0	43.5	0.0	0.0	0.0	14.6	65.5	0%
	Food Products and Beverages	0.0	121.5	0.3	0.0	0.0	77.9	37.4	0.0	4.9	0.2	1,948.1	0.0	0.0	0.0	421.5	1,591.0	26%
	Chemicals and Chemical Products	0.0	105.2	0.3	0.0	0.6	67.4	32.4	0.0	4.3	0.2	461.5	0.0	0.0	0.0	85.5	652.2	11%
	Electric and Electronic Products and Machinery	0.0	5.7	0.0	0.0	0.0	3.6	1.8	0.0	0.2	0.0	143.6	0.0	0.0	0.0	86.2	235.5	4%
	Fabricated Metal Products and Machinery	0.0	9.7	0.0	0.0	0.1	6.2	3.0	0.0	0.4	0.0	82.5	0.0	0.0	0.0	35.6	127.7	2%
	Other Non-Metallic	99.8	17.2	0.0	0.0	0.1	11.0	5.3	0.0	3.2	0.1	103.5	0.0	0.0	0.0	35.3	255.7	4%
	Rubber and Plastics Products	0.0	78.1	0.2	0.0	0.4	50.0	24.1	0.0	3.2	0.1	389.3	0.0	0.0	0.0	95.4	562.7	9%
	Total	99.8	345.6	1.0	0.0	2.0	222.1	106.1	0.0	13.9	0.6	2,275.2	0.0	0.0	0.0	773.9	3,494.5	52%
Residential	Petrolium Products (total)														Total	Ratio of All Sector		
	Coal	Gasoline	Naphtha	Jet Fuel	Kerosene	Diese Oil	Heavy Oil	Lubricating Oil	LPG	Petrol. Hydro	Petrol. Coke	Natural gas	LNG	Renewables	Electricity	Total	Ratio of All Sector	
	0.0	17.7	0.0	0.0	0.0	0.0	0.0	0.0	17.7	0.0	0.0	57.3	0.0	144.2	592.0	721.2	12%	
Commercial	Petrolium Products (total)														Total	Ratio of All Sector		
	Coal	Gasoline	Naphtha	Jet Fuel	Kerosene	Diese Oil	Heavy Oil	Lubricating Oil	LPG	Petrol. Hydro	Petrol. Coke	Natural gas	LNG	Renewables	Electricity	Total	Ratio of All Sector	
	0.0	90.3	0.0	0.0	0.0	0.0	32.0	0.0	58.3	0.0	0.0	34.8	0.0	193.7	415.2	734.0	12%	
Transport	Petrolium Products (total)														Total	Ratio of All Sector		
	Coal	Gasoline	Naphtha	Jet Fuel	Kerosene	Diese Oil	Heavy Oil	Lubricating Oil	LPG	Petrol. Hydro	Petrol. Coke	Natural gas	LNG	Renewables	Electricity	Total	Ratio of All Sector	
		0.0	64.6	40.0	0.0	0.0	24.6	0.0	0.0	0.0	0.0	107.7	0.0	60.3	0.0	232.6	4%	
	Passenger vehicle	0.0	58.6	36.3	0.0	0.0	22.3	0.0	0.0	0.0	0.0	97.6	0.0	54.6	0.0	210.8	3%	
	Motorcar	0.0	6.1	3.8	0.0	0.0	2.3	0.0	0.0	0.0	0.0	10.1	0.0	5.7	0.0	21.8	0%	
	Motorcycle	0.0	5.3	3.3	0.0	0.0	2.0	0.0	0.0	0.0	0.0	8.8	0.0	5.3	0.0	19.4	0%	
	Bus	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
	Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
	Ship	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
	Aviation	0.0	255.3	158.2	0.0	0.0	97.1	0.0	0.0	0.0	0.0	425.5	0.0	236.4	0.0	917.2	13%	
Goods vehicle	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0%	
Rail	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
Ship	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0%	
Aviation	0.0	325.2	201.5	0.0	0.0	123.7	0.0	0.0	0.0	0.0	542.0	0.0	302.0	0.9	1,170.2	19%		
Total	99.8	778.9	202.5	0.0	0.0	345.8	138.1	0.0	89.9	0.6	2,490.3	0.0	639.9	1,692.0	6,119.8	100%		

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GROUP VII: THE PLANNING OF URBAN ENERGY AND ENVIRONMENTAL SYSTEMS

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