LOW CARBON SOCIETY SCENARIOS

MALAYSIA 2030

Universiti Teknologi Malaysia
Kyoto University, Japan
National Institute for Environmental Studies, Japan

November 2013

Preface

The Low Carbon Malaysia research is one of the outcomes emerging from the *Development of Low Carbon Society Scenarios for Asian Regions* project conducted by the Low Carbon Asia Research Group. The group assembles some 50 researchers from multi-disciplinary backgrounds from Malaysia and Japan with a view to creating a low carbon future for Asia, beginning with developing the Iskandar Malaysia Low Carbon Society (LCS) Blueprint. In the process, the need to position the proposed LCS actions and projected emission reduction for the region within the context of national low carbon initiatives as well as the need to compare and benchmark with other Asian countries become apparent. There is evidently a gap where a national level study needs to be carried out to provide the overall framework and outline the pathway for Malaysia's progression towards becoming a Low Carbon Nation, in line with the Malaysian Government's aspiration to achieve a 40% voluntary reduction of CO_2 emission intensity by 2020. This report is thus prepared and serves as a baseline study of GHG emissions of all drivers of GHG emission which include major sectors such as energy, agriculture, forestry and solid waste generation. Furthermore, this national level low carbon study also serves to enrich other comparable Asian studies that have been conducted using the Asia-Pacific Integrated Model (AIM) and further expand and strengthen the LoCARNet international research network.

In order to ensure the accuracy and validity of the baseline study on GHG emission, official published data from ministries and government authorities have been used and, where necessary, informed technical assumptions are made in the projection. Specifically, the Second National Communication to the UNFCCC (NC2), 10th Malaysia Five-year Plan 2011-2015 (RMK-10), National Physical Plan-2 (NPP-2) and various national sectoral plans have been used as the bases for the projection of future scenarios. In addition, several progress presentations have been given to key agencies such as the Ministry of National Resources and Environment (NRE) and the Federal Town and Country Planning Department to update and obtain feedback and comments for further improvement of the projected scenarios.

The research would not have been possible without the support from the Science and Technology Research Partnership for Sustainable Development (SATREPS).

In addition to the above, we wish to record our sincere thanks to the following agencies that have made this Low Carbon Nation project possible:

Ministry of Natural Resources and Environment, Malaysia
Ministry of Energy, Green Technology and Water, Malaysia
Ministry of Urban Wellbeing, Housing and Local Government, Malaysia
Federal Department of Town and Country Planning, Malaysia

Lastly we wish to acknowledge and thank Datuk Dr. Abdul Rahim Hj Nik, Dr. Lian Kok Fei, Dr. Gary W. Theisera and Dr. Elizabeth Phillip of the Ministry of National Resources and Environment and all individuals, departments, agencies and ministries that have directly or indirectly contributed to giving this Low Carbon Nation project a good start.

MATSUOKA Yuzuru (Professor), Kyoto University, Japan
HO Chin Siong (Professor), Universiti Teknologi Malaysia, Malaysia.

Contents

Executive Summary

Objective of this study

At COP 15 in Copenhagen, Prime Minister YAB Dato' Sri Mohd Najib Tun Abdul Razak announced that Malaysia would voluntarily reduce its emissions intensity of GDP by up to 40% based on 2005 levels by 2020. In line with the target, Malaysia's Second National Communication to the UNFCCC (NC2) proposed a mitigation analysis.
This study is a follow-up to the NC2 analysis and aims to investigate future socio-economic scenarios and GHG mitigation potentials of low-carbon measures in more detail and more options based on the integrated modeling and backcasting approach. The target year has been set to 2020, and extended also to 2030 to offer a longer perspective of the mitigation effects of some low-carbon measures.

Scenarios and tools

Three scenarios are projected: BaU, EXT and APS. The BaU scenario ("BaU" stands for "business as usual") assumes development without introduction of low-carbon measures. The EXT scenario ("EXT" stands for "existing") involves the introduction of low-carbon measures mentioned in the NC2 and other measures which are already planned by the government. APS is an "Alternative Planning Scenario" and assumes more intensive implementation of the measures than currently planned, as well as additional measures which are likely available in the target years, so that the official mitigation target is achieved. The low-carbon measures considered here consist of energy efficiency improvement in the energy demand and power supply sectors; use of renewable energy in the transportation and power supply sectors; modal shift; avoiding deforestation; waste recycling and so on. Portfolios of low-carbon measures have been identified through an iterative process in the EXT and APS scenarios.
Socio-economic scenarios are described and quantified based on existing official economic and physical development plans. Energy demand, waste generation, AFOLU activities and associated GHG emissions are projected based on the socio-economic scenarios. Two quantification tools are used: ExSS (Extended Snapshot tool) for socio-economic indicators and the energy and waste sectors; and AFOLUB (agriculture, forestry and other land use bottom-up model) for AFOLU sectors. Combining the results from both the ExSS and AFOLUB models, emissions and mitigation potential are analyzed.

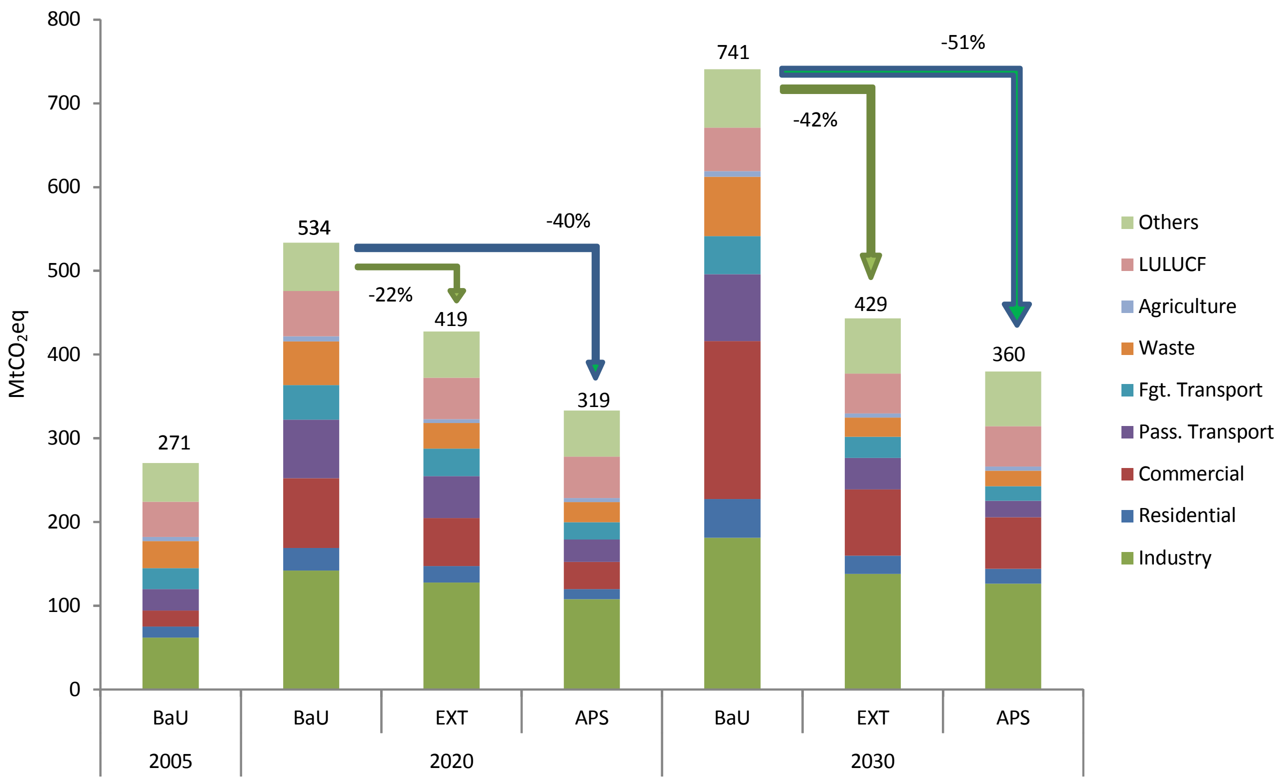


Figure 1. Greenhouse gas emissions and mitigation in Malaysia

Source : LCSM 2030

Results of the modelling

The main results are summarized in Table 1. In 2020, GDP is almost doubled from the base year (2005). Tertiary industry, which currently shares about half the Malaysian GDP, is expected to expand faster than the primary and secondary industries. As a result, its share of GDP is projected to increase up to 65% in 2020 and 74% in 2030.

Figure 1 shows the projected GHG emissions by emission sectors: energy demand sectors, agriculture, LULUCF, solid waste and other emission sources. Industry is the largest emitter in all scenarios except for 2030BaU, in which the commercial sector emerges to the biggest emitting sector. The official target of 40% reduction of GHG intensity in 2020 is only achieved in the APS scenario. In 2020BaU, total GHG emission increases up to 534 $MtCO_2eq$, a 97% increase from 2005. In 2020EXT and 2020APS, total emissions are reduced by 22% and 40% from BaU. In 2030BaU, total GHG emission increases up to 741 $MtCO_2eq$, a 174% increase from 2005. In 2030EXT and 2030APS, emissions are reduced by 42% and 51% from 2030BaU. As for the contribution to emission reduction, energy efficient (EE) technology is the most important in the long term while forest management and avoiding deforestation in the LULUCF (land use, land-use change and forestry) sector are the other indispensable options (Figure 2). Renewable energy (RE) and waste recycling are next most significant emission reduction contributors in most of the scenarios.

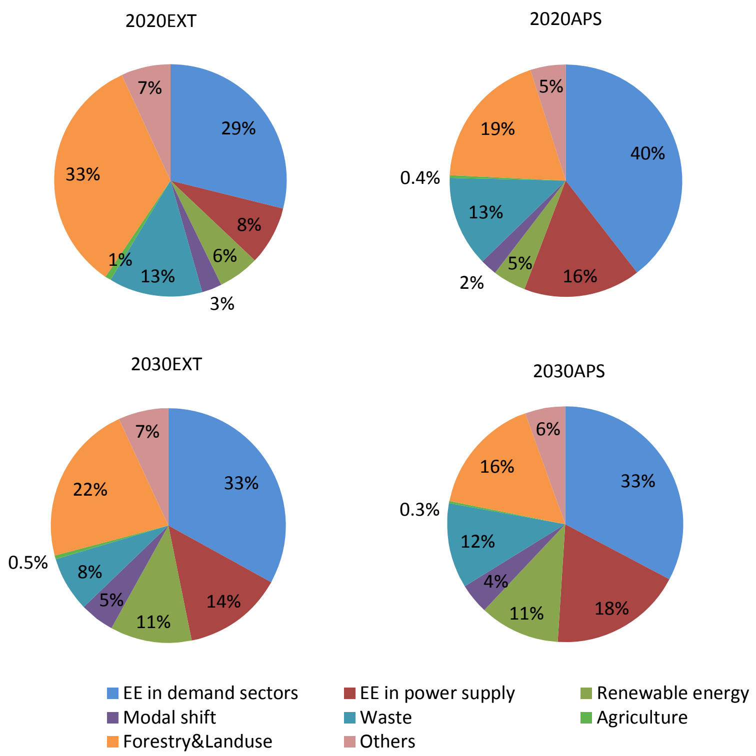


Figure 2. Contribution to emissions reductions

Source : LCSM 2030

Table 1. Projected socio-economic indicators in 2020 and 2030 in Malaysia

		2005*	2020 BaU	2020 EXT	2020 APS	2030 BaU	2030 EXT	2030 APS
Population	1000	26,128	32,760	32,760	32,760	37,266	37,266	37,266
GDP	Mill.RM	509,272	995,746	995,746	995,746	1,703,518	1,703,518	1,703,518
Final Energy Demand	ktoe	36,109	80,839	68,950	56,478	108,370	75,332	70,832
GHG emission								
Total	$ktCO_2eq$	270,710	533,575	418,709	318,567	741,247	429,007	359,837
Per capita	tCO_2eq	10.4	16.3	12.8	9.7	19.9	11.5	9.7
GHG emission per GDP	$kgCO_2eq/RM$	0.53	0.54	0.42	0.32	0.44	0.25	0.21

**Source : NC2*

Socio-economic Scenario

Since GHG emission is strongly driven by socio-economic activity level, such as population and GDP, a low-carbon society scenario must consider future socio-economic development. In this study, socio-economic scenarios have been developed for 2020 and 2030 as a basis for low-carbon society based on official demographic projections and Malaysia's economic plans, such as the New Economic Model (NEM) under the Economic Transformation Program (ETP). Results of main variables and assumptions for socio-economic scenarios are summarised in Table 2 and Table 3. Population and GDP, the two indicators which affect overall energy demand the most, will be 1.4 and 3.1 times greater in 2030 than 2005. Passenger transport demand increases according to population increase. Freight transport demand, too, increases according to increase of output of primary and secondary industries. Assumptions in 2020 follow existing Malaysian planning documents, while in 2030, since detailed official plan is not available, trends in 2020 have been assumed to continue to 2030.

Demography

The projected population growth rate is 1.5%/year between 2005 and 2020, 1.3% between 2020 and 2030 and thus populations in 2020 and 2030 are 33 million and 37 million, a 25% and 43% increase from 2005. Number of households increases more due to a smaller average household size reflecting the current trend of urbanisation (Figure 3). Since energy consumption per capita is larger in smaller households, this result makes household energy consumption increase more than population increase.

Economy

Future scenario of the economy in 2020 is built mainly based on the NEM. By 2020, GDP growth rate is projected to be 5.5%/year and the GDP is almost doubled from the base year. Final demand by industry has been adjusted in order to fit the share of each industry to that of the NEM. In general, primary industries will decrease their share in final

Table 2. Projected socio-economic indicators in 2020 and 2030 in Malaysia

		2005	2020	2030	2020/2005	2030/2005
Population *1	Million	26	33	37	1.3	1.4
Household *1	Million	5.8	8.2	9.3	1.4	1.6
GDP *1	Bill. RM	509	996	1,704	2.0	3.3
Per capita GDP	1000.RM	20	30	43	1.5	2.2
Gross output *1	Bill. RM	1,604	3,135	4,929	2.0	3.1
Primary		55	84	97	1.5	1.8
Secondary		920	1,507	2,175	1.6	2.4
Tertiary		629	1,544	2,657	2.5	4.2
Passenger transport *2	Bill. pass-km	169	315	359	1.9	2.1
Freight transport *1	Bill. t-km	92	150	214	1.6	2.3

Source : LCSM 2030

demand while the share of tertiary industries increases (Figure 4). In 2030 scenarios, GDP growth rate is assumed to be the same as the average of 2000 to 2020. Share of each final demand is assumed to be the same as that of 2020. As for changes of the industrial structure, the trend between 2005 and 2020 is assumed to continue to 2030.

Passenger transport

Passenger transport demand is given by the total distance of movement by the people in Malaysia in one year and expressed in passenger-km. The demand is projected by multiplying residential population by the trip generation per person per day, modal share and average trip distance. Since the statistical information about passenger transport in Malaysia has not been fully obtained, passenger transport demand and parameters are estimated from indirect information. The result (Figure 5) shows that demand for vehicular transport will grow significantly and triple in the BaU scenario. In the EXT and APS scenarios, more use of public transport (train and bus) has been anticipated.

Freight transport

Freight transport demand is defined as the total movement of freight in one year in Malaysia. It is projected by multiplying output of industry by freight transport generation per output, modal share, and average trip distance. Although statistical information about freight transport in Malaysia has not been fully obtained, it is evident that freight transport will experience significant growth attributable to growth of industries (Figure 6).

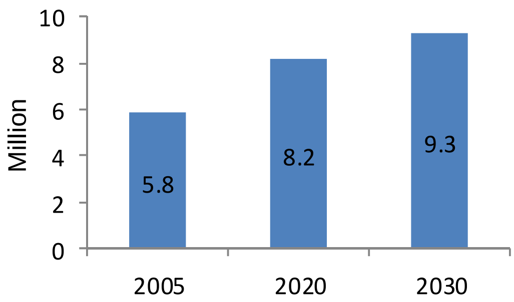


Figure 3. Number of household

Source : LCSM 2030

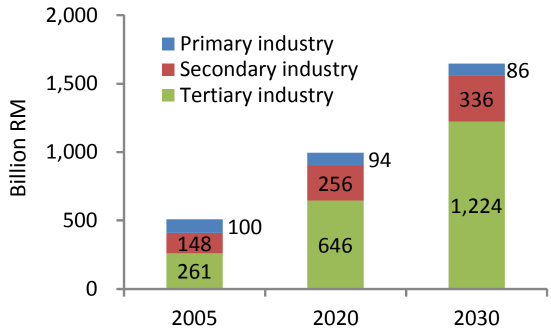


Figure 4. Value added

Source : LCSM 2030

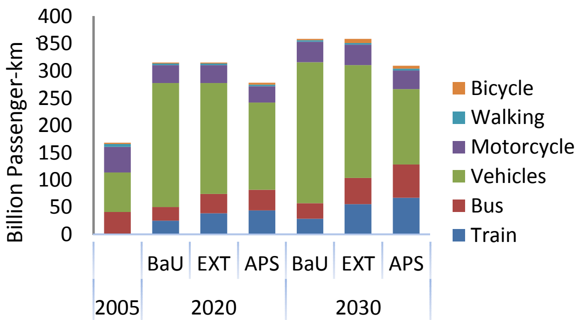


Figure 5. Passenger transport demand

Source : LCSM 2030

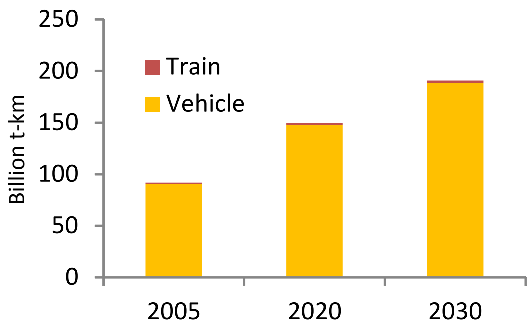


Figure 6. Freight transport demand

Source : LCSM 2030

Table 3. Quantitative socio-economic assumption in 2020 and 2030

Field	Variables	2020 Assumptions	2030 Assumptions
Demography	Population	Annual growth rate 1.14%/year, 32.76 million in 2020	37.27 million in 2030
	Household	Average household size is assumed to decrease to 4.0 in 2020 from 4.36 in 2010. (4.47 in 2005)	Average household size is assumed same as 2020 (4.0).
Economy	GDP	Average annual growth rate 5.5% (2011 to 2020)	Average annual growth rate was assumed 4.86% (2021 to 2030), which is same as average of 2000 to 2020.
	Industrial structure	GDP share of service industries increase from 58.9% to 67.3%.	The trend from 2000 to 2020 will continue to 2030.
	Demand structure	Export and FDI maintain their share in GDP.	Same structure as in 2020.
Transport	Passenger	Number of trips increases proportionally to population. Increase share of passenger vehicles & trains.	Number of trips increases proportionally to population. Same structure as in 2020.
	Freight	Increase proportionally to output of secondary industry.	Increase proportionally to output of secondary industry.

Source : NC2, NEM, NPP, UN

Greenhouse Gas Emissions

Three scnearios were developed for GHG emissions: BaU, EXT and APS, in 2020 and 2030. In the BaU scenario, current technology and energy demand structure continue to be used in the target years. The EXT scenario introduces existing initiatives by the Malaysian government and the APS scenario considers more intensive implementation of low-carbon measures to achieve the intensity reduction target of 40% by 2020.

GHG emissions in the scenarios

Table 4 shows a summary of projected emissions for the scenarios. In the year 2005, estimated GHG emission was 271 $MtCO_2eq$, sink 247 $MtCO_2eq$, and net emission 24 $MtCO_2eq$. In 2020BaU, total GHG emission increases up to 534 $MtCO_2eq$, a 97% increase from 2005. In 2020EXT and 2020APS, emissions are reduced by 22% and 40% from the BaU emissions. In 2030, the BaU scenario's GHG emissions increase up to 741 $MtCO_2eq$, a 174% increase from 2005. The BaU emissions are reduced by 42% and 51% in the EXT and APS scenarios respectively. Although Malaysia was known as a "net negative emission" country in the year 2000 (NC2), its net emissions taking into account the carbon sink were in the positive by 2005 and are expected to increase significantly especially in the BaU scenarios.

GHG emissions by sectors

Figure 7 shows GHG emissions by emission sectors. Emission from power generation is attributed to each sector which consumes electricity. Total of energy sectors has greater emissions than AFOLU sectors in all scenarios. In all scenarios except for 2030BaU, the industry sector has the largest emissions among the energy demand sectors, agriculture and LULUCF sectors. Its share is about one fourth of all emissions in BaU scenarios and more than 30% in EXT and APS scenarios. Share of the commercial sector in 2030BaU is 25% of total GHG emissions. In the 2020BaU and 2030BaU scenarios, the LULUCF sector shares less than 10% of total emissions while agriculture accounts for only

Table 4. Projected Greenhouse gas in 2020 and 2030 in Malaysia

	2005	2020 BaU	2020 EXT	2020 APS	2030 BaU	2030 EXT	2030 APS
Emission ($ktCO_2eq$)	270,710	533,575	418,709	318,567	741,247	429,007	359,837
Net emission ($ktCO_2eq$)	23,724	295,329	128,813	28,672	513,686	131,977	62,807
Per capita emission (tCO_2eq)	10.4	16.3	12.8	9.7	19.9	11.5	9.7
(Net)	0.9	9.0	3.9	0.9	13.8	3.5	1.7
Emission intensity ($kgCO_2eq$/RM)	0.53	0.54	0.42	0.32	0.44	0.25	0.21
(Net)	0.05	0.30	0.13	0.03	0.30	0.08	0.04

Source : LCSM 2030

1%. The result suggests that in terms of mitigation of GHG emissions, Malaysia should channel larger efforts in reducingenergy consumption of the industry and commercial sectors. Details of GHG emissions in the scenarios can be found at the end of this report.

Per capita GHG emissions

In 2005, per capita GHG emissions in Malaysia was 10.2 tCO_2eq although in BaU scenarios, it is projected to increase up to 16.3 tCO_2eq in 2020 and 19.9 tCO_2eq in 2030. These are similar with the range of per capita GHG emissions of current developed countries. In the EXT scenario it can be reduced to 12.8 and 11.5 tCO_2eq in 2020 and 2030. In the APS scenario the per capita emissions are less than 10 tCO_2eq.

Emission intensity

Figure 8 shows the result of GHG emission intensity. In 2005, estimated GHG emission intensity was 0.53 $kgCO_2eq$/RM. In 2020BaU, emission intensity increases slightly to 0.54 $kgCO_2eq$/RM. In 2030BaU, it reduces to 0.44 $kgCO_2eq$/RM mainly because of a greater share of tertiary industries in the GDP. In the EXT scenario, which assumes full adoption of existing planned low-carbon measures, emission intensity will be 0.42 $kgCO_2eq$/RM in 2020 and 0.25 $kgCO_2eq$/RM in 2030. These represent a 22% and 53% reduction from 2005, thus implying that the national target of 40% reduction in 2020 may not be achieved in this scenario. In the APS scenario, which assumes more intensive implementation of LCS measures, emission intensity is 0.32 $kgCO_2eq$/RM in 2020 and 0.21 $kgCO_2eq$/RM in 2030. These are a 40% and 60% reduction from 2005; the target is hence achieved. More details of the low-carbon measures are described in the later part of this report.

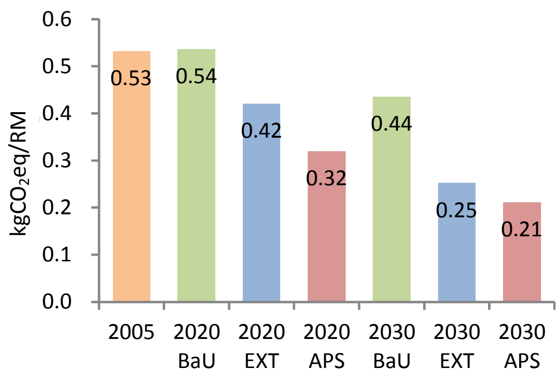


Figure 8. Emission intensity ($kgCO_2eq$/RM)

Source: LCSM 2030

GHG emission reduction breakdown

Breakdown of GHG emission reduction is shown in Figure 2 of the Executive Summary (p2). In 2020, share of the energy sectors in emission reduction is 41% and that of the AFOLU sectors is 59%. However in 2030, relative contribution of the AFOLU sectors is less than 2020 and its share is decreased to 30% of total emission reduction. This result suggests that in the longer term such as 2030, emission reduction in the energy sector is getting more important because, as result of long-term economic growth, future Malaysia needs much more energy than present. Nonetheless, 30% is not negligible; contribution of the AFOLU sectors, mainly by forest management and avoiding deforestation, must be considered in the portfolio of low-carbon actions. In conclusion, investment in energy efficient technology is the most important in the long term while forest management is another indispensable option.

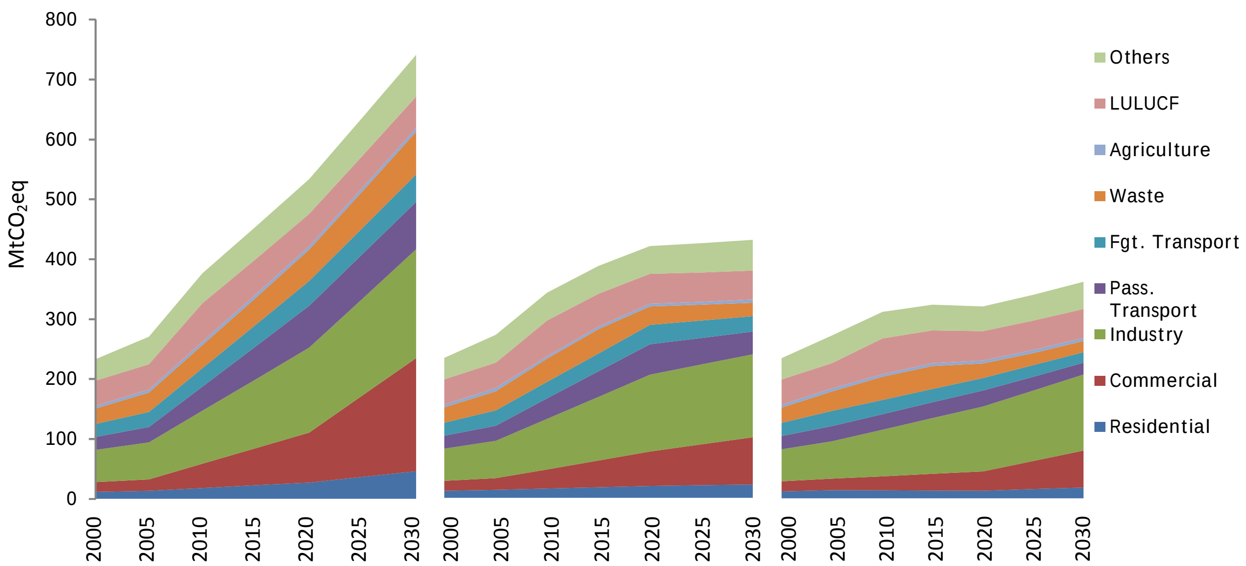


Figure 7. GHG emissions in BaU scenario (left) and CM scenarios (EXT: middle, APS: right)

Source : LCSM 2030

Energy Scenarios

In its energy policy, Malaysia has devoted its effort to diversifying energy sources, including renewable energy (RE) and more efficient utilization through mainly energy In its energy policy, Malaysia has devoted its effort to diversifying energy sources, including renewable energy (RE) and more efficient utilization through mainly energy efficiency (EE) improvement. The energy scenarios project energy demand and supply in 2020 and 2030 and show the contribution of EE, RE and other low-carbon measures to GHG emission reductions.

Scenarios

Table 5 shows a summary of assumptions in the BaU scenario. The BaU scenario basically follows Malaysia's Second National Communication to the UNFCCC (NC2) for total energy demand and fraction of fuels. Among the sectors, because of higher growth rates of tertiary industries, the commercial sector commands a larger share in the future than base year. Residential sector energy demand is driven by increase of population and households, as well as higher diffusion of energy-consuming equipment due to rising incomes. Energy efficiency is constant (frozen) in future years in the BaU scenario.

In the EXT scenario, 40% and 75% of the equipment are replaced with the efficient type in 2020 and 2030, and in APS, 60% in 2020 and 80% in 2030. Technology data have been sourced from the database of energy-using devices available in the literature. Introduction of renewable energy is considered as well in the power supply and transportation sectors (See Table 6).

Table 5. Assumption of energy demand and supply in BaU

Field	Variables	2020 Assumptions	2030 Assumptions
Final energy demand	Total	From 2005 to 2020, total final energy demand grows by 4.7%/year from 2005 to 2020.	Same structure as in 2020
	By sectors	Commercial & residential sectors grow in higher rate than total demand.	Same structure as in 2020
	By fuels	Electricity and petroleum products grow in higher rate than total demand.	Same structure as in 2020
Power supply	Share of fuels Efficiency	Related parameters were adjusted so that the primary energy demand structure is similar to that of NC2	Same structure as in 2020

Source: NC2

Table 6. Summary of low-carbon measures in energy sector

	EXT		APS	
	2020	2030	2020	2030
Defusion of energy-efficient device in energy demand sectors	40%	75%	60%	85%
Efficiency improvement of power plant	10%	20%	21%	30%
Renewable energy in power supply	2,080 MW	4,160 MW	4,160 MW	10,400 MW
Renewable energy in transport (bio diesel in transport fuel)	2.0%	3.1%	5.9%	7.8%

Source : LCSM 2030

Final energy demand

Figure 9 shows the projected final energy demand. The largest energy consumer is the industry sector in all scenarios. In the BaU scenario, final energy demand increases by 124% and 200% from the base year. In terms of growth rate from the base year, the commercial sector registers the highest rates: 3.5 and 7.4 times in 2020BaU and 2030BaU respectively. Oil has the largest share in final energy demand in all scenarios while electricity shows higher growth rate than oil. In the EXT scenario, final energy demand in 2020EXT is reduced by 15% from 2020BaU, and in 2030EXT, 30% from 2030BaU because of energy efficiency improvement and modal shift from private vehicles to public transport. In the APS scenario, the reduction from BaU is 30% (in 2020) and 35% (in 2030).

Power supply and primary energy demand

Since energy efficiency of energy demand sectors is improved in the CM scenarios, total power generation in EXT and APS is reduced by 15% and 32% from the BaU scenario in 2020. Since more use of coal in the power supply sector is expected due to limitation of natural gas production in Malaysia, coal has higher share in all future scenarios (Figure 10). New and renewable energies, including nuclear, biomass and biogas, solar and hydro (both mini and conventional) combine to account for 30% of total power supply in 2030APS.

As for primary energy demand, while total supply increases by 2 to 3 times in future scenarios from the base year, the structure does not change so much. Crude oil has the largest share in all scenarios mainly due to oil demand of the transportation sector. Even though the renewable energy capacity is doubled and quadrupled from the planned level in 2020 under the NC2, partly due to lower load factor of solar PV, its share does not exceed 4% of the total primary energy supply.

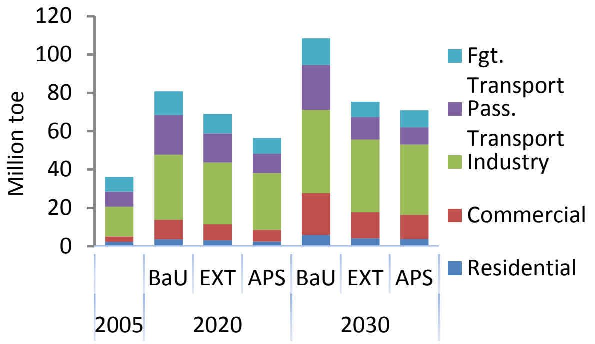


Figure 9. Final energy demand

Source : LCSM 2030

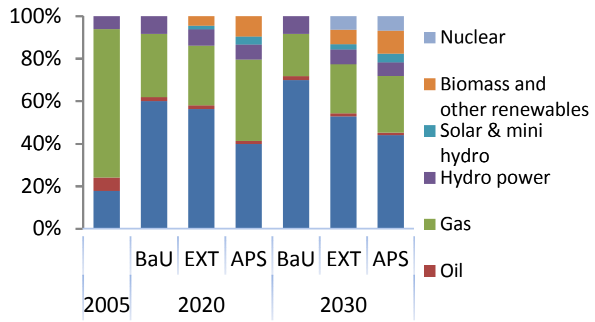


Figure 10. Share of power supply by energy source

Source : LCSM 2030

CO_2 emissions and reductions

In 2020BaU, CO_2 emissions from the energy sector are 363 $MtCO_2$, which is an increase of 150% from 2005. In 2030BaU, the emissions are 541$MtCO_2$, an increase of 273% from 2005. In the EXT scenario, CO_2 emissions from energy use are reduced by 21% and 44% in 2020 and 2030 from the BaU scenarios and in the APS scenario, the reductions are 45% and 55%.

EEI (energy efficiency improvement) in demand sectors shows the largest emission reduction in all scenarios (Table 7). Among the energy demand sectors, the commercial sector shows the largest reduction because of high potential of energy efficiency improvement of their buildings and equipment. Share of emission reduction by renewable energy ("Bio diesel in transport" plus "RE in power supply") is the highest in 2030APS, 17% of total emission reductions in the energy sector.

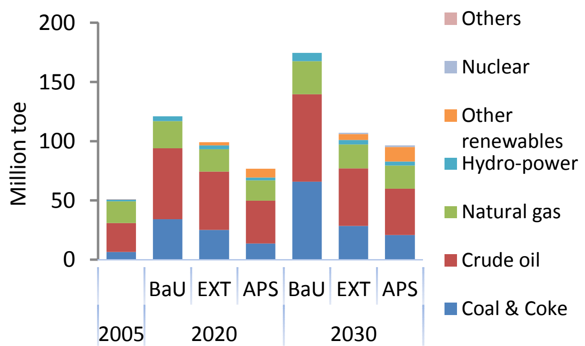


Figure 11. Primary energy supply by fuel

Source : LCSM 2030

Table 7. Emission reduction from BaU in energy sector ($ktCO_2$)

	2020 EXT		2030 EXT		2020 APS		2030 APS	
EE in demand sectors	48,146	63%	150,928	63%	83,362	53%	147,404	49%
Residential	*5,043*	*7%*	*15,055*	*6%*	*8,427*	*5%*	*16,264*	*5%*
Commercial	*17,769*	*23%*	*71,233*	*30%*	*29,710*	*19%*	*76,146*	*26%*
Industry	*6,174*	*8%*	*21,900*	*9%*	*16,231*	*10%*	*26,227*	*9%*
Pass. Transport	*11,663*	*15%*	*25,884*	*11%*	*16,912*	*11%*	*16,408*	*6%*
Fgt. Transport	*7,497*	*10%*	*16,855*	*7%*	*12,081*	*8%*	*12,359*	*4%*
Bio diesel in transport	1,998	3%	3,933	2%	17,729	11%	31,454	11%
Modal shift	4,605	6%	8,780	4%	11,837	7%	18,658	6%
RE in power supply	7,546	10%	13,779	6%	10,742	7%	18,146	6%
EE in power supply	13,587	18%	62,083	26%	34,814	22%	82,492	28%
Total	75,881	100%	239,503	100%	158,483	100%	298,153	100%

Source : LCSM 2030

Agriculture, Forestry and Other Land Use (AFOLU) Scenarios

AFOLU stands for "Agriculture, Forestry and Other Land Use". In Malaysia, due to its large forested area and mainly deforestation, this sector has both significant carbon sink and emissions. To consider the country's specific situation, we refer to national statistics/reports/publications such as the Malaysia Second National Communication to the UN-FCCC (NC2) and international statistics such as FAOSTAT (2011) to set historical trends of activity levels from base year (1970 for land use change; 2000 for agriculture) to 2009 and future scenarios. Future trends of activity levels are assumed based on current government plans/policies. If they are not available, future scenarios are estimated based on the extrapolation of the historical trend.

Assumptions in the BaU Scenarios

Assumptions in The BaU scenarios are shown in Table 8. Total harvested area of crops will increase to 11.3 million ha in 2030. Harvested area of oil palm in 2020 is referred to Wicke et al. (2011). The areas of other crops are extrapolated using the growth rates from 2005 to 2010. Numbers of all types of livestocks are set based on FAOSTAT (2011) for historical trends from 2005 to 2009. The future number of animals is estimated using a growth ratio averaged from 2005 to 2009. Forestland for 2000 and 2005 is based on the Ministry of Plantation Industries and Commodities (2008).

Table 8. Quantitative AFOLU sector assumption in 2030

Assumptions of AFOLU sector	
Harvested area of crops	Total harvested area of crops are 9.6 million ha (2000), 11.3 million ha (2030).
	Yields are increasing 2.5 times from 2000 to 2030. (Hasegawa, 2012)
	Oil palm area is increasing up to 5 million ha by 2020. (Wicke et al., 2011)
	Other crops is projected by extrapolation from 2005 to 2030 using a growth ratio from 2005 to 2009.
	Fertilizer per area is set based on yield.
Livestock animals	2000 is following NC2.
	2009 is the latest data, and following FAOSTAT.
	From 2010 to 2030, the numbers are estimated using a growth ratio from 2005 to 2009.
Land use & land use change	Forestland is following NC2 for 2000, 2005, 2009, 2010 and 2020.
	Grassland is following FAOSTAT (2011).
	Cropland is total harvested area of crops.
	A ratio of settlements to total country area: 5.8% (2008), 7.3% (2020) (NPP2, 2010)
	Other land: Total Land area – others

Source : LCSM 2030

Forestland has been classified into natural forests and plantation forests using data from the Ministry of Plantation Industries and Commodities, Malaysia (2009). Grassland is determined from historical trends of "Permanent meadows and pastures" in FAOSTAT (2011). Cropland from 1970 to 2009 is from "Arable land and Permanent crops" of FAOSTAT (2011). The values from 2010 to 2030 are extrapolated using a growth rate of total harvested area of crops from 2009 to 2030. Fraction of settlements in Peninsular Malaysia (5.8% in 2008, NPP2, 2010) is applied to the whole country. Other land is land not classified as the other categories.

Result of BaU Emissions

In the year 2030, the result shows that total GHG emission in the BaU case is expected to be -155MtCO_2eq. GHG emission from agriculture sector would be 7.9MtCO_2eq and GHG emissions and sink from LULUCF sector would be 54 and –217MtCO_2eq, respectively. N_2O emission is estimated from managed soils and livestock are expected to increase drastically (Figure 14).

Mitigation in AFOLU sectors

In the AFOLU sectors, we simulated GHG mitigation potentials by countermeasures under a wide range of Allowable Additional Costs (AAC) for GHG emission mitigation.

The result shows the potential in 2030 is 1.0 MtCO_2eq under AAC of 0 US$/t$CO_2$eq. It will increase to 75 MtCO_2eq under AAC of 10 US$/t$CO_2$eq and 75 and 76 Mt$CO_2$eq with 100 and over 100 US$/t$CO_2$eq of AAC. Since the potential does not increase much over 10 US$/t$CO_2$eq of AAC, 10 US$/tCO_2eq case was adopted for both EXT and APS scenarios.

With those countermeasures, emission from AFOLU sectors can be reduced by 8.3% in 2020 and 8.1% in 2030 from BaU scenario. The sink is increased by 22% in 2020 and 32% in 2030 from the BaU scenario.

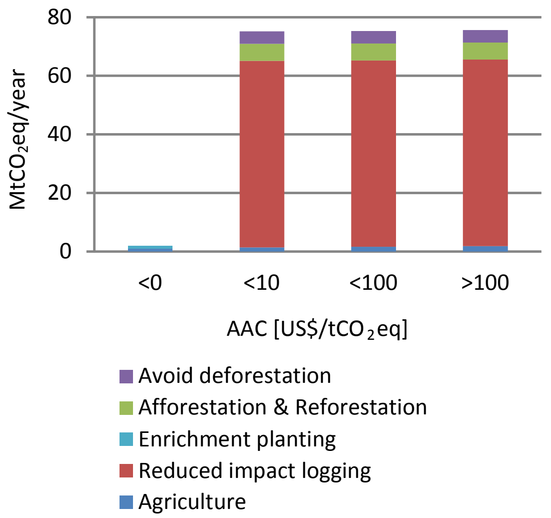


Figure 12. GHG mitigation potential in AFOLU sector in 2030

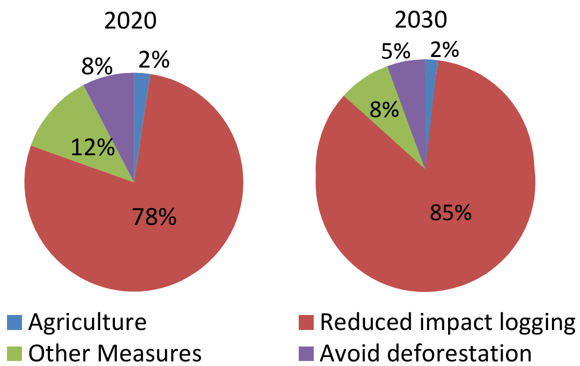


Figure 13. Composition of total mitigation potentials under 10US$/t$CO_2$eq of allowable additional cost

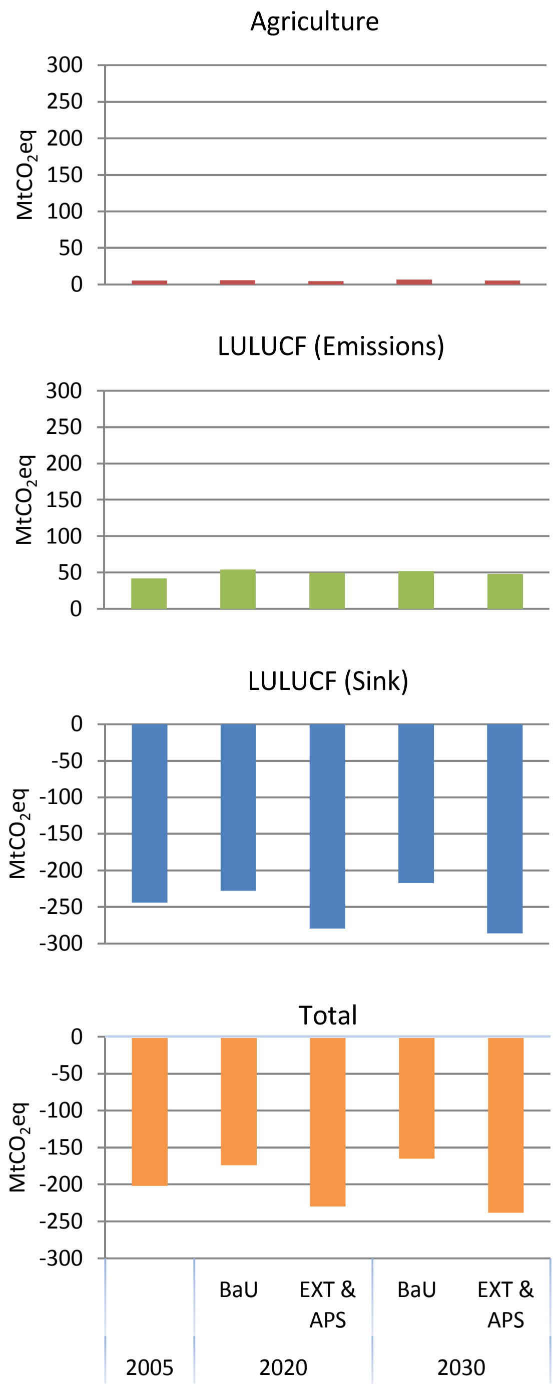


Figure 14. Amount of emissions and sink under 10US$/t$CO_2$eq of allowable additional cost

Waste & Other Emission Sources

GHG emissions, mainly methane, from waste management has a significant share in Malaysia's emission inventory. Policies for efficient resource use such as recycling also contribute to reducing GHG emissions. This section describes emission projection and contribution of the measures in the waste sector. Other emission sources are also considered.

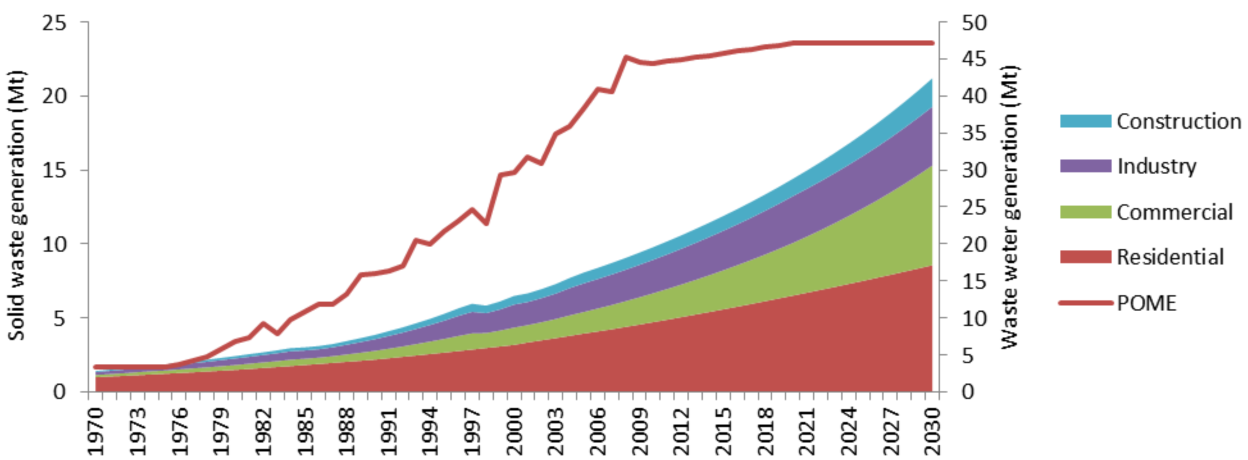
Assumptions of solid waste generation

Since it is necessary to develop a time-series inventory for estimation of GHG emission from solid waste disposal, the time period is extended for 1970 to 2030 (Figure 15). From 1970 to 1999, it is based on reported value of municipal solid waste (MSW) generation and composition in Malaysia.

Table 10. Assumption of Solid Waste Management

		BaU	EXT	APS
Recycling	2020	5.5%	40%	55%
	2030	5.5%	50%	60%
Incineration	2020	0.0%	10%	15%
	2030	0.0%	20%	20%
Composting	2020	2.2%	15%	15%
	2030	2.2%	25%	25%
CH_4 recovery	2020	0.0%	25%	35%
	2030	0.0%	40%	40%

Source : LCSM 2030



Source : LCSM 2030

Figure 15. Projection of Waste Generation

From 2021 to 2030, MSW of the residential sector was assumed by extrapolation of per capita waste generation using trends between 2000 and 2010. Municipal solid waste of the commercial sector and industrial waste are projected using the same generation factor as in the base year. Since palm oil mill effluent (POME) is considered a large emission source in Malaysia, its generation is also projected.

Scenarios

Table 10 summarises the assumptions for waste management and low-carbon measures. In the BaU scenario, the same share of management (recycling, landfill, incineration and biological treatment) is assumed and most of the solid waste is landfilled. In the EXT scenario mitigation options in Scenario 2 in NC2 are introduced. In the APS scenario, it includes more intensive implementation of mitigation options than that of the EXT scenario.

Projection of waste generation and GHG emissions

Solid waste generation increases by 25% in 2020 and 39% in 2030 from 2007. In BaU, GHG emission increases more than 2 times in 2020 and 2.8 times in 2030. In EXT, emission is reduced by 41% (2020) and 68% (2030) from BaU. In APS, emission is reduced by 54% (2020) and 74% (2030) from BaU. In the EXT scenario, CH_4 recovery shows the largest contribution. In the APS scenario, recycling is the largest and CH_4 recovery is less than in the EXT scenario because of less CH_4 generation resulted from other mitigation options (Figure 16).

Emissions from other emission sources

"Other emission sources" consists of two groups: (1) industrial process, and (2) fugitive emissions. In industrial process, CO_2 emissions from cement production and N_2O emission from nitric acid production are considered. This sector shared about 17% of the total emissions in 2005.

As for CO_2 emissions from cement production, CO_2 emissions in 2020 and 2030 in BaU are assumed to increase proportionally to the growth of that industry projected in the socio-economic scenario. CO_2 emissions in EXT and APS are assumed to decrease by 10% from BaU according to NC2, Chapter 3 Mitigation Analysis. About N_2O emission from nitric acid production, since nitric acid is no longer produced in Malaysia since 2005, emission from this sector is zero in all future scenarios. Fugitive emissions, CH_4 emissions from the energy sector, are assumed to change proportionally with natural gas production in the BaU scenario. In the EXT and APS scenarios, the emissions are reduced by 30% to 70% from BaU through measures such as capturing and leak monitoring system (Figure 17).

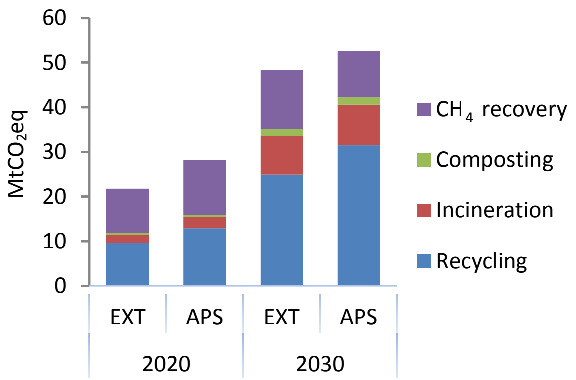


Figure 16. Contribution of Mitigation Options
Source : LCSM 2030

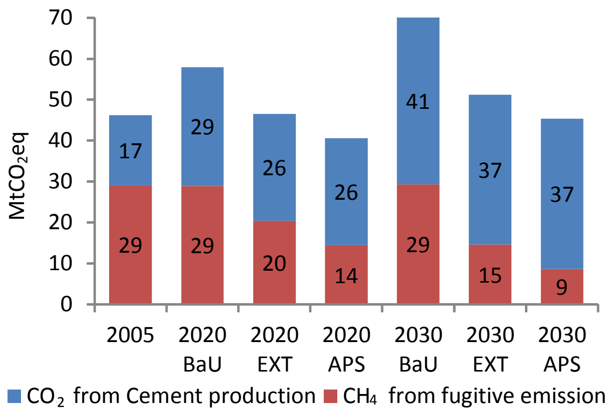


Figure 17. Emissions from other sources
Source : LCSM 2030

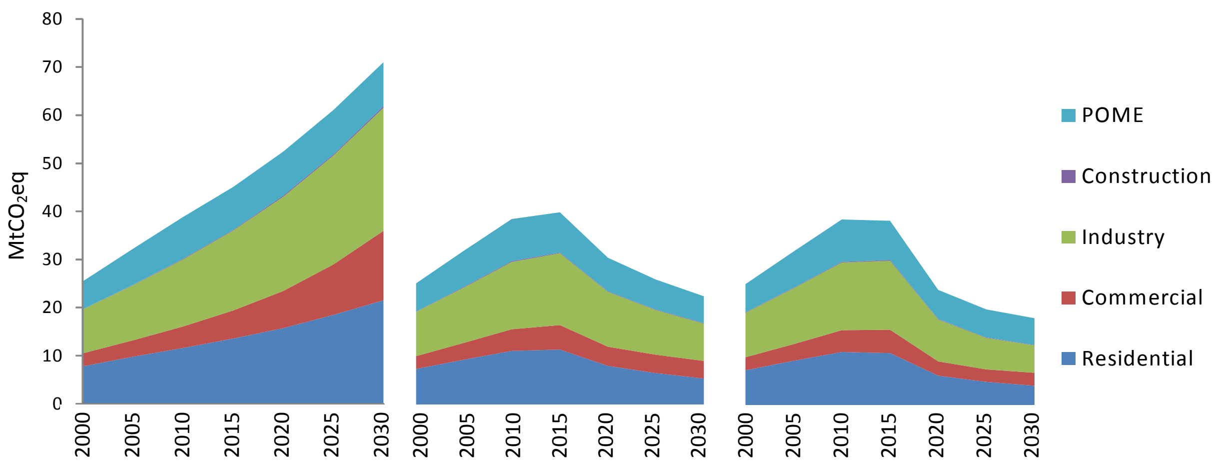


Figure 18. Projected Greenhouse Gas Emission of all scenarios in waste sectors and other emission sources
Source : LCSM 2030

Methodology

Framework of the study

In order to create a local low-carbon society scenario, a method based on the idea of "back casting", which sets a desirable goal first, and then seek the way to achieve it, was adopted. As common in most of the modeling studies, it also demands a number of statistical data in a wide range of field. Table 11 shows main information sources.

(1) Setting framework of the scenarios

Framework of a LCS scenario includes; target area, base year, target year, environmental target, and number of scenarios. 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 Malaysia in 2020 because of its official target year and extended to 2030 in order to consider investment which requires longer perspective. Environmental targets are -40% of GHG emission intensity in 2020 from 2005 (Malaysia's official target) and -60% in 2030 as an extension.

(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. This study followed existing governmental plans.

(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 projects socio-economic indices of the target year such as population, GDP, output by industry, transport demand, etc.

(4)Collection of low-carbon measures

To collect counter measures which are thought to be available in the target year. For example, energy efficient devices, transport structure change such as public transport, use of renewable energy, energy saving behavior and carbon sink in energy sector, recycling and CH4 recovery in waste sector, fertilizer management and manure management in agriculture, avoiding deforestation in forestry sector. Technical data is required to estimate their effect to reduce GHG emissions. In this research we employed the measures in preceding studies from Malaysian and international literatures.

(5)Setting introduction of counter measures

Technological parameters related to energy demand and CO2 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 and emission reductions by measures are calculated.

Extended Snapshot Tool (ExSS)

ExSS is a simplified simulation model for LCS study and projects socio-economic activity, energy demand and supply, waste generation, GHG emissions and emission reduction by measures. While each part of the tool is relatively simple, it can describe whole

Table 11. Main information sources

- Akiyama, H., X. Yan and K. Yagi, 2010: Evaluation of effectiveness of enhanced-efficiency fertilizers as mitigation options for N_2O and NO emissions from agricultural soils: meta-analysis, Global Change Biology (2010) 16, 1837-1846, doi: 10.1111/j.1365-2486. 2009.02031.x
- Amann, M., L. Hoglund Isaksson, W. Winiwarter, A. Tohka, F. Wagner, W. Schopp, I. Bertok, C. Heyes, 2008: Emission scenarios for non-CO_2 greenhouse gases in the EU-27 Mitigation potentials and costs in 2020.
- Asia Pacific Energy Research Centre, 2006: Apec Energy Demand And Supply Outlook 2006.
- Bates, J., 2001: Economic Evaluation of Sectorial Emission Reduction Objectives for Climate Change, ATAT Environment.
- DeAngelo, B. J., F. C. de la Chesnaye, R. H. Beach, A. Sommer, B. C. Murray, 2006: Methane and Nitrous Oxide Mitigation in Agriculture, The Energy Journal , Volume Multi-Greenhouse Gas Mitigation and Climate Policy, Special Issue #3, p. 89-108.
- Department of Statistics, Malaysia, 2010: Malaysia Yearbook of Statistics 2006.
- FAO, 2003: World Agriculture: Towards 2015/2030. An FAO Perspective. FAO, Rome.
- FAO, 2011: FAOSTAT. Download from: http://faostat.fao.org/default.aspx
- Fulton, L. and G. Eads, 2004: IEA-SMP Model Documentation and Reference Case Projection.
- Hasegawa T., Matsuoka Y. 2012: Greenhouse gas emissions and mitigation potentials in agriculture, forestry and other land use in Southeast Asia. Journal of Integrative Environmental Sciences, 9 (1), p.159-176.
- Ho, C.S., A. Supian, Z. S. M. H. Muhammad, L. W. Chau, Y. Matsuoka, G. Kurata, T. Fujiwara, K. Shimada, K. Gomi, K. Yoshimoto, J. J. Simson, 2009) Low-carbon city 2025 Sustainable Iskandar Malaysia.
- IPCC, 2007: Climate Change 2007, Mitigation of Climate Change, Working Group III Contribution to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change Summary for Policymakers and Technical Summary.
- Ministry of Energy, Water and Communications, Malaysia, 2005: National Energy Balance 2005 Malaysia.
- Ministry of Natural Resources and Environment Malaysia, 2011: Malaysia Second National Communication to the UNFCC.
- Ministry of Work, Malaysia, 2006: Road Traffic Volume Malaysia 2006.
- National Economic Advisory Council, 2010: New Economic Model for Malaysia Part1.
- National Physical Plan-2 (NPP2), 2010: Federal Department of Town and Country Planning.
- National Timber Industry Policy 2009-2020 (NATIP), 2009: Ministry of Plantation Industries and Commodities, Malaysia.
- Tang, C.K., 2005: Energy Efficiency in Residential Sector: A report prepared under the Malaysian - Danish Environmental Cooperation Programme Renewable Energy and Energy Efficiency Component.
- U.S. Department of Energy, 2003: Model Documentation Report: System for the Analysis of Global Energy Markets.
- United Nations Population Division, 2010: World Population Prospects: The 2010 Revision.
- Wetlands International – Malaysia, 2010: A Quick Scan of Peatlands in Malaysia.
- Wicke, B., Richard Sikkema, Veronika Dornburg, André Faaij (2011): Exploring land use changes and the role of palm oil production in Indonesia and Malaysia, Land Use Policy 28, 193–206.

picture of future society as a LCS in a quantitative and consistent manner with a greater flexibility than many other models. It also can consider most of the low-carbon measures existing and expected in near future.

Figure 19 shows the structure of ExSS; seven modules 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 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.

Passenger transport demand is projected 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 forces, activity level of each sector, energy demand by fuels determined with three parameters: 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.

Though it does not appear in the figure, ExSS also has a module to project GHG emissions from waste management. It projects waste generation from all sectors with variables from other modules (i.e. Macro-economy and Industry) and related parameters. For GHG emissions from landfill, it applies first-order decay method in order to consider delay of decomposition of organic waste after disposed.

AFOLUB model

AFOLU Bottom-up model (AFOLUB) is a bottom-up type model to estimate GHG emissions and mitigation potential in AFOLU sectors at country or regional level, dealing with quantified mitigation countermeasures. The emissions and mitigation potential are calculated using a function of Allowable Abatement Costs (AAC), which are representative parameters representing willingness of GHG reduction under several constraints for mitigation costs and mitigation potential. Moreover, the calculation is also based on future assumptions of crops harvested areas, numbers of livestock animal and area of land use change. The model illustrates selection of production countermeasures of the agricultural commodities and mitigation countermeasures by producers (i.e. farmers) based on economic rationality. Mitigation potential is estimated as a result of cost minimization choice of GHG mitigation countermeasures. In the AFOLUB, it is considered that the selection depends not only on cost and mitigation potential but also dependent relation between countermeasures.

As shown in Figure 20, the data set input in AFOLUB includes: i) list of countermeasures; ii) characteristics of the countermeasure such as cost, reduction effect, life time, diffusion ratio, energy consumption and recovery; iii) scenarios of crop production, number of livestock animals and area of land use and land-use change; iv) scenarios of fertilizer input, price of commodity and energy, and production technologies; and vi) future assumption on policy such as AAC for GHG mitigation, energy tax rate, subsidy and so on. Sources of emission and sink taken into account in the study are enteric fermentation and manure management of livestock, LULUCF (land use, land-use change and forestry), managed soils and rice cultivation. Target GHG in the study are carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O). LULUCF sector is considered as a source of both emission and sink of carbon.

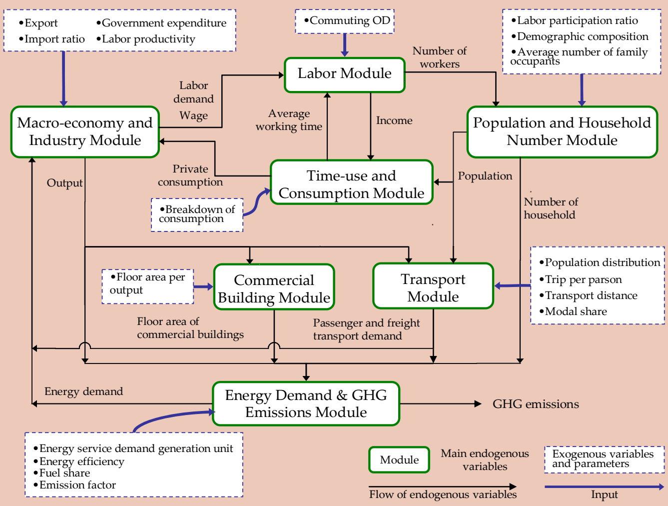


Figure 19. Structure of ExSS

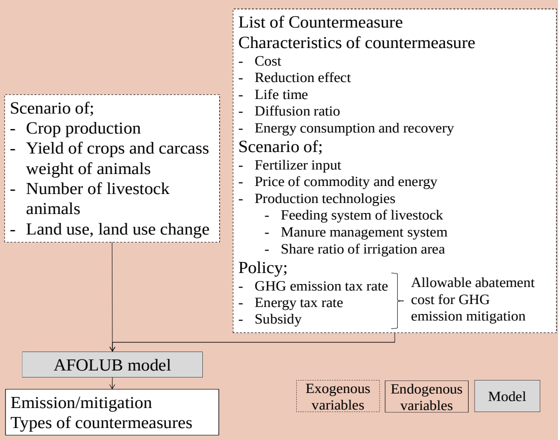


Figure 20. Input and output of AFOLUB

Data Tables

Input-Output tables (Billion RM)

2005

	Agriculture, Forestry & Fishing	Oil and Gas Mining	Other Mining	Food, Drink & Tabacco Products	Textiles & Wearing Apparel	Paper & Pulp	Petrolium Refinery & Coal Products	Chemical Products	Cement, Ceramic, Stone & Cray Products	Iron & Steel	Other Metal Products	General Machinery	Electric and Electronic Equipments	Transport Equipments	Other Manufacturing Products	Construction	Electricity & Gas supply	Water Works	Transport Services	Finance & Insurance	Real Estate	Wholesale & Retail	Accomodation & Restraunts	Education, Research & Development	Other Private Services	Public Services	Total Intermediate Input	Private Consumption	Government Consumption (General)	Gross Fixed Capital Formation	Change in Inventories	Exports	Imports	Total Final Demand	Total Output
Agriculture, Forestry & Fishing	6.2	0.0	0.0	24.1	1.0	0.8	0.0	1.1	0.0	0.0	0.0	0.1	0.5	0.0	6.3	0.1	0.0	0.0	0.0	0.0	0.0	6.8	0.0	0.0	0.3	0.2	47.7	8.1	0.0	1.2	-0.9	9.7	-10.6	7.4	55.1
Oil and Gas Mining	0.0	0.0	0.0	0.0	0.0	0.0	42.8	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	2.1	0.0	0.0	1.2	0.0	46.5	0.0	0.0	4.4	0.2	45.4	-13.5	36.6	83.1
Other Mining	0.0	0.1	0.0	0.0	0.0	0.1	0.1	0.5	0.6	0.7	0.5	0.0	0.0	0.0	0.2	1.2	1.2	0.0	0.0	0.0	0.0	0.4	0.0	0.0	0.1	0.1	5.7	0.1	0.0	0.0	-0.1	1.1	-3.1	-1.9	3.8
Food, Drink & Tabacco Products	2.2	0.0	0.0	26.7	0.0	0.0	0.0	2.9	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	5.5	0.0	0.0	0.2	0.5	38.3	24.7	0.0	0.0	-0.1	31.5	-13.9	42.2	80.5
Textiles & Wearing Apparel	0.0	0.0	0.0	0.0	3.9	1.0	0.0	0.0	0.0	0.0	0.0	0.2	0.1	0.5	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.1	0.3	7.3	3.6	0.0	0.0	0.3	8.0	-6.1	5.7	13.1
Paper & Pulp	0.0	0.0	0.0	1.3	0.1	9.8	0.0	0.3	0.2	0.0	0.2	0.1	1.0	0.1	0.9	0.0	0.0	0.0	0.4	0.3	0.2	2.0	0.1	0.5	0.9	0.5	19.0	5.5	0.0	0.5	0.2	10.9	-7.8	9.2	28.2
Petrolium Refinery & Coal Products	1.8	4.2	0.4	2.1	0.4	0.5	9.3	11.1	3.1	1.5	1.0	0.4	1.1	1.0	2.2	2.2	7.4	0.1	8.6	3.1	0.7	5.4	2.9	0.2	2.8	0.9	74.6	2.8	0.0	0.0	-0.1	18.9	-18.0	3.7	78.3
Chemical Products	3.4	0.0	0.0	0.5	1.0	0.7	3.5	14.1	0.4	0.2	1.0	0.4	10.1	0.9	6.8	0.3	0.0	0.0	0.2	0.1	0.0	6.2	0.0	0.0	0.6	1.4	52.0	6.8	0.0	0.0	0.4	35.7	-35.6	7.4	59.4
Cement, Ceramic, Stone & Cray Products	0.0	0.0	0.0	0.3	0.0	0.1	0.2	0.5	2.4	0.0	0.1	0.1	1.3	0.0	0.2	7.1	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.0	0.8	0.0	14.0	0.5	0.0	0.0	0.3	4.2	-3.2	1.8	15.8
Iron & Steel	0.0	0.0	0.0	0.0	0.0	0.4	0.0	0.1	0.4	5.9	7.3	2.1	0.5	3.5	0.4	2.9	0.0	0.0	0.0	0.0	0.0	2.4	0.0	0.0	0.5	0.0	26.3	0.0	0.0	0.0	-0.3	6.0	-11.9	-6.2	20.2
Other Metal Products	0.0	0.0	0.0	1.5	0.0	0.4	0.2	0.6	0.4	2.6	12.5	2.6	11.8	3.2	1.3	2.5	0.4	0.0	0.0	0.0	0.0	4.8	0.0	0.0	1.0	0.3	46.3	1.2	0.0	0.9	1.6	14.2	-26.8	-8.9	37.3
General Machinery	0.9	0.9	0.0	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.2	5.6	1.0	2.2	0.9	0.6	0.0	0.0	0.0	0.0	0.0	1.6	0.0	0.0	1.7	0.5	16.9	1.3	0.0	21.1	0.1	14.7	-30.9	6.2	23.1
Electric and Electronic Equipments	0.0	0.1	0.0	0.0	0.0	0.2	0.0	0.0	0.1	0.0	0.3	1.3	174.7	3.4	6.4	0.4	0.1	0.0	0.1	0.0	0.1	28.2	0.0	0.1	3.1	0.5	219.1	12.4	0.0	28.4	-0.5	252.2	-198	94.7	313.8
Transport Equipments	1.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.5	0.3	11.5	0.2	0.2	0.0	0.0	0.2	0.1	0.0	2.4	0.1	0.0	0.5	1.6	18.7	23.6	0.0	13.9	0.3	10.6	-25.6	22.9	41.6
Other Manufacturing Products	0.5	0.0	0.0	0.9	0.7	1.1	0.2	1.5	1.2	1.8	2.8	0.9	5.1	0.8	17.2	3.0	0.0	0.0	0.6	0.3	0.1	5.6	0.0	0.2	1.1	1.6	47.4	10.0	0.0	7.7	-1.4	37.8	-27.7	26.4	73.9
Construction	0.0	0.4	0.2	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	0.2	0.7	1.7	0.9	0.3	0.3	0.0	1.4	2.1	4.2	12.4	11.3	0.0	24.7	0.0	0.0	0.0	35.9	48.3
Electricity & Gas supply	0.3	0.0	0.0	0.4	0.3	0.3	0.4	0.7	0.4	0.5	0.5	0.2	1.1	0.5	1.1	0.1	4.5	0.2	0.2	0.3	0.4	1.3	1.3	0.3	1.3	0.7	17.5	8.2	0.0	0.0	0.0	0.3	0.0	8.5	26.0
Water Works	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	0.7	0.5	0.0	0.0	0.0	0.1	0.1	0.0	0.5	0.0	2.0	2.4	0.0	0.0	0.0	0.0	0.0	2.4	4.4
Transport Services	0.8	0.9	0.1	2.0	0.4	0.8	3.8	1.6	0.8	0.4	1.0	0.5	5.8	1.3	2.1	1.0	0.2	0.0	15.3	6.7	0.1	4.6	0.2	0.2	2.7	1.5	54.4	5.4	0.0	1.8	0.0	5.6	-10.4	2.4	56.9
Finance & Insurance	0.8	0.1	0.0	0.5	0.3	0.5	0.1	2.2	0.1	2.0	0.5	0.2	0.7	0.4	0.8	1.5	0.1	0.0	4.1	29.6	1.0	2.8	1.0	0.2	8.3	0.3	58.1	17.2	0.0	0.0	0.0	31.6	-2.4	46.4	104.5
Real Estate	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.8	3.0	1.2	2.2	0.4	2.2	1.3	13.7	20.0	0.0	0.0	0.0	0.0	0.0	20.0	33.7
Wholesale & Retail	3.4	6.9	0.9	6.6	0.9	2.4	10.9	4.2	0.9	0.9	2.4	2.2	43.9	2.8	5.6	2.8	0.7	0.0	1.0	3.7	0.1	19.5	0.2	0.6	3.6	4.1	131.3	18.1	0.0	11.5	0.1	28.6	0.0	58.3	189.5
Accomodation & Restraunts	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	0.0	0.0	0.0	0.1	0.1	1.6	5.9	0.1	0.5	0.4	9.1	23.5	0.0	0.0	0.0	0.0	-5.9	17.6	26.7
Education, Research & Development	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	0.0	0.4	0.1	0.0	0.9	7.1	17.8	0.1	0.0	0.0	-3.5	21.6	22.5
Other Private Services	0.5	3.8	0.4	0.8	0.2	0.4	2.1	1.2	0.3	0.1	0.5	0.4	8.1	1.0	0.8	7.5	1.0	0.5	7.0	9.4	6.2	8.4	2.2	3.0	27.9	6.7	100.6	14.2	1.0	1.5	0.0	31.2	-34.3	13.7	114.2
Public 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	0.2	0.4	0.0	0.0	0.0	0.0	1.4	4.0	6.2	6.1	45.5	0.0	0.4	0.0	-8.0	44.0	50.2
Total Intermediate Input	21.8	17.5	2.3	67.8	9.4	19.7	73.8	43.1	11.5	16.9	30.9	18.0	267.3	33.3	53.6	33.8	16.5	2.2	41.1	57.1	12.5	114.8	16.3	7.9	65.4	31.6	1086	234.2	64.2	117.6	0.6	598.2	-497	517.9	1604
Domestic Tax	0.1	0.1	0.0	0.3	0.0	0.1	0.1	0.3	0.1	0.0	0.0	0.2	0.1	4.4	0.2	0.2	0.2	0.0	0.2	0.1	0.0	1.1	0.1	0.0	0.7	0.0	8.6								
Total Value Added	33.2	65.5	1.5	12.4	3.6	8.4	4.4	15.9	4.1	3.3	6.4	4.8	46.4	3.9	20.0	14.3	9.3	2.2	15.7	47.3	21.2	73.6	10.4	14.6	48.1	18.6	509.3								
- Compensation of Employee	10.9	1.0	0.4	2.5	1.0	2.4	0.6	2.3	1.3	0.8	2.0	1.1	11.4	1.0	5.9	8.9	0.8	0.2	5.9	11.8	1.2	21.8	5.7	10.3	20.1	14.4	145.7								
- Operating Surplus	22.3	64.5	1.1	9.9	2.6	6.1	3.9	13.6	2.8	2.4	4.4	3.8	35.0	2.9	14.1	5.5	8.5	2.0	9.8	35.6	20.0	51.8	4.7	4.2	28.0	4.2	363.5								
Total Input	55.1	83.1	3.8	80.5	13.1	28.2	78.3	59.4	15.8	20.2	37.3	23.1	313.8	41.6	73.9	48.3	26.0	4.4	56.9	104.5	33.7	189.5	26.7	22.5	114.2	50.2	1604								

2020

	Agriculture, Forestry & Fishing	Oil and Gas Mining	Other Mining	Food, Drink & Tabacco Products	Textiles & Wearing Apparel	Paper & Pulp	Petrolium Refinery & Coal Products	Chemical Products	Cement, Ceramic, Stone & Cray Products	Iron & Steel	Other Metal Products	General Machinery	Electric and Electronic Equipments	Transport Equipments	Other Manufacturing Products	Construction	Electricity & Gas supply	Water Works	Transport Services	Finance & Insurance	Real Estate	Wholesale & Retail	Accomodation & Restraunts	Education, Research & Development	Other Private Services	Public Services	Total Intermediate Input	Private Consumption	Government Consumption (General)	Gross Fixed Capital Formation	Change in Inventories	Exports	Imports	Total Final Demand	Total Output
Agriculture, Forestry & Fishing	9.5	0.0	0.0	36.4	1.6	1.5	0.0	2.2	0.0	0.0	0.0	0.2	0.9	0.0	11.1	0.2	0.0	0.0	0.0	0.0	0.1	16.6	0.0	0.0	0.9	0.3	81.6	7.9	0.0	2.5	0.0	9.7	-17.8	2.3	83.9
Oil and Gas Mining	0.0	0.0	0.0	0.0	0.0	0.0	85.1	0.6	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	5.2	0.0	0.0	3.3	0.0	94.2	0.0	0.0	9.2	0.0	33.7	-83.0	-40.1	54.1
Other Mining	0.0	0.0	0.0	0.0	0.0	0.1	0.2	1.0	1.0	1.3	0.8	0.0	0.0	0.0	0.4	2.0	2.7	0.0	0.0	0.0	0.0	0.9	0.0	0.0	0.2	0.2	10.8	0.1	0.0	0.0	0.0	1.1	-9.0	-7.9	3.0
Food, Drink & Tabacco Products	3.3	0.0	0.0	40.4	0.0	0.1	0.0	5.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	13.4	0.0	0.1	0.6	0.8	64.6	25.5	0.0	0.0	0.0	51.8	-20.3	57.1	121.7
Textiles & Wearing Apparel	0.0	0.0	0.0	0.0	6.7	1.7	0.0	0.0	0.0	0.0	0.0	0.3	0.3	1.0	0.4	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.1	0.3	0.5	13.5	7.0	0.0	0.0	0.0	13.1	-11.4	8.7	22.2
Paper & Pulp	0.0	0.0	0.0	1.9	0.1	17.6	0.0	0.5	0.3	0.0	0.4	0.2	1.7	0.3	1.5	0.0	0.1	0.0	0.8	0.8	0.5	4.9	0.3	1.0	2.6	0.9	36.6	10.8	0.0	1.0	0.0	17.8	-15.3	14.3	50.9
Petrolium Refinery & Coal Products	2.8	2.7	0.3	3.2	0.7	1.0	18.5	21.4	5.4	2.7	1.7	0.8	1.8	2.0	3.9	3.5	17.0	0.4	18.3	7.9	2.0	13.1	8.0	0.5	7.6	1.5	148.7	5.6	0.0	0.0	0.0	37.9	-36.7	6.8	155.5
Chemical Products	5.2	0.0	0.0	0.8	1.8	1.3	6.9	27.2	0.7	0.4	1.7	0.7	16.9	1.8	12.1	0.5	0.0	0.1	0.4	0.2	0.1	15.1	0.0	0.0	1.7	2.4	97.9	13.3	0.0	0.0	0.0	71.4	-68.2	16.6	114.5
Cement, Ceramic, Stone & Cray Products	0.0	0.0	0.0	0.5	0.0	0.1	0.4	0.9	4.2	0.1	0.2	0.1	2.2	0.1	0.3	11.5	0.0	0.0	0.0	0.0	0.1	1.7	0.0	0.0	2.2	0.0	24.6	0.9	0.0	0.0	0.0	7.0	-5.7	2.2	26.8
Iron & Steel	0.0	0.0	0.0	0.0	0.0	0.7	0.0	0.2	0.6	10.5	12.4	3.7	0.8	6.9	0.7	4.6	0.0	0.0	0.0	0.0	0.1	5.7	0.0	0.0	1.4	0.0	48.2	0.0	0.0	0.0	0.0	9.9	-22.5	-12.6	35.6
Other Metal Products	0.0	0.0	0.0	2.2	0.0	0.6	0.4	1.2	0.7	4.7	21.2	4.6	19.9	6.3	2.3	4.1	1.0	0.1	0.0	0.0	0.2	11.6	0.0	0.0	2.8	0.4	84.2	2.4	0.0	1.9	0.0	23.3	-48.5	-20.9	63.4
General Machinery	1.3	0.6	0.0	0.2	0.2	0.2	0.1	0.2	0.2	0.1	0.3	9.8	1.6	4.3	1.6	1.0	0.0	0.0	0.0	0.0	0.1	4.0	0.0	0.0	4.6	0.9	31.3	2.6	0.0	48.2	0.0	24.1	-66.0	9.0	40.3
Electric and Electronic Equipments	0.0	0.1	0.0	0.0	0.0	0.4	0.0	0.0	0.2	0.0	0.5	2.3	293.5	6.6	11.4	0.6	0.1	0.0	0.1	0.1	0.2	68.5	0.0	0.2	8.5	0.8	394.3	24.4	0.0	88.6	0.0	414.6	-395	132.9	527.2
Transport Equipments	1.5	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.8	0.5	22.5	0.3	0.3	0.0	0.0	0.5	0.3	0.1	5.8	0.3	0.0	1.5	2.8	37.3	46.4	0.0	34.7	0.0	17.5	-54.6	44.0	81.2
Other Manufacturing Products	0.7	0.0	0.0	1.4	1.3	2.0	0.4	2.8	2.1	3.2	4.8	1.6	8.6	1.5	30.4	4.9	0.0	0.1	1.2	0.8	0.2	13.6	0.0	0.4	3.0	2.8	88.1	19.7	0.0	16.0	0.0	62.2	-54.9	43.0	131.1
Construction	0.0	0.3	0.1	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	0.4	2.0	3.6	2.3	1.0	0.8	0.0	2.8	5.7	7.2	26.3	13.2	0.0	38.5	0.0	0.0	0.0	51.7	78.0
Electricity & Gas supply	0.4	0.0	0.0	0.6	0.5	0.6	0.8	1.4	0.6	0.9	0.8	0.4	1.8	1.0	2.0	0.2	10.3	0.6	0.5	0.8	1.1	3.2	3.7	0.7	3.6	1.2	37.7	21.3	0.0	0.0	0.0	0.5	-0.1	21.7	59.5
Water Works	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	0.0	1.5	1.4	0.0	0.0	0.0	0.1	0.2	0.1	1.3	0.1	5.1	8.0	0.0	0.0	0.0	0.0	0.0	8.0	13.1
Transport Services	1.2	0.6	0.1	3.0	0.7	1.4	7.5	3.0	1.3	0.7	1.6	0.9	9.7	2.6	3.7	1.6	0.5	0.0	32.7	16.8	0.2	11.2	0.6	0.3	7.4	2.5	111.7	18.1	0.0	3.7	0.0	10.8	-22.9	9.8	121.5
Finance & Insurance	1.2	0.0	0.0	0.7	0.5	1.0	0.2	4.2	0.2	3.5	0.8	0.3	1.1	0.8	1.4	2.5	0.1	0.1	8.8	74.3	2.9	6.9	2.7	0.4	22.8	0.6	138.2	57.5	0.0	0.0	0.0	72.8	-6.4	123.9	262.1
Real Estate	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	3.2	4.6	9.1	2.9	6.0	0.8	6.0	2.2	35.0	66.9	0.0	0.0	0.0	0.0	0.0	66.9	102.0
Wholesale & Retail	5.2	4.5	0.7	10.0	1.5	4.3	21.7	8.2	1.5	1.5	4.0	3.8	73.7	5.4	10.0	4.6	1.6	0.1	2.1	9.3	0.4	47.5	0.7	1.3	9.8	7.0	240.4	60.6	0.0	23.9	0.0	136.4	0.0	220.9	461.2
Accomodation & Restraunts	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	0.1	0.1	0.1	0.2	0.2	4.0	16.4	0.3	1.3	0.7	23.8	78.5	0.0	0.0	0.0	0.0	-28.3	50.2	74.0
Education, Research & Development	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	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.1	0.0	0.9	0.2	0.1	1.8	23.9	26.5	0.2	0.0	0.0	-7.2	43.5	45.3
Other Private Services	0.7	2.5	0.3	1.2	0.4	0.7	4.2	2.3	0.6	0.2	0.8	0.7	13.7	1.9	1.5	12.2	2.4	1.4	14.9	23.7	18.9	20.4	6.1	6.0	76.6	11.6	225.7	47.6	1.4	3.2	0.0	118.4	-82.9	87.7	313.4
Public 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	0.4	1.1	0.1	0.1	0.0	0.0	3.8	6.9	12.7	20.4	67.6	0.0	0.0	0.0	-14.1	73.8	86.5
Total Intermediate Input	33.2	11.4	1.8	102.5	16.0	35.5	146.5	83.2	19.7	29.8	52.4	31.5	449.0	65.0	95.2	54.6	37.8	6.5	87.7	143.2	37.7	279.3	45.1	15.9	179.5	54.4	2114	582.7	95.5	271.6	0.0	1134	-1071	1013	3128
Domestic Tax	0.2	0.0	0.0	0.5	0.0	0.1	0.2	0.7	0.1	0.1	0.1	0.4	0.2	8.6	0.4	0.3	0.4	0.0	0.3	0.1	0.1	2.7	0.1	0.0	1.9	0.0	17.5								
Total Value Added	50.6	42.6	1.2	18.7	6.1	15.2	8.8	30.6	7.0	5.8	10.9	8.5	78.0	7.6	35.5	23.1	21.3	6.6	33.5	118.7	64.2	179.2	28.7	29.3	132.0	32.1	995.7								
- Compensation of Employee	16.6	0.6	0.3	3.7	1.8	4.3	1.1	4.4	2.2	1.5	3.4	1.9	19.2	2.0	10.5	14.3	1.9	0.7	12.5	29.5	3.7	53.2	15.7	20.8	55.2	24.8	305.8								
- Operating Surplus	34.0	42.0	0.9	15.0	4.4	10.9	7.7	26.2	4.8	4.3	7.5	6.6	58.8	5.6	25.0	8.8	19.4	5.9	21.0	89.2	60.5	126.0	13.0	8.5	76.8	7.2	690.0								
Total Input	83.9	54.1	3.0	121.7	22.2	50.9	155.5	114.5	26.8	35.6	63.4	40.3	527.2	81.2	131.1	78.0	59.5	13.1	121.5	262.1	102.0	461.2	74.0	45.3	313.4	86.5	3128								

2030

	Agriculture, Forestry & Fishing	Oil and Gas Mining	Other Mining	Food, Drink & Tabacco Products	Textiles & Wearing Apparel	Paper & Pulp	Petrolium Refinery & Coal Products	Chemical Products	Cement, Ceramic, Stone & Cray Products	Iron & Steel	Other Metal Products	General Machinery	Electric and Electronic Equipments	Transport Equipments	Other Manufacturing Products	Construction	Electricity & Gas supply	Water Works	Transport Services	Finance & Insurance	Real Estate	Wholesale & Retail	Accomodation & Restraunts	Education, Research & Development	Other Private Services	Public Services	Total Intermediate Input	Private Consumption	Government Consumption (General)	Gross Fixed Capital Formation	Change in Inventories	Exports	Imports	Total Final Demand	Total Output
Agriculture, Forestry & Fishing	10.0	0.0	0.0	49.1	2.0	2.1	0.0	3.0	0.1	0.0	0.0	0.2	1.1	0.1	14.6	0.3	0.0	0.0	0.0	0.0	0.2	31.3	0.0	0.1	1.9	0.5	116.4	9.3	0.0	4.1	0.0	9.2	-50.3	-27.7	88.8
Oil and Gas Mining	0.0	0.0	0.0	0.0	0.0	0.0	129.9	0.8	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	9.8	0.0	0.0	7.0	0.0	147.5	0.0	0.0	14.8	0.0	26.2	-148	-107	40.7
Other Mining	0.0	0.0	0.0	0.0	0.0	0.2	0.3	1.4	1.4	1.6	0.9	0.0	0.0	0.0	0.5	3.3	4.6	0.0	0.0	0.0	0.0	1.7	0.0	0.0	0.4	0.3	16.8	0.1	0.0	0.0	0.0	0.9	-15.8	-14.7	2.0
Food, Drink & Tabacco Products	3.5	0.0	0.0	54.5	0.0	0.1	0.0	7.6	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.3	0.0	0.0	0.0	0.0	0.1	25.2	0.0	0.1	1.2	1.5	94.4	34.5	0.0	0.0	0.0	68.4	-32.8	70.0	164.4
Textiles & Wearing Apparel	0.0	0.0	0.0	0.0	8.4	2.4	0.0	0.1	0.0	0.0	0.0	0.3	0.3	1.3	0.5	0.0	0.0	0.0	0.0	0.0	0.1	4.0	0.0	0.1	0.7	0.9	19.1	9.4	0.0	0.0	0.0	17.3	-18.0	8.7	27.8
Paper & Pulp	0.0	0.0	0.0	2.6	0.2	24.2	0.0	0.7	0.4	0.0	0.5	0.2	2.0	0.3	2.0	0.0	0.1	0.0	1.3	1.4	1.0	9.3	0.6	1.9	5.5	1.6	56.0	14.6	0.0	1.5	0.0	23.5	-25.9	13.7	69.7
Petrolium Refinery & Coal Products	2.9	2.0	0.2	4.3	0.9	1.3	28.3	29.0	7.9	3.3	2.1	0.8	2.2	2.6	5.1	5.7	29.6	0.7	31.6	13.9	3.7	24.7	16.6	0.9	16.2	2.6	239.4	7.5	0.0	0.0	0.0	57.0	-66.6	-2.1	237.3
Chemical Products	5.6	0.0	0.0	1.1	2.2	1.8	10.6	37.0	1.0	0.5	2.1	0.7	20.2	2.3	15.8	0.7	0.0	0.2	0.7	0.3	0.2	28.5	0.0	0.0	3.5	4.3	139.2	18.0	0.0	0.0	0.0	107.4	-109	16.2	155.4
Cement, Ceramic, Stone & Cray Products	0.0	0.0	0.0	0.6	0.0	0.2	0.6	1.2	6.1	0.1	0.3	0.1	2.7	0.1	0.4	18.8	0.0	0.1	0.0	0.0	0.2	3.3	0.0	0.0	4.6	0.0	39.4	1.2	0.0	0.0	0.0	9.2	-10.2	0.2	39.6
Iron & Steel	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.3	0.9	13.1	15.1	3.9	0.9	8.9	0.9	7.5	0.0	0.0	0.0	0.0	0.1	10.8	0.0	0.0	2.9	0.0	66.5	0.0	0.0	0.0	0.0	13.1	-35.2	-22.1	44.3
Other Metal Products	0.0	0.0	0.0	3.0	0.1	0.9	0.6	1.7	1.1	5.8	25.8	4.9	23.8	8.2	3.0	6.7	1.7	0.1	0.0	0.0	0.3	21.8	0.0	0.0	6.0	0.8	116.1	3.2	0.0	3.1	0.0	30.8	-76.0	-38.9	77.2
General Machinery	1.4	0.5	0.0	0.3	0.2	0.3	0.2	0.2	0.3	0.1	0.4	10.5	2.0	5.6	2.1	1.6	0.0	0.1	0.0	0.0	0.1	7.5	0.0	0.0	9.7	1.6	44.7	3.5	0.0	77.4	0.0	31.9	-114	-1.6	43.1
Electric and Electronic Equipments	0.0	0.1	0.0	0.0	0.0	0.5	0.0	0.0	0.3	0.1	0.6	2.5	350.9	8.6	14.9	1.0	0.3	0.1	0.2	0.2	0.3	129.4	0.0	0.4	18.0	1.4	529.7	33.0	0.0	142.4	0.0	547.0	-622	100.6	630.2
Transport Equipments	1.6	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.9	0.6	29.2	0.4	0.4	0.0	0.0	0.9	0.5	0.1	10.9	0.6	0.0	3.2	5.0	54.4	62.7	0.0	55.7	0.0	23.1	-90.4	51.1	105.5
Other Manufacturing Products	0.8	0.0	0.0	1.9	1.6	2.8	0.6	3.8	3.1	4.0	5.8	1.8	10.3	2.0	39.9	8.0	0.0	0.1	2.1	1.4	0.3	25.7	0.0	0.7	6.5	4.9	128.3	26.6	0.0	25.7	0.0	82.0	-90.8	43.6	171.9
Construction	0.0	0.2	0.1	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	0.7	3.7	6.2	4.1	1.9	1.5	0.0	5.0	12.1	12.6	48.3	17.8	0.0	61.8	0.0	0.0	0.0	79.7	127.9
Electricity & Gas supply	0.5	0.0	0.0	0.8	0.6	0.8	1.2	1.9	0.9	1.1	1.0	0.4	2.2	1.3	2.6	0.3	17.9	1.1	0.9	1.4	2.1	6.0	7.6	1.2	7.7	2.0	63.6	39.1	0.0	0.0	0.0	0.8	-0.1	39.9	103.5
Water Works	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.0	2.6	2.5	0.1	0.0	0.1	0.2	0.4	0.1	2.8	0.1	9.5	14.7	0.0	0.0	0.0	0.0	0.0	14.7	24.2
Transport Services	1.2	0.4	0.0	4.0	0.9	1.9	11.4	4.1	1.9	0.8	2.0	1.0	11.6	3.3	4.9	2.6	0.9	0.0	56.4	29.7	0.5	21.1	1.3	0.6	15.7	4.4	182.6	33.4	0.0	6.0	0.0	15.9	-28.6	26.7	209.4
Finance & Insurance	1.3	0.0	0.0	0.9	0.6	1.3	0.3	5.7	0.4	4.4	1.0	0.4	1.4	1.1	1.9	4.0	0.2	0.2	15.1	131.4	5.4	12.9	5.6	0.6	48.5	1.0	245.9	105.8	0.0	0.0	0.0	120.2	-8.6	217.5	463.3
Real Estate	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	5.6	8.2	16.9	5.5	12.4	1.4	12.8	3.8	66.9	123.3	0.0	0.0	0.0	0.0	0.0	123.3	190.2
Wholesale & Retail	5.5	3.4	0.5	13.6	1.8	5.9	33.1	11.1	2.1	1.9	4.9	4.1	88.1	7.0	13.1	7.5	2.8	0.2	3.6	16.4	0.8	89.6	1.4	2.3	20.9	12.3	354.0	111.6	0.0	38.4	0.0	366.4	0.0	516.3	870.4
Accomodation & Restraunts	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	0.5	0.2	0.2	0.2	0.3	0.3	7.5	33.7	0.5	2.8	1.2	47.7	144.6	0.0	0.0	0.0	0.0	-39.9	104.7	152.4
Education, Research & Development	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.0	0.0	0.0	0.0	0.1	0.1	0.1	0.2	0.1	1.6	0.4	0.1	3.2	44.0	42.6	0.4	0.0	0.0	-9.3	77.7	80.9
Other Private Services	0.8	1.8	0.2	1.6	0.4	0.9	6.4	3.2	0.9	0.3	1.0	0.7	16.3	2.5	1.9	20.0	4.1	2.6	25.7	41.9	35.2	38.5	12.5	10.7	163.1	20.4	413.6	87.7	2.3	5.1	0.0	272.7	-114	253.9	667.5
Public 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	0.6	2.0	0.3	0.2	0.0	0.1	8.2	12.1	23.6	37.6	108.6	0.0	0.0	0.0	-17.9	128.3	151.9
Total Intermediate Input	35.1	8.6	1.2	138.5	20.1	48.7	223.6	113.0	29.0	37.1	63.8	33.7	536.8	84.4	124.8	89.5	65.8	12.1	151.1	253.2	70.4	527.1	93.0	28.4	382.4	95.6	3267	983.4	153.5	436.5	0.0	1823	-1723	1673	4940
Domestic Tax	0.2	0.0	0.0	0.7	0.1	0.2	0.4	0.9	0.2	0.1	0.1	0.4	0.2	11.2	0.6	0.5	0.6	0.0	0.6	0.3	0.1	5.1	0.3	0.0	4.0	0.1	26.5								
Total Value Added	53.5	32.1	0.8	25.2	7.7	20.8	13.4	41.6	10.4	7.2	13.3	9.0	93.2	9.9	46.5	37.9	37.1	12.1	57.7	209.9	119.7	338.2	59.2	52.5	281.2	56.3	1646								
- Compensation of Employee	17.6	0.5	0.2	5.0	2.2	5.8	1.7	5.9	3.3	1.9	4.1	2.0	23.0	2.6	13.7	23.5	3.2	1.3	21.6	52.2	6.8	100.3	32.4	37.2	117.7	43.6	529.3								
- Operating Surplus	35.9	31.6	0.6	20.2	5.5	15.0	11.7	35.6	7.1	5.3	9.2	7.0	70.3	7.3	32.8	14.4	33.8	10.9	36.1	157.7	112.9	237.8	26.8	15.3	163.5	12.7	1117								
Total Input	88.8	40.7	2.0	164.4	27.8	69.7	237.3	155.4	39.6	44.3	77.2	43.1	630.2	105.5	171.9	127.9	103.5	24.2	209.4	463.3	190.2	870.4	152.4	80.9	667.5	151.9	4940								

Greenhouse Gas Emissions

BaU ($MtCO_2eq$)

	2005		2020		2030	
Energy	145	54%	363	68%	541	73%
Residential	*13*	*5%*	*27*	*5%*	*46*	*6%*
Commercial	*19*	*7%*	*83*	*16%*	*189*	*25%*
Industry	*62*	*23%*	*142*	*27%*	*181*	*24%*
Pass. Transport	*25*	*9%*	*70*	*13%*	*80*	*11%*
Fgt. Transport	*25*	*9%*	*41*	*8%*	*46*	*6%*
Waste	32	12%	52	10%	71	10%
Solid waste	*25*	*9%*	*43*	*8%*	*62*	*8%*
Waste water	*7*	*3%*	*9*	*2%*	*9*	*1%*
AFOLU (emission)	47	17%	60	11%	59	8%
Agriculture	*5*	*2%*	*6*	*1%*	*7*	*1%*
LULUCF	*42*	*16%*	*54*	*10%*	*52*	*7%*
Others	46	17%	58	11%	70	9%
Energy (fugitive emission)	*29*	*11%*	*29*	*5%*	*29*	*4%*
Industrial process	*17*	*6%*	*29*	*5%*	*41*	*5%*
Emission total	271	100%	534	100%	741	100%
AFOLU (sink)	-244		-228		-217	
Net Emission	27		306		524	

EXT ($MtCO_2eq$)

	2005		2020		2030	
Energy	145	55%	288	71%	302	72%
Residential	*13*	*5%*	*20*	*5%*	*22*	*5%*
Commercial	*19*	*7%*	*57*	*14%*	*79*	*19%*
Industry	*62*	*23%*	*128*	*32%*	*138*	*33%*
Pass. Transport	*25*	*10%*	*50*	*12%*	*38*	*9%*
Fgt. Transport	*25*	*10%*	*32*	*8%*	*25*	*6%*
Waste	25	10%	31	8%	23	5%
Solid waste	*20*	*7%*	*24*	*6%*	*17*	*4%*
Waste water	*6*	*2%*	*7*	*2%*	*6*	*1%*
AFOLU (emission)	47	18%	30	8%	30	7%
Agriculture	*5*	*2%*	*5*	*1%*	*5*	*1%*
LULUCF	*42*	*16%*	*26*	*6%*	*25*	*6%*
Others	46	17%	55	14%	66	16%
Energy (fugitive emission)	*29*	*11%*	*29*	*7%*	*29*	*7%*
Industrial process	*17*	*6%*	*26*	*6%*	*37*	*9%*
Emission total	264	100%	404	100%	421	100%
AFOLU (sink)	-244		-279		-286	
Net Emission	20		125		140	

APS ($MtCO_2eq$)

	2005		2020		2030	
Energy	145	55%	200	65%	243	68%
Residential	*13*	*5%*	*12*	*4%*	*18*	*5%*
Commercial	*19*	*7%*	*32*	*10%*	*61*	*17%*
Industry	*62*	*23%*	*108*	*35%*	*127*	*35%*
Pass. Transport	*25*	*10%*	*27*	*9%*	*19*	*5%*
Fgt. Transport	*25*	*10%*	*21*	*7%*	*18*	*5%*
Waste	25	10%	24	8%	18	5%
Solid waste	*20*	*7%*	*18*	*6%*	*13*	*4%*
Waste water	*6*	*2%*	*6*	*2%*	*6*	*2%*
AFOLU (emission)	47	18%	30	10%	30	9%
Agriculture	*5*	*2%*	*5*	*1%*	*5*	*1%*
LULUCF	*42*	*16%*	*26*	*8%*	*25*	*7%*
Others	46	17%	55	18%	66	18%
Energy (fugitive emission)	*29*	*11%*	*29*	*9%*	*29*	*8%*
Industrial process	*17*	*6%*	*26*	*8%*	*37*	*10%*
Emission total	264	100%	309	100%	357	100%
AFOLU (sink)	-244		-279		-286	
Net Emission	20		30		76	

Energy Consumption

		Coal	Oil	Gas	Biomass	Electricity	Total
2005	Residential	0	783	5	0	1,395	2,183
	Commercial	0	756	23	0	2,172	2,951
	Industry	1,348	5,556	5,317	0	3,371	15,592
	Pass. Transport	0	7,671	46	0	3	7,720
	Fgt. Transport	0	7,612	49	0	2	7,663
	Total	1,348	22,378	5,440	0	6,943	36,109
2020BaU	Residential	0	1,160	8	0	2,459	3,627
	Commercial	0	2,204	46	0	7,986	10,236
	Industry	2,364	15,808	9,574	0	6,096	33,842
	Pass. Transport	0	20,291	132	0	227	20,650
	Fgt. Transport	0	12,402	80	0	2	12,484
	Total	2,364	51,865	9,840	0	16,770	80,839
2020EXT	Residential	0	1,113	8	0	1,959	3,079
	Commercial	0	2,078	46	0	6,195	8,319
	Industry	2,225	15,172	8,955	0	5,886	32,238
	Pass. Transport	0	14,523	120	364	251	15,258
	Fgt. Transport	0	9,730	80	243	2	10,056
	Total	2,225	42,617	9,208	607	14,293	68,950
2020APS	Residential	0	989	7	0	1,447	2,444
	Commercial	0	1,794	44	0	4,270	6,108
	Industry	1,936	14,823	7,580	0	5,379	29,719
	Pass. Transport	0	7,490	95	2,230	237	10,053
	Fgt. Transport	0	6,202	80	1,870	2	8,154
	Total	1,936	31,299	7,807	4,100	11,336	56,478
2030BaU	Residential	0	1,865	12	0	3,953	5,830
	Commercial	0	4,696	98	0	17,083	21,877
	Industry	3,293	20,267	12,857	0	7,011	43,428
	Pass. Transport	0	23,082	151	0	258	23,490
	Fgt. Transport	0	13,653	88	0	3	13,744
	Total	3,293	63,563	13,207	0	28,307	108,370
2030EXT	Residential	0	1,663	12	0	2,416	4,091
	Commercial	0	3,982	98	0	9,612	13,693
	Industry	2,801	18,130	10,689	0	6,134	37,754
	Pass. Transport	0	10,687	123	598	303	11,711
	Fgt. Transport	0	7,565	88	428	3	8,084
	Total	2,801	42,027	11,011	1,026	18,467	75,332
2030APS	Residential	0	1,620	12	0	2,220	3,852
	Commercial	0	3,831	98	0	8,690	12,619
	Industry	2,706	17,691	10,259	0	5,916	36,572
	Pass. Transport	0	5,306	86	3,333	292	9,016
	Fgt. Transport	0	5,251	88	3,431	3	8,773
	Total	2,706	33,699	10,543	6,763	17,120	70,832

Universiti Teknologi Malaysia
Ho Chin Siong
Chau Loon Wai

Kyoto University, Japan
Yuzuru Matsuoka
Kei Gomi
Janice Simson
Ryohei Osawa

National Institute for Environmental Studies, Japan
Mikiko Kainuma
Junichi Fujino
Tomoko Hasegawa

November 2013