MALAYSIA

BIENNIAL UPDATE REPORT TO THE UNFCCC

Malaysia

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This is Malaysia's First Biennial Update Report submitted to the United Nations Framework Convention on Climate Change in December 2015.

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UNITS

mm	millimetre
cm	centimetre
m	metre
km	kilometre
km^2	square kilometer
ha	hectare
m^3	cubic metre
g	gram
kg	kilogram
t	tonne
kt	kilotonne
Gg	gigagram
Mt	million tonnes
hr	hour
yr	year
TJ	Tera Joule
PJ	Peta Joule
toe	tonnes of oil equivalent
ktoe	kilo tonne of oil equivalent
Mtoe	million tonne of oil equivalent
t CO_2eq	tonnes of carbon dioxide equivalent
kWh	kilowatt hour
MW	megawatt
MWh	megawatt hour
GWh	gigawatt hour
RM	Ringgit Malaysia (Malaysian Ringgit)
^oC	degree Celsius

CHEMICAL ELEMENTS

C	carbon
K	potassium
N	nitrogen
P	phosphorous

GASES

CFC	chlorofluorocarbon
CF_4	tetrafluoromethane
C_2F_6	hexafluoroethane
CO_2	carbon dioxide
CH_4	methane
HFC	hydrofluorocarbon
N_2O	nitrous oxide
PFC	perfluorocarbon
SF_6	sulphur hexafluoride

CONVERSION TABLE

1 tonne	=	10^3 kg	=	10^6 g		
1 k tonne	=	10^6 kg	=	10^9 g	=	1 Gg
1 M tonne	=	10^9 kg	=	10^{12} g	=	10^3 Gg

$1km^2$	=	100 ha

1 TJ	=	10^{12} Joules
1 PJ	=	10^{15} Joules = 10^3 TJ

LIST OF ACRONYMS

ADB	Asian Development Bank
AGB	Above ground biomass
ATF	Automotive Authorised Treatment Facilities Framework
AWMS	Animal waste management system
BAU	Business as usual
BEI	Building energy index
BOF	Blast oxygen furnace
BUR	Biennial Update Report
BUR-ICA	Biennial Update Report International Consultation and Analysis
B5	A blend of 5% palm oil diesel and 95% petroleum diesel
B7	A blend of 7% palm oil diesel and 93% petroleum diesel
B10	A blend of 10% palm oil diesel and 90% petroleum diesel
CDM	Clean Development Mechanism
CER	Certified Emission Reduction
CETDEM	Centre for Environment, Technology and Development, Malaysia
CFS	Central Forest Spine
CKD	Completely knocked down
CNCA	Cement and Concrete Association of Malaysia
CNG	Compressed natural gas
COD	Chemical oxygen demand
COP	Conference of Parties
CPA	Component project activities
CVA	Completion and verification assessment
DAP	Diammonium phosphate
DEFRA	Department for Environment, Food and Rural Affairs (United Kingdom)
dbh	Diameter at breast height
DOA	Department of Agriculture
DOC	Degradable organic carbon
DOE	Department of Environment
DOM	Dead organic matter
DOS	Department of Statistics Malaysia
DRI	Direct reduced iron
DSM	Demand side management
DVS	Department of Veterinary Science
EAF	Electric arc furnace
EC	European Commission
EEV	Energy-efficient vehicle
EFB	Empty fruit bunch
EPC	Energy Performance Contracting
EPP	Entry point project
EPU	Economic Planning Unit
ESG	Environmental, Social and Governance
EToU	Enhanced Time of Use
ETP	Economic Transformation Programme
EU	European Union

EWS	Early warning system
FFB	Fresh fruit bunch
F-gases	Fluorinated gases
FiT	Feed-in Tariff
FMRS	Forest Monitoring System using Remote Sensing
FRL	Forest Reference Level
FRIM	Forest Research Institute Malaysia
FTSE	Financial Times Stock Exchange
F4GBM	FTSE4Good Bursa Malaysia
GBI	Green building index
GDP	Gross domestic product
GEF	Global Environment Facility
GGP	Government Green Procurement
GHG	Greenhouse gas
GITA	Green investment tax allowance
GITE	Green income tax exemption
GLBE	Government lead by example
GNI	Gross national income
GWP	Global warming potential
GTFS	Green Technology Financing Scheme
GTP	Government Transformation Programme
HCVF	High conservation value forests
HoB	Heart of Borneo
ICE	Internal Combustion Engine
ICLEI	Local Governments for Sustainability
IFM	Integrated flood management
INC	Initial National Communication
IPCC	Intergovernmental Panel on Climate Change
IRDA	Iskandar Regional Development Authority
ISGAN	International Smart Grid Action Network
ITTO	International Tropical Timber Organisation
KL	Kuala Lumpur
KLIA	Kuala Lumpur International Airport
KTM	*Keretapi Tanah Melayu* (Malayan Railways)
KVMRT	Klang Valley Mass Rapid Transit
LCCF	Low Carbon Cities Framework
LCS	Low-carbon society
LEAD	Low Emissions Asian Development
LEAF	Lowering Emissions in Asia's Forest
LFG	Landfill gas
LPG	Liquified petroleum gas
LRT	Light rail transit
LULUCF	Land use, land-use change and forestry
MAA	Malaysian Automotive Association
MABDR	Malaysia Automotive Bumiputera Development Roadmap
MAHR	Malaysia Automotive Human Capital Roadmap
MAI	Mean annual increment
MAP	Monoammonium phosphate

MARDI	Malaysian Agricultural Research and Development Institute
MARR	Malaysia Automotive Remanufacturing Roadmap
MASCR	Malaysia Automotive Supply Chain Roadmap
MATR	Malaysia Automotive Technology Roadmap
MEGTW	Ministry of Energy, Green Technology and Water
MEPS	Minimum energy performing standards
MGTC	Malaysian Green Technology Corporation
MIGHT	Malaysian Industry-Government Group for High Technology
MIROS	Malaysian Institute of Road Safety Research
MISIF	Malaysian Iron and Steel Federation
MOA	Ministry of Agriculture and Agro-based Industry
MoW	Ministry of Works
MPA	Malaysian Petrochemicals Association
MPOB	Malaysian Palm Oil Board
MRSA	Malaysian Remote Sensing Agency
MRT	Mass rapid transit
MRV	Measurement, reporting and verification
MSPO	Malaysian sustainable palm oil
MSW	Municipal solid waste
MTC	Malaysian Timber Council
MTCC	Malaysian Timber Certification Council
MTCS	Malaysian Timber Certification Scheme
MURNInets	Malaysian Urban Indicator Network
MyGAP	Malaysian Good Agriculture Practices
NAHRIM	National Hydraulic Research Institute of Malaysia
NAP	National Automotive Policy
NCBURNSC	National Communication and Biennial Update Report National Steering Committee
NSCCC	National Steering Committee on Climate Change
NC	National Communication
NC2	Second National Communication
NC3	Third National Communication
NEB	National Energy Balance
NEEAP	National Energy Efficiency Action Plan
NEM	New Economic Model
NSC	National Steering Committee
NSCREDD	National Steering Committee for REDD+
NFA	National Forestry Act
NFI	National Forest Inventory
NFP	National Forestry Policy
NGO	Non-governmental organisation
NKEA	National Key Economic Area
NKRA	National Key Results Area
NRE	Ministry of Natural Resources and Environment
NWRP	National Water Resources Policy
PoA	Programme of activities
POME	Palm oil mill effluent
PRF	Permanent reserved forest
PV	Photovoltaic

PWD	Public Works Department
QA/QC	Quality assurance, quality control
RE	Renewable energy
REDD+	Reducing Emissions from Deforestation and Forest Degradation, and the Role of Conservation, Sustainable Management of Forests and Enhancement of Forest Carbon Stocks in Developing Countries
RISDA	Rubber Industry Smallholders Development Authority
RSO	Research and Systematic Observation
RSPO	Roundtable on Sustainable Palm Oil
RT	Refrigerant tonne
SAR	Second Assessment Report (of IPCC)
SAVE	Sustainability achieved via energy efficiency
SBST	Stage bus services transformation
SEDA	Sustainable Energy Development Authority
SIT	Special Industrial Tariff
SLF	State land forest
SMR	Standard Malaysian Rubber
SPAD	*Suruhanjaya Pengangkutan Awam Darat* (Land Public Transport Commission)
SRI	Strategic Reform Initiative
SWDS	Solid waste disposal site
SWG	Sub-Working Group
TOD	Transit-orientated development
TPA/PA	Totally Protected Areas
TWG	Technical Working Group
TWN	Third World Network
UK	United Kingdom
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development
USEPA	United States Environmental Protection Agency
VCS	Verified carbon standard
VCU	Verified carbon unit
WGIA	Workshop on Greenhouse Gas Inventories in Asia
WWF	World Wide Fund for Nature
3R	Reuse, Reduce, Recycle

FOREWORD

It gives me great pleasure to present to you Malaysia's first Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC). This document provides an update on the information contained in Malaysia's Second National Communication (NC2) which was submitted to the UNFCCC in January 2011. The BUR contains information on national greenhouse gas inventory for 2011 and time series information where possible from 1990. Apart from the listing of mitigation actions and their effects, the report also provides an overview of the programmes that are beneficial to mitigation of climate change that the country would be implementing in its development plan up to 2020.

At the 15th Conference of Parties (COP15) in Copenhagen, our Prime Minister announced that Malaysia would voluntarily reduce its emissions intensity of gross domestic product (GDP) by up to 40% by 2020 based on 2005 levels. This initiative, which is conditional to technology transfer and financial support from developed countries, demonstrates Malaysia's commitment to addressing greenhouse gas (GHG) emissions in the context of sustainable development. Being a tropical country with abundant rainfall, forest has been among our natural heritage. We are committed to maintaining at least 50% of the country with forest cover. In this regard, in 2011, the GHG emission intensity per unit of GDP, taking into account Land Use, Land-Use Change and Forestry (LULUCF) emissions only, has improved by approximately 23% compared with 2005 levels. With the inclusion of removals by LULUCF, the GHG emission intensity per unit GDP had improved by 32% in 2011 compared with 2005 levels.

Malaysia's BUR would not have been possible without the cooperation and commitment of numerous experts and stakeholders and the contributions of valuable data from government ministries, agencies, research organisations, industries, industry associations, universities and non-governmental organisations. My sincere thanks also go to the National Steering Committee, Technical Working Groups and Sub-Working Groups for their hard work and dedication in making this report possible. I would also like to take this opportunity to thank the UNFCCC, Global Environment Facility (GEF) and United Nations Development Programme (UNDP) for providing the funds for this report.

DATO' SRI DR HAJI WAN JUNAIDI TUANKU JAAFAR
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EXECUTIVE SUMMARY

Introduction

This Biennial Update Report (BUR) has been prepared to meet Malaysia's obligations as a Party to the United Nations Framework Convention on Climate Change (UNFCCC). As a non-Annex I Party, the BUR is submitted to meet Malaysia's reporting requirements under Article 4, paragraph 1(a) and Article 12 of the Convention and Decision 1/CP.16.

The BUR provides an update on Malaysia's Second National Communication (NC2), which was submitted to the UNFCCC in 2011. In accordance with the Guidelines in Annex III of Decision 2/CP.17, the BUR comprises the following:

- Chapter 1 provides updated information on national circumstances and institutional arrangements;
- Chapter 2 is an update on the national greenhouse gas inventory;
- Chapter 3 provides information on mitigation actions and their effects;
- Chapter 4 describes the level of support received, including information on the support received to enable the preparation and submission of the BUR;
- Chapter 5 highlights the constraints and gaps, and related financial, technical and capacity needs; and
- Chapter 6 provides other information on addressing climate change.

The BUR is a Government of Malaysia output of the United Nations Development Programme-Global Environment Facility (UNDP-GEF) Project, Third National Communication to the UNFCCC and Biennial Update Reporting for Malaysia. The BUR builds on the NC2 process.

1. National Circumstances

Information is provided on national circumstances up to the year 2013 for the sectors where published statistics are available. Over the past four decades, increasing temperature trends have been observed.

The total population of Malaysia in 2011 was estimated at 29.1 million. This grew to 29.9 million in 2013. Population increased by 24.9% over the period 2000-2011. Malaysia launched the Economic Transformation Programme (ETP) in 2010 to catalyse investment and economic growth. GDP (at 2005 constant prices) grew from RM543.6 billion in 2005 to RM711.8 billion in 2011 and RM787.6 billion in 2013.

Primary energy supply and energy demand are expected to grow with population and economic growth. Recent policies have focussed on reducing dependency on petroleum products and mainstreaming environmental considerations, while ensuring reliable, affordable energy and safeguarding energy security. The promotion of renewable energy remains a priority for Malaysia, as evidenced by enforcement of Renewable Energy Act 2011 and implementation of Feed-in Tariff (FiT) scheme. In the Eleventh Malaysia Plan, new renewable energy resources such as wind and geothermal energy will be explored in diversifying the energy mix.

The Land Public Transport Commission (SPAD) was established in 2010 to provide a holistic solution to land public transport system in cities. Efforts are underway to reduce traffic congestion by extending the light rail transit (LRT) system and developing the Klang Valley Mass Rapid Transit (KVMRT) project.

Oil palm is the most economically important agricultural crop. Sustainable practices have been introduced, including utilisation and optimisation of idle agriculture land, and product certification. As of 2011, about 5 million ha have been planted with oil palm; however, the ETP National Key Economic Area (NKEA) suggests that the potential arable land for oil palm cultivation is limited and therefore enhancement of productivity is a key target. Other agricultural crops of significant hectarage are rubber and paddy. Overall livestock population, landings of marine fish and aquaculture production increased in the period 2000-2011. Key data on these for 2011 is provided in Appendix 1.

Malaysia has taken a stepwise approach to privatise and centralise its solid waste management. In 2012, the average waste generation per capita per day increased compared with 2007. Food residues are the biggest contributor (45%), while plastics decreased from 24% to 13.2% and paper increased from 7% to 8.5%, from 2005 to 2012.

Finally, in terms of institutional arrangements, the National Green Technology & Climate Change Council, chaired by the Hon. Prime Minister of Malaysia, was established to provide a platform for high-level decision-making on climate change. Operational matters are guided and endorsed by a National Steering Committee on Climate Change (NSCCC). Technical Working Groups were established under the National Communication and Biennial Update Report National Steering Committee (NCBURNSC) which reports to NSCCC to prepare national communications and biennial update reports to the UNFCCC. In addition, the National Steering Committee on REDD+ (NSCREDD) was established in 2011 to guide the development of a national REDD+ strategy for implementation.

2. National Greenhouse Gas Inventory

The greenhouse gas (GHG) inventory details the anthropogenic emissions and removals for the year 2011 for five sectors: energy; industrial processes; agriculture; land use, land-use change and forestry (LULUCF); and waste. The inventory also contains time series estimates that were recalculated to reflect updated activity data. Total GHG emissions were 290.23 Mt CO_2eq and net emissions were 27.28 Mt CO_2eq as presented in Table ES 1.

Table ES 1: GHG Inventory for 2011

Sector	Emissions (Mt CO_2eq)	Sink (Mt CO_2eq)
Energy	218.914	
Industrial Processes	18.166	
Agriculture	15.775	
LULUCF	2.490	- 262.946
Waste	34.885	
Total	290.230	- 262.946
Net Total (after subtracting sink)	27.284	

Apart from the LULUCF sector, which was a major source in the inventory reported in NC2, emission contributions between sectors were similar to those reported in that report. For 2011, the energy sector was the highest contributor to GHG emissions at 76%, followed by the waste sector at 12%,

industrial processes sector at 6%, agriculture sector at 5% and LULUCF emissions at 1%. Emissions in the energy sector increased by 48%, industrial processes sector by 46%, agriculture sector by 35%, waste sector by 45% and LULUCF net removals increased by 14% between the years 2000 and 2011. Carbon dioxide (CO_2) emissions amounted to 72% of total GHG emissions in 2011 and methane (CH_4) and nitrous oxide (N_2O) emissions amounted to 23% and 5% respectively. Over the same period, CO_2 emissions including LULUCF emissions only, increased by 31%, CH_4 emissions by 37% and N_2O emissions by 44%.

Three different approaches were used to calculate the GHG emission intensity indices. With LULUCF emissions, GHG emissions per capita and per GDP were 9.974 t CO_2eq/capita and 0.4078 t CO_2eq/thousand RM respectively in 2011. Compared with 2005 levels, GHG emissions per capita decreased by 9.8% while GHG emission intensity of GDP decreased by 23%. Taking into consideration both LULUCF emissions and removals, GHG emissions per capita and per GDP were 0.938 t CO_2eq/capita and 0.0383 t CO_2eq/thousand RM respectively in 2011. Under this approach GHG emissions per capita and per GDP decreased by 20.7% and 32.5% respectively compared to 2005 levels. The population and GDP increased by 11.5% and 30.9% respectively over the same period.

3. Mitigation Actions and Effects

In 2009, Malaysia announced it would voluntarily reduce GHG emission intensity of GDP by up to 40% by 2020 as compared with 2005 levels, conditional upon receiving technology transfer and adequate financing from developed countries. This chapter links Malaysia's policies and programmes with specific mitigation actions and their effects. However, only a subset of the measures could be adequately quantified in terms of GHG emission reductions. Table ES 2 shows that in 2013, a total of 18.57 million t CO_2eq emissions were reduced.

Table ES 2: Summary of Emissions Reduction Achieved in 2013 and Projected for 2020

Sector	Mitigation Action	Emission Reduction Achieved in 2013 (kt CO_2eq)	Potential Emission Reduction in 2020 (kt CO_2eq)
Energy	RE implementation through Feed-in Tariff mechanism	252.78	5,458.09
	RE electricity generation by non Feed-in Tariff regulated public and private licensees and other mechanisms	948.77	2,179.29
	Use of palm-based biodiesel in blended petroleum diesel	719.74	1,802.49
	Application of green technology	94.81	1,426.35
	Implementation of green building rating scheme	60.40	858.40
	Efficient electricity consumption in all Federal Government ministry buildings (baseline established in 2013)	-	98.21
	Reducing emissions through development and usage of energy-efficient vehicles (EEVs)	40.96	199.74
	Use of compressed natural gas (CNG) in motor vehicles	154.62	217.57
	Rail-based public transport	214.93	977.51
LULUCF	Sustainable forest management	13,797.37	13,800.00
Waste	Waste paper recycling	1,993.47	2,159.45
	Biogas capture from palm oil mill effluent (POME) treatment	300.95	3,001.89
Total		**18,578.80**	**32,178.99**

The measurement, reporting and verification (MRV) of mitigation actions in Malaysia are coordinated by the Ministry of Natural Resources and Environment (NRE). Mitigation action data are collated by the Technical Working Group (TWG) on Mitigation, and verification is conducted by the Technical Working Group on Verification under the National Steering Committee on Climate Change. Guidelines for MRV are being developed and tested.

Malaysia has benefited from investments in GHG emissions reduction projects through participation in the Clean Development Mechanism (CDM) under the Kyoto Protocol. As of April 2015, Malaysia has a total of 143 registered CDM projects. Up to the end of the first Kyoto commitment period, the projects were expected to yield 23.95 million t CO_2eq emissions reduction. Malaysia has also participated in 11 voluntary carbon market projects.

4. Level of Support

As per Article 4.3 of the UNFCCC, Malaysia has received capacity building, technical and financial support from international sources to enable the country to fulfil its obligations under the Convention and to better implement actions to address climate change. In the chapter, the support received by federal agencies to specifically address climate change is described, while the support received at sub-national level is reported to the extent possible. The manner in which international funds have been channelled has, however, not enabled tracking and clear identification of the support.

The bulk of the financial support has been provided through the GEF, the operating entity of the financial mechanism of the UNFCCC. Since the entry into force of the UNFCCC, the total amount of funding received from GEF for climate change activities up to June 2014 is USD46,510,020.

The support received has focused mainly on enhancing Malaysia's institutional and technical capacity on reporting obligations to the UNFCCC and on implementing mitigation actions. This has been channelled through the UNDP and the United Nations Industrial Development Organisation (UNIDO) in Malaysia.

Financial support of USD352,000 was provided for the preparation of the BUR, which also enabled the development of the national GHG inventory and the mitigation analysis. Additional funding contributed to capacity building and the development of the MRV system.

In the area of forests, a REDD+ readiness programme was supported. Two initiatives with a regional focus paid particular attention to the strengthening of institutional capacity in technical and policy issues with regard to the potential implementation of REDD+ activities. Other forest-related support included external consultancy expertise for institutional capacity building, and for sustainable forest management and community development.

Malaysia has also received capacity building support from the Intergovernmental Panel on Climate Change (IPCC) and a number of Annex 1 Parties. Japan and the United States have helped enhance the technical capacity of Malaysia's GHG inventory compilers.

5. Constraints Gaps, and Needs

This chapter describes the constraints, gaps and related needs for GHG inventory, mitigation, vulnerability and adaptation, and research and systematic observation. These are summarised and presented in Appendix 2. Many constraints and gaps exist for the various GHG emitting economic

sectors, particularly in terms of technical and capacity gaps. Malaysia also faces challenges in adapting to the impacts of climate change while ensuring that development gains are protected. It is critical that the constraints and gaps hindering more systematic and widespread uptake of both mitigation and adaptation efforts are concurrently addressed to avoid loss of mitigation gains.

In general, there are persistent constraints in the areas of institutional arrangements, and in the regulatory and financial support needed to create an enabling environment for mitigation action. All efforts require substantial and continued technical capacity development, financial assistance and as appropriate, international collaboration.

6. Other Information on Addressing Climate Change

Information on several cross-cutting and other initiatives that are addressing climate change is provided in this chapter. This is in addition to the policies described in Chapter 3. The areas addressed are a framework of low-carbon or green cities, Government Green Procurement (GGP) and National Corporate Greenhouse Gas Reporting Programme for Malaysia (also known as MyCarbon).

While concrete efforts have been undertaken thus far, real challenges remain in ensuring policy coherence. There is also an urgent need for better coordination across the various ministries and agencies. In addition, proper implementation of the policies in order to yield concrete results remains a substantial challenge. Additional and timely international assistance in the forms of financing, technology transfer and capacity building would help shift Malaysia on its path towards low-carbon economic development more quickly and more substantially.

INTRODUCTION

This Biennial Update Report (BUR) is prepared to meet Malaysia's reporting obligations to the United Nations Framework Convention on Climate Change (UNFCCC) in line with Decision 1/CP.16 and following the guidelines in Annex III of Decision 2/CP17. The report contains an update of the National Circumstances until 2013 in Chapter 1. This is followed by a description of the Greenhouse Gas (GHG) Inventory for 2011, with time series GHG emissions information in Chapter 2. Mitigation Actions and their Effects for 2013 are contained in Chapter 3. A brief description of the Level of Support received for climate change from international sources is provided in Chapter 4. Constraints, Gaps and Needs for addressing climate change and Additional Information on Addressing Climate Change are presented in Chapters 5 and 6 respectively.

The preparation of the report was funded by the United Nations Development Programme-Global Environment Facility (UNDP-GEF) Project on Third National Communication to the UNFCCC and Biennial Update Report for Malaysia (NC3/BUR Project). The overall NC3/BUR Project budget USD1,656,450, with USD852,000 from GEF, USD300,000 cost sharing by the Government of Malaysia, USD404,450 in-kind from the Government and USD100,000 in-kind from UNDP. This is for both the preparation of this BUR and the NC3 including BUR2 due in 2017. Of the USD852,000 from GEF, USD352,000 is for the preparation of this BUR.

This BUR preparation constituted the first part of the NC3/BUR Project. During this phase, strong emphasis was placed on updating the GHG Inventory, quantification of mitigation actions and their effects and establishing a sustainable and low cost Measurement, Reporting and Verification (MRV) system for mitigation actions.

The NC3/BUR process is conducted under the stewardship of the Ministry of Natural Resources and Environment, Malaysia (NRE). Consequently, NRE chairs both the Project Management Group and the Project Steering Committee. Technical guidance is provided by six Technical Working Groups (TWG), these being on GHG Inventory, Mitigation, MRV, Vulnerability and Adaptation (V&A), Socio Economic Aspects of Climate Change, and Research and Systematic Observation (RSO). The main technical work for the BUR/NC is carried out by Sub-Working Groups (SWG) constituted under each of the TWGs, assisted as necessary by consultants. The institutional arrangement for NC3/BUR is discussed in greater detail in section 1.11 of Chapter 1: National Circumstances.

The report preparation process has helped Malaysia further develop its institutional arrangements for the preparation of NC/BUR. The project structure required direct involvement from a wide pool of stakeholders representing a broad range of government agencies, the private sector, research institutions, non-governmental organisations (NGOs) and academic institutions. This exercise has therefore strengthened the coordination, capacity and capability of the TWGs and enlarged the pool of experts, in particular for GHG inventory development. Numerous meetings and workshops were held by each TWG and its SWGs. This process, while time consuming, has helped fill data gaps and resolve data inconsistencies. It has also increased participating stakeholders' knowledge and strengthened collaboration on climate change.

In the Eleventh Malaysia Plan (2016-2020), one of the main thrusts is on 'Pursuing Green Growth for Sustainability and Resilience'. The strategies to embark on green growth were highlighted in the

three accompanying namely Strategy Paper 11: ‘Climate Resilient Development’; Strategy Paper 12: ‘Growth through Sustainable Use of Natural Resources’; and Strategy Paper 17: ’Sustainable Usage of Energy to Support Growth’. These papers focussed on prudent and efficient management of resources by adopting the sustainable consumption and production concept. Hence, climate change actions are already being mainstreamed into national development to realise adaptation and mitigation co-benefits from all sectors of the economy. Awareness of the need to quantify mitigation actions and their effects is increasing among the government agencies and the private sector; however, the institutional arrangements for MRV are still under development.

CHAPTER 1

NATIONAL CIRCUMSTANCES

CHAPTER 1: NATIONAL CIRCUMSTANCES

This chapter updates information on national circumstances up to the year 2013 for the sectors where published statistics are available. The information contained in this chapter was used for the assessment in the rest of the report.

1.1 Geography: Location & Topography

Malaysia is a nation located in Southeast Asia and together with its territorial waters lie between 0º 51' N and 7º 33' N, and 98º 01' E and 119º 30' E. It consists of 13 states and three Federal Territories. Eleven of the states and two of the Federal Territories (of Kuala Lumpur and Putrajaya) are in Peninsular Malaysia, and these are separated by the South China Sea from the states of Sabah and Sarawak in the island of Borneo. The Federal Territory of Labuan consisting of the whole island of Labuan is located off the coast of western Sabah. Malaysia has an area of approximately 330,803 km^2, with about 5,267 km of coastline and over 879 islands.

The topography of Peninsular Malaysia ranges from coastal areas to mountainous regions. It has a land area of approximately 132,631 km^2 and a coast length of about 1,938 km. Its north-south extent is about 746 km and its maximum east-west width is about 315 km. The central mountainous spine known as the Titiwangsa Range extends from north to south for about 617 km in length and reaches 2,183 m above sea level. It divides the peninsula between its east and west coasts. The main trunk of the Pahang River at 482 km is the longest river in Peninsular Malaysia and the third longest in Malaysia. The Federal Territory of Labuan has a land area of about 91 km^2.

Sabah lies on the northeastern part of Borneo Island and has a land area of approximately 73,631 km^2. It has a coastline of approximately 2,155 m. The topography of Sabah is mountainous, especially in the west coast, with undulating lowland basins in the eastern part. The Crocker Range divides the western coastal plains from the rest of Sabah. Mount Kinabalu, the highest mountain in Malaysia at 4,095 m above sea level, is part of the Crocker Range. The main trunk of the Kinabatangan River at 568 km is the longest river in Sabah and the second longest in Malaysia.

Sarawak with a land area of approximately 124,450 km^2, lies on the north central and western parts of Borneo Island. It has a coastline of about 1,109 km. The topography of Sarawak shows flat coastal plains followed by a narrow belt of hills before sharply rising into

a mountainous region towards the Kalimantan border. Mount Murud is its highest peak at 2,422 m, followed by Mount Mulu at 2,377 m. Mount Mulu has the largest natural limestone cave system in the world. The main trunk of the Rejang River at 780 km is longest river in Sarawak and Malaysia.

1.2 Governance

Malaysia is a federation of 13 states operating within a constitutional elective monarchy based on the Westminster parliamentary system. The Head of State is the Yang Di-Pertuan Agong, also known as the King, and is elected from among the nine monarchial states for a five-year term. The heads of state for the states of Kedah, Perak, Selangor, Johor, Pahang, Terengganu and Kelantan are their respective Sultans, while the heads of state for the states of Negeri Sembilan and Perlis are the Yang Di-Pertuan Besar and Raja respectively. The heads of state of the other four states, namely Penang, Malacca, Sarawak and Sabah, are called Yang Di-Pertua Negeri, sometimes referred to as Governor. They are appointed by the Yang Di-Pertuan Agong for a renewable four-year term, on the advice of the Prime Minister in consultation with the state governments.

Legislative power is divided between federal and state legislatures. At the federal level, Malaysia's bicameral Parliament consists of the Dewan Rakyat (House of Representatives) and Dewan Negara (Senate). The 222 members of the House of Representatives are elected in a general election, due every five years. The Dewan Negara consists of 70 senators of which 26 are elected by the state legislative assemblies (that is, two senators from each state in the Federation), and the remaining 44 are appointed by the Yang Di-Pertuan Agong on the advice of the Prime Minister. The term of office for each of the senator is three years and may only be reappointed once.

The Prime Minister of Malaysia is the Head of Government and the Cabinet. The Prime Minister must be a member of the House of Representatives, and comes from the majority party in Parliament. The Cabinet is also chosen from members of the majority party from both houses of Parliament and has executive powers.

At the state level, the unicameral state legislative assemblies are also elected every five years. The head of government for each of the nine monarchial states is the Menteri Besar, and for the four remaining states the Chief Minister. They are chosen from the majority party in their respective legislative assemblies. Local governments are administered by municipal councils, where councillors are appointed by the respective State Governments.

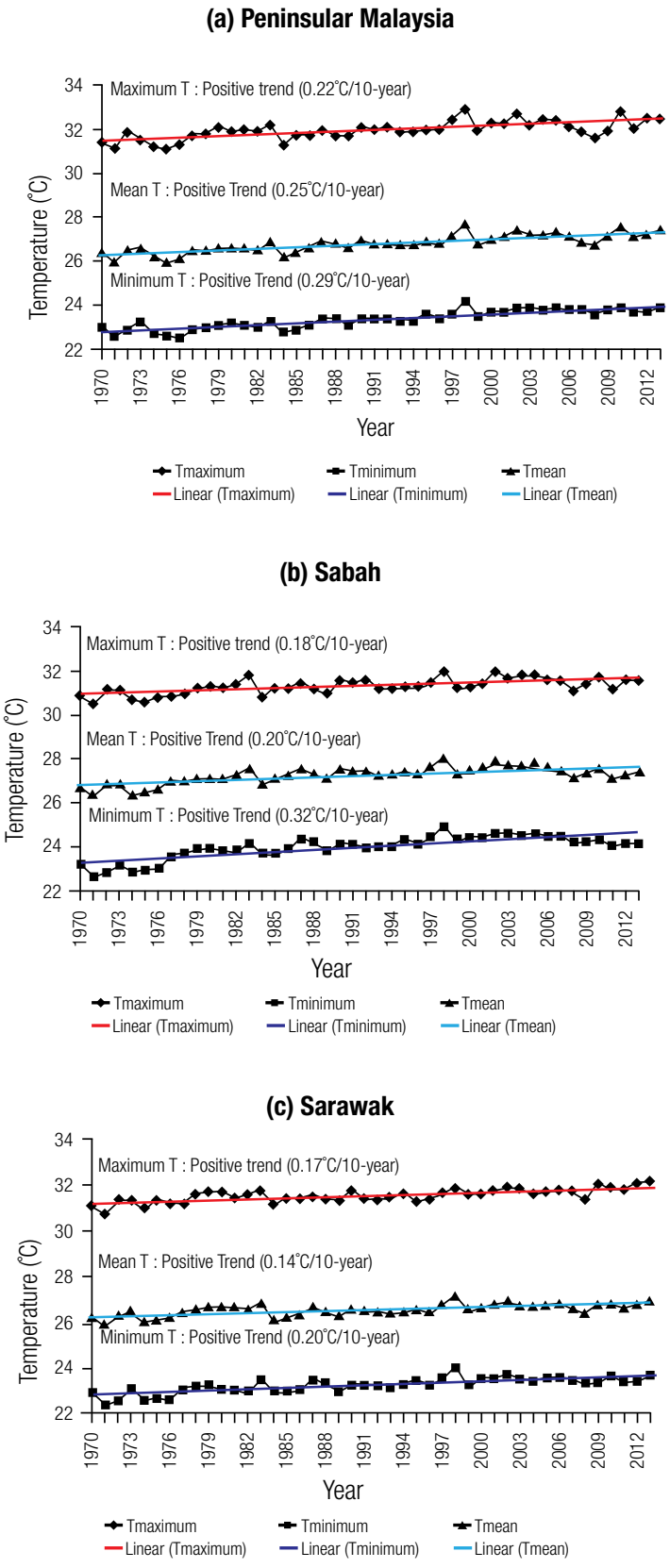
The highest court in the judicial system is the Federal Court headed by the Chief Justice, followed by the Court of Appeal, and two High Courts, namely the High Court in Malaya and the High Court in Sabah and Sarawak. The Subordinate Courts consist of Sessions Courts and Magistrate's Courts. There are also the Syariah (Muslim religious) Courts having limited jurisdiction over matters of state Islamic law. There are also specialised courts such as Children's Court, Native Courts and the recent Environmental Court.

Generally the Federal Government has overall responsibility for environmental matters, but the State Governments have jurisdiction over the management of natural resources, especially land, forestry and water.

1.3 Climate

Malaysia has an equatorial climate with relatively uniform diurnal variations of temperatures throughout the year. The daily mean temperature is between 26°C and 28°C. At the lowlands, temperatures are between 22.5°C during the night and 33°C during daytime. Over the past 43 years, positive trends in temperature increase have been observed. Figure 1.1 shows the annual trends of temperature for Peninsular Malaysia, Sabah and Sarawak from 1970 to 2013. The surface

Figure 1.1: Annual Temperature Trends for Peninsular Malaysia, Sabah and Sarawak



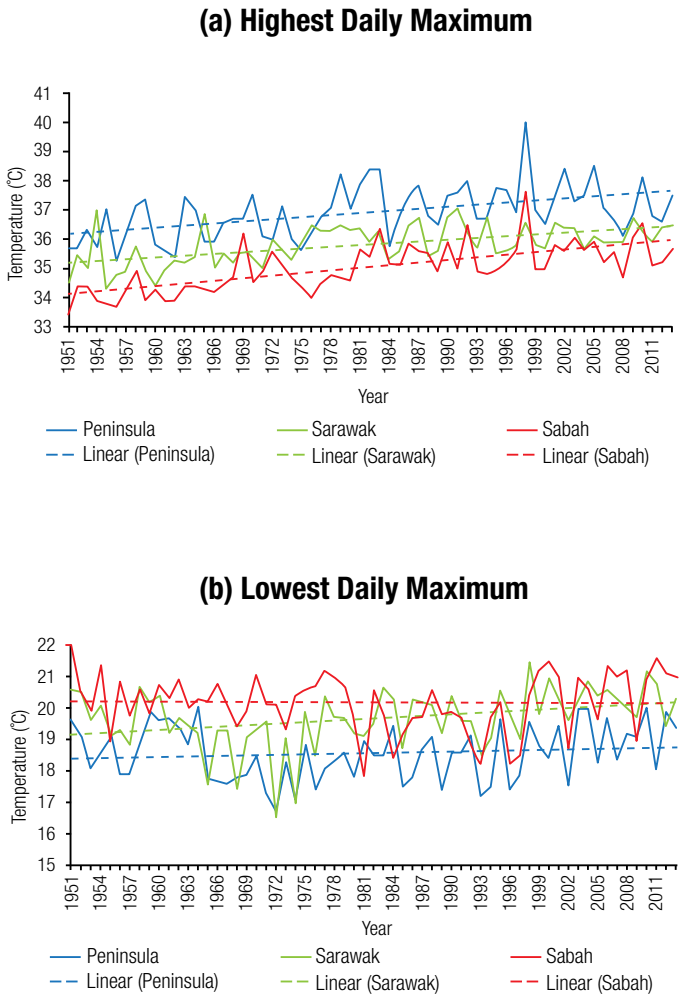
Source: Malaysian Meteorological Department

mean temperature increase is around 0.14°C to 0.25°C per decade. The surface maximum temperature increase is around 0.17°C to 0.22°C per decade, and the surface minimum temperature increase is around 0.20°C to 0.32°C per decade.

The highest daily maximum and lowest daily minimum temperatures for each year from 1951 to 2013 from 12 meteorological stations in Peninsular Malaysia, three meteorological stations in Sabah and four meteorological stations in Sarawak are shown in Figure 1.2. The highest daily maximum temperature shows an increasing trend in Peninsular Malaysia, Sabah and Sarawak. The highest daily maximum temperature is the highest over Peninsular Malaysia, followed by Sarawak and Sabah. The lowest daily minimum temperature, however, shows a different trend. Sabah records a decreasing trend whereas Peninsular Malaysia and Sarawak show an increasing trend.

The winds over the country are generally light and variable. There are, however, some uniform periodic changes in the wind flow patterns. Northeasterly winds prevail during the boreal winter monsoon (locally known as the northeast monsoon) from November to March. Southwesterly winds prevail during the boreal summer monsoon (locally known as the southwest monsoon) from May to September. These monsoons are separated by two shorter inter-monsoon periods.

Figure 1.2: Highest Daily Maximum and Lowest Daily Minimum Temperature for Peninsular Malaysia, Sabah and Sarawak



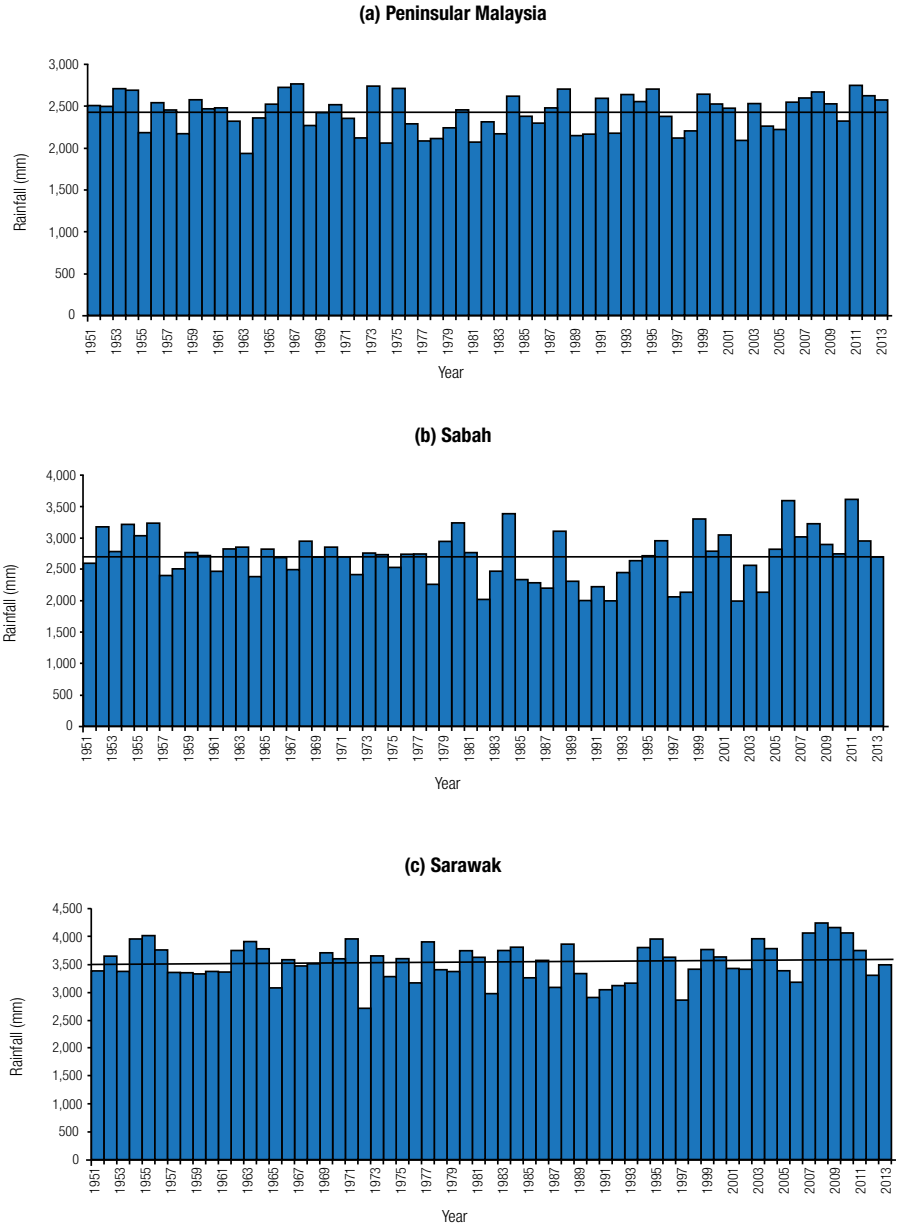
Source: Malaysian Meteorological Department

Rainfall distribution is greatly influenced by topography and the monsoon winds. These features have enabled Malaysia to be blessed with abundant annual rainfall, with average ranging from about 2,000 mm to 4,000 mm. During the northeast monsoon, the east coast of Peninsular Malaysia, northeast of Sabah and southern Sarawak can sometimes experience spells of heavy rain lasting about three days, sometimes resulting in severe floods. Comparatively, the southwest monsoon is drier. During the inter-monsoon periods, heavy rain from convective showers and thunderstorms occur in the late afternoons and evenings.

Figure 1.3 shows the annual rainfall for Peninsular Malaysia, Sabah and Sarawak from 1951 to 2013. For this period, there is a very slight decreasing trend in the rainfall for Peninsular Malaysia and Sabah, whereas for Sarawak, there is a slight increasing trend. For a shorter time frame from 1990 onwards, increasing trends in rainfall are observed for Peninsular Malaysia, Sabah and Sarawak.

Clouds cut off a substantial amount of direct sunlight in the afternoons and evenings and Malaysia receives about six hours of direct sunlight per day.

Figure 1.3: Annual Rainfall Trend for Peninsular Malaysia, Sabah and Sarawak



Source: Malaysian Meteorological Department

1.4 Forests and Land Use

Forest ecosystems play a major role in global carbon cycle. Forest ecosystems are also important for water regulation and flood management in river basins. They are also a source of timber products, income for the rural populations as well as home to local ethnic peoples.

Malaysian forests are complex ecosystems and rich in species. In 2000, approximately 56% of the total land area of Malaysia was still forested. This included permanent reserved forest (PRFs), state land forests (SLF) and totally protected areas (TPA/PA). In 2011, 17.931 million ha, or approximately 54.3% of the total land area of Malaysia, was still forested. The remaining comprises areas of agricultural crops, rubber plantations, oil palm plantations, urban or other uses. Table 1.1 below presents a breakdown of the total forested areas in Malaysia.

The management of all type of forests is enshrined in the National Forestry Policy 1978 (revised 1992) (NFP) or other relevant State Forest Policies. The NFP was approved by the National Forestry Council in 1977, and later endorsed by the National Land Council in 1978. This policy provided for greater uniformity in the implementation of strategies for the achievement of forest conservation, management as well as social and educational needs. It represents an important policy framework, which is unequivocal in maintaining that forest management must fulfil environmental and conservational needs besides meeting rational economic production goals. It provides guidelines and strong emphasis on the necessity for sound management, conservation, utilisation, development and protection of the forests. This commitment is duly recognised and given specific attention by the National Forestry Act 1984 (revised 1993) (NFA). In Sabah, the necessary legal backing is provided by the Sabah Forest Enactment 1968 while in Sarawak the Sarawak Forest Ordinance 1958 provides the necessary legal framework.

To ensure sustainable forest management, a National Committee on Sustainable Forest Management in Malaysia comprising representatives from various agencies in the forestry sector was formed in 1994 to ensure that the International Tropical Timber Organisation's (ITTO) Criteria and Indicators on sustainable forest management are fully implemented.

To ensure sustainable harvesting of timber, a forest certification scheme was started from 2002 with the adoption of the Malaysian Criteria and Indicators for forest management certification. The maximum cutting limit has been capped at 85 m^3/ha. The Malaysian Timber Certification Council was established in October 1998 as an independent organisation to develop and operate the Malaysian Timber Certification Scheme (MTCS). The MTCS provides for independent assessment of forest management practices, to ensure the sustainable management of Malaysia's natural forest as well as to meet the demand for certified timber products. As of August 2014, about 4.7 million ha of natural forest have been certified.

Table 1.1 Total Forested Areas (million ha)

Year	2000	2005	2010	2011	2012	2013
Peninsular Malaysia	5.915	5.830	5.864	5.807	5.789	5.831
Sabah	4.420	4.360	4.436	4.436	4.430	4.430
Sarawak	7.861	7.624	7.627	7.688	7.795	7.795
Total	**18.196**	**17.814**	**17.927**	**17.931**	**18.014**	**18.056**

Source: Ministry of Natural Resources and Environment

1.5 Biodiversity

Malaysia is considered one of the world's mega-diverse countries with an estimated 15,000 species of vascular plants, 306 species of wild mammals, more than 742 species of birds, 567 species of reptiles, 242 species of amphibians, approximately 1,619 species of marine fish, more than 449 species of freshwater fish, 612 species of coral and over 150,000 species of invertebrates[1]. Malaysia's terrestrial biodiversity is concentrated within its tropical rainforests that extend from coastal plains to mountain areas, including inland waters such as lakes and rivers. Marine biodiversity is found among islands and coastal ecosystems, especially in coral reefs and sea grasses. Agricultural biodiversity is supported in plantations, rice fields, fruit orchards, and farms. Table 1.2 presents the general overview of ecosystems in Malaysia.

Table 1.2 Overview of Ecosystems

Thematic Area	Ecosystem
Forest Biodiversity	• Lowland evergreen forest • Lowland dipterocarp forest • Heath forest • Limestone forest • Mixed dipterocarp forest • Hill dipterocarp forest • Hill mixed dipterocarp forest
Mountain Biodiversity	• Montane forest • Subalpine forest
Inland Waters Biodiversity	• Peat swamp forest • Freshwater swamp forest • Riparian forest • Rivers, ponds, lakes, etc.
Marine and Coastal Biodiversity	• Coastal hill dipterocarp forest • Mangrove forests • Mudflats • Coral reef • Sea grass
Agricultural Biodiversity	• Plantations • Rice fields • Fruit orchards & vegetable farms • Livestock rearing and aquaculture farms

The Federal Government has been increasing its efforts in synergising forest and biodiversity conservation. The increased awareness of the concept of High Conservation Value Forests (HCVF) has led to its inclusion as an important criterion in the assessment of PRFs in relation to Sustainable Forest Management compliance standards. The identification, sound management and protection of HCVF results in in-situ conservation of various unique flora species, water catchment areas, seed production areas, pristine virgin jungle reserves, lowland dipterocarp forest and customary burial grounds.

In Peninsular Malaysia, a central forest runs the length of the peninsula, straddling eight states and comprises four main forest complexes. To synergise forest and biodiversity conservation and enhance ecosystem services, the Central Forest Spine (CFS) Master Plan was adopted by the Government in 2011. The plan aims to restore connectivity of forest complexes within the CFS that forms the backbone of networks of environmentally sensitive areas in Peninsular Malaysia. A total of 17 primary forested linkages are proposed. The CFS Master Plan is institutionalised in Malaysia's National Physical Plan 2 (2010), which provides the backdrop of national strategic spatial planning policies and measures in terms of general direction as well as broad land use and physical development and conservation in Peninsular Malaysia up till the year 2020.

The Heart of Borneo (HoB) Initiative was declared in 2007 by the Governments of Brunei, Indonesia and Malaysia as a trans-boundary collaboration to enable conservation and sustainable development that improves the welfare of those living on the island, while minimising deforestation, forest degradation and the associated loss of biodiversity and ecosystem services. This government-led initiative, in collaboration with non-governmental organisations (NGOs), seeks to ecologically connect approximately 200,000 km^2 forests in Borneo. Approximately 60,000

[1] Fifth National Report (of Malaysia) to the Convention on Biological Diversity

km^2 are represented by the Malaysian States of Sabah and Sarawak.

1.6 Water Resources

Malaysia depends on its abundant annual rainfall for its main water resources. The National Water Resources Study (2000-2050) reported that the country receives about 973 billion cubic metres of water from rainfall annually. From this, total surface runoff is estimated to be 496 billion cubic metres per year. About 414 billion cubic metres would return to the atmosphere annually through evapotranspiration and 63 billion cubic metres as groundwater recharge. Rainfall is unevenly distributed with some States having more rain than others. High intensity and/or long duration rainfalls will result in flooding in low-lying and coastal areas where rivers are short and catchment areas are small. Smaller catchment areas may also expose certain regions to water stress and droughts.

Considering that surface water, i.e. from rivers and reservoirs, provides about 97% of the nation's water demands, the management of forests as water catchment areas is vital in ensuring a sustainable source of water. Due to increasing population and sustained economic growth, demand for water is expected to increase. The Tenth Malaysia Plan (2011-2015), which is the main five-year socio-economic development plan for the country, stressed the need for a water resources policy that charts the future course for the water sector in Malaysia. Endorsed by the Cabinet in 2012, the National Water Resources Policy (NWRP) for Malaysia is intended to act strategically towards ensuring that the demand for water by all user sectors is met in terms of quantity and quality for both man and nature. It provides clear directions and strategies in water resources management to ensure water security as well as sustainability. Its four focus areas are water resources security, water resources sustainability, partnership, and capacity building and awareness.

1.7 Population

1.7.1 Population and Population Density

The total population of Malaysia in 2011 was 29.1 million (Table 1.3). Population increased approximately 24.9% over the period 2000-2011. There is gradual increase of population density of Malaysia from 71 per km^2 in year 2000 to 88 per km^2 in 2011.

1.7.2 Urbanisation Rate

The urbanisation rate of Malaysia increased from 62.0% in 2000 to 71.0% in 2010. The rate varied from state to state. Table 1.4 presents the urbanisation rates of the states in Malaysia from 2000 to 2010.

1.7.3 Age Distribution

In 2011, approximately 26.9% of the population was under 15 years old, 68.0% was from between ages 15-64, and only 5.1% was over 65 years of age (Table 1.5). In 2012, there was a slight decline of population under 15 years old to 26.4%. This was offset by increase in the age group 15 to 64, and 65 and above, to 68.3%, and 5.3% respectively.

1.7.4 Life Expectancy

The average life expectancy at birth continues in an upward trend, reaching 74.32 years in 2011 compared to 72.2 years in 2000 (Table 1.6). Compared to year 2000, female and

Table 1.3 Population and Population Density of Malaysia

Year	1990	2000	2005	2010	2011	2012	2013
Population (mid-year) (million)	18.1	23.3	26.1	28.6	29.1	29.5	29.9
Population Density (population/km^2)	55	71	79	86	88	89	90

Source: Department of Statistics Malaysia

Table 1.4 Urbanisation Rates by State

State \ Year	2000 (A)	2005 (B)	2010 (C)
	Percentage (%)		
Johor	65.2	66.5	71.9
Kedah	39.3	39.8	64.6
Kelantan	34.2	33.4	42.4
Melaka	67.2	70.6	86.5
Negeri Sembilan	53.4	56.3	66.5
Pahang	42.0	43.5	50.5
Perak	58.7	59.3	69.7
Perlis	34.3	35.1	51.4
Pulau Pinang	80.1	79.8	90.8
Sabah	48.0	49.8	54.0
Sarawak	48.1	49.5	53.8
Selangor	87.6	88.4*	91.4
Terengganu	48.7	49.8	59.1
Federal Territory of Kuala Lumpur	100.0	100.0	100.0
Federal Territory of Labuan	77.7	77.6	82.3
Federal Territory of Putrajaya	-		100.0
Malaysia	**62.0**	**63.0**	**71.0**

Sources: (A) and (C) from Department of Statistics Malaysia[2]; (B) from Ninth Malaysia Plan (2006-2010)
Note: *includes Federal Territory of Putrajaya

male life expectancies at birth increased by about 2.25 years and 2.16 years respectively. Female life expectancy increased from 74.65 years in 2000 to 76.90 years in 2011. Male life expectancy increased from 70.0 years in 2000 to 72.16 years in 2011.

1.7.5 Public Health

Health and well-being are part of the improved standard of living and quality of life that the nation aspires to achieve. Within the Tenth Malaysia Plan (2011-2015), the Government of Malaysia is reforming the healthcare delivery system, focussing on the following four key areas:

- Transforming delivery of the healthcare system;
- Increasing quality, capacity and coverage of the healthcare infrastructure;
- Shifting towards wellness and disease prevention, rather than treatment; and
- Increasing the quality of human resource for health.

As the lead agency, the Ministry of Health (MOH) is the main provider of healthcare services. An extensive network of primary

Table 1.5 Population by Age Group (%)

Age Group \ Year	2000	2005	2010	2011	2012	2013
Less than 15 years	34.1	29.6	27.2	26.9	26.4	26.1
15 to 64 years	62.0	66.2	68.1	68.0	68.3	68.4
65 years and above	4.0	4.2	4.7	5.1	5.3	5.5
Total	**100**	**100**	**100**	**100**	**100**	**100**

Source: EPU (2013), The Malaysian Economy in Figures 2013

Table 1.6 Life Expectancies at Birth (Years)

Year	2000	2005	2010	2011 (p)	2012(e)	2013(e)
Female	74.65	76.17	76.58	76.90	77.03	77.18
Male	70.00	71.36	71.93	72.16	72.37	72.56
Overall	72.20	73.64	74.09	74.32	74.54	74.72

Notes: (p) - provisional, (e) - estimate
Source: Department of Statistics Malaysia

[2] from 2000 and 2010 Population and Household Census

healthcare services is delivered by Government health facilities together with private medical and dental clinics. This network is supported by secondary and tertiary services provided by the Government and private sector. Table 1.7 presents a summary of the health care facilities in 2008 and 2011.

1.8 Economy

1.8.1 Economic Transformation Programme

Malaysia launched the Economic Transformation Programme (ETP) in September 2010 as part of its National Transformation Programme. The ETP represents the catalyst for economic growth and investments. Twelve National Key Economic Areas (NKEAs) representing economic sectors which account for significant contributions to Gross National Income (GNI) were identified for implementation until 2020. The 12 NKEAs are Oil, Gas and Energy; Palm Oil & Rubber; Financial Services; Tourism; Business Services; Electronics & Electrical; Wholesale & Retail; Education; Healthcare; Communications Content and Infrastructure; Agriculture; and Greater Kuala Lumpur/Klang Valley. Each NKEA comprises Entry Point Projects (EPPs), which explore new growth areas, and business opportunities hence enabling the sectors to move further up the value chain. Identified are 154 EPPs across the 12 NKEAs. The Government facilitates the

Table 1.7 Summary of Healthcare Facilities

Year	2008		2011	
	Number	Beds (Official)	Number	Beds (Official)
Primary Health Care Facilities				
Ministry of Health				
- Health Clinics	802		985	
- Maternal and Child Health	95			
- Community Clinics	1,927		1,864	
- 1 Malaysia Health Clinics			109	
- 1 Malaysia Mobile Clinics (Bus)			5	8 (b)
- 1 Malaysia Mobile Clinics (Boat)			1	2 (b)
- Mobile Health Clinics (Teams)	193		184 (b)	
- Flying Doctor Services (Helicopter)			5	12 (b)
- Dental Clinics	1,707		51*	459**
- Mobile Dental Clinics	493***	1,149**	27	27**
Registered Private Entities				
- Private Medical Clinics	6,371		6,589	
- Private Dental Clinics	1,435		1,576	
Secondary and Tertiary Services				
Ministry of Health				
- Hospitals	130	33,004	132	33,812
- Special Medical Institutions	6	5,000	6 (a)	4,582
Non- Ministry of Health				
- Hospitals	7	3,245	8	3,322
Licensed Private Facilities				
- Hospitals	209	11,689	220	13,568
- Maternity homes	22	174	25	105
- Nursing homes	12	274	14	362
- Hospice	3	28	4	38

Notes: (a) Leprosy-1, Respiratory-1, and Psychiatrics Institution-4; (b) Refer to teams
*Standalone Dental Clinics, ** Dental Chairs; *** Includes Mobile and Pre-School Dental Team
Source: Ministry of Health, Health Facts Sheet 2008 and 2012

ETP by coordinating, tracking and monitoring the programme. While the Government will prioritise its policies and spending for the ETP, the bulk of investments are to be financed by the private sector.

The programme aims to raise Malaysia's competitiveness through the implementation of six Strategic Reform Initiatives (SRIs). The main thrust of the SRIs is to create an efficient, competitive and business-friendly environment in Malaysia that will allow world-class, local champions to thrive and attract valuable foreign investment. The SRIs comprise policies which strengthen the country's commercial environment to ensure Malaysian companies are globally competitive. The six SRIs are Competition, Standards & Liberalization; Public Finance Reform; Public Service Delivery; Narrowing Disparities; Government's Role in Business; and Human Capital Development.

1.8.2 Gross Domestic Product

The Gross Domestic Product (GDP) of Malaysia has shown a continual upward trend from 2005 to 2013, except for 2009. The compound average growth rate for GDP at constant prices from 2005 to 2011 was approximately 4.6%. GDP per capita grew from RM20,870 in year 2005 to RM24,492 in year 2011. Table 1.8 shows key data on GDP and GNI.

The main contributions to GDP in 2005 and 2011 were the services sector, manufacturing sector and mining and quarrying as presented in Figures 1.4 and 1.5 respectively.

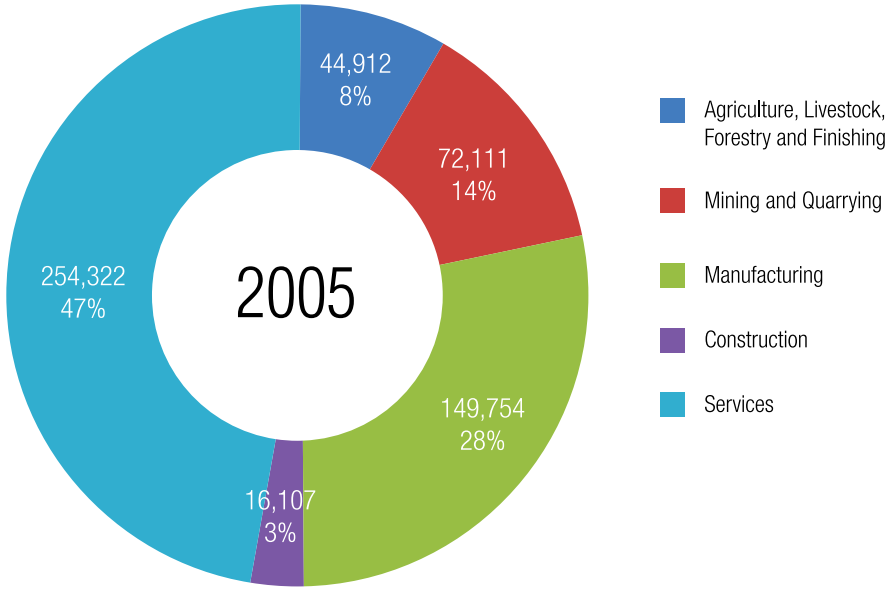
Within the services sector for the year 2011, the retail trade, accommodation and restaurants subsector contributed 17%, the finance, insurance, real estate and business service subsector contributed about 15%, the wholesale, and the transport, storage and communications subsector contributed 7%. The remaining sub-sectors are government services (8%); electricity and utilities (3%) and other services (5%).

Table 1.8 Gross Domestic Product and Gross National Income at Current and Constant Prices (2005 = 100)

Year	Gross Domestic Product		Gross National Income		Gross Domestic Product *per capita*	Gross National Income *per capita*
	RM (billion)				RM	
	Current Prices	Constant Prices (2005 = 100)	Current Prices	Constant Prices (2005 = 100)	Constant Prices	Constant Prices
2005	543.6	543.6	519.6	519.6	20,870	19,951
2006	596.8	573.9	579.5	554.2	21,617	20,875
2007	665.3	610.1	651.3	589.0	22,547	21,768
2008	769.9	639.6	746.9	605.4	23,200	21,960
2009	712.9	629.9	698.6	607.9	22,430	21,649
2010	797.3	676.7	771.0	635.7	23,669	22,238
2011	885.3	711.8	863.5	667.3	24,492	22,961
2012(e)	941.9	751.9	905.9	693.6	25,473	23,498
2013(p)	986.7	787.6	952.6	730.5	26,299	24,392

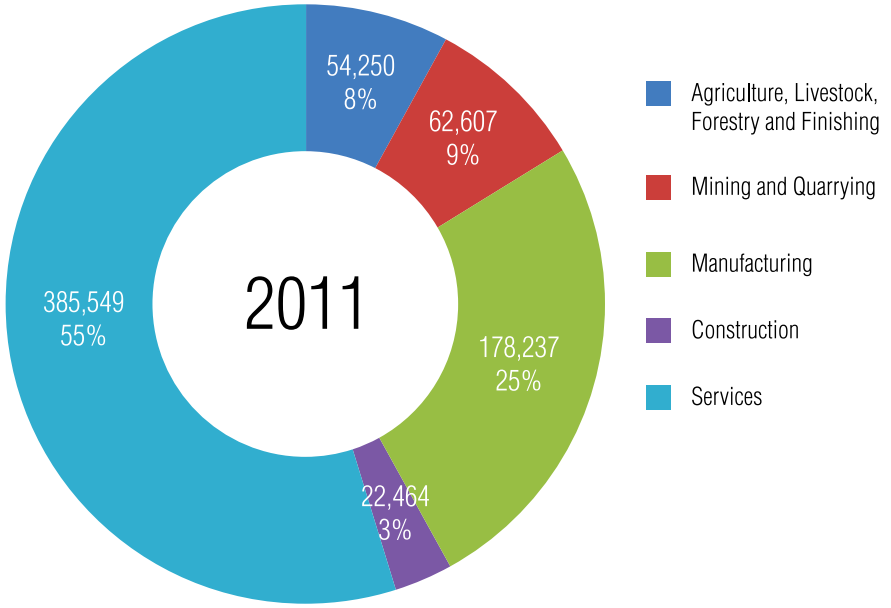
Source: Department of Statistics Malaysia (2014), Gross Domestic Product 2005-2013

Figure 1.4: Contribution to Gross Domestic Product for 2005 (RM million and %)



Note: Contribution before adding import duties
Source: EPU Website[3]

Figure 1.5: Contribution to Gross Domestic Product for 2011 (RM million and %)



Note: Contribution before adding import duties GDP is at Constant Prices 2005
Source: EPU Website[3].

[3] http://www.epu.gov.my/documents

1.8.3 Unemployment

The unemployment rate of Malaysia during the period 2000-2013 was 3.0% and above (Table 1.9). It peaked at 3.7% in 2009. In 2011, the unemployment rate was 3.1%.

Table 1.9 Unemployment Rates

Year	Unemployment Rate (%)
2000	3.0
2005	3.5
2010	3.3
2011	3.1
2012	3.0
2013	3.1

Source: Department of Statistics Malaysia

1.9 Energy Sector

1.9.1 Energy Security

In tandem with population and economic growth energy demand is expected to grow. Hence, there is a need to ensure reliable and affordable energy for the economy, while at the same time limiting negative impacts on the environment and safeguarding long-term energy security. Malaysia's energy policy is guided by three principle objectives stated in the National Energy Policy (1979):

- Supply Objective - to ensure adequate, secure and cost-effective energy supply through developing and utilising alternative sources of energy, both non-renewable and renewable, from within and outside the country;
- Utilization Objective - to promote efficient utilisation of energy and discourage wasteful and non-productive patterns of energy consumption;
- Environmental Objective - to minimise the negative environmental impacts on the energy supply chain, i.e. energy production, conservation, transportation and utilisation.

Efforts to ensure greater energy security, reduce dependency on petroleum products and environmental considerations are major objectives of subsequent energy policies such as the National Depletion Policy (1980), Four Fuel Diversification Policy (1981), Five Fuel Policy (2001) and National Biofuel Policy (2006).

1.9.2 Energy Balance

Malaysia's primary energy supply in 2000 was 50,710 ktoe (Figure 1.6 and Table 1.10). This increased to 66,211 ktoe in 2005 and 79,289 ktoe in 2011. The main source of primary energy supply of Malaysia comes from oil and gas. In terms of total share for year 2011, natural gas was highest at 45% (reduced from 51% in year 2005) followed by crude oil and petroleum products at 34% (reduced from 36% in 2005). The contributions from oil and gas declined from a combined 87% in year 2005 to 79% in year 2011. The share of coal and coke represented 19% (increased from 11% in 2005), while hydropower was maintained at 2% (similar to year 2005).

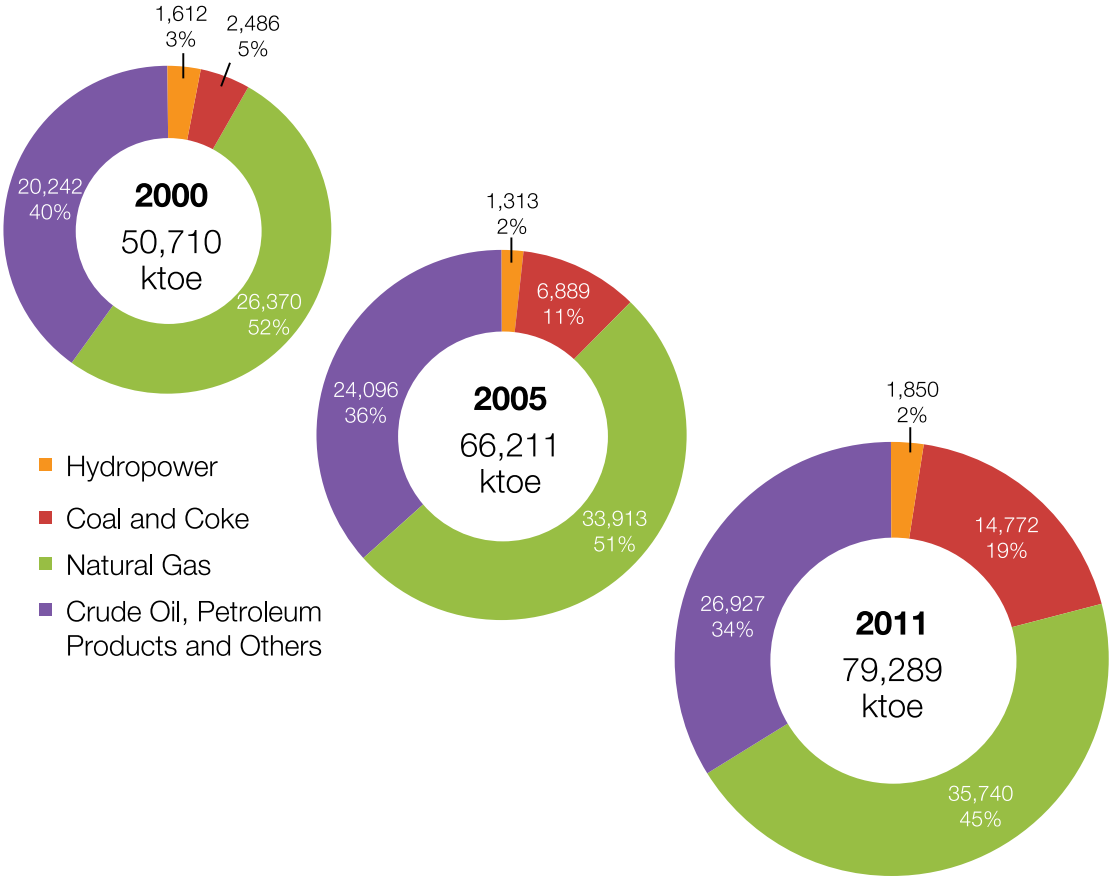
Final energy consumption was 29,699 ktoe in 2000. By 2005 this increased to 38,284 ktoe and by 2011, final energy consumption was 43,456

Table 1.10 Primary Energy Supply (ktoe)

Source \ Year	2000	2005	2010	2011	2012	2013
Hydropower	1,612	1,313	1,577	1,850	2,150	2,688
Coal and Coke	2,486	6,889	14,777	14,772	15,882	15,067
Natural Gas	26,370	33,913	35,447	35,740	38,647	39,973
Crude Oil, Petroleum Products and Others	20,242	24,096	25,008	26,927	29,815	33,003
Total	**50,710**	**66,211**	**76,809**	**79,289**	**86,494**	**90,731**

Source: National Energy Balance 2013

Figure 1.6: Primary Energy Supply (ktoe)



Source: Ministry of Energy, Green Technology and Water (2013), National Energy Balance 2012.

ktoe. Table 1.11 shows the trend of final energy consumption by sector. All sectors exhibited growth in energy consumption. In 2011 energy demand was highest for the transport sector at 39.3%, followed by the industrial sector at 27.8%. These were followed by residential and commercial demand at 16.1%, the non-energy sector at 14.7% and the agriculture sector at 2.1%.

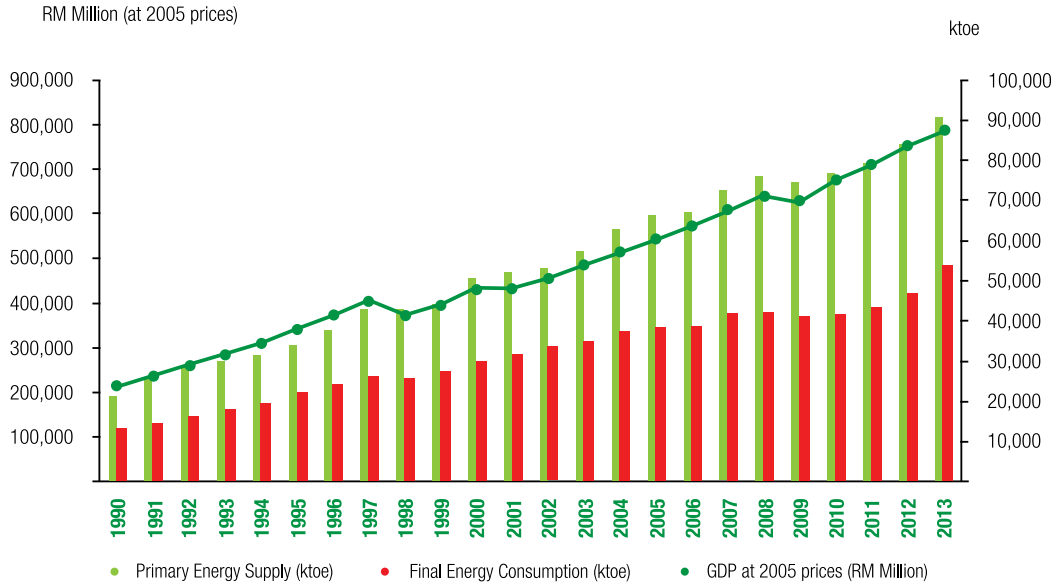
GDP has remained coupled to primary energy supply as shown in Figure 1.7. With increasing wealth, final energy consumption per capita increased from 1.26 toe per capita in the year 2000 to 1.50 and 1.72 toe per capita in 2011 and 2013 respectively. Electricity consumption per capita rose from 2,603 kWh in 2000 to 3,706 kWh and 4,110 kWh in 2011 and 2013 respectively (Figure 1.8).

Table 1.11 Final Energy Consumption by Sector (ktoe)

Year / Sectors	2000	2005	2010	2011	2012	2013
Agriculture	104	101	1,074	916	1,053	1,051
Non-Energy	2,250	2,173	3,696	6,377	7,497	7,277
Residential & Commercial	3,868	5,134	6,951	6,993	7,065	7,403
Transport	12,071	15,384	16,828	17,070	19,757	22,357
Industrial	11,406	15,492	12,928	12,100	13,919	13,496
Total	**29,699**	**38,284**	**41,477**	**43,456**	**49,291**	**51,584**

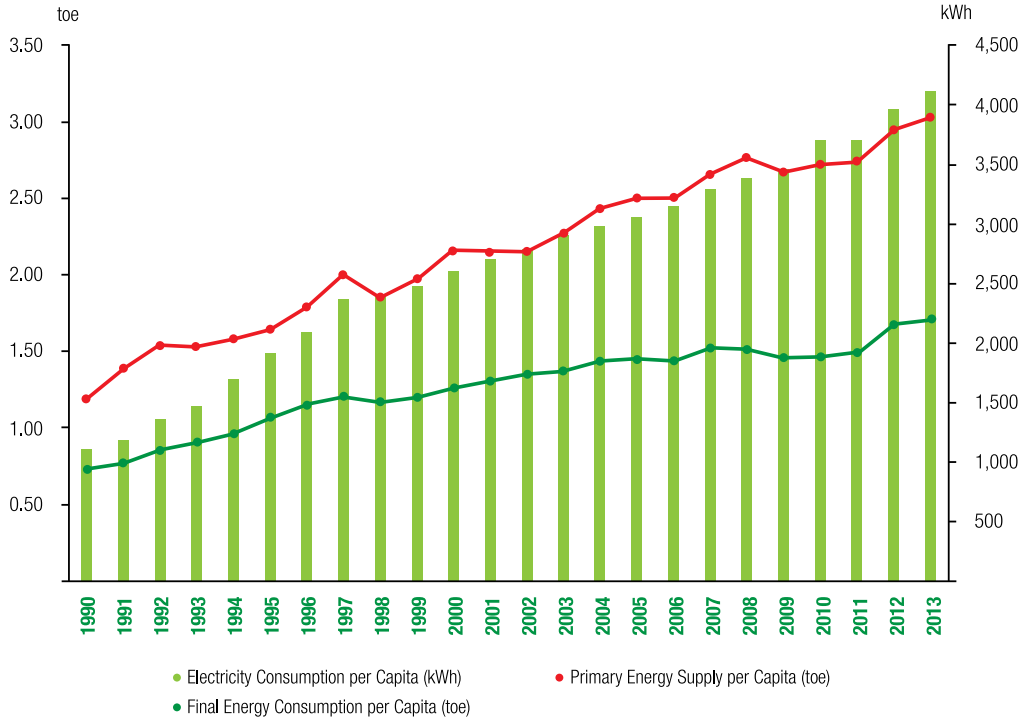
Source: National Energy Balance 2013

Figure 1.7: Trends in Gross Domestic Product, Primary Energy Supply and Final Energy Consumption



Source: National Energy Balance 2013

Figure 1.8: Primary Energy Supply, Electricity Consumption and Final Energy Consumption Per Capita



Source: National Energy Balance 2013

1.9.3 Renewable Energy

The promotion of renewable energy (RE) is addressed by the National Renewable Energy Policy and Action Plan, approved by the Cabinet in 2010, with the vision of "enhancing the utilisation of indigenous renewable energy resources to contribute towards national electricity supply security and sustainable socio-economic development". The adoption of RE technology is also supported by the National Green Technology Policy (2009) aimed at providing a conducive environment for the development of green technology to become one of the economic drivers in the country. It is centred around the four primary pillars of energy, environment, economy, and social perspective.

The Renewable Energy Act 2011 provided for the establishment and implementation of a Feed-in Tariff (FiT) scheme to catalyse the generation of electricity from renewable energy sources. This scheme offers long-term agreements to renewable energy producers to sell electricity to the grid at premium prices. Furthermore companies generating energy from renewable sources have a choice of applying for incentives, such as pioneer status with income tax exemption; or investment tax allowance on qualifying capital expenditure incurred. Other incentives include import duty and sales tax exemption on equipment used to generate energy from renewable sources.

The Sustainable Energy Development Authority of Malaysia (SEDA Malaysia), formed under the Sustainable Energy Development Authority Act 2011, has the key responsibility to administer and manage the implementation of the FiT mechanism. From December 2011, an additional 1% on the monthly electricity bill exceeding 300kWh was collected and deposited into the Renewable Energy Fund to finance the implementation of the FiT mechanism. The rate had been increased to 1.6% in January 2014.

As of 2013, the cumulative grid-connected installed capacity of RE since the inception of FiT reached 147.9 MW (Table 1.12).

Table 1.13 shows the amount of RE generated under the FiT system on an annual basis. Compared with 2012, the annual power generation of commissioned RE installations more than tripled in 2013.

1.10 Other Sectors

1.10.1 Transport

The Land Public Transport Commission (SPAD) was established in 2010 with the mission to ensure "a safe, reliable, responsive, accessible, planned, integrated, affordable, and sustainable land and public transport system to enhance economic growth and quality of life". SPAD's main role includes

Table 1.12 Installed Capacities of Grid-Connected FiT Renewable Energy Projects (MW)

Year	Biogas	Biomass	Small Hydro	Solar PV	Total
2012	7.41	50.40	15.70	25.02	98.53
2013	1.12	0.00	0.00	48.27	49.39
Total	**8.53**	**50.40**	**15.70**	**73.29**	**147.92**

Source: SEDA Annual Report, 2014

Table 1.13 Annual Power Generation of Commissioned FiT Renewable Energy Installations (MWh)

Year	Biogas	Biomass	Small Hydro	Solar PV	Total
2012	0.00	96,299.35	7,229.21	1,340.15	104,868.71
2013	29,258.26	228,796.89	91,432.69	53,710.85	403,196.68

Source: SEDA, 2015

policies, planning and regulation of all aspects of train, bus and taxi services as well as road and rail-based freight transport. It is expected to work closely with other planning authorities such as the Department of Town and Country Planning and local councils to ensure that the development of public transport is in line with land-use development.

There is a continual trend in the increase in the length of roads, motor-vehicle registration and use of public transportation. The public transport modes consist of buses, trains and taxis. In particular there is a growth in passenger ridership on the light rail transit (LRT) and commuter trains in the Klang Valley, where the capital city of Kuala Lumpur is situated.

1.10.1.1 Roads

In 2011, the total length of roads in Malaysia was approximately 155,427 km. The total length of roads increased by 133% from 2000 to 2011. Table 1.14 shows the breakdown of roads into state roads and federal roads.

Table 1.14 Lengths of Roads (km)

Year	State Roads	Federal Roads	Total
2000	50,814	15,631	**66,445**
2005	70,749	16,276	**87,025**
2010	127,149	17,254	**144,403**
2011	137,952	17,475	**155,427**
2012	163,272	17,610	**180,882**
2013	184,708	17,625	**202,333**

Source: Public Works Department

1.10.1.2 Motor-vehicle Registration

There is an increasing trend in motor-vehicle registration for all categories of vehicles (Table 1.15). There were 21.4 million registered vehicles in 2011. The majority of vehicles registered were motorcars and motorcycles representing 45.4% and 46.7% respectively.

1.10.1.3 Urban Rail Transit

Rail services have become a significant public transport in Kuala Lumpur and its suburbs. Based on ridership numbers, rail travel is the most used public land transport option and will continue to play an important and integral role in public transport in the Klang Valley. There are four urban rail network lines running though the Klang Valley – LRT AMPANG LINE (previously known as STARLINE), LRT KELANA JAYA LINE (previously known as PUTRALINE), KL Monorail and KTM Komuter. In addition, the EXPRESS RAIL LINK SDN BHD provides high-speed airport rail-link service between Kuala Lumpur Sentral (KL Sentral) and the Kuala Lumpur International Airport (KLIA). The LRT AMPANG LINE is a 27 km light rail transit line and it commenced operation on 16 December 1996. The second light rail transit line is the 29 km LRT KELANA JAYA LINE which commenced operation on 1 September 1998. The 8.6 km KL Monorail started operations on 31 August 2003. The KTM Komuter is a 175 km meter gauge network consisting of two cross-city routes and

Table 1.15 Motor-Vehicle Registration

Year / Type of Vehicle	2000	2005	2010	2011	2012	2013
Motorcars	4,145,982	6,473,261	9,114,920	9,721,447	10,354,678	10,535,575
Motorcycles	5,356,604	7,008,051	9,441,907	9,985,308	10,589.818	11,087,878
Taxi and Hired Cars	66,585	79,130	102,961	109,214	112,336	153,875
Buses	48,662	57,370	69,149	71,784	73,536	62,784
Goods vehicles	665,284	805,157	966,177	997,649	1,032,004	1,116,167
Others*	315,687	393,438	493,451	515,867	539,849	862,977
Total	**10,598,804**	**14,816,407**	**20,188,565**	**21,401,269**	**22,702,221**	**23,819,256**

Note: * Including Government motorcars, trailers, and driving school vehicles
Sources: Ministry of Transport and Department of Statistics Malaysia

a shuttle service. Table 1.16 below presents ridership of all these urban rail transits.

The LRT KELANA JAYA LINE is being extended another 17.4 km while the LRT AMPANG LINE is being extended an additional 18.1 km, the extensions being expected to be completed by 2016.

1.10.1.4 Inter-city Railway Statistics

Malaysia has approximately 1,800 km of inter-city/inter-state railway tracks. This consists of 1,641 km of meter gauge railway in Peninsular Malaysia and 134 km of railway in Sabah. The Electric Train Service (ETS) provides intercity train service, connecting Kuala Lumpur and Ipoh. The table below shows the railway statistics up to year 2013 for Peninsular Malaysia.

1.10.1.5 Air Traffic Statistics

Between 2000 and 2013 there has been a general increase of air traffic passengers for both domestic and international air travel (Table 1.18). The total number of embarked and disembarked domestic passengers increased from 19.1 million in 2000 to over 34.2 million in 2011 and 42.9 million in 2013. The number of embarked and disembarked international passengers increased from 12.5 million in 2000 to 30.4 million in 2011 and 38 million on 2013. From 2000 to 2013 the domestic passengers increased by 2.24 times and the international passengers by 3.03 times showing increasing trends of air travel.

Air cargo also showed an increase from 2000 to

Table 1.16 Ridership of Rail Transit and Commuter Trains, 2000 - 2013

Year / Transit / Commuter	2000	2005	2010	2011	2012	2013
LRT KELANA JAYA LINE	44,542,496	60,290,467	58,037,663	68,398,561	71,574,675	78,702,931
LRT AMPANG LINE	28,426,201	45,636,997	51,572,117	53,568,672	56.809,978	60,207,397
KL MONORAIL	N.A.	16,206,441	22,108,308	24,200,299	24,113,243	25,437,623
KTM-KOMUTER	19,154,197	30,934,651	34,995,000	35,510,000	34,847,000	43,942,000
EXPRESS RAIL LINK SDN BHD*	N.A.	2,075,105	1,508,734	1,581,476	1,649,410	2,063,419

Notes: *Started operations in 2002
Source: Ministry of Transport

Table 1.17 Railway Statistics for Peninsular Malaysia

	Unit	2000	2005	2010	2011	2012	2013
Total railway route length	km	1,620	1,665	1,665	1,641	1,641	1641
Electrified track railway route length	km	151	151	335	344	437	774
Total number of rail passengers	‘000	3,825	3,675	4,216	3,685	3,056	2,703
Rail passenger-kilometre	‘000,000	1,220	1,181	1,528	1,425	1,215	1,081
ETS*	‘000	N.A.	N.A.	215	913	1,179	1,563
ETS* passenger-kilometre	‘000,000	N.A.	N.A.	53	226	276	371
Freight	‘000 tonnes	5,481	4,031	5,431	5,914	6,096	6,623
Freight-kilometre	‘000,000 tonne km	916	1,178	1,483	1,535	1,539	1,760

* This commuter service started operations in August 2010
Source: Ministry of Transport

Table 1.18 Total Numbers of Domestic and International Passengers Handled by Airports

Year	Domestic			International		
	Embarked	Disembarked	Total	Embarked	Disembarked	Total
2000*	9,617,220	9,496,637	19,113,857	6,164,429	6,385,026	12,549,755
2005	10,456,749	11,954,473	22,411,222	8,267,880	8,298,555	16,566,435
2010	15,398,630	15,392,084	30,790,714	13,784,044	13,789,691	27,573,735
2011	17,113,299	17,125,874	34,239,173	15,301,772	15,159,809	30,461,581
2012	17,828,991	17,805,021	35,634,012	16,289,942	16,107,022	32,396,964
2013	21,507,550	21,476,323	42,983,873	19,111,317	18,921,138	38,032,455

Sources: Ministry of Transport
*Malaysia Airports Holdings Berhad

Table 1.19 Total Domestic and International Cargo Handled by Airports (tonnes)

Year	Domestic			International		
	Loaded	Unloaded	Total	Loaded	Unloaded	Total
2000*	58,324	56,273	114,597	360,564	287,216	647,780
2005	61,705	57,979	119,685	421,790	353,523	775,313
2010	80,808	85,517	166,325	393,463	351,626	745,089
2011	82,582	87,929	170,511	374,843	348,382	723,225
2012	86,301	80,971	167,272	360,670	351,790	712,460
2013	89,742	78,627	168,369	355,519	373,339	728,858

Sources: Ministry of Transport
*Malaysia Airports Holdings Berhad

2013 with domestic cargo increasing by about 1.47 times and international cargo increasing by 1.12 times over the period (Table 1.19).

1.10.2 Agriculture

The National Agro-food Policy was adopted in 2011, replacing the Third National Agriculture Policy. The objectives of the National Agro-food Policy, 2011-2020 are to: (i) ensure adequate food supply and food safety; (ii) develop the agro-food industry into a competitive and sustainable industry; and (iii) increase the income level of agricultural entrepreneurs. Sustainable agriculture development is one of the key thrusts under the policy in which the importance of the environment and biodiversity are addressed.

1.10.2.1 Agricultural Crops

Oil palm and rubber are the two most important agricultural crops for the country, providing income and employment - upstream and downstream. In ensuring that the growths of these crops are aligned with the sustainable development goals of the country, practices such as utilisation and optimisation of idle agriculture land are implemented and product certification is introduced. Comparing year 2011 with year 2000, there has been a decline in the land area planted with rubber and cocoa; however, the land area planted with oil palm has increased by 1.48 times. Table 1.20 shows the planted areas of major agricultural crops.

Chapter 9 of the NKEA addressed the need for expansion of both upstream and downstream

Table 1.20 Planted Areas of Major Agricultural Crops ('000 ha)

Year / Crop	2000	2005	2010	2011	2012	2013
Rubber	1,,430.70	1,271.30	1,020.40	1,027.04	1,041.19	1,057.27
Oil Palm	3,376.66	4,051.37	4,853.77	5,000.11	5,076.93	5,229.74
Cocoa	75.77	33.99	20.08	20.85	11.75	13.73
Paddy*	698.71**	666.82**	677.88	687.94	684.55	671.70

Sources: Statistics on Commodities 2006 and 2013, Ministry of Primary Industries and Commodities
* Agrofood Statistics 2014, Ministry of Agriculture and Agro-Based Industry
** Paddy Statistics of Malaysia 2010, Department of Agriculture

activities of the palm oil sector. As of 2011, about five million ha are planted with oil palm in Malaysia and the report suggests that the potential arable land for oil palm cultivation is limited and the maximum expansion potential is estimated at one million ha, thus capping the cultivated area of oil palm in Malaysia to six million ha. The NKEA focusses on increasing the national average productivity.

1.10.2.2 Livestock

Upward trends in livestock were noted for goats and poultry. Goats population doubled in 2011 compared with 2000 and poultry increased by 1.86 times over the same period. Table 1.22 shows selected livestock population.

1.10.2.3 Fisheries

Landings of marine fish (including shellfish collection) were 1.373 million tonnes in 2011, compared with 1.286 million tonnes in 2000 (Table 1.22).

Aquaculture production in Malaysia increased from 168,000 tonnes in 2000 to 526,000 tonnes in 2011 (Table 1.23). Fresh water aquaculture activities carried out in ponds, ex-mining pools, cages, cement tanks as well as pen cultures contributed 122,000 tonnes, while brackish water marine aquaculture cultivated in ponds, cages and water tanks contributed 404,000 tonnes.

1.10.3 Solid Waste

A developing and growing population is expected to generate an increasing amount of solid waste. Unless solid waste management is effective and efficient, there will be negative impacts on the environment and the health of local community. To enhance solid waste

Table 1.21 Selected Livestock Population

Year / Livestock	2000*	2005*	2010	2011	2012	2013
Buffalo	142,042	133,232	129,878	128,205	124,985	123,646
Cattle	733,892	781,316	836,859	768,710	744,377	751,497
Goats	237,634	287,670	498,385	479,444	462,510	434,202
Sheep	157,070	115,922	123,475	126,412	131,923	141,918
Swine	1,807,950	2,035,647	1,931,207	1,816,557	1,851,842	1,842,953
Horses*	4,000	7,000	3,706	3,903	4,101	4,162
Chicken	123,650,000	174,694,165	217,227,467	229,142,007	251,157,340	273,451,321
Duck	31,000,000	8,052,997	8,490,975	9,219,884	9,351,106	9,691,491

Sources: Agrofood Statistics 2014, Ministry of Agriculture and Agro-Based Industry
*FAOStat website: faostat.fao.org

Table 1.22 Landings of Marine Fish

Year	2000*	2005*	2010	2011	2012	2013
Landings of Marine Fish (million tonnes)	**1.286**	**1.210**	**1.429**	**1.373**	**1.472**	**1.483**

Sources: Agrofood Statistics 2014, Ministry of Agriculture and Agro-Based Industry
* Agriculture Statistical Handbook 2007, Ministry of Agriculture and Agro-Based Industry

Table 1.23 Aquaculture Production – Brackish and Coastal Areas ('000 tonnes)

Year	2000*	2005*	2010	2011	2012	2013
Freshwater	51	62	155	122	164	133
Brackish water/ marine	117	145	426	404	471	397
Total	**168**	**207**	**581**	**526**	**635**	**630**

Source: Agrofood Statistics 2014, Ministry of Agriculture and Agro-Based Industry
* Agriculture Statistical Handbook 2007, Ministry of Agriculture and Agro-Based Industry

management, Malaysia has taken a stepwise approach to privatise and centralise its solid waste management.

For States that accept the implementation of the Solid Waste and Public Cleansing Management Act 2007 (Act 672), the solid waste is managed by the Department of National Solid Waste Management and Solid Waste and Public Cleansing Management Corporation. This Act only applies to Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. In 2011 the Act was enforced in six of the states in Peninsular Malaysia and the Federal Territories. For the States of Selangor, Perak, Pulau Pinang, Kelantan, Terengganu, Sabah and Sarawak, solid waste management is under the jurisdiction of the respective city/ municipal/district councils based on the Local Government Ordinance.

Table 1.24 shows the breakdown of daily waste generation for years 2007 and 2012 for Peninsular Malaysia, Sabah and Sarawak. For year 2012, the overall waste generation for Malaysia was approximately 33,130 tonnes per day, or an average of 1.17 kg/capita/day compared with 0.87 kg/capita/day in 2007. The average per capita waste generation ranges from 1 to 1.33 kg per person per day across the strata and housing type. Population distribution and the level of development dictate the distribution of waste disposal sites and waste characteristics in the country. More waste is generated in areas where developments are highest.

Table 1.24 Average Waste Generations per Day in 2007 and 2012

Year / Region	2007*	2012**
Peninsular Malaysia (tonnes/day)	20,500	27,802
Sabah (tonnes/ day)	1,210	2,984
Sarawak (tonnes/day)	1,988	2,344

* Reported in NC2
** Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia (Internal Report of the National Solid Waste Management Department, 2014)

There were 165 operational landfills and 131 closed landfills in Malaysia in 2011-2013. Among these were eight sanitary landfills and three inert landfills. Ninety-six of the operational landfills and 115 of the closed landfills were located in Peninsular Malaysia. Based on the estimates made for year 2012, the overall waste generation in Peninsular Malaysia (combining household, institutional, commercial and industry) is about 27,802 tonnes per day. Per capita waste generation ranges from 1.10 to 1.35 kg/capita/day, with an average of 1.23 kg/capita/day. Klang Valley residents produce more waste, 1.35 kg/capita/day than the other regions whereas the East Coast has the lowest waste generation rate at 0.95 kg/capita/day.

For Sarawak there were 49 landfills in 2011-2013 and 45 of these landfills were categorised as open dumpsites and four were categorised as sanitary landfills. There were also 19 closed dumpsites spread out over the State of Sarawak in 2013. In 2012, the average daily waste collected in Sarawak was 2,344 tonnes or average of 0.95 kg/capita/day.

For Sabah, there were 19 operational landfills and two closed landfills spread out over the State in 2011- 2013. In 2012, the average waste collected in Sabah was 2,984 tonnes or 0.91 kg/capita/day.

Table 1.25 shows the estimation of solid waste composition for the whole of Malaysia based

Table 1.25 Solid Waste Composition

Composition	2005*	2012**
	Percentage (%)	
Food Residue	45	45.0
Plastic	24	13.2
Paper	7	8.5
Metal	6	2.7
Glass	3	3.3
Others	15	27.3
Total	**100**	**100.0**

Sources: * EPU (2006) *Ninth Malaysia Plan 2006-2010*
** Survey on Solid Waste Composition, Characteristics and Existing Practice of Solid Waste Recycling in Malaysia (Internal Report of the National Solid Waste Management Department, 2014)

on the Survey on Solid Waste Composition, Characteristics and Existing Practice of Solid Waste Recycling carried out by the National Solid Waste Management Department for the year 2012. Food residue remains the biggest proportion of the waste at 45%. Plastics had decreased from 24% of waste in 2005 to 13.2% in 2012. However, paper waste has increased from 7% of the waste in 2005 to 8.5% in 2012. In 2012, under the category "Others", disposable diapers and disposable feminine sanitary products formed 12.1% of the waste.

1.11 Institutional Arrangement

1.11.1 National Green Technology and Climate Change Council

The National Green Technology and Climate Change Council was established in September 2009 to formulate policies and identify strategic issues to implement in the National Green Technology Policy and the National Policy on Climate Change. It is chaired by the Prime Minister and comprises a number of key Cabinet Ministers as members making it an ideal platform for high-level decision-making on climate change.

1.11.2 National Steering Committee on Climate Change

Operational matters on climate change are guided and endorsed by the National Steering Committee on Climate Change (NSCCC) chaired by the Secretary General of the Ministry of Natural Resources and Environment (NRE). Its membership includes representatives from ministries, agencies, the private sector and non-government organisations.

The coordination for the preparation of national communications (NCs) and biennial update reports (BURs) is under the National Communication and Biennial Update Report National Steering Committee (NCBURNSC) which reports to the NSCCC. The secretariat to this Steering Committee is the Environmental Management and Climate Change Division of NRE, which is also the national focal point for climate change to the UNFCCC. The technical work of the NCs and BURs is carried out through five Technical Working Groups (TWG) established under the NCBURNSC. Figure 1.9 shows the institutional arrangement and thematic groupings to address climate change and NC/BUR reporting.

1.11.3 National Steering Committee and Technical Working Committee for REDD+

At the national level, the National Steering Committee on REDD+ (NSCREDD) was established in 2011 to formulate directions and strategies for REDD+ implementation. The NSCREDD is chaired by the Secretary General of NRE, with membership from State Economic Planning Units, Forestry Departments and relevant Federal Ministries. NSCREDD is supported by a Technical Committee on REDD+, chaired by the Deputy Secretary General (Environment) of NRE. The roles of this Technical Committee include providing methodological guidance on REDD+ implementation and formulating national action plans.

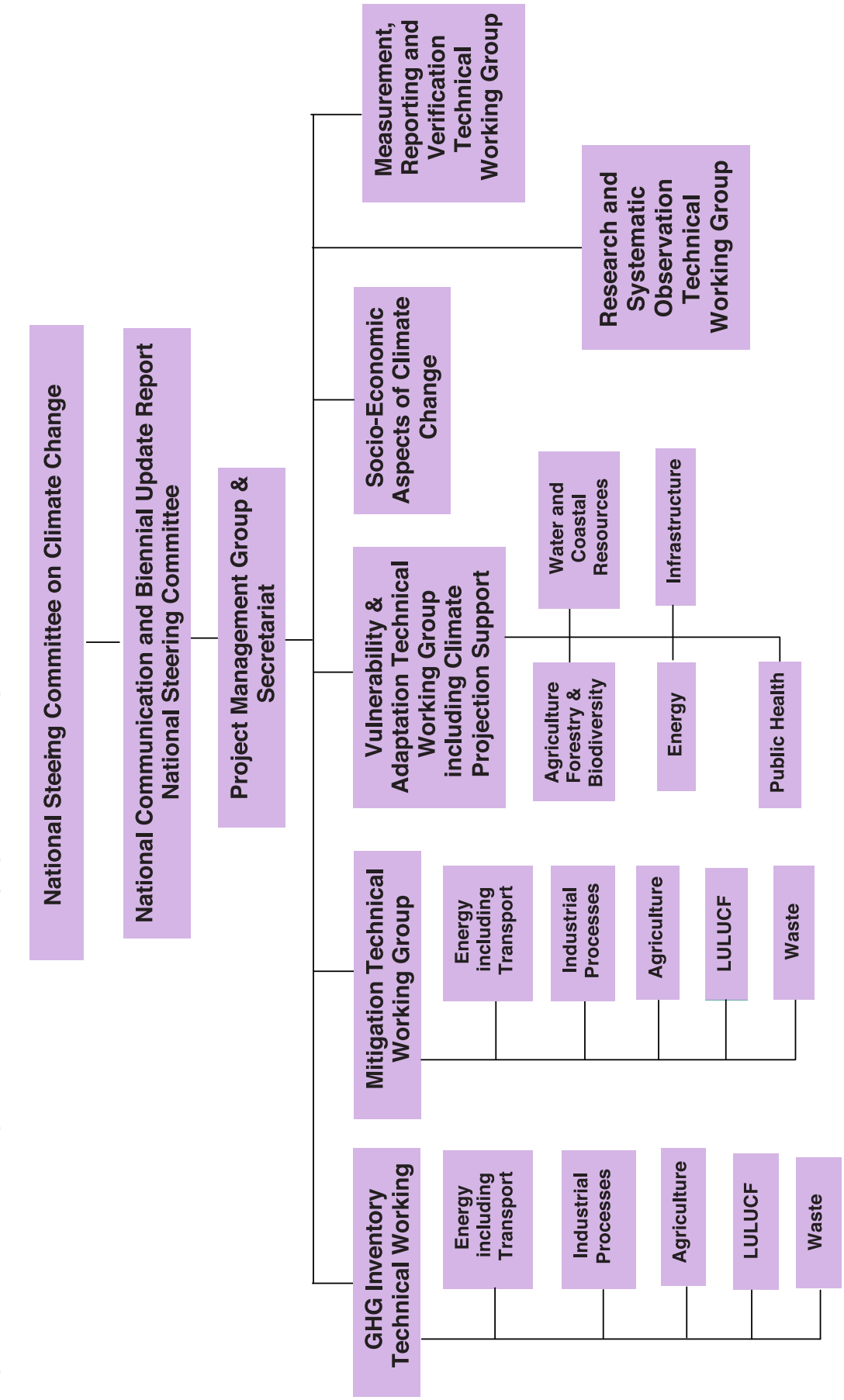
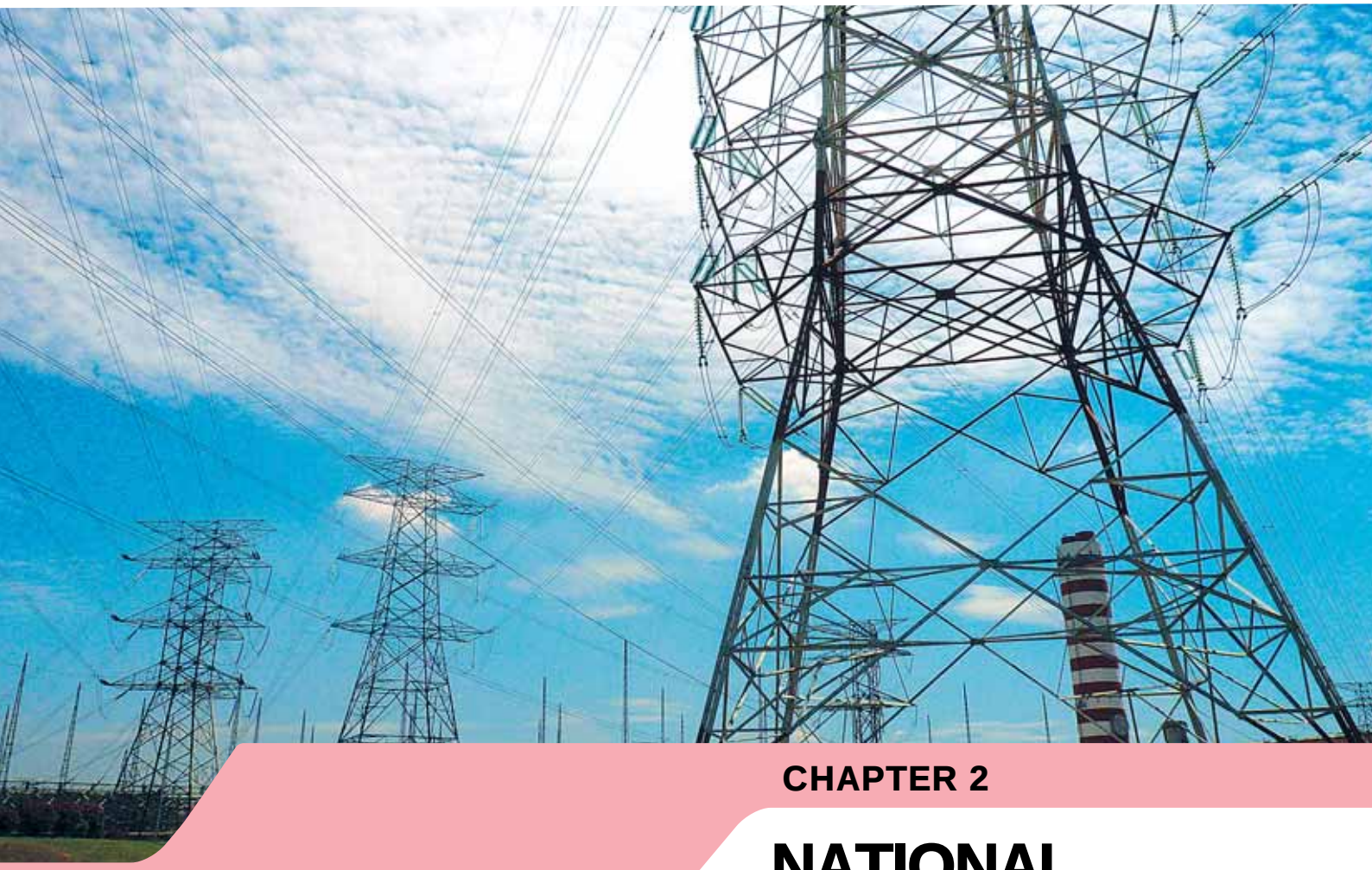


Figure 1.9: Institutional Arrangement and Thematic Grouping for Climate Change



CHAPTER 2

NATIONAL GREENHOUSE GAS INVENTORY

CHAPTER 2: NATIONAL GREENHOUSE GAS INVENTORY

2.1 Methodology for Greenhouse Gas Emissions Calculation

The Greenhouse Gas (GHG) inventory described in this chapter details the national anthropogenic emissions and removals for the year 2011. Estimations were carried out for five sectors, namely the energy; industrial processes; agriculture; land use, land-use change and forestry (LULUCF); and waste sectors. The inventory also contains time series estimates from (i) 1990 to 2011 for the energy, agriculture and LULUCF sectors; (ii) 1991 to 2011 for the waste sector; and (iii) 2000 to 2011 for the industrial processes sector.

In line with Decision 17/CP.8 and Annex III of Decision 2/CP.17 of UNFCCC, the *Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories* were used to estimate GHG emissions. The *Good Practice Guidance for Land Use, Land-Use Change and Forestry* was used to estimate emissions and removals for the LULUCF sector. In addition, the *Good Practice Guidance and Uncertainty Management in National Greenhouse Gas Inventories* was applied to improve the transparency, accuracy, consistency, comparability and completeness of the inventory. The time series were recalculated to reflect updated activity data in accordance with these guidelines.

Emission estimates were based on the sectoral approach for the energy sector. Estimates were made using the default conversion and emission factors provided in the *Revised 1996 IPCC Guidelines* for the energy, agriculture and waste sectors. For the LULUCF and industrial processes sectors, country-specific emission factors were applied in some subsectors. However, the emissions from iron and steel production were estimated using emission factors from the *2006 IPCC Guidelines for National Greenhouse Gas Inventories.*

The estimated methane (CH_4), nitrous oxide (N_2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF_6) emissions were converted to carbon dioxide equivalents (CO_2eq) using the global warming potential (GWP) values reported in the *IPCC Second Assessment Report* (AR2). Data sources and assumptions for generation of activity data required for the estimation for each sector are contained in Technical Annex 1.

2.2 Improvements in Current Greenhouse Gas Inventory Preparation

A broader base of stakeholders was engaged either directly or indirectly throughout

the preparation of the inventory. The key categories included in this inventory as compared with the INC and NC2 are shown in Table 2.1. Improvements in terms of coverage, activity data and emission factors as well as changes in technologies and practices were also considered. Energy sector activity data for domestic and international aviation have been disaggregated. Industrial processes sector emissions from aluminium

Table 2.1: Comparison between Key Categories within Sectors between INC (1994), NC2 (2000) and BUR (2011)

Key categories	INC 1994	NC2 2000	BUR 2011
Energy			
Sectoral Approach[4]			
Fuel Combustion			
• Energy industries	NE	✓	✓
• Transport	✓	✓	✓
• Manufacturing industries and construction	✓	✓	✓
• Residential & commercial	✓	✓	✓
• Agriculture	✓	✓	✓
• Others	✓	✓	✓
Fugitive Emissions from Fuel	✓	✓	✓
Reference Approach[5]	✓	✓	✓
Industrial Processes			
• Mineral Products			
➢ Cement production	✓	✓	✓
➢ Lime production	NE	✓	✓
➢ Limestone & dolomite use	NE	✓	✓
• Chemical Industries			
➢ Ammonia production	NE	✓	✓
➢ Nitric acid production	NE	✓	NO
➢ Carbide production	NE	✓	✓
➢ Petrochemicals	NE	✓	✓
• Metal Production			
➢ Iron & steel production	NE	✓	✓
➢ Aluminium production	NO	NO	✓
• Consumption of Halocarbons and Sulphur Hexafluoride			
➢ Mobile air conditioning	NE	✓	✓
➢ SF_6 use in electricity industry	NE	✓	✓
Agriculture			
• Enteric fermentation in domestic livestock	✓	✓	✓
• Manure management	✓	✓	✓
• Rice production	✓	✓	✓
• Agricultural residue burning	✓	✓	✓
• Agricultural soils	NE	✓	✓
Land Use, Land-Use Change and Forestry			
• Forest land remaining forest land			
➢ Natural forest	NE	✓	✓
➢ State land	NE	✓	✓
➢ Plantation forest	✓	✓	✓
• Cropland remaining cropland			
➢ Plantation crops			
❍ Rubber	✓	✓	✓
❍ Oil palm	✓	✓	✓
❍ Cocoa	NE	NE	✓
➢ Peat-land cultivation	NE	NE	✓
• Wetland remaining wetland	-	-	NA
• Grassland remaining grassland	-	-	NA
• Settlement remaining settlement	-	-	NA
• Forest land converted to other land	✓	✓	✓
Waste			
• Solid waste disposal sites	✓	✓	✓
• Domestic wastewater handling	✓	✓	
• Industrial wastewater handling			
➢ Natural Rubber SMR	✓	✓	✓
➢ Natural Rubber Latex	✓	✓	✓
➢ Palm Oil Mills	✓	✓	✓

Note:
NO (not occurring) - activities or processes that do not occur for a particular gas or source/sink category within a country;
NE (not estimated) - existing emissions and removals which have not been estimated;
NA (not applicable) - for activities in a given source/sink category which do not result in emissions or removals of a specific gas.

[4] Sectoral Approach: estimation of CO_2 from fuel consumption by sector or "bottom-up" approach.
[5] Reference Approach: estimation of total CO_2 from total fuel supplied to the country or "top-down" approach.

production have been included (whereas nitric acid production ceased in 2009). For the agriculture sector, activity data on crop residues have been included for estimation of emissions from agricultural soils. Emissions of N_2O from domestic wastewater handling are now included in the waste sector emissions. Emissions and removals from cocoa cultivation are included for the LULUCF sector.

2.3 Summary of Greenhouse Gas Emissions and Removals for 2011

2.3.1 Major Sources of Greenhouse Gas Emissions

Malaysia's GHG emission was 290,230 Gg CO_2eq in 2011 and removal was 262,946 Gg CO_2eq. The net emission after accounting for removal was 27,284 Gg CO_2eq (Table 2.2).

Emissions in the energy sector increased by 48%, industrial processes sector by 46%, agriculture sector by 35%, waste sector by 45% and LULUCF net removals increased by 14% between the years 2000 and 2011 (Figure 2.1).

Over the same period, CO_2 emissions including LULUCF emissions only, increased by 31%, CH_4 emissions by 37% and N_2O by 44% (Figure 2.2). In the comparison the recalculated values for the year 2000 were used.

For the year 2011, the energy sector was the highest contributor to GHG emissions at 76%,

Table 2.2: Emissions and Removals of Greenhouse Gas for each Sector in 2011

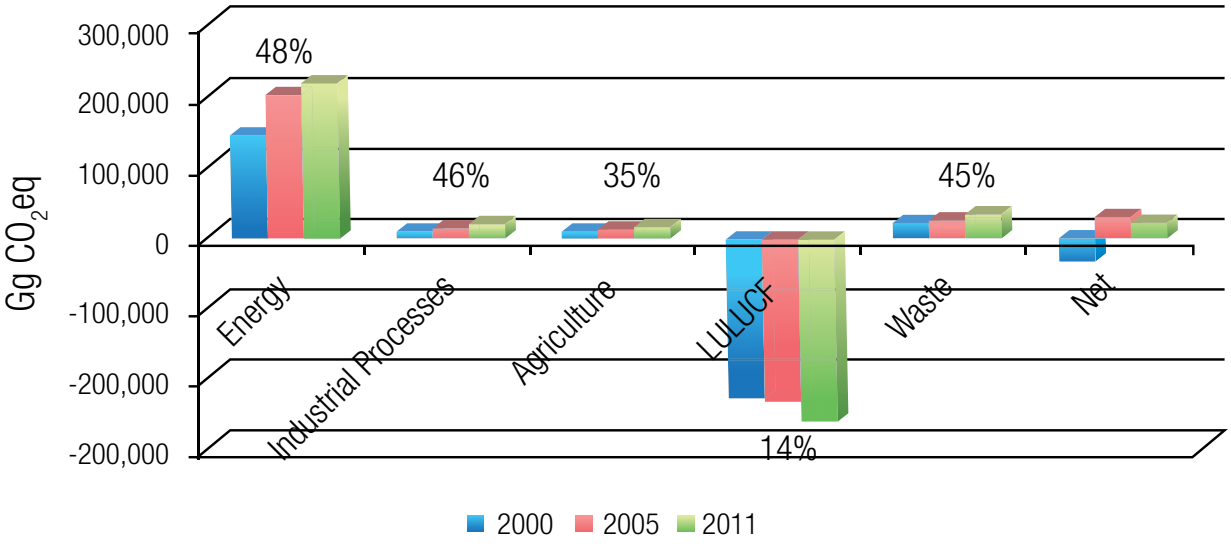
Sector	Gas	Emissions (Gg) A	GWPs B	CO_2 Equivalent (Gg) C=(A x B)
Energy	CO_2	188,575.12	1	188,575.12
	CH_4	1,421.38	21	29,848.98
	N_2O	1.58	310	489.53
Sub-total				**218,913.63**
Industrial Processes	CO_2	17,192.91	1	17,192.91
	CH_4	5.12	21	107.52
	N_2O	-	310	-
	HFC	0.5244	1,300	681.72
	SF_6	0.00058	23,900	13.86
	CF_4	0.0248	6,500	161.20
	C_2F_6	0.000992	9,200	9.13
Sub-total				**18,166.34**
Agriculture	CH_4	159.27	21	3,344.58
	N_2O	40.10	310	12,430.72
Sub-total				**15,775.30**
Waste	CH_4	1,630.05	21	34,230.94
	N_2O	2.11	310	654.10
Sub-total				**34,885.04**
Land Use, Land-Use Change and Forestry (Source)	CO_2	2,489.67	1	2,489.67
	CH_4	0.00	21	0.00
	N_2O	0.00	310	0.00
Land Use, Land-Use Change and Forestry (Sink)	CO_2	-262,946.41	1	-262,946.41
Sub-total				**- 260,456.56**
Total (emissions only)				**290,229.98**
Net Total (after subtracting sink)				**27,283.57**

Note: Negative values indicates sink.

followed by the waste sector at 12%, industrial processes at 6%, agriculture sector at 5% and LULUCF at 1%. For the GHG inventory for the years 2000 and 2005, the energy sector contributed 68% and 71% respectively (Figure 2.3).

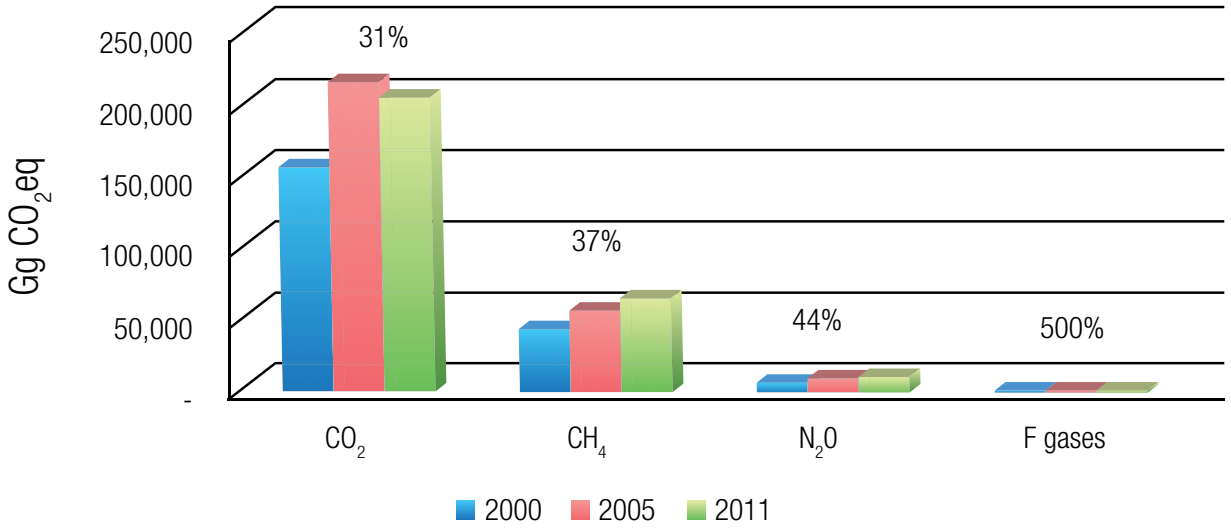
CO_2 emissions amounted to 73%, 76% and 72% of the total GHG emissions in 2000, 2005 and 2011 respectively (Figure 2.4). CH_4 emissions were 23%, 20% and 23% respectively for those years. N_2O emissions increased from 4% to 5% between 2000 and 2011.

Figure 2.1: Comparison of Greenhouse Gas Emissions by Sector between 2000 and 2011



Note: Percentage indicates the % emission increase/decrease between 2000 and 2011.

Figure 2.2: Comparison of Greenhouse Gas Emissions by Gas between 2000 and 2011



Note: Percentage indicates the % emission increase/decrease between 2000 and 2011.

Figure 2.3: Percentages of Greenhouse Gas Emissions by Sector in 2000, 2005 and 2011

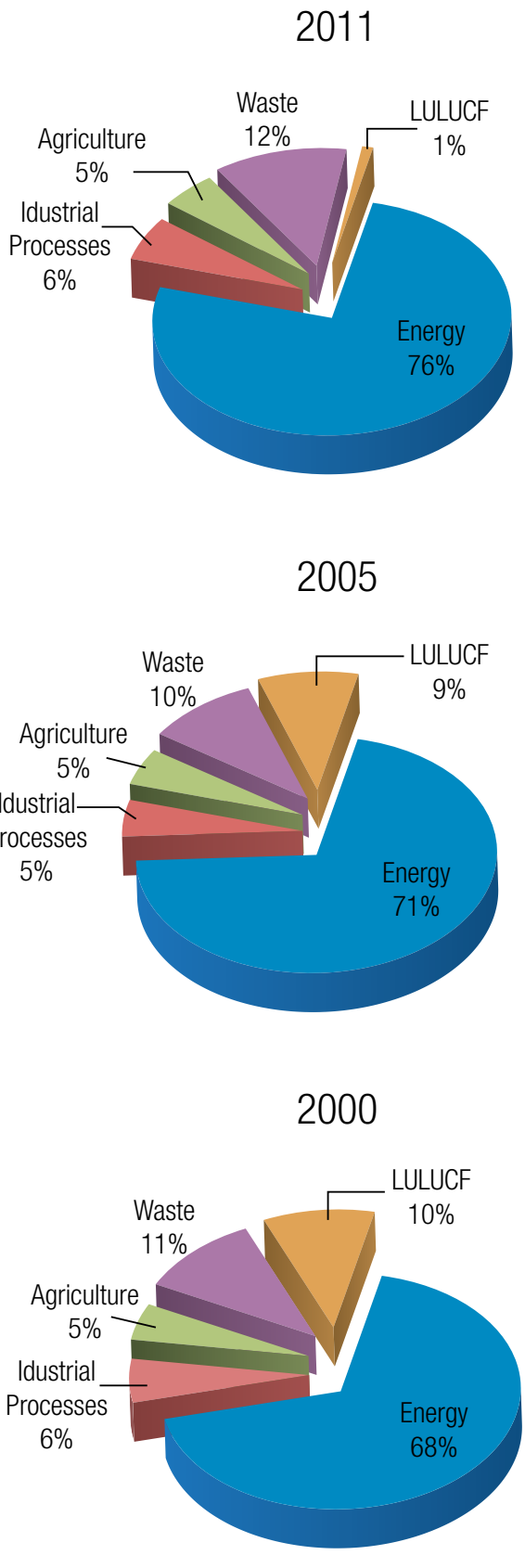
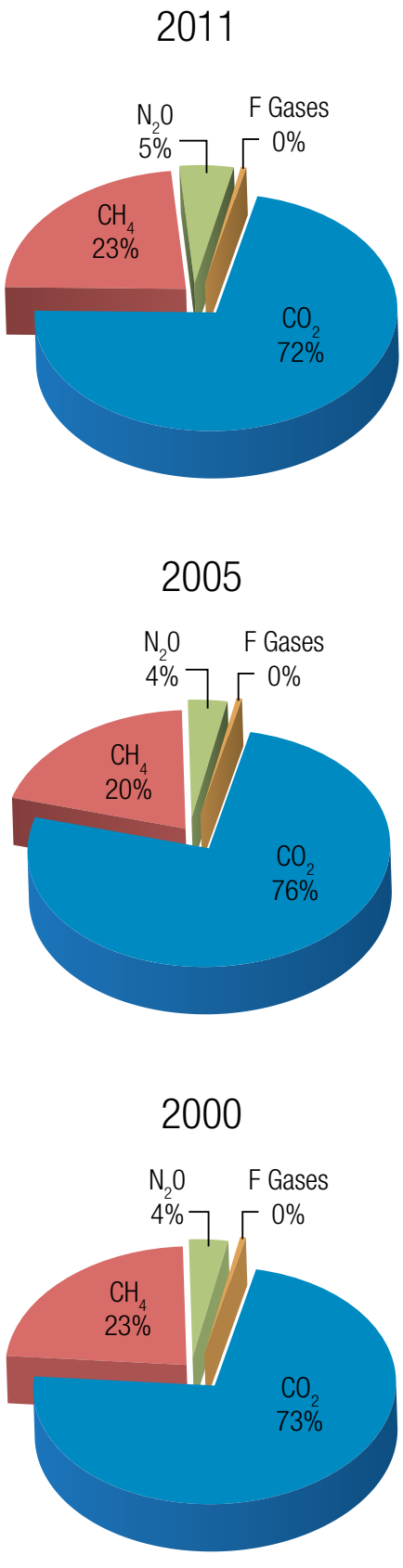


Figure 2.4: Percentage Emissions According to Greenhouse Gas in 2000, 2005 and 2011



2.3.2 Major Sources of Carbon Dioxide Emissions

In 2011, a total of 208,258 Gg CO_2 was emitted. The CO_2 emission from energy industries was the highest at 113,567 Gg CO_2 (55%), followed by emissions from transport at 44,007 Gg CO_2 (21%) (Figure 2.5). Emissions from energy industries were due to the fuels used by the power and auto producers for producing electricity, petroleum refining and natural gas transformation. Manufacturing industries and construction was the third largest contributor to CO_2 emissions at 23,004 Gg CO_2 (11%).

2.3.3 Major Sources of Methane Emissions

For 2011, a total of 67,532 Gg CO_2eq was emitted (Figure 2.6). The highest emission was from the solid waste disposal sites, which accounted for about 46% of the CH_4 emissions, followed closely by fugitive emissions from oil and natural gas, amounting to 44%.

Figure 2.5: Major Sources of Carbon Dioxide Emissions in 2011

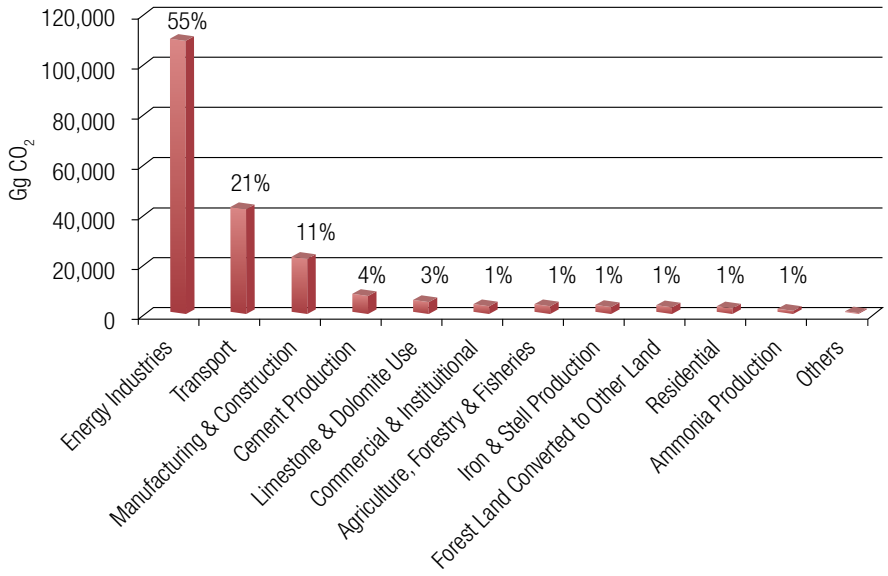


Figure 2.6: Major Sources of Methane Emissions in 2011

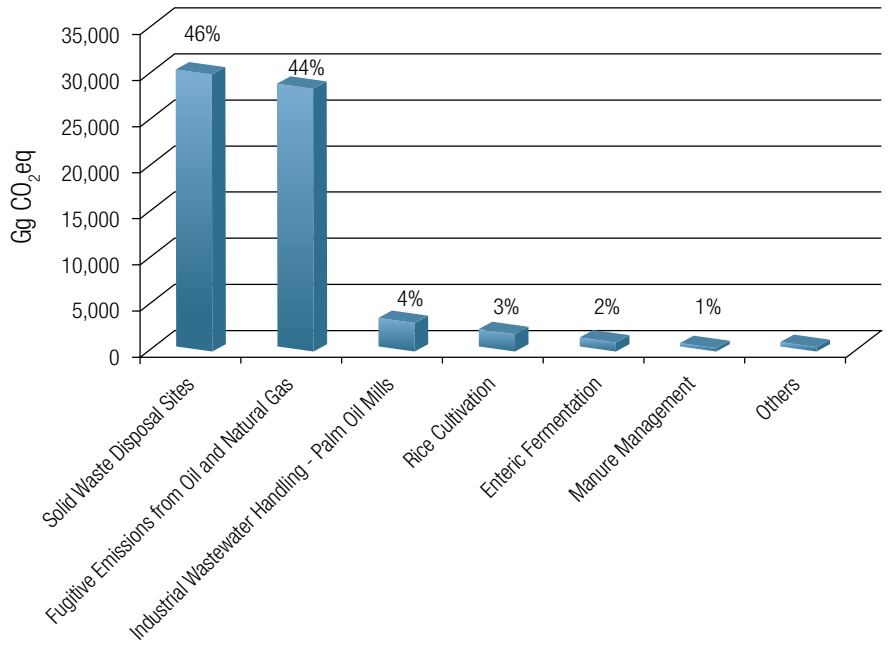
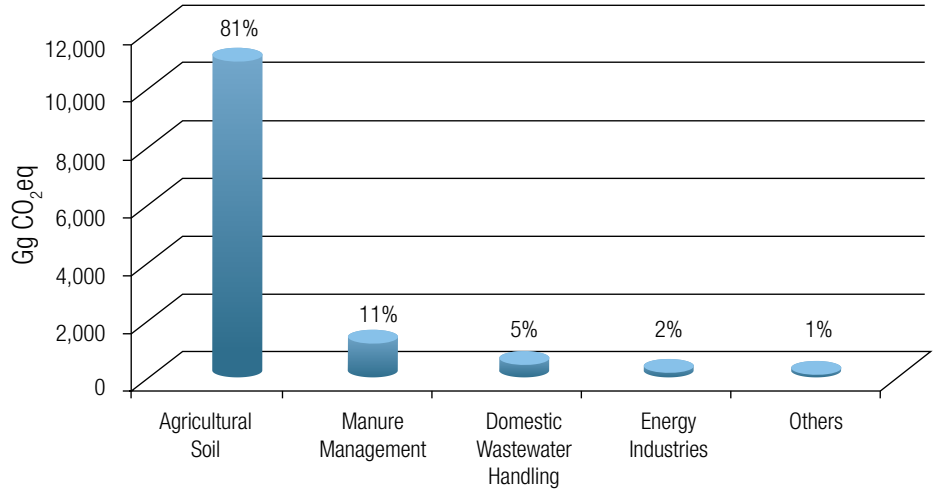


Figure 2.7: Major Sources of Nitrous Oxide Emissions, in 2011



2.3.4 Major Sources of Nitrous Oxide Emissions

In 2011, a total of 13,574 Gg CO_2eq of N_2O were emitted. The emissions were primarily from the agriculture sector as shown in Figure 2.7. Agriculture soils contributed 81% of the emissions.

2.3.5 Carbon Dioxide Removals

CO_2 removals by sinks occurred in the LULUCF sector. Net removal from the LULUCF sector amounted to 260,457 Gg CO_2eq. Emissions considered in *Forest Land Remaining Forest Land* were carbon loss from commercial harvest, forest fires and emissions from drained peat swamp forest. For *Crop Land Remaining Crop Land*, emissions considered were from total harvest and cultivation in drained peat-lands (Table 2.3).

2.4 Key Categories of Emissions and Uncertainty Assessment

2.4.1 Key Category Analysis

The key source of GHG emissions for 2011 are shown in Tables 2.4 and 2.5. Overall, the key categories did not change much between 2000 and 2011. However, emission from LULUCF is ranked last in the key category unlike in 2000.

The inventory in the BUR has further disaggregated the sources of GHG emissions and hence provides more specific sources of emission of GHGs. Without LULUCF, the main bulk of the emissions under the key categories analysis (Table 2.4) are from the energy sector (74.15%), followed by the waste sector (11.85%), the industrial processes sector (5.38%) and the agriculture sector (3.80%).

Table 2.3 Summary of Removals and Emissions from Land Use, Land-Use Change and Forestry

Activity	Uptake (Gg CO_2eq)	Emissions (Gg CO_2eq)	Net (Gg CO_2eq)
Forest land remaining forest land	-305,159.34	57,683.93	-247,475.41
Crop land remaining crop land	-33,786.87	18,316.05	-15,471.00
Forest land converted to other land use	0.00	2,489.67	2,489.67
Net LULUCF	-338,946.21	78,489.65	-260,456.74

Table 2.4 Key Source Analysis of Greenhouse Gas Emissions for 2011, without Land Use, Land-Use Change and Forestry Emission

Sector	Key source	Gas	Current Year estimate (Gg CO_2eq)	Level assessment (%)	Cumulative
Energy	Energy industries: Public electricity	CO_2	87,885.41	30.54%	30.54%
Energy	Transport: Road transportation	CO_2	41,601.95	14.46%	45.00%
Waste	Solid waste disposal sites	CH_4	31,127.82	10.82%	55.82%
Energy	Fugitive emissions from oil and gas operations	CH_4	29,536.66	10.26%	66.08%
Energy	Manufacturing industries and construction	CO_2	23,003.97	7.99%	74.07%
Energy	Energy industries: Manufacture of solid fuels & other energy industries (natural gas transformation)	CO_2	22,920.48	7.97%	82.04%
Agriculture	Agricultural soils	N_2O	10,943.82	3.80%	85.84%
Industrial Processes	Mineral products: Cement production	CO_2	7,766.20	2.70%	88.54%
Industrial Processes	Limestone and dolomite use	CO_2	5,152.17	1.79%	90.33%
Waste	Industrial wastewater: Palm oil mills	CH_4	2,960.14	1.03%	91.36%
Energy	Other sectors: Commercial	CO_2	2,933.97	1.02%	92.38%
Energy	Energy industries: Petroleum refining	CO_2	2,761.16	0.96%	93.34%
Energy	Other sectors: Agriculture, forestry and fishery	CO_2	2,732.81	0.95%	94.29%
Industrial Processes	Metal industry: Iron and steel industry	CO_2	2,565.33	0.89%	95.18%

Table 2.5 Key Source Analysis of Greenhouse Gas Emissions for 2011, with Land Use, Land-Use Change and Forestry Emission

Sector	Key source	Gas	Current Year estimate (Gg CO_2eq)	Level assessment (%)	Cumulative
Energy	Energy industries: Public electricity	CO_2	87,885.41	30.28%	30.28%
Energy	Transport: Road transportation	CO_2	41,601.95	14.33%	44.61%
Waste	Solid waste disposal sites	CH_4	31,127.82	10.73%	55.34%
Energy	Fugitive emissions from oil and gas operations	CH_4	29,536.66	10.18%	65.52%
Energy	Manufacturing industries and construction	CO_2	23,003.97	7.93%	73.45%
Energy	Energy industries: Manufacture of solid fuels & other energy industries (natural gas transformation)	CO_2	22,920.48	7.90%	81.35%
Agriculture	Agricultural soils	N_2O	10,943.82	3.77%	85.12%
Industrial Processes	Mineral products: Cement production	CO_2	7,766.20	2.68%	87.80%
Industrial Processes	Limestone and dolomite use	CO_2	5,152.17	1.78%	89.58%
Waste	Industrial wastewater: Palm oil mills	CH_4	2,960.14	1.02%	90.60%
Energy	Other sectors: Commercial	CO_2	2,933.97	1.01%	91.61%
Energy	Energy industries: Petroleum refining	CO_2	2,761.16	0.95%	92.56%
Energy	Other sectors: Agriculture, forestry and fishery	CO_2	2,732.81	0.94%	93.50%
Industrial Processes	Metal industry: Iron and steel industry	CO_2	2,565.33	0.88%	94.38%
LULUCF	Forest land converted to other land use	CO_2	2,489.67	0.86%	95.24%

With LULUCF emissions, the total percentages of emissions under the key categories (Table 2.5) do not differ very much. These consist of energy sector (73.52%), waste sector (11.75%), industrial processes (5.34%), agriculture sector (3.77%) and LULUCF (0.86%).

For both categories, the two largest key sources of emissions were from the energy sector. They were emissions from public electricity generation, followed by transport. The third largest source was from solid waste disposal. Fugitive emissions from oil and gas operations ranked fourth.

2.4.2 Uncertainty Assessment

Uncertainty information is intended to help prioritise efforts to improve the accuracy of the GHG inventory in the future and guide decisions on methodological choices. A tier 1 uncertainty analysis across the sectors was carried out in line with the IPCC Good Practice Guidelines (2000, 2003). The activity data were mainly from nationally published sources, for example the National Energy Balance for the energy sector assessment and the Agrofood Statistics for the agriculture sector assessment. Additional required data were also drawn from international reports, surveys and expert judgement. IPCC default emission factors were used in most sectors. Data from facility level has a 5% uncertainty, published reports between 5-8% uncertainty, while data from surveys has uncertainty in the range between 5-22%. Overall, the uncertainty across the sectors were between 5-20%.

2.5 Sectoral Time Series of Emissions

Time series of emissions for the energy, industrial processes, LULUCF, agriculture and waste sectors are shown in Figures 2.8, 2.9, 2.10, 2.11 and 2.12 respectively. Details of the time series values are in Tables E.1 to E.5 of Technical Annex 1.The trend in the energy sector emissions follows the GDP trend of the country. The increasing trend in the waste sector was due mainly to an increase in solid waste generation arising from population growth.

Figure 2.8: Emissions Time Series from 1990 to 2011 for Energy Sector

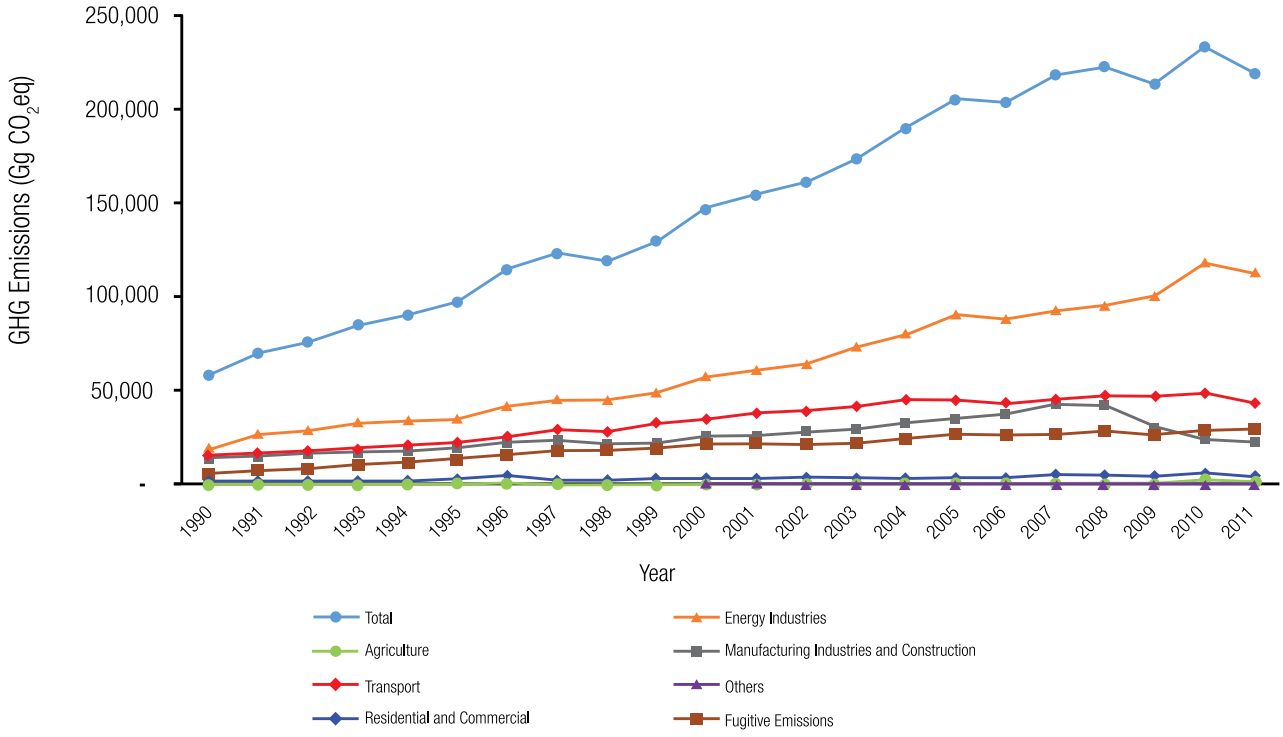


Figure 2.9: Emissions Time Series from 2000 to 2011 for Industrial Processes Sector

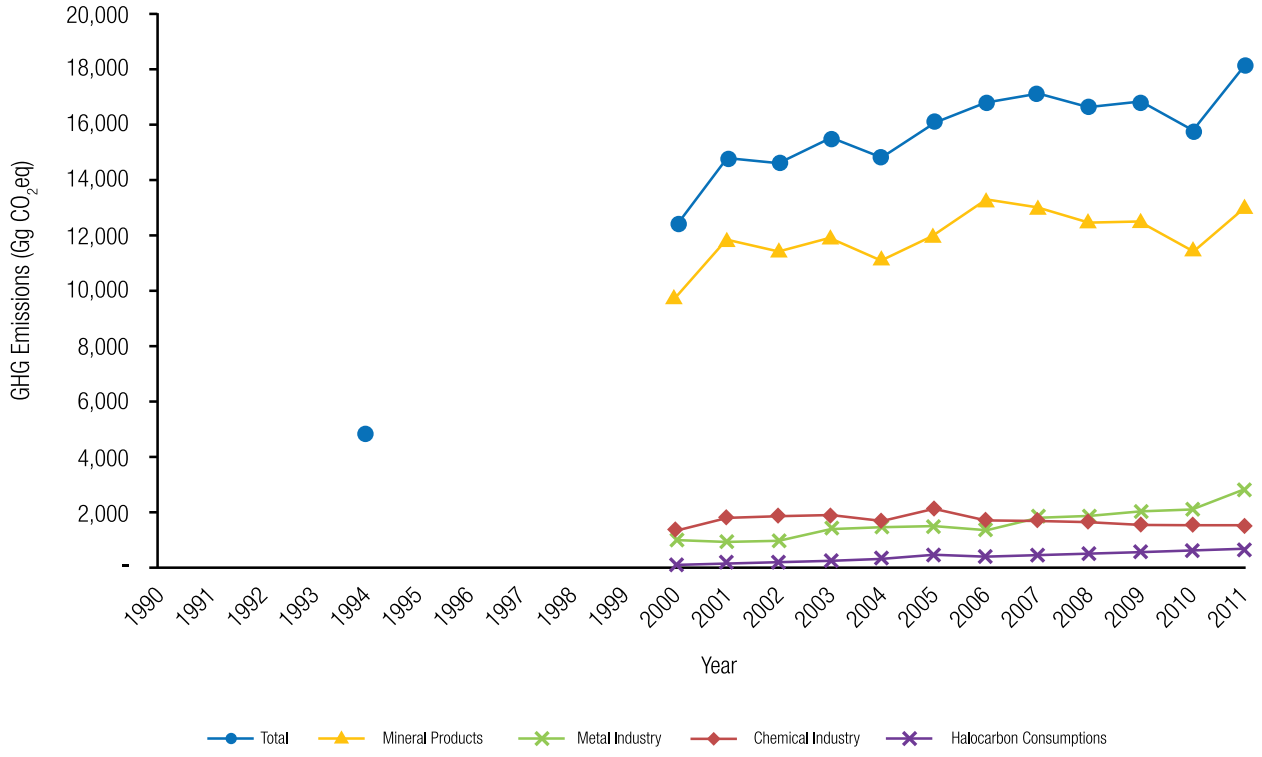


Figure 2.10: Emissions Time Series from 1990 to 2011 for LULUCF Sector

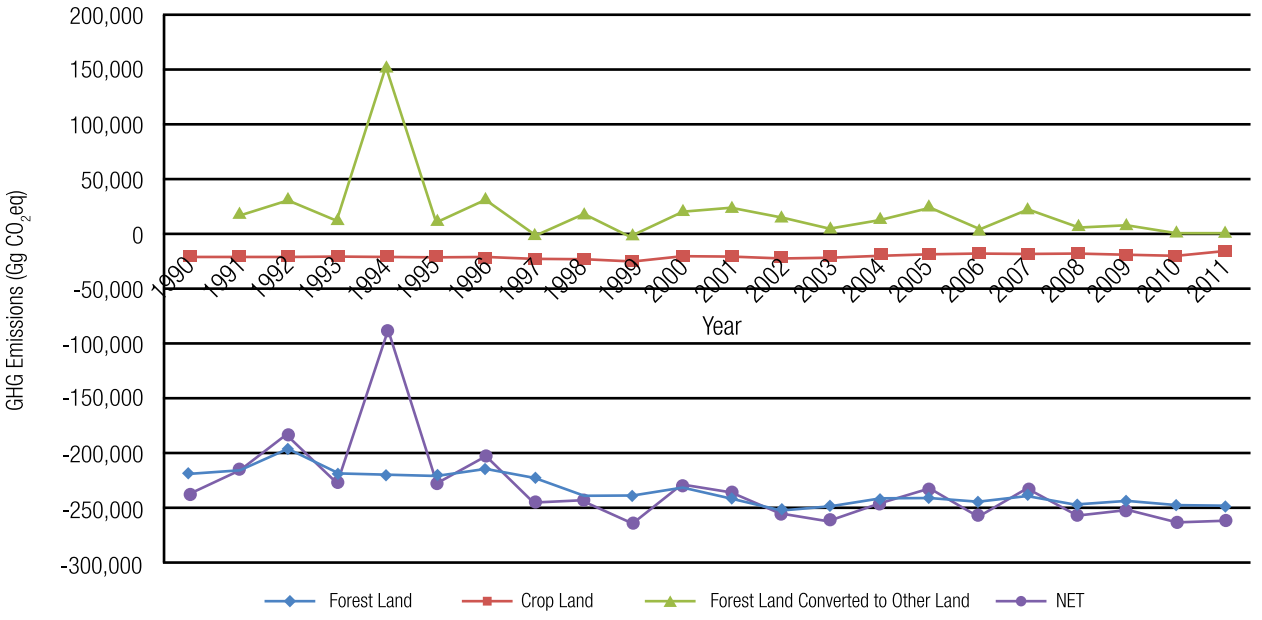


Figure 2.11: Emissions Time Series from 1990 to 2011 for Agriculture Sector

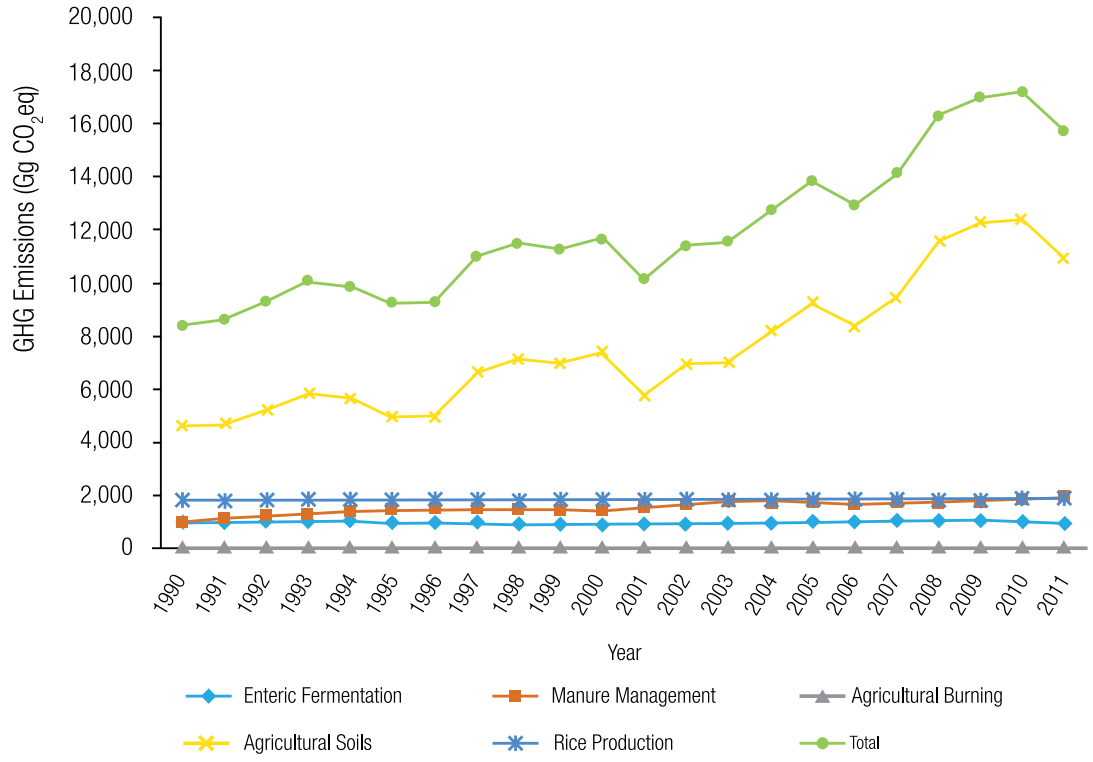
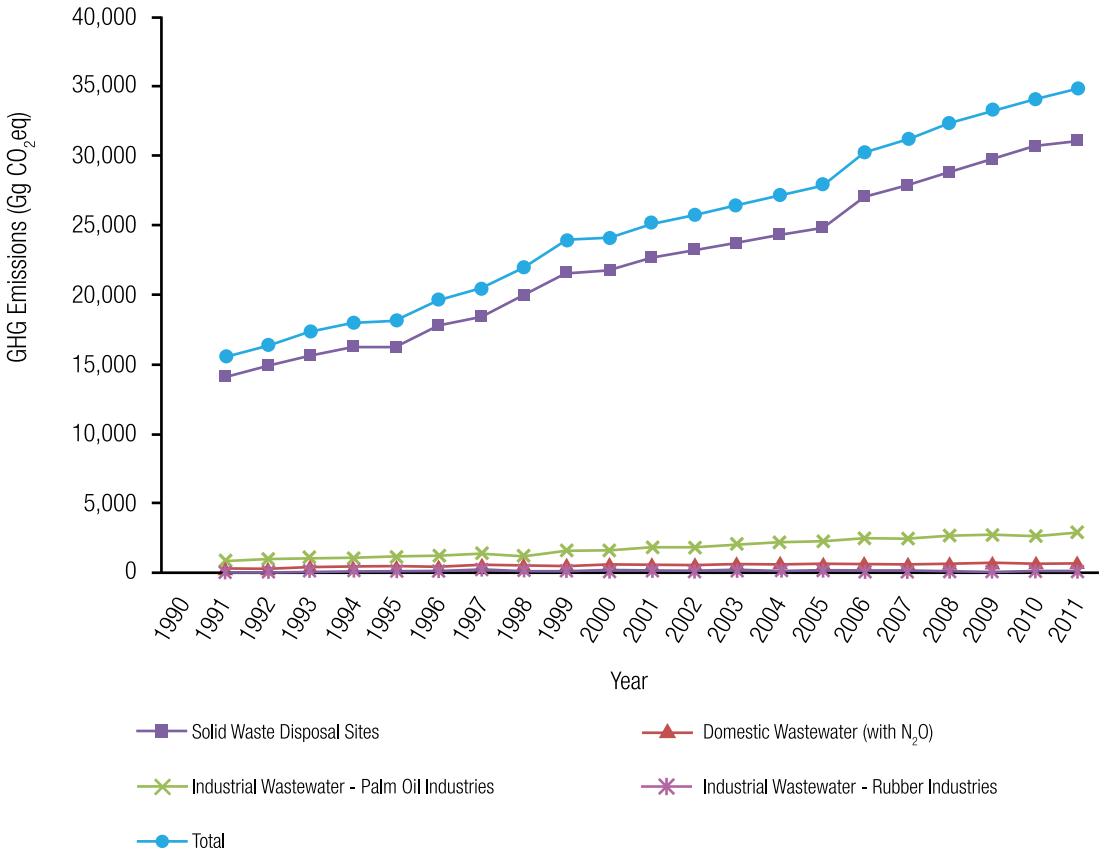


Figure 2.12: Emissions Time Series from 1991 to 2011 for Waste Sector



2.5.1 Emissions from Energy Sector

Emissions from the energy industries consistently remained the largest source throughout the time series period. The emissions from this subsector increased from 39.6% in 2000 to 52.0% in 2011. The transport sector was the second largest source comprising 24.3% of the emissions of the energy sector in 2000 and 20.2% in 2011. Emissions from manufacturing industries and construction peaked in 2007 and showed a decreasing trend since then. The emissions from this subsector were 20.1% of the total emissions of the energy sector in 2007 and decreased to 10.6% in 2011.

2.5.2 Emissions from Industrial Processes Sector

The mineral products industry was the highest source of emissions for this sector, specifically from cement production and limestone and dolomite use. The contributions of emissions from this subsector to the total emissions of the industrial processes sector were 78.7% in 2000 and 71.9% in 2011.

2.5.3 Emissions from Land Use, Land-Use Change and Forestry Sector

Removals and emissions from the LULUCF sector have been stable since 1995. The largest removal was from *Forest Land Remaining Forest Land* and the sole emission was from *Forest Land Converted to Other Land*.

2.5.4 Emissions from Agriculture Sector

For the agriculture sector, N_2O emissions from agricultural soils were the largest source throughout the whole time series period. The emissions were 63.5% of the total emissions from the agriculture sector in 2000 and 69.4% in 2011.

2.5.5 Emissions from Waste Sector

For the waste sector, methane emissions from solid waste disposal sites remained the largest source throughout the time series period. The emissions were 90.4% of the total emissions of the waste sector in 2000 and 89.2% in 2011. Emissions from wastewater handling in the oil palm industries consistently remained the second largest contributor throughout the time series period.

2.6 Greenhouse Gas Emissions for Years 1994, 2000, 2005 and 2011

GHG emissions for 1994, 2000, 2005 and 2011 are shown in Table 2.6. While NC2 reported that Malaysia was a net sink of 26.80 Mt CO_2eq in 2000, current recalculations show that Malaysia was a net sink of 32.86 Mt CO_2eq for that year. In 2005 and 2011 Malaysia was a net source of emissions of 30.87 Mt CO_2eq and 27.29 Mt CO_2eq respectively. The increase of emissions was due to the significant increase in GHG emissions from the energy sector, while LULUCF's sink capacity has stabilised. The

Table 2.6 Greenhouse Gas Emissions for the Years 1994, 2000, 2005 and 2011

Sector	Emissions/ Removals (Gg CO_2eq)			
	1994	2000	2005	2011
Energy	90,890.33	147,472.09	205,100.14	218,913.63
Industrial Processes	4,805.41*	12,416.23	16,115.77	18,166.34
Agriculture	9,886.82	11,699.10	13,845.80	15,775.30
LULUCF (Emissions)	153,970.04	22,359.79	25,666.67	2,489.67
Waste	18,005.26	24,115.89	27,934.73	34,885.04
Total emissions	**277,557.86**	**218,063.10**	**288,663.11**	**290,229.98**
Total sink	**-241,115.10**	**-250,927.51**	**-257,794.46**	**-262,946.41**
Net total (after subtracting sink)	**36,442.76**	**-32,864.41**	**30,868.65**	**27,283.57**

*The emissions from Industrial Processes for 1994 only contained cement production

rates of forest conversion have also decreased as indicated by the reduction in emissions from LULUCF.

2.7 Greenhouse Gas Emission Intensity Indices

Three approaches are presented in this section (Table 2.7). In the first approach, when LULUCF is excluded, the indices reflect only a modest gain. This is due to the cost differential between carbon-intensive and low-carbon technologies to achieve further emissions reductions. In the second approach, the significant effects of emissions reductions from the LULUCF sector are apparent. The third approach emphasises the impact of forest management and associated GHG removals on the indices.

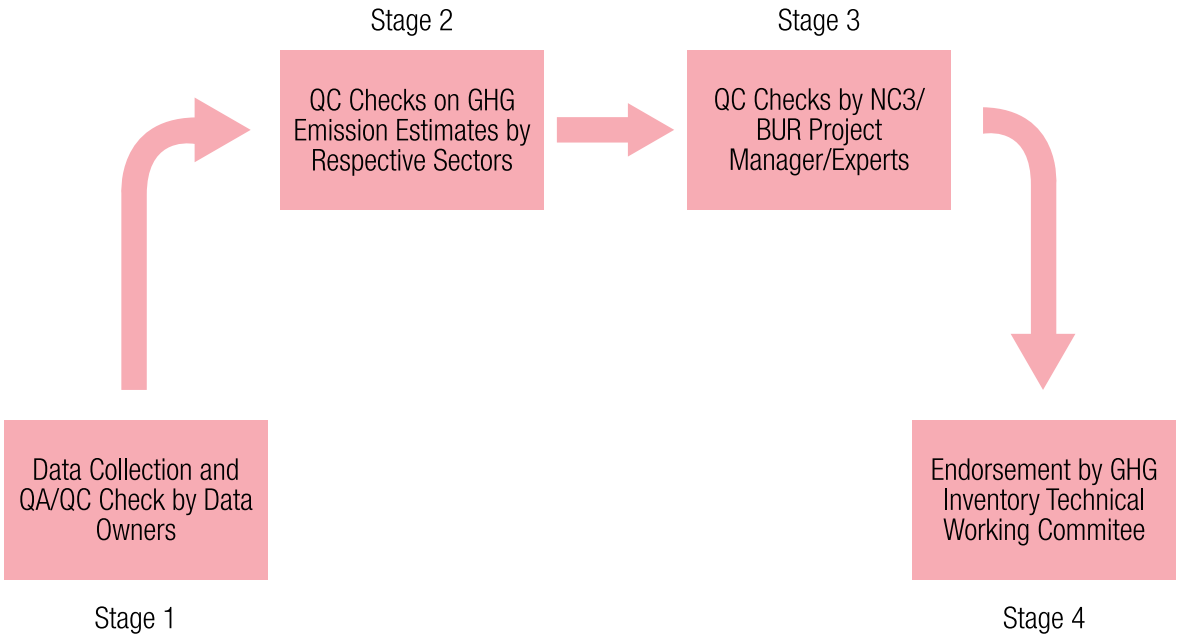
2.8 Quality Assurance and Quality Control Arrangement for Greenhouse Gas Inventory

Quality assurance and quality control (QA/QC) arrangements for the GHG Inventory are shown in Figure 2.13. The sector coordinators were charged with ensuring that adequate QC procedures were performed in the inventory, its supporting documents and spreadsheets. Procedure templates for QA/QC and uncertainty analysis were developed following the USEPA template obtained through the Southeast Asia GHG Inventory Capacity Building Project. The procedures included collecting and reviewing checklists for completeness. The BUR & NC3 Project Manager serves as the QA Manager, ensuring transparency, completeness and accuracy of the GHG inventory. In addition, sectoral experts also reviewed the sectoral reports.

Table 2.7 Greenhouse Gas Emission Indices for Malaysia

	Unit	2000	2005	2011	Percentage increase between 2005 and 2011
Population	Million	23.3	26.1	29.1	11.49%
GDP at constant 2005 prices	billion RM	431.234	543.578	711.760	30.94%
Approach 1: Without LULUCF					
CO_2eq emissions	mil tonne	195.703	262.996	287.740	9.41%
CO_2eq emissions per capita	tonne/capita	8.399	10.076	9.888	-1.87%
CO_2eq emissions per GDP	tonne/ thousand RM	0.4538	0.4838	0.4043	-16.43%
Approach 2: With LULUCF (Emissions only)					
CO_2eq emissions	mil tonne	218.063	288.663	290.230	0.54%
CO_2eq emissions per capita	tonne/capita	9.360	11.060	9.974	-9.82%
CO_2eq emissions per GDP	tonne/ thousand RM	0.5057	0.5310	0.4078	-23.20%
Approach 3: With LULUCF (Emissions and Removals)					
CO_2eq emissions	mil tonne	-32.864	30.869	27.284	-11.62%
CO_2eq emissions per capita	tonne/capita	-1.410	1.183	0.938	-20.71%
CO_2eq emissions per GDP	tonne/ thousand RM	-0.0762	0.0568	0.0383	-32.57%

Figure 2.13: Schematic Diagram showing Quality Assurance and Quality Control Arrangement for Greenhouse Gas Inventory



CHAPTER 3

MITIGATION ACTIONS AND THEIR EFFECTS

CHAPTER 3: MITIGATION ACTIONS AND THEIR EFFECTS

3.1 Introduction

Malaysia has undertaken a number of efforts to address climate change and continually re-evaluates its mitigation potential in various key sectors. These actions will contribute towards achieving Malaysia's conditional voluntary indicator to reduce its greenhouse gas emissions intensity of GDP by up to 40% by 2020 as compared with 2005 levels, conditional on receiving technology transfer and finance of adequate and effective levels from developed countries.

This chapter provides an overview of the national policy and planning framework for Malaysia that is relevant to addressing climate change. This is followed by a detailed description of specific mitigation actions for which sufficient quantitative and verifiable data on implementation and effects are available.

3.2 National Policy and Planning Framework

3.2.1 National Policy on Climate Change

Malaysia's National Policy on Climate Change, approved by the Cabinet in 2009, provides the framework to mobilise and guide Government agencies, industry, communities, as well as other stakeholders in addressing the challenges of climate change in an effective and holistic manner. Its overriding aim is to ensure climate-resilient development to fulfil national aspirations for sustainable development.

The objective of the National Policy on Climate Change is to mainstream climate change through wise management of resources and enhanced environmental conservation. This should integrate responses into national policies, plans and programmes, and strengthen institutional and implementation capacity resulting in improved economic competitiveness and quality of life.

Five principles set the national direction in responding to the challenges of climate change. The adverse effects and impacts of climate change are recognised and national responses that consolidate economic, social and environmental development goals are mainstreamed based on the following principles:

- ***Development on a sustainable path:*** To integrate climate change responses into national development plans to fulfil the country's aspiration for sustainable development;

- ***Conservation of environment and natural resources:*** To strengthen implementation of climate change actions that contribute to environmental conservation and sustainable use of natural resources;
- ***Coordinated implementation:*** To incorporate climate change considerations into the implementation of development programmes at all levels;
- ***Effective participation:*** To improve participation of stakeholders and major groups for effective implementation of climate change responses; and
- ***Common but differentiated responsibilities and respective capabilities:*** International involvement on climate change will be based on the principle of common but differentiated responsibilities and respective capabilities.

3.2.2 New Economic Model and Transformation Programmes

The New Economic Model (NEM) formulated in 2010 aims at transforming Malaysia into a high-income economy that is inclusive and sustainable in both economic and environmental terms. Among the policy measures in the NEM that are relevant to addressing climate change are:

- ***Follow international standards on sustainability:*** including to address climate change, such as emission reductions, providing incentives for the deployment of low-carbon energy technologies to reduce carbon emissions, and enforcing clean air and water standards;
- ***Internalise externalities:*** including rationalisation of subsidies and removal of price controls on energy to encourage the adoption of renewable and green technologies in the long run;
- ***Promote green growth and energy efficiency*** *through* adoption of energy efficiency standards, together with the greater use of alternative renewable green energy sources;
- ***Strive for energy resource sustainability:*** including the introduction of new and renewable resources and establishment of a transparent priority-based ranking system for research and development and use of green energy technology so that the private sector can readily invest, such as in downstream projects related to non-fossil based energies; and
- ***Favour sustainable agriculture:*** including setting standards on sustainable agri-food production and distribution, such as organic food standards.

The NEM is operationalised through the Economic Transformation Programme (ETP) containing six Strategic Reform Initiatives (SRIs), and 12 National Key Economic Areas (NKEAs), implemented through Entry Point Projects (EPPs). Implementation of the ETP began under the Tenth Malaysia Plan (2010-2015) and continues through the Eleventh Malaysia Plan (2016-2020). The NKEAs and their EPPs relevant to climate change issues are discussed under the relevant cross-sectoral and sector-specific initiatives in sections 3.3 and 3.4.

The other pillar of implementation of the NEM is through the Government Transformation Programme (GTP), which aims to strengthen public services in the National Key Result Areas (NKRAs). The aim is to enhance governance and efficiency in Government institutions, which are accountable and consultative, and whose performance will be measured against performance-based outcomes. Relevant to the topic of addressing climate change, the NKRAs include one on *Improving Urban Public Transport*, which is discussed in section 3.4.2.

3.2.3 Tenth and Eleventh Malaysia Plans

The foundation for addressing climate change in a more coherent manner was established in the Tenth Malaysia Plan (2011-2015). The Tenth Malaysia Plan expressed the Government's commitment to, *inter alia*, "building an

environment that enhances the quality of life". Among the strategies identified was the valuing of the nation's environmental endowments, with focus on developing a climate resilient strategy and enhancing conservation of the ecological assets. Development of climate resilient strategy was two-pronged: firstly, adaptation strategies to protect the nation from the impacts of climate change; and secondly, mitigation strategies to reduce GHG emissions.

The Eleventh Malaysia Plan (2016-2020) takes these efforts further by having a strategic thrust on *Pursuing Green Growth for Sustainability and Resilience.* The fundamental shift is towards a development model that views resilient, low-carbon, resource-efficient and socially-inclusive development as an investment that will yield future gains.

Thrust four of the Eleventh Malaysia Plan focusses on four key areas in pursuing green growth namely:

- ***Strengthening the enabling environment for green growth***, particularly in terms of the policy and regulatory framework, human capital, green technology investment and financial instruments. The strategies by which this will be done are through strengthening governance, enhancing awareness and establishing sustainable financing mechanisms. The latter is crucial due to the high costs of adaptation and mitigation measures, including that required for the acquisition of related technologies;
- ***Adopting the sustainable consumption and production concept***, so that the economy is shifted accordingly, particularly in the private sector. The Government is committed to lead in creating green markets through Government Green Procurement (GGP), while promoting the adoption of criteria for green buildings and strengthening green certification. The share of renewables in the energy mix will be increased, while demand side management (DSM) will be enhanced. Low-carbon mobility through the utilisation of energy-efficient vehicles and public transportation will be promoted. Waste will also be managed holistically through better coordination, encouraging reduction, reuse and recycling and using waste as a resource for other industries;
- ***Conserving natural resources for present and future generations***, so that their function as natural buffer against climate change and natural disasters will be strengthened. The conservation of Malaysia's forests is also seen as a key effort to protect carbon sinks and to reduce emissions from deforestation and forest degradation; and
- ***Strengthening resilience against climate change and natural disasters*** to protect people and development gains as well as to ensure the standards of living enjoyed by people today still continue to rise for future generations.

3.3 Cross-Sectoral Initiatives

3.3.1 A Roadmap of Emissions Intensity Reduction in Malaysia

In 2010 a study was initiated to comprehensively analyse mitigation prospects, potential and strategies across various sectors, make recommendations, and delineate a mitigation roadmap for Malaysia. The sectors include energy, industrial processes, agriculture, LULUCF and waste.

The analysis time frame of the study is from 2005 to 2030 and examines business-as-usual (BAU) and mitigation scenarios. The study indicates that there are opportunities across various sectors to meet Malaysia's voluntary reduction of up to 40% emissions intensity of GDP by 2020. However large efforts including adequate finance, appropriate technologies, the right skill sets and enabling policies and institutional environments would be required to achieve the emissions intensity reduction.

3.3.2 National Green Technology Policy

The National Green Technology Policy was launched in 2009 to spearhead the development of the green technology sector in the country. The Policy has the following five main objectives:

- ***Decreasing growth of energy consumption*** while enhancing economic development;
- ***Facilitating growth of the green technology industry*** and enhancing its contribution to the national economy;
- ***Increasing national capabilities and capacity for innovation in green technology development*** and enhancing Malaysia's green technology competitiveness in the global arena;
- ***Ensuring sustainable development*** and conserving the environment for future generations; and
- ***Enhancing public education and awareness of green technology*** and encouraging its widespread use.

Concurrently, the Green Technology Financing Scheme (GTFS) was set up in 2009 with a funding of RM1.5 billion. It has since been augmented with an additional RM2 billion to encourage companies, especially small and medium-sized enterprises, to use green technologies in their operations. The implementation of projects under the GTFS has since resulted in an estimated reduction in GHG emissions of 94.81 kt CO_2eq in 2013.

At the implementation level, the EPP on *Jump-starting a Vibrant Green Technology Industry* further focuses on raising Malaysia's profile as an Asian green technology hub and on increasing the capabilities of the local industry. Investments in the industry reached RM2.59 billion in 2014, surpassing the target of RM2 billion. Forty-five projects worth RM438 million were approved under the GTFS in 2014.

Subsequently a master plan on green technology is being drafted by the Ministry of Energy, Green Technology and Water. Several policy initiatives provided the building blocks for that master plan, including an initial foresight study focussing on energy, transportation, manufacturing, building, waste, water, information and communication technology, agriculture and forestry sectors; an inventory of green growth and green economy initiatives; a regulatory framework analysis exploring statutory options for green technology development and application; an economic assessment of green businesses; an impact assessment of current and previous incentives; a green tax incentives framework and implementation; and an exploration of green financial institutions for green investment.

3.4 Sector-Specific Initiatives

3.4.1 Energy Management and Conservation

While the oil, gas and energy EPPs under the ETP focus on developing the sector further, some attention is also paid to energy efficiency and renewable energy such as solar and hydroelectric power, as alternatives to fossil fuels. Similarly, during the Eleventh Malaysia Plan, the optimisation of the fuel mix and exploration of alternative fuels will be given priority to reduce the nation's dependency on fossil fuels for electricity generation.

The Government has further committed to ensuring that future power plants must incorporate more stringent emission control technologies to ensure a progressive reduction of the energy industry's carbon footprint. The use of clean and green energy sources in power generation will also be made a priority and is expected to increase substantially in the generation mix. Nonetheless, challenges remain for the energy sector, for example, national priorities on energy security spelled out in the Eleventh Malaysia Plan dictate that the share of coal in the total electricity generation mix is anticipated to increase to 53% by 2020.

3.4.1.1 Energy Efficiency

It has been recognised that energy efficiency measures will go a long way in addressing climate change, with multiple benefits of emissions reduction, energy and cost savings, and cleaner air. The *Efficient Management of Electrical Energy Regulations 2008* aims to ensure that high electrical energy users or generators, with a total electrical energy consumption or generation, respectively, equal to or exceeding 3,000,000 kWh over any period not exceeding six consecutive months, put in place measures for efficient electrical energy management. These include obligations to appoint or designate a registered electrical energy manager and to report net energy usage and measures implemented for efficient electrical energy management to the Energy Commission. The Commission and related agencies are currently working to improve the regulations for all industry players to adhere to the regulations and to improve the efficiency of their installation.

Efforts were made during the Tenth Malaysia Plan via the EPP on *Improving Energy Efficiency* to address energy demand management through the Minimum Energy Performance Standards (MEPS) for domestic appliances, which were gazetted in 2013. In an effort to raise awareness, a two-year programme called the Sustainability Achieved via Energy Efficiency (SAVE) Programme (2011-2013) was implemented under which households were offered rebates of RM100 and RM200 for any purchase of new energy efficient refrigerators and air conditioners for domestic use as well as RM200 per refrigerant tonne (RT) of chillers replacement.

This programme is estimated to have reduced energy consumption by 306.9 GWh over the lifetime of the programme. Moreover, pilot projects for energy audits and retrofitting of selected Government buildings has been implemented. The retrofitting of four Government buildings located in Putrajaya is estimated to have reduced electricity use ranging from 4 - 19% monthly, equivalent to RM7,000–RM130,000 in savings.

Demand Side Management is spelt out in the Eleventh Malaysia Plan and marks an important paradigm shift towards further efficient management of energy resources. This initiative aims to give due emphasis to the demand side for a balanced management of the entire energy spectrum. One of the goals of DSM is to encourage consumers to use less energy during peak hours and to move the time of energy use to off-peak hours. This is also known as Enhanced Time of Use (EToU) where for domestic consumers it is anticipated to build on the MEPS programmes initiated during the Tenth Malaysia Plan. A comprehensive long-term DSM master plan will need to be formulated to steer prudent energy usage in Malaysia. The scope of the proposed DSM master plan will include electric and thermal energy, and usage in the transport sector.

Likewise, the National Energy Efficiency Action Plan (NEEAP), which is currently at the final stage of its development, is focussed on tackling issues pertaining to energy supply by managing demand efficiently. The Plan will prescribe a path towards improving energy efficiency by pursuing the implementation of measures that are considered as “harvesting the low hanging fruits”, as they are mutually viable for the country’s economic growth and enhancing social well-being. It is targeted for implementation in 2016.

Although the private sector is anticipated to be the key contributor to the success of the NEEAP, it is however recognised that to obtain widespread acceptance of the action plan, the role of Government in leading this initiative is crucial. The Government will, through circulars, direct its ministries and agencies to practise energy efficiency in its operations. Initial implementation of energy audits and management of Government buildings has already yielded encouraging results through the Government Lead by Example

(GLBE) initiative. Through efficient electricity consumption practices in Federal Government Ministry buildings, an emissions reduction of approximately 10.94 kt CO_2eq was achieved in 2014.

During the Eleventh Malaysia Plan period, measures are also planned to identify potential improvements and appropriate approaches to ensure the efficient use of energy in buildings, industries and households. These include actions to increase the competencies of energy service providers, promote the implementation of Energy Performance Contracting (EPC), enhance user awareness on energy labelling, promote the availability of standards such as ISO 50001 and MS1525 for buildings and MEPS for appliances, gradually abolish the Special Industrial Tariff (SIT) for energy-intensive industries and implement infrastructure related initiatives such as smart grids and highly efficient co-generation technologies for combined heat and power systems.

In terms of energy efficiency in buildings, the promotion of "green buildings" will not only reduce emissions, but also ensure the efficient use of resources, particularly of energy and water. In this respect, the Eleventh Malaysia Plan foresees that new government buildings will adopt green features and designs and use green building materials in accordance with existing standards such as *Skim Penarafan Hijau Jabatan Kerja Raya Malaysia (Malaysia Public Works Department Green Rating Scheme)*. Existing Government buildings will be gradually retrofitted while industry players will be encouraged to obtain green certification such as GreenPASS and the Green Building Index, for private buildings. GreenPASS which uses Building Energy Index (BEI) and carbon reduction assessment to rate the degree of energy efficiency of buildings will be further promoted in the country. In 2013 the implementation of green building rating scheme has resulted in 60.4 kt CO_2eq emissions reduction.

3.4.1.2 Renewable Energy

Renewable energy was first identified as the "fifth fuel" resource under the Eight Malaysia Plan (2001-2005) in addition to the other four energy resources consisting of oil, gas, coal and hydropower. The Renewable Energy Policy and Action Plan was adopted in 2010, the Renewable Energy Act legislated in 2011 and the Sustainable Energy Development Authority formed to provide the impetus for greater use of renewable energy in electricity generation. The renewable energy sources that are identified in the Policy and Action Plan are palm oil biomass wastes and palm oil mill effluents; mini-hydro; solar power; solid waste and land-fill gas; and wastes and gases from agro-based and farming industries. However, the detailed resource potentials have not been fully examined and verified yet for wastes and gases from agro-based and farming industries. Electricity generation capacity through renewable sources including biomass, biogas, solar photovoltaics and mini hydro are projected to reach 7.8% of total installed capacity in Peninsular Malaysia and Sabah by 2020, or about 2,080 MW.

The Tenth Malaysia Plan set a renewable energy target of 985 MW by 2015. Under the ETP, several EPPs have focussed on renewable energy in particular the EPP on *Building Up Renewable Energy and Solar Power Capacity* and the EPP on *Tapping Malaysia's Hydroelectricity Potential.* Solar power is expected to contribute at least 220 MW to the country's total capacity mix. Several policy measures and incentives were initiated to achieve this, including the introduction of a FiT with a clear buy-back mechanism that allowed locally produced electricity to be sold to power utilities at a fixed premium over a specific period and that spurred investment in renewable energy; and the establishment of a Renewable Energy Fund to support renewable energy development. The installed capacity of the FiT renewable energy has since grown to 148 MW in 2013. Renewable energy generation from the FiT and non-FiT public regulated and

private licensees has contributed to a reduction of 1201.55 kt CO_2eq in 2013.

The EPP on *Developing Biogas Facilities at Palm Oil Mills* encourages palm oil mills to capture methane via biogas trapping facilities. The objective is to ensure that mills capture methane to generate electricity for supply to the national grid or for their own use. The estimated potential energy generated from biogas in Malaysia is 1.88 million MWh of electricity. The EPP aims to develop biogas plants at the 500 mills over the next 10 years. In 2014, the Government mandated new palm oil mills and mills that are expanding their capacity to install methane avoidance facilities. Biogas capture from palm oil mill effluent has reduced emissions by 300.95 kt CO_2eq in 2013.

The National Biofuel Policy 2006 had already laid the ground for these initiatives, by focussing on the transport sector (using B5 diesel for land and sea transport, a blend of 5% processed palm oil and 95% petroleum diesel); supplying B5 diesel to the industrial sector; research, development and commercialisation of biofuel technologies; supplying the growing global demand for biofuel; and focussing on biofuel as a means to minimise the emission of GHGs. The National Biofuel Industry Act 2007 was further put in place to regulate the biofuel industry in Malaysia and to promote the mandatory use of the B5 domestic palm biodiesel.

Nonetheless, there have been challenges in implementing the biofuel mandate throughout Malaysia, including logistical, infrastructure and distributional capacity challenges. To support the implementation of the biodiesel B5 Programme, 35 depots were constructed nationwide with in-line blending facilities during the Tenth Malaysia Plan. This has been an important effort, as there have been infrastructural, logistical and distributional challenges in implementing the B5 Programme. Development and usage of palm oil-based biodiesel in blended petroleum diesel had reduced emissions by 719.74 kt CO_2eq in 2013. At the end of 2014, Malaysia had also introduced the bio-diesel B7 Programme (7% bio-diesel blending) nationwide under the EPP on *Commercialising Second Generation Biofuels.* The EPP on *Commercialising Second Generation Biofuels* (B7 and higher) focus is on biofuels that are produced from non-food biomass, with targets to fast-track the commercialisation of palm biomass-to-liquid technology to generate electricity, fire up boilers and fuel diesel engines. Investment in Sarawak has been secured to create Southeast Asia's first biomass processing hub, while a bio-oil plant capable of producing 30 MW of energy is planned near Lahad Datu, Sabah. The plan is to then progressively upgrade to the B10 Programme.

The ASEAN Meeting of Energy Ministers in September 2014 adopted a new definition of renewable energy that includes all types of renewable energy sources including large capacity hydro dams. However, in line with the Renewable Energy Act 2011, the Malaysian Feed-in Tariff programme is only applicable for installations with less than 30 MW installed capacity.

The EPP on *Tapping Malaysia's Hydroelectricity Potential* aims to increase the use of hydroelectricity in the country in a responsible and sustainable manner. In 2014, 17 areas in Sabah were identified as potential sites for small hydropower development. Installed capacity of small hydro under the FiT programme reached 15.70 MW by the end of 2013.

The Eleventh Malaysia Plan will further focus on promoting new renewable energy sources. Other sources such as wind, geothermal and ocean as well as off-grid renewable energy facilities will be explored and promoted.

3.4.2 Transport

The transport sector accounts for a significant amount of emissions and energy demand in Malaysia. Therefore, the implementation of

public transport initiatives is critical to reduce the use of private vehicles on the roads and consequently, to reduce emissions. The Land Public Transport Commission was established in 2010 and subsequently launched its National Land Public Transport Master Plan (2012-2030) to promote integrated planning of public transportation and management of the growth of private vehicles. It explicitly targets an increase of 40% in the public transport share in urban areas by 2030.

The emphasis on public transport is also reflected in the GTP, with the Urban Public Transport NKRA focussing on increasing public transport ridership in key urban areas in several States, improving reliability and journey times, enhancing comfort and convenience, as well as ensuring first- and last-mile accessibility. The EPP *Building an Integrated Urban Mass Rapid Transit System* is a key driver in growing the public transport modal share.

During the Tenth Malaysia Plan, major public transport projects were initiated. The major effort encompasses the expansion of the Kuala Lumpur Light Rail Transit (LRT) coverage and the implementation of the Mass Rapid Transit (MRT) system as major investment priorities. Construction of the MRT Line 1 started in 2012 and is expected to be operational in 2017. Initiatives carried out under the Tenth Malaysia Plan have so far enabled a 31.7% increase in the annual ridership of urban rail in the Greater Kuala Lumpur/Klang Valley area to 226 million in 2014. The Klang Valley Mass Rapid Transit (KVMRT) system is expected to become operational during the Eleventh Malaysia Plan. The KVMRT Line 1 will traverse 51 km through 31 stations, serving about 1.2 million people with a daily expected ridership of 400,000. Construction on KVMRT Line 2 will start in 2016 and is estimated to become operational by 2022. Additionally, construction on Light Rail Transit (LRT) Line 3 running over 36 km and serving 25 stations will start in 2016 with expected completion in 2020. Outside this area, the electrified double-track railway from Perlis to Negeri Sembilan operated by *Keretapi Tanah Melayu Berhad* has also been completed. In 2013 the Klang Valley urban rail-based public transport has led to an emissions reduction of 214.93 kt CO_2eq.

For buses, an additional 470 new buses were provided for the following services – Rapid KL, Rapid Kuantan and Rapid Penang – leading to significant increases in passenger ridership. The Go-KL free bus service was introduced in 2013 to ease road congestion during peak hours in the Kuala Lumpur central business district. Stage bus annual ridership showed a mixed performance with an increase in four capital cities and a decrease in seven other cities from 2012 to 2014. The Stage Bus Services Transformation (SBST) Programme was introduced in 2015 to improve operator viability and expand route coverage. The SBST Programme was rolled out to five cities in 2015.

Integration between transport modes was also enhanced by providing first- and last-mile connectivity including by extending pedestrian walkways, building parking facilities at terminals, and revitalising inter-urban terminal hubs. In the Greater Kuala Lumpur/Klang Valley region, the public transport modal share improved from 16.9% in 2010 to 18.1% in 2014, while the morning peak hour ridership increased to 799,992 passengers in 2014. Network coverage, measured by population living within 400 metres of public transport nodes, improved from 63% in 2010 to 72% in 2014.

To take these efforts further, the Eleventh Malaysia Plan adopts the concept of “low-carbon mobility”, which emphasises the usage of public transport. Further public transport investments in cities – including additional MRT lines in Greater Kuala Lumpur/Klang Valley and bus systems in other State capitals – are planned in line with the declared targets of achieving 40% public transport modal share in Greater Kuala Lumpur/Klang Valley and 20% in other cities. Rural, rural-urban

and inter-city connectivity will also need to be strengthened, so as improve availability, reliability and convenience. The transit-oriented development (TOD) concept will also be promoted to optimise land use and public transport infrastructure planning. As such, planning for the development of road and rail networks should be better integrated to promote a multimodal transport system.

Other efforts to reduce energy consumption and air pollution from road vehicles have also reduced GHG emissions. These efforts include the use of compressed natural gas (CNG), the promotion of energy-efficient vehicles (EEVs) and the adoption of higher fuel standards. The use of compressed natural gas (CNG) by vehicles started in late 1990s; however, adoption has been limited to predominantly taxi and a number of bus fleets in specific areas in Peninsular Malaysia. This usage has led to a reduction of 154.62 kt CO_2eq in 2013. The National Automotive Policy (NAP) 2014 specifies that 85% of the vehicles produced in Malaysia by 2020 would be EEVs. The Government is particularly committed to increase the adoption of EEVs for public transport. In 2013 the use of EEVs has reduced emissions by 40.96 kt CO_2eq.

The Eleventh Malaysia Plan also calls for accelerating the utilisation of more environmentally friendly fuel. The Government gazetted EURO 4M standards in 2013 and enforced its use in RON 97 in 2015. The plan is to extend EURO 4M standards to RON 95 petrol and EURO 5 standards to diesel.

3.4.3 Waste Management

The waste sector in Malaysia accounted for the second largest share of emissions in 2011, and emissions from the sector have been rising due to increasing population and consumption. To address this problem, the EPP on *Developing an Efficient Solid Waste Management System* identified four initiatives: encouraging greater implementation of the Reduce, Reuse, Recycle (3R) programme; increasing waste treatment capacity to reduce reliance on landfills; improving the governance of solid waste management and public cleaning services; and assessing the potential of new technological developments such as automatic waste collection and the use of deep bins.

The 3R programme was intensified during the Tenth Malaysia Plan, which saw household recycling rates rise from 5.0% in 2010 to 10.5% in 2012. The Government has set a goal of attaining a 22% household recycling rate by 2020. Waste separation at source for households is being implemented in selected States starting in September 2015 in line with the enforcement of the Solid Waste and Public Cleansing Management Act 2007. In 2013, the waste paper recycling industry reduced emissions by 1,993.47 kt CO_2eq.

The Eleventh Malaysia Plan further envisages that all seven types of waste – solid, agricultural, construction, radioactive, mining, sewage, and scheduled waste – will be managed in a holistic manner based on a life-cycle approach. This approach extends beyond merely disposing the waste, and instead aims to increase investment to channel waste away from landfills to be used as resource, either converted to energy or used as an input for other products.

3.4.4 Land Use, Land-Use Change and Forestry

The LULUCF sector plays a key role in Malaysia's actions to address climate change. This sector remains a net sink while contributing to the nation's GDP. It is thus imperative that efforts are strengthened to maintain and enhance the country's forest reserves.

The Tenth Malaysia Plan included a chapter on *Valuing Our Environmental Endowments*, wherein enhancing forest management was one of the priorities. The Natural Resources Conservation Trust Fund was established in 2013 to further enhance sustainable forest management and conservation of biodiversity.

The Central Forest Spine (CFS) in Peninsular Malaysia and the Heart of Borneo (HoB) in Sabah and Sarawak are enablers to increase connectivity between forests and to reduce fragmentation while improving natural resource management. The Government has allocated about USD30 million for these projects between 2010 and 2015. In 2013, approximately 53,750 ha have been gazetted as Permanent Reserved Forest. This has contributed to emissions reduction of 13,797.37 kt CO_2eq.

The Eleventh Malaysia Plan aims to have 17% of terrestrial and inland water areas gazetted as protected areas by 2020. Reforestation and forest enrichment efforts will also be carried out in affected areas to improve degraded forests. Meanwhile, measures to reduce illegal logging activities and forest degradation will be taken through stricter enforcement. In an effort to provide alternative livelihood, the tourism EPP *Establishing Malaysia Mega Biodiversity Hub* aims to provide employment and business opportunities from ecotourism. This will require a comprehensive system to monitor and conserve the country's natural attractions, including its biodiverse forests, which are critical carbon sinks. These initiatives will promote responsible tourism and foster sustainable management of natural ecosystems.

In addition, the REDD+ Strategy is also being developed for Malaysia. The Strategy outlines policy actions to ensure at least 50% of Malaysia's land mass remains forested. This is achieved through enhancing sustainable management of forest and conservation activities. In this vein, the National Forestry Policy is being revised to include addressing climate change challenges.

In line with the aim to maintain at least 50% of forest cover, both upstream and downstream activities of the palm oil sector are being addressed/improved. As of 2011, about 5 million ha were planted with oil palm in Malaysia and the maximum additional arable land for this crop is estimated at 1.0 million ha. The anticipated increase in global demand for vegetable oil will be met through increased oil yield. Under the NKEA, the average oil yield is targeted at 6 t/ha/yr and fresh fruit bunch (FFB) yields to increase from the current 21 t/ha in 2009 to 26 t/ha by 2020. Environmental performance regulations and sustainability criteria are complied with through the Malaysian Sustainable Palm Oil (MSPO), Roundtable on Sustainable Palm Oil (RSPO) and other sustainability certification schemes. Currently, most big oil palm plantations are MSPO or RSPO certified to ensure environmental sustainability.

3.4.5 Agriculture

Agriculture accounts for 5% of GHG emissions in Malaysia in 2011. Emissions are primarily from the agricultural soils and efforts are being made to optimise fertiliser application.

The development of the agriculture sector in Malaysia is guided by the National Agro-food Policy (2011-2020) and the National Commodity Policy (2011-2020), which aim to increase food production and exports of industrial commodities. The objectives of the National Agro-food Policy are to ensure adequate food security that is safe to eat; to make the agro-food industry competitive and sustainable; and to increase the agro-based entrepreneur's level of income.

Two certification schemes guide sustainable agriculture implementation in Malaysia. The Malaysian Organic Scheme (currently known as MyOrganic) is a certification programme to recognise organically cultivated farms which do not use chemical pesticides and synthetic fertilisers. It was launched in 2007 and sets out the requirements for the production of, labelling and claims for organically produced foods. The requirements cover all stages of production, including farm operations, preparation, storage, transport and labelling. It is based on *Malaysian Standard MS 1529:2001 – The production, processing, labelling and marketing of plant-based organically produced foods.*

The Malaysian Good Agricultural Practices (MyGAP) was launched in 2013 and is a comprehensive certification scheme for the agricultural, aquaculture and livestock sectors. MyGAP is a rebranding of Malaysian Farm Scheme for Good Agriculture Practices introduced in 2002, Livestock Farm Practices

Scheme and Malaysian Aquaculture Farm Certification Scheme. The agricultural practices promoted in MyGAP place emphasis on environmental, economic and social aspects to ensure safe and good quality produce. Among other objectives, MyGAP aims to reduce environment pollution and assist in developing an environmentally friendly and sustainable national agricultural industry. MyGAP is an ETP initiative under the *SRI Competition, Standard and Liberalisation*, which is an enabler to the Agriculture NKEA. Under the Eleventh Malaysia Plan, incentives will be provided to further enhance the implementation of MyGAP.

3.5 List of Mitigation Actions and their Effects

The policies and programmes identified in the previous sections all yield direct or indirect environmental benefits. Currently only a subset of these can be adequately quantified in terms of greenhouse gas emissions reductions. In 2013 a total of 18,578.80 kt CO_2eq emissions were reduced.

Table 3.1 Summary of Emissions Reduction Achieved in 2013 and Projections for 2020

Sector	Mitigation Action	Emission Reduction Achieved in 2013 (kt CO_2eq)		Potential Emission Reduction in 2020 (kt CO_2eq)	
Energy	RE Implementation through Feed-in Tariff mechanism		252.78		5,458.09
	- *Biomass*	127.89		1,511.19	
	- *Biogas*	21.68		906.71	
	- *Small hydropower*	63.41		2,507.92	
	- *Solar photovoltaic*	39.80		403.13	
	- *Geothermal*	-		129.14	
	RE electricity generation by non-Feed-in Tariff regulated public and private licensees and other mechanisms		948.77		2,179.29
	- *Biomass*	822.25		822.25	
	- *Biogas*	17.28		17.28	
	- *Small hydropower*	108.39		108.39	
	- *Solar photovoltaic*	0.85		1,231.37	
	Use of palm-based biodiesel in blended petroleum diesel		719.74		1,802.49
	Application of green technology		94.81		1,426.35
	Implementation of green building rating scheme		60.40		858.40
	Efficient electricity consumption in all Federal Government ministry buildings (baseline established in 2013)		-		98.21
	Reducing emissions through development and usage of energy-efficient vehicles (EEVs)		40.96		199.74
	Use of compressed natural gas (CNG) in motor vehicles		154.62		217.57
	Rail-based public transport		214.93		977.51
LULUCF	Emissions reduction through sustainable management of forest				
	- Gazettement under CFS and HoB	6,214.41	13,797.37		13,800.00
	- Other gazettment	7,582.96			
Waste	Waste paper recycling		1,993.47		2,159.45
	Biogas capture from palm oil mill effluent (POME) treatment		300.95		3,001.89
Total			**18,578.80**		**32,178.99**

Table 3.2 Energy Sector Mitigation Actions – Renewable Energy

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
1. RE implementation through Feed-in Tariff mechanism[6,7,8]	To increase proportion of RE in the fuel mix for grid electricity generation so as to enhance national electricity supply security and sustainable socio-economic development	Generation of RE power for supply to the grid network from indigenous RE sources, namely, biogas (agro-industrial waste & landfill gas), biomass (agro-waste & municipal solid waste), small hydropower, and solar photovoltaic	Sustainable Energy Development Authority (SEDA)	Total approved RE capacity to reach 1,482 MW generating 8,023 GWh, accounting for 6.4% of total electricity generation Potential emission reduction: 5,458.09 kt CO_2eq	• Establishment of the Renewable Energy Fund sustained by surcharge on tariffs to finance the scheme; • Provision of financing support to capital investment by qualified Feed-in Tariff project developers through the Green Technology Financing Scheme.	Total approved Feed-in capacities and RE generated by operational projects	• RE generation is based on statements of claims on sales by all approval holders submitted by distribution licensees for recovery from the Renewable Energy Fund. • GHG emissions of the displaced grid electricity are computed by applying the most recent regional carbon emission baselines of grid-connected electricity generation published by Malaysian Green Technology Corporation. • The RE sources are assumed to be non-limiting, and emission avoidance or leakage is not considered.	CO_2	Grid electricity displaced by RE in 2013: 403,199 MWh Emission reduction achieved in 2013: 252.78 kt CO_2eq

[6] Renewable Energy Act 2011, Act 725.
[7] Sustainable Energy Development Authority Act 2011, Act 726.
[8] National Renewable Energy Policy and Action Plan 2010

Table 3.2 Energy Sector Mitigation Actions – Renewable Energy (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
2. RE electricity generation by non-FiT regulated public and private licensees and other mechanisms[9,10]	To promote the use of RE sources in electricity generation	Power generation from RE sources, such as biomass, biogas, hydropower and solar photovoltaic, by the private sector for both on-site and off-site consumption, including supply to the grid not under the FiT scheme	• Energy Commission • Sustainable Energy Development Authority • Private sector	Total installed RE capacity not under the FiT scheme to increase to 2,038 MW generating 3,204 GWh, accounting for 2.6% of total electricity generation. The Utility Scale Solar mechanism to be operational from 2017 is expected to contribute 1,000 MW of the installed capacity. Potential emission reduction: 2,179.29 kt CO_2eq	• Provision of fiscal incentives to commercial and industrial business entities which undertake generation of energy using RE resources either for generation of electric power to supply to the distribution grid system or for their own consumption.	Total approved licensed installed capacities of RE and total units of RE electricity generated	• Total units of RE electricity generated are captured by annual reports made by public and private licensees to Energy Commission, and published in the annual National Energy Balance. • GHG emissions of the displaced grid electricity are computed by applying the most recent regional carbon emission baselines of grid-connected electricity generation published by Malaysian Green Technology Corporation. •Electricity generated under the FiT scheme for supply to the grid system is excluded.	CO_2	RE installed capacity by public and private licensees in 2013: 1,039.84MW, generating 1,576,025 MWh Emission reduction achieved in 2013: 948.77 kt CO_2eq.

[9] Ibid
[10] National Energy Balance 2013

Table 3.2 Energy Sector Mitigation Actions – Renewable Energy (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
3. Use of palm oil-based biodiesel in blended petroleum diesel[11]	To increase the use of palm oil-based biodiesel as a renewable clean-burning petroleum diesel replacement to contribute towards reducing Malaysia's dependence on fossil fuel and enhancing sustainable socio-economic development.	Blending 5% of palm methyl ester with 95% of petroleum diesel under the B5 programme, increasing to 7% palm biodiesel blended with 93% petroleum diesel under the B7 programme.	Ministry of Plantation Industries and Commodities	Use of palm oil-based biodiesel in blended diesel targeted to reach 576,000 tonnes with full implementation of the B7 programme Potential emission reduction: 1,802.49 kt CO_2eq	• Completion of the B5 mandate nationwide by 2015; • Launch of the B7 programme in November 2014.	Nationwide biodiesel consumption data compiled monthly	• Monthly data on the quantity of biodiesel supplied to the domestic consumer market is captured from the records of the Ministry of Finance and aggregated annually. • The annual GHG emissions of displaced petroleum diesel are calculated by applying the IPCC default carbon emission factor. • Leakage emission relating to the production of biodiesel is not considered.	CO_2	Petroleum diesel displaced by palm oil-based biodiesel in 2013: 230,000 tonnes Emission reduction achieved in 2013: 719.74 kt CO_2eq

[11] Annual Report 2013, Ministry of Plantation Industries and Commodities.

Table 3.2 Energy Sector Mitigation Actions – Renewable Energy (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
4. Application of green technology	To promote the supply and application of green technology through providing financing support in the form of soft loan guarantee and interest rate rebate to producers or users of green technology, in cooperation with participating financial institutions, with the prime objective of achieving emission reductions in the target business activities.	Application and development of green technology in the energy, water & waste management, transport, and building & township sectors for producers or users of products, equipment and systems which minimise environmental degradation, achieve GHG emission reduction or avoidance, promote healthy and improved environment, conserve use of energy & natural resources, and/ or promote the use of RE resources.	Malaysian Green Technology Corporation (MGTC)	Target of RM3.5 billion as soft loan guarantee for approved projects. Potential emission reduction: 1,426.35 kt CO_2eq	• Promotion of the Green Technology Financing Scheme to the target sectors through regular nationwide roadshows & dialogues and provision of technical support since its launch in 2010; • Conduct of annual monitoring and verification audit on commissioned and operational projects approved under the scheme.	Monthly statistics on: • Number and amount of projects financed; • Amount of Green Investment; • Number of expected green employment created; • Volume of GHG emission reduction.	• Commissioning and/or operating status of GTFS-approved projects is updated monthly by MGTC. • Annual performance verifications of all commissioned and operational projects, including achieved GHG emission reductions, are conducted using project-specific monitoring methodologies and monitoring plans. • Aggregated GHG emission reductions achieved by all audited projects are reported. • Projects whose emission reductions are reported under other mitigation actions are excluded to avoid double counting.	CO_2 CH_4	As of 2013: • Total number of approved projects – 300; • Total number of projects with secured financing – 120; • Total financing - RM1.66 billion, with RM522.7 million disbursed. Emission reduction achieved in 2013: 94.81 kt CO_2eq

Table 3.3 Energy Sector Mitigation Actions – Green Buildings

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
1. Implementation of green building rating scheme	• To promote sustainability in the built environment through the application of green rating tools for buildings and townships by stakeholders in the building sector; • To encourage property developers and owners to plan, design, construct and sustainably manage buildings and sites to optimise energy and water efficiency, enhance indoor environment quality, and to use materials and resources sustainably.	Implementation of the Green Building Index (GBI) certification as a private-sector regulated green building rating tool in line with the demand for good corporate social responsibility.	Green Building Index Sdn Bhd	Total grid electricity savings by completed and verified buildings amounting to 1,262.35 GWh in 2020, with potential emission reduction of 858.40 kt CO_2eq.	• Organisation of roadshows, awareness seminars, briefing sessions, training courses, and certification consultation sessions; • Roll-out and updating of rating tools.	Monthly performance data on electricity consumption savings and corresponding emission reductions achieved by certified projects against set benchmarks under the BAU scenario as reported by GBI.	• Data on electricity consumption of all completed, assessed and verified buildings is compiled by GBI based on findings of completion and verification assessments (CVAs) conducted. • The difference in electricity use from the business-as-usual scenario in the various building categories is computed. • Emission reduction from reduced electricity consumption is calculated based on the most recent grid GHG emission factors for Peninsular Malaysia, Sabah and Sarawak as appropriate. • Monthly executive summaries reporting on the performance of all GBI certified projects by categories are published on the GBI website: http://www.greenbuildingindex.org/organisation-certified-buildings-Summary.html.	CO_2	In 2013, 190 projects certified, out of a cumulative total of 476 registered, of which 17 received final certification after CVA, and 173 in construction phase received provisional certification after design assessment. Electricity savings of CVA projects: 88,824 MWh Emission reduction achieved in 2013 by CVA projects: 60.40 kt CO_2eq

Table 3.3 Energy Sector Mitigation Actions – Green Buildings (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
2. Efficient electricity consumption in all Federal Government ministry buildings	To promote energy efficiency in buildings through behavioural change of building occupants.	Implementation of good practices to optimise energy use in buildings as a public-sector initiative	Ministry of Energy, Green Technology and Water	Reduction of energy consumption in all Federal Government ministry buildings by 5% from 2013 baseline. Potential emission reduction : 98.21 kt CO_2eq	• Participation of all 25 Federal Government ministries comprising 54 buildings located in Putrajaya and Kuala Lumpur; • Monthly reporting of activity performance by all building managers, and quarterly reporting to the Cabinet.	Energy consumption savings against benchmarks in the BAU scenario	• The baseline building electricity consumption in 2013 was determined. • The actual electricity use for subsequent years are regularly monitored in each building. • The baseline and actual building emissions are computed by applying the most recent carbon emission factor of the grid published by MGTC, and the emission reduction achieved is determined. • Energy savings are achieved solely through behavioural change of building occupants without retrofitting.	CO_2	Total reduction of grid electricity consumption by all 54 buildings covered by the study: 14,758 MWh Emission reduction achieved in 2014: 10.94 kt CO_2eq

Table 3.4 Energy Sector Mitigation Actions – Energy Efficiency in Transport

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
1. Reducing emissions through development and usage of energy-efficient vehicles (EEVs)[12]	To increase the number of on-the-road EEVs in the country.	EEVs are defined as vehicles that meet a set of defined specifications in terms of carbon emission level (gCO_2eq/km) and fuel consumption (L/100 km). EEVs include fuel-efficient internal combustion engine (ICE) vehicles, hybrid and electric vehicles, and alternative-fuelled vehicles.	• Ministry of International Trade and Industry • Malaysia Automotive Institute	85% of vehicles produced in Malaysia will be EEVs Potential emission reduction: 199.74 kt CO_2eq	• Six roadmaps have been established to support the implementation of National Automotive Policy 2014, viz. the Malaysia Automotive Technology Roadmap (MATR), Malaysia Automotive Supply Chain Development Roadmap (MASCR), Malaysia Automotive Human Capital Roadmap (MAHR), Development of Automotive Authorised Treatment Facilities Framework (ATF), Malaysia Automotive Bumiputera Development Roadmap (MABDR) and Malaysia Automotive Remanufacturing Roadmap (MARR). • Fiscal incentives of 100% tax exemption for both import duty and excise duty for hybrid electric vehicles with 2.0 litre-engines and below commenced in 2011 and ended in 2013. Tax exemption is extended for models assembled in Malaysia - for hybrids until 31 Dec 2015; for EVs until 31 Dec 2017. Beyond these dates, the exemptions will be determined based on the strategic value of these CKD assembly investments. • Sale of Euro 5 diesel started in 2014. Rollout of EURO 4 Ron 97 petrol started in 2015.	Statistics of nationwide EEV sales.	• Computation of the difference in emissions of total EEVs on the road and the corresponding categories of conventional vehicles; • Default average km driven per year per passenger vehicle in Malaysia as reported by Malaysian Institute of Road Safety Research (MIROS); • Default vehicle emission factors as reported by Department for Environment, Food & Rural Affairs (DEFRA), United Kingdom.	CO_2	Total hybrid electric vehicles on the road increased to 28,709 units in 2013 from 52 units in 2009. Emission reduction achieved from hybrid electric vehicles on the road in 2013: 40.96 kt CO_2eq

[12] National Automotive Policy 2014.

Table 3.4 Energy Sector Mitigation Actions – Energy Efficiency in Transport (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
2. Use of compressed natural gas (CNG) in motor vehicles[13]	To promote the use of CNG as an alternative fuel in automobiles for enhancing environmental quality and reducing carbon emissions.	Avoidance of greenhouse gas emissions through energy efficiency in the transport sector	• Economic Planning Unit, Prime Minister's Department • Ministry of Finance	Consumption of CNG for fuel switch in the transport sector is projected to reach 406,650 toe. Potential emission reduction: 217.57 kt CO_2eq	Progressive increase in CNG supply stations at strategic locations throughout the country.	Sale and consumption of CNG in the transport sector	• Computation of the difference in emissions between the use of alternative fuels and motor gasoline. • Default emission factors of fuels based on IPCC Guidelines for National Greenhouse Gas Inventories.	CO_2	Total consumption of CNG in 2013: 289,000 toe Emission reduction achieved from CNG consumption in 2013: 154.62 kt CO_2eq

[13] National Energy Balance 2013

Table 3.4 Energy Sector Mitigation Actions – Energy Efficiency in Transport (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
3. Urban rail-based public transport	• To upgrade and integrate the urban public transport system; • To promote reduced use of private transport and demand on road infrastructure through increasing public transport modal share.	Public investment in rail-based urban mass transit infrastructure in the Klang Valley in the form of the Light Rail Transit (LRT), the Mass Rapid Transit (MRT) and the Monorail networks.	Land Public Transport Commission	Annual ridership on rail-based public transport from year 2013 to year 2020 to increase by 355%. Potential net emission reduction: 977.51 kt CO_2eq	• Construction of new rail-based mass rapid transit networks to integrate with the existing networks; • Extension of existing networks to increase coverage and enhance efficiency.	Daily ridership volumes on the LRT, MRT and Monorail networks	• Daily ridership data based on the number of trips on the LRT, MRT and Monorail networks are compiled and aggregated for the year. • The number of commuters is determined by dividing the ridership by two on the basis of return trips. • The number of cars and the corresponding commuting distance avoided are computed using default values from the most recent study by MIROS. • The emissions avoided are calculated based on the carbon emission factor for the passenger vehicle category as reported by DEFRA, United Kingdom, or equivalent. • Monthly data on operational electricity consumption of the LRT, MRT and Monorail networks are compiled and aggregated for the year. • Emissions of electricity consumption are computed by applying the most recent carbon emission factor of the grid published by MGTC. • The net emission reduction achieved is the difference between avoided emissions from not using private vehicles and emissions from rail-based public transport.	CO_2	109,660 passenger vehicles that would have travelled $1{,}541.44 \times 10^6$ km per year were taken off the road in 2013. Net emission reduction achieved in 2013: 214.93 kt CO_2eq.

Table 3.5 Land Use, Land-Use Change and Forestry Sector Mitigation Actions – Sustainable Forest Management

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/ Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
1. Emission reduction through sustainable management of forest	Gazettement of State land Forests (SLF) to Permanent Reserved Forests (PRF) which otherwise would be subjected to deforestation.	Emission reduction by means of forest conservation through gazettement of additional sustainably managed PRF.	State Governments	Maintaining minimum 50% of land area in Malaysia under forest cover in perpetuity. Potential emission reduction through gazettement in 2020 : 13,800 kt CO_2eq.	Issuance of gazette notice by the State Government.	Annual reporting of PRF gazettement by State Governments.	• The total hectarage of SLF converted to PRF by gazettement in the year is determined. • The total hectarage of PRF degazetted is deducted from the total gazetted area in the year. • The biomass carbon stocks are assessed through the national inventory. Values used are 70 tonnes C per ha for SLF. • The carbon stock is converted to CO_2 equivalent by the molecular weight (1 tC = 3.6667 t CO_2eq).	CO_2	Total hectarage of SLF gazetted to PRF in 2013: 59,277 ha Total hectarage of PRF degazetted in 2013: 5,521 ha Net gazettement to PRF in 2013: 53,756 ha Emission reduction achieved in 2013: 13,797.37 kt CO_2eq

Table 3.6 Waste Sector Mitigation Actions – Waste Management

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
1. Waste paper recycling[14]	Methane avoidance through recycling of waste paper.	Sustainable waste management through recycling and utilisation of waste paper for manufacture of paper products.	Paper products industry	Quantity of waste paper recycled projected to reach 834,700 tonnes. Potential emission reduction to reach: 2,159.45 kt CO_2eq	Continuous demand by paper products manufacturers	Annual quantities of waste paper recycled and utilised by the paper products industry	• Data on generation, composition, characteristics and recycling of municipal solid waste (MSW) are based on the most recent survey conducted by the National Solid Waste Management Department. • The quantity of paper waste generated is computed based on per capita MSW generation rate and MSW composition with reference to the relevant population statistics published by the Department of Statistics Malaysia. • The weight of paper waste recycled is calculated based on the most recent data on recycling rate. • The total net annual methane emission avoided from disposal of the equivalent weight of landfilled paper waste to be recycled is computed in accordance with the 1996 IPCC Guidelines for National Greenhouse Gas Inventories. • Methane emission is converted to CO_2 equivalent by the GWP value of 21.	CH_4	Waste paper recycled and avoided from landfills in 2013: 770,500 tonnes Emission reduction achieved in 2013: 1,993.47 kt CO_2eq

[14] Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia, (Internal Report of the National Solid Waste Management Department, 2014).

Table 3.6 Waste Sector Mitigation Actions – Waste Management (continue)

Mitigation Action	Objectives	Description	Key Implementing Agency	2020 Quantitative Goal	Progress of Implementation/Steps Taken or Envisaged to Achieve Action	Progress Indicators	Methodologies and Assumptions	Gas Coverage	Results Achieved
2. Biogas recovery from palm oil mill effluent (POME) treatment	Avoidance of methane released from existing open lagoon treatment of POME through biogas capture and destruction	Utilisation of recovered methane for energy generation or destruction via flaring; GHG emissions reduction are accounted for by methane combustion/ destruction only.	Malaysian Palm Oil Board (MPOB)	Full compliance by Malaysian palm oil mills in implementing biogas capture projects by 2020, achieving an emission reduction of 3,001.89 kt CO_2eq.	• Inclusion of 'Developing biogas facilities at palm oil mills' as an Entry Point Project of the Palm Oil National Key Economic Area (NKEA-EPP5) under the Economic Transformation Programme launched by the Government of Malaysia in 2010. • Effective 1 January 2014, all new mills and all existing mills applying for throughput expansion mandated to install full biogas trapping or methane avoidance facilities. • Ongoing studies to evaluate various strategies and measures, including formulating appropriate regulations and providing reasonable incentives to enforce the programme on all existing mills.	• Number of mills having implemented on-site biogas capture or avoidance projects; • Annual throughput of mills with on-site biogas trapping or avoidance facilities.	• Data on monthly CPO production output is reported by MPOB and aggregated annually. Data on the total number of biogas projects implemented by palm oil mills and the method use to recover the biogas is monitored and recorded by MPOB. • The total methane emissions captured are computed by applying the 1996 IPCC Guidelines for National Greenhouse Gas Inventories using the specified default parameter values. • Methane emission is converted to CO_2 equivalent by the GWP value of 21.	CH_4	16.36% of compliance achieved in 2013. Emission reduction achieved in 2013: 300.95 kt CO_2eq

3.6 Domestic Measurement, Reporting and Verification

Measurement, reporting and verification (MRV) of mitigation actions in Malaysia are coordinated by the Ministry of Natural Resources and Environment (NRE). Monitoring and measurement of emission reductions associated with mitigation actions are at different levels of integration into the functions of the implementing agencies. The mitigation action data is collated by the Technical Working Group (TWG) on Mitigation and verification will be conducted by the Technical Working Group on Verification. The TWG members are multi-agency experts appointed by the Chair of the National Steering Committee on Climate Change. An overview of the domestic MRV process under development is shown in Figure 3.1. Guidelines for MRV of mitigation actions are being developed and tested.

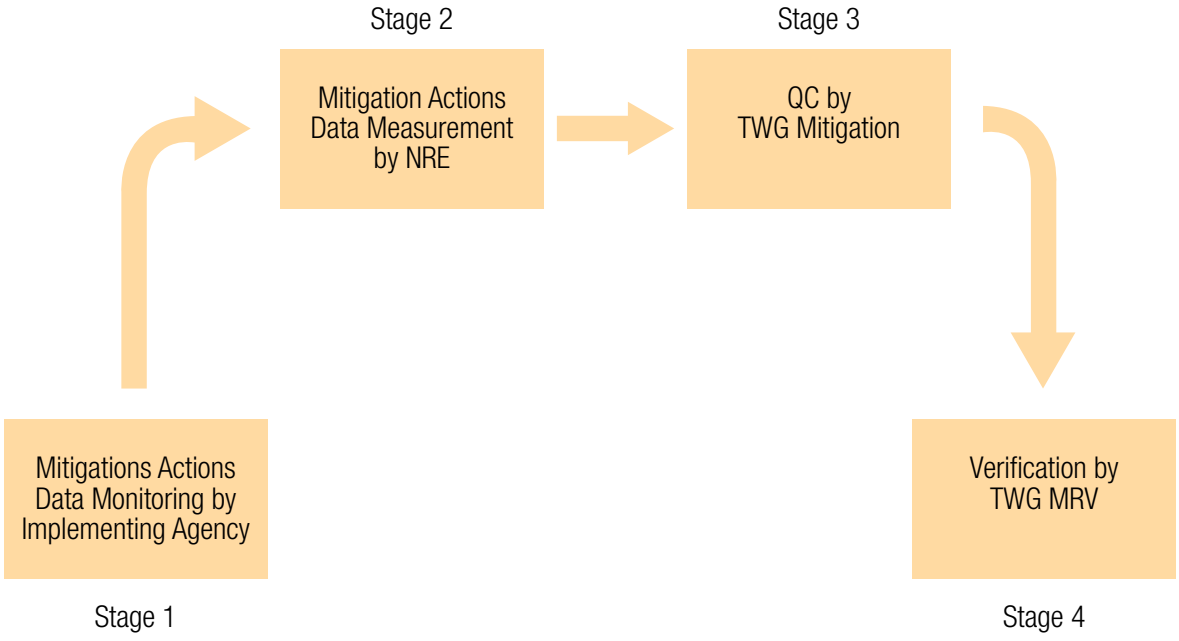
3.7 International Market Mechanisms

3.7.1 Clean Development Mechanism

Malaysia ratified the Kyoto Protocol on 4 September 2002, prompting establishment of the national strategy on Clean Development Mechanism (CDM) which took into account both the short- and long-term perspectives of the country's position with regard to climate change mitigation measures. Through participation in the CDM under this Protocol, Malaysia has benefited from investments in GHG emission reduction projects which have contributed towards the overall improvement of the environment in line with its national sustainable development goals.

As of April 2015, Malaysia has a total of 143 CDM projects and five Programme of Activities (PoAs) with ten Component Project Activities (CPAs) registered with the CDM Executive Board. This forms 1.9% of the total CDM project activities under the Kyoto Protocol. These projects involved an estimated investment of USD1,529.65 million. Up to the end of the first Kyoto commitment period, the projects were expected to yield 23.95 million tonnes CO_2eq of emissions reduction. Of these, a total of 9,844,435 CERs have been issued. Since 2013, Malaysia's CDM activities have been much curtailed due to decline and uncertainty of the carbon markets.

Figure 3.1: Measurement, Reporting and Verification Process for Mitigation Actions



The bulk of the project activities are associated with oil palm processing residues, focussing on biomass energy, methane capture and co-composting using either the solid or liquid wastes, or both. Collectively, these oil palm-related project activities account for 78.3% of Malaysia's CDM pipeline of registered projects, contributing to 63.2% of the total potential emission reduction. Table 3.7 shows the distribution of CDM project activities, categorised according to project type, along with their potential annual emission reductions and reported investments.

3.7.2 Voluntary Carbon Market

In addition to the CDM, Malaysia participated in 11 voluntary carbon market projects which were validated to the criteria of the Verified Carbon Standard (VCS). Of these, eight were methane emission avoidance projects, and one each were biomass energy, hydropower and reforestation projects respectively. Table 3.8 shows the status of these projects.

Table 3.7 Distribution of Clean Development Mechanism Project Activities by Project Type (as at April 2015)

Type	Sub-type	No. of Registered Projects	Percentage of Total no. of Projects	Annual Emission Reduction Potential (t CO_2eq/yr)	Percentage of Total Annual Emission Reduction Potential	Total CERs Issued for 1st Crediting Period (kt CO_2eq)	Estimated Investment (mil USD)
Biomass energy	Oil palm solid biomass	31	21.68	2,547,431	28.92	5,604.858	148.554
	Agricultural residues	5	3.50	615,834	6.99	114.472	8.880
	Wood waste	4	2.80	110,777	1.26	0.000	27.973
	Gasification	1	0.70	26,983	0.31	0.000	0.000
Energy efficiency	Electronics	2	1.40	7,786	0.09	0.000	0.000
	Machinery	1	0.70	173	0.00	0.000	0.484
Hydropower	Run of river	3	2.10	105,083	1.19	42.922	48.803
	New dam	2	1.40	260,421	2.96	16.920	824.226
Landfill gas	LFG power	6	4.20	586,488	6.66	1,112.171	22.460
	LFG flaring	3	2.10	360,707	4.09	12.623	10.201
CH_4 avoidance	Palm oil mill effluent	54	37.76	2,249,808	25.54	1,411.135	188.171
	Composting	27	18.88	770,107	8.74	203.207	47.877
EE supply side	Single to combined cycle	1	0.70	595,460	6.76	1,326.055	102.241
Fuel switch	New NG plant	1	0.70	299,832	3.40	0.000	99.825
Geothermal	Geothermal electricity	1	0.70	269,026	3.05	0.000	0.000
Transport	Efficient vehicles	1	0.70	3,156	0.04	0.072	0.000
Total		**143**	**100.00**	**8,809,072**	**100.00**	**9,844.435**	**1,529.694**

Table 3.8 Distribution of Voluntary Carbon Market Project Activities by Project Type (as at April 2015)

Project Type	No. of Projects	Project Estimate of Annual ERs (t CO_2eq)	Total VCUs Issued	Total VCUs Retired	Balance Issued VCUs in VCS Registry
CH_4 avoidance	8	217,714	25,087	25,087	0
Biomass energy	1	10,034	10,692	10,692	0
Hydropower	1	21,660	0	0	0
Reforestation	1	138,013	509,540	84,493	425,047
Total	**11**	**387,421**	**545,319**	**120,272**	**425,047**

CHAPTER 4

LEVEL OF SUPPORT

CHAPTER 4: LEVEL OF SUPPORT

4.1 Introduction

Efforts by Malaysia to reduce its GHG emissions and enhance its resilience to the increasing impacts of climate change have been supported by both national and international resources. As per Article 4.3 of the UNFCCC, Malaysia has received capacity building, technical and financial support from international sources to enable the country to fulfil its obligations under the Convention and to better implement actions to address climate change. This chapter only describes the support received by federal agencies to specifically address climate change. Support received at sub-national level is reported to the extent possible. It does not include financial support received directly by private and non-government entities. The manner in which international funds have been channelled has not enabled tracking and clear identification of the support.

4.2 Support Received

Malaysia has been a beneficiary of various assistance from bilateral and multilateral agencies in the form of technical as well financial assistance. The bulk of the financial support has been provided through the Global Environment Facility (GEF), the operating entity of the financial mechanism of the UNFCCC. Since the entry into force of the UNFCCC, the total amount of funding received from GEF for climate change activities is USD46,510,020 from GEF cycle 1 to GEF cycle 5. Table 4.1 shows the amount received during each GEF cycle.

Table 4.1 Summary of Global Environment Facility Funding on Climate Change Activities to Malaysia

GEF Cycle	Period	Approved Amount (USD)
1	July 1994 – June1998	7,770,600
2	July 1998 – June 2002	4,000,000
3	July 2002 – June 2006	8,699,420
4	July 2006 – June 2010	11,800,000
5	July 2010 – June2014	14,240,000

The support received has focussed mainly on enhancing Malaysia's institutional and technical capacity on reporting obligations to the UNFCCC and implementing mitigation actions. These have been channelled through the United Nations Development Programme (UNDP) and United Nations Industrial Development Organisation (UNIDO) in Malaysia. The projects for the period from 2010 are listed in Table 4.2. The information was compiled to the extent possible from various

Table 4.2 Financial Support Received from Global Environment Facility, International Organisations and Other Multi-lateral and Bilateral Sources for Implementation of Climate Change Actions, from 2010

Source	Project Description	Project Duration	Implementing Agencies	Approved Amount
GEF/UNDP	Second National Communication	2006 – 2011	NRE	USD556,795
GEF/UNDP	Building Sector Energy Efficiency Project	2010 – 2016	MoW/PWD	USD5,000,000
GEF/UNDP	Third National Communication to the UNFCCC and Biennial Update Reporting for Malaysia	2014 – 2017	NRE	USD852,000
GEF/UNDP	Green Technology Application for the Development of Low Carbon Cities	2014 – 2019	MEGTW	USD4,354,790
GEF/ UNIDO	Industrial Energy Efficiency for Malaysian Manufacturing Sector	2012 – 2017	MEGTW	USD4,200,000
GEF/ UNIDO	GEF UNIDO Cleantech Programme for SMEs in Malaysia	2013 – 2016	MIGHT	USD990,000
GEF/ UNIDO	GHG Emissions Reductions in Targeted Industrial Subsectors through EE and Application of Solar Thermal Systems	2015 – 2018	MEGTW	USD4,000,000
GEF/ UNIDO	Energy-Efficient Low Carbon Transport	2015 – 2018	MGTC, MEGTW	USD2,000,000
UNDP	Economics of Climate Change Study	2010 – 2013	EPU	USD350,000
UNDP	National REDD+ Readiness	2011 – 2013	NRE, FRIM	USD163,652
UNDP	National Corporate GHG Reporting Programme	2013 – 2015	NRE	USD300,000
UNEP	MyCarbon Web Portal Planning, Design and Piloting	2015	NRE	USD25,000
UNEP	National Climate Change Web Portal Content Development	2015	NRE	USD25,000
UNEP	Vulnerability Assessment and Adaptation Study of Climate Change Impacts on Floods in Sarawak River Basin	2015	NAHRIM	USD48,000
ADB	Strengthening Planning Capacity for Low Carbon Growth in Developing Asia	2011 – 2014	EPU	USD284,000
EC, Germany, Australia/ UNDP	Low Emission Capacity Building Programme for Malaysia	2013 – 2015	NRE	USD802,500
EU	Sustainable Consumption and Production	2012 – 2016	EPU	€2,000,000
UK	REDD+ Capacity Building	2011 – 2012	NRE, FRIM	£35,000
UK	Policy Approaches for REDD+ Implementation	2013 – 2014	NRE, FRIM	£27,500
EU	Tackling Climate Change through Sustainable Forest Management and Community Development	2014 – 2017	Sabah Parks, Sabah Forestry Department	€4,000,000

sources identified as providing funding for climate change activities.

The mitigation projects focussed on energy efficiency of buildings and the manufacturing, industrial and transport sectors. Clean and green technologies were another focus area, with projects targeting small and medium enterprises and low-carbon cities. Projects on low-carbon society, sustainable consumption and production, and the national corporate GHG reporting programme attempt to address climate change more holistically by including key stakeholders, including consumers.

Another important aspect of the support provided has been the focus on strengthening institutional arrangements, given the cross-cutting nature of climate change and the challenges presented by Malaysia's federation system.

4.2.1 Support Received for BUR

Malaysia would also like to acknowledge the financial support of USD352,000 provided for the preparation of this first biennial update report (BUR). The funds for the BUR have enabled the development of the national GHG inventory and the mitigation analysis for the report. The *Low Emission Capacity Building Programme for Malaysia* project listed in Table 4.2 provided additional funding for capacity building and contributed to the development of the measurement, reporting and verification (MRV) system required to be reported in the BUR.

4.2.2 Support for Climate-related Forestry Activities

The Malaysian forestry sector has attracted some interest from the international community to address emissions from this important contributor to the national economy. In the area of forests, a REDD+ readiness programme for mitigation action through strengthening of the institutional framework, assessment of the legal architecture and the financing mechanism was supported as identified in Table 4.2.

Two initiatives with a regional focus paid particular attention to the strengthening of institutional capacity in technical and policy issues with regard to the potential implementation of REDD+ activities. The United Kingdom Foreign and Commonwealth Office, through its Southeast Asia Prosperity Fund, a technical cooperation programme managed by the British High Commission, provided £35,000 in 2012 and £27,500 in 2013 respectively for REDD+ readiness implementation in Malaysia. The USAID-funded Lowering Emissions in Asia's Forests (LEAF) Programme provided external consultancy expertise for institutional capacity building for a sub-national REDD+ pilot project with the objective of developing market-oriented policies.

More recently, the European Union provided Euro 4 million in funding for a four-year plan (2014-2017) to tackle climate change through sustainable forest management and community development with a sub-national entity in the Borneo region.

4.2.3 Other Capacity Building Assistance

Apart from those sources listed in Table 4.2, Malaysia has also received capacity building from the Intergovernmental Panel on Climate Change and a number of Annex 1 Parties. In particular Japan and the United States have helped to enhance the technical capacity of Malaysia's greenhouse gas inventory compilers through the USAID Low Emissions Asian Development (LEAD) Training Programmes and Japan's annual Workshop on GHG Inventories in Asia (WGIA).

The United States Environmental Protection Agency had also extended technical assistance to build Malaysia's capacity in GHG inventories.

CHAPTER 5

CONSTRAINTS, GAPS AND NEEDS

CHAPTER 5: CONSTRAINTS, GAPS AND NEEDS

5.1 Introduction

As a fast-developing country, Malaysia faces challenges in decoupling the growth of its economy from its GHG emissions. Many constraints and gaps exist for the various GHG emitting economic sectors, particularly in terms of technical and capacity gaps. Nevertheless, conscious efforts have been made to reduce the country's carbon footprint while growing its economy.

Like many developing countries, Malaysia is also experiencing the impacts of climate change and challenges to adapt to the changes while ensuring that its development gains are protected. It is critical that the constraints and gaps hindering more systematic and widespread uptake of both mitigation and adaptation efforts are concurrently addressed to avoid loss of mitigation gains.

The constraints, gaps and related needs for GHG inventory, mitigation, vulnerability and adaptation, and research and systematic observation are described below. The constraints, gaps and needs identified here are non-exhaustive. They do not prejudge the need for closer scrutiny and targeted interventions in future assessments.

5.2 Greenhouse Gas Inventory

Since the preparation of the NC2, Malaysia has taken steps to ensure retention of institutional memory of technical capacity developed. Conscious efforts have been made to institutionalise the processes, resulting in a structured framework of data collection agencies for the five major sectors identified for GHG inventory estimation. A series of capacity building activities was conducted to enhance knowledge and skills in inventory preparation.

However, challenges remain in the following aspects:

- Activity data – limited technical capacity in applying the national data and proxy data to generate the required data for GHG inventory;
- Lack of historical data – particularly for the waste, industrial processes and transport sectors;
- Tracking deforestation – difficulties in understanding differences of data sets reported in national and international publications;
- Completeness – not all sectors were covered to satisfaction due to technical and data gaps described above;

- Development of local emission factors – difficulties in moving to higher tiers in several key source categories; and
- Uncertainty assessment – limited technical capacity in carrying out such assessments.

Nevertheless, since NC2, the application of local emission factors for the forestry sector has expanded to cover the whole of Malaysia. The agriculture sector is also developing its local emission factors.

To overcome these challenges, some possible steps have been identified and actions taken:

- A centralised data collection and compilation mechanism to ensure the quality, consistency and reliability of inventories is being developed;
- Subsectors identified in the GHG Inventory improvement plan as "not yet reported" will be explored for future inclusion;
- Efforts are being taken to enhance the collection of identified missing historical activity data from key sectors to meet new IPCC requirements;
- To address data confidentiality issues, particularly in the energy and industrial processes sectors, a memorandum of understanding between the sectors and the central statistic compilation agency is being explored;
- Increase greater cooperation with data providers from the private sector;
- Enhance research and development of local emission factors; and
- Continuous capacity building to increase the pool and capability of GHG inventory compilers and data providers.

All efforts would require substantial continued technical capacity development, financial assistance and international collaboration.

5.3 Mitigation

The key mitigation areas identified in the Chapter on "Mitigation Actions and Their Effects" are to increase renewable energy in the energy mix, energy efficiency, land transportation, waste management, and protection of forest carbon pools. Efforts in these areas have gained traction but have faced some persistent constraints in the areas of institutional arrangements, as well as in the regulatory and financial support needed to create an enabling environment for speedy implementation of mitigation actions.

5.3.1 Energy Security

Coal has established a strong foothold under the country's four fuel diversification policy since 1981, with the share of coal in the total electricity generation mix projected in the Eleventh Malaysia Plan to increase to 53% by 2020. This highlights the energy security challenge faced by Malaysia amidst the need to control its carbon emissions level. As a result, switching from conventional sub-critical plants to supercritical and ultra-supercritical plants and even integrated gasification combined cycle technology has become a necessity for the long-term. However, the high capital investment is posing yet another financial burden to achieving emission reductions in this growing source of energy generation.

5.3.2 Renewable Energy

The Renewable Energy Fund started in 2011 for the promotion of renewable energy through a FiT mechanism. The fund is supplemented through a 1% additional collection on the monthly electricity bill exceeding 300 kWh. The rate was increased to 1.6% in January 2014. Nevertheless, the fund is still insufficient to enable a wider deployment of renewable energy through the FiT mechanism.

This is evident from the gap between the actual achievement and the target set out in the

Tenth Malaysia Plan, largely due to financial barriers. In spite of this, Malaysia is aiming to increase the target to 2,080 MW during the Eleventh Malaysia Plan period, with other planned mechanisms contributing towards achieving the target. Access to international financial assistance, capacity development and technology transfer would facilitate greater deployment of renewable energy. Table 5.1 provides a list of mitigation actions in the energy sector that require funding, clearly demonstrating the financing needs for this area.

Solar photovoltaics (PVs) have high potential for growth for both commercial and individual residential installations. Solar PVs contributed 47% of the FiT installed capacity in 2013, of which 16% of the capacity is from individual installations through the *Solar Rooftop Programme.* This programme was well-received by the general public as shown by the 92.6% contribution of the solar PV individual subcategory to the overall FiT approved applications in 2013. The acceleration of solar PV technology transfer will further reduce the cost of renewable electricity and hasten the achievement of grid energy price parity with fossil-generated electricity.

Table 5.1 Mitigation-related Actions in the Energy Sector, with Needs for External Financial Support

Activity	Status	Support needed (Finance)	Support needed (Technical/ Technology)	Remarks
FiT – solar PV (individual)	Ongoing (since 2011)	RM300mil/year until 2037	None	Will be able to continue with release of new PV quota till 2020, instead of ending in 2016/2017.
FiT – geothermal	Expected to come into operations in 2020	RM250mil/year until 2041	Technical, legal and financial expertise	The 1st geothermal plant of 30 MW already catered for under RE Fund. This amount is for another estimated 70 MW resource.
FiT – geothermal resource assessment study	Ongoing (since 2012)	RM30mil (one-off)	Technical support on resource assessment	Estimated 100 MW resource available in Tawau area; needs a detailed study to confirm resource.
FiT – biomass	Ongoing (since 2012)	RM150mil/year until 2032	None	Will double the quota release for biomass from the years 2016 to 2025.
FiT – biogas	Ongoing (since 2012)	RM100mil/year until 2032	None	Will double the quota release for biogas from the years 2016 to 2025.
FiT – wind resource mapping	Ongoing (since 2012)	RM100mil (one-off)	Technical support for offshore wind mapping	Present project is for onshore wind mapping under the Malaysian Electricity Supply Industry Trust Account grant. Proposed new project for offshore wind mapping off the coasts of Kelantan, Terengganu and Sabah.
Storage technology	New project	RM50mil (pilot project including study) (one-off)	Collaboration with International Smart Grid Action Network (ISGAN)	Proposed pilot project (probably in conjunction with Smart Grid project).
Smart grid	New project	RM50mil (pilot project) (one-off)	Collaboration with ISGAN	Proposed pilot project.
Green grid (Sabah)	Ongoing	RM350mil (one-off)	None	Green grid to connect potential biogas and biomass plants to rural communities remote from the grid in Sabah.

Apart from financing and technology constraints, the development of renewable energy requires a coherent policy and institutional framework governing the energy sector as a whole. Streamlining of the energy-related institutional framework and addressing energy resource utilisation from primary energy to transformation and final energy use remain the biggest challenge for the energy sector. This needs to be addressed holistically to promote renewable energy as a mainstream energy source.

5.3.3 Energy Efficiency

Past plans to implement energy efficiency have delivered limited results due to limited financial resources and capacity. Moving forward, the proposed National Energy Efficiency Action Plan (NEEAP) (2016-2025), which is in the final stages of development, builds on the experiences and lessons learnt from past energy efficiency programmes. Key initiatives would include energy performance standards, promotion of energy-efficient appliances, energy audits and management in buildings, industries and energy-efficient building design.

Limited financial resources compounded by the high cost of related technologies are key barriers to widespread implementation and sustainability of energy efficiency programmes. Retrofitting of Government buildings with energy-efficient systems can only be carried out on a limited basis. In the industrial sector, slow penetration of the practice of energy auditing requires priority action. This would be addressed by one of the key initiatives of the NEEAP.

5.3.4 Waste

Coordination among relevant local, state and federal agencies in the waste sector is a key requisite for effective waste management. Efforts are also required to obtain a better understanding of waste composition and to enable the development of a holistic strategy plan for the management of industrial, commercial and residential waste. The National Strategic Plan for Solid Waste Management formulated in 2005 for the period up to 2020 only targets municipal solid waste in Peninsular Malaysia. The legislation that governs solid waste management is restricted by the constitutional arrangements between Peninsular Malaysia, Sabah and Sarawak. As a consequence, the Solid Waste and Public Cleansing Management Act enacted in 2007, is applicable only to Peninsular Malaysia and the Federal Territories of Putrajaya and Labuan. As of August 2015, the legislation has only been adopted by six States and two Federal Territories in Peninsular Malaysia. Moving forward, the Eleventh Malaysia Plan calls for the establishment of a national committee on sustainable waste management to enhance coordination nationally.

The National Strategic Plan for Solid Waste Management has set a target of 22% for household waste recycling by 2020. However the lack of coordination among agencies involved in waste management has affected the effective implementation of the 3R (reuse, reduce and recycle) programme. Apart from enhancing coordination, awareness and education programmes will be continued under the Eleventh Malaysia Plan to inculcate better consumption and waste disposal behaviour. The Eleventh Malaysia Plan also envisions waste recycling and recovery of waste to reduce dependency on natural resources or, as appropriate, as a viable energy resource. This can help to reduce greenhouse gas emissions from the waste sector.

Accurate quantification of greenhouse gas emissions from the waste sector remains a challenge due to lack of proper assessment tools and skills. As a consequence, although several local Government-led efforts to reduce emission levels from the waste sector through enhanced recycling and composting have been implemented, the impacts of these initiatives have not been quantified.

5.3.5 Land Use, Land-Use Change and Forestry

Malaysia has taken significant efforts to maintain at least 50% forest cover. However, the aspiration is being challenged by socio-economic development needs. The country continues to face threats of forest degradation as economic valuation of the ecosystem services provided by forests remains largely invisible and undervalued. Population growth, resulting in demand for housing and infrastructure, is also putting a considerable strain on land-use patterns.

Sustainable forest management began in the 1970s with the introduction of the selective management system. This initiative was followed by project-based forest certification systems implemented since the mid-1990s in Peninsular Malaysia and Sabah, and is being expanded to cover Sarawak. This would help ensure that more forest concessions are being managed with sustainable logging practices and certified by the Malaysian Timber Certification Scheme or the Forest Stewardship Council. Harmonisation of the forest management system will be strengthened further with the alignment of the National Forestry Inventory by 2022 among Peninsular Malaysia, Sabah and Sarawak. This is expected to enhance the management of forest cover and its importance as a carbon sink.

Land-use change affecting peat-lands and associated peat fires have been a considerable challenge over the last two decades. Efforts to reduce the emissions due to peat subsidence and fires on peat soil would require restoring the water table, replanting the degraded forests and putting in place effective fire monitoring systems. Towards this end, the Government in the Tenth Malaysia Plan has invested in 137 check dams, 40 water tube wells and three watch towers in hot spot areas to address peat-land fires.

Further, to ensure that Malaysia maintains at least 50% of its forest cover, the UNFCCC REDD+ mechanism is regarded as a viable incentive for sub-national entities to maintain their existing forest cover. Towards this end, the Federal Government has submitted its Forest Reference Level (FRL) for REDD+ results-based payments in December 2014 to the UNFCCC Secretariat. The inclusion of the submission in Technical Annex 2 is voluntary and exclusively for the purpose of obtaining and receiving payments for REDD+ actions, pursuant to paragraph 2 of Decision 13/CP.19 and paragraphs 7 and 8 of Decision 14/CP.19.

5.3.6 Transportation

Energy consumption in the transportation sector has grown significantly with the rapid rise in motor vehicle ownership in the last two decades, from 4.7 million in 1990 to 20.1 million in 2010 which has increased further to 23.8 million in 2013. Development of an efficient and integrated public transportation system, covering the densely populated areas and accessible to the first- and last-mile, is crucial to reverse this trend. This requires integrated long-term urban planning.

5.3.6.1 Urban Transportation

In the Greater Kuala Lumpur region, the promotion of an efficient public transportation system has thus far focussed largely on mass rail connection. To further improve accessibility and connectivity, the bus rapid transit network identified in the Greater Kuala Lumpur/Klang Valley Public Transport Master Plan needs to be developed concurrently. Financial constraints pose a challenge to expand the network and to replicate similar public transportation systems in other rapidly growing cities that are facing an increase in traffic congestion and pollution problems from high private vehicle ownership.

As the public transport system develops, the mind-set of the people also needs to be cultivated to move away from private vehicle ownership to the use of public transportation.

5.3.6.2 Inter-City Connectivity

Reduction of private vehicle usage for inter-city travel can be realised with better inter-city rail connection. This includes the proposed High Speed Rail System connecting Kuala Lumpur to Singapore in the south and the extension of the double-tracking system from Seremban in Negeri Sembilan to Perlis in the north. Cost constraints and optimal ridership are barriers towards further expansion to the east coast of Peninsular Malaysia and development of such inter-city rail connection in the states of Sabah and Sarawak.

5.3.6.3 Biodiesel Compatibility

The plan by the Government to progressively move towards higher composition of palm oil biofuel in biodiesel blends (higher than B7) for vehicle fuel usage is faced with technology compatibility challenges for certain vehicle engine models. This would require further collaborative testing and refinement with the automotive industry and the willingness to develop engine models that are compatible with the higher palm oil biodiesel fuel mixes.

5.3.7 Promotion of Green Technology

Fiscal instruments to help the private sector's transition to low-carbon operations through the Green Technology Financing Scheme (GTFS) that was launched in 2009 have faced considerable challenges. The conservative approach of commercial banks perceived this instrument as risky despite the Government's absorption of 2% of the interest rates and guaranteeing of up to 60% of the loan amount.

5.4 Vulnerability and Adaptation

As Malaysia strives to develop in a sustainable manner, the increase in vulnerabilities arising from the impacts of climate change poses additional challenges which could partially negate the development and mitigation gains which the country has achieved thus far. As such, the issue of vulnerability and adaptation is seen as a critical area for Malaysia to communicate in its Biennial Update Report.

Past development efforts that have provided early adaptation benefits to the country have been largely carried out on a sectoral basis in response to specific needs. In light of the increasing threats of climate change and in order to be able to plan holistically and in advance, adaptation efforts will therefore need to be considerably scaled up via a comprehensive and proactive national adaptation plan. Under the Eleventh Malaysia Plan, two key adaptation-related initiatives, namely enhancing adaptation measures through the development of a national adaptation plan and strengthening disaster risk management will be undertaken to increase the nation's resilience to the impacts of climate change and natural disasters. These efforts will further mainstream climate change adaptation planning into national development plans and activities.

Adequate technical and financial support is necessary to ensure that adaptation measures are effective and sustainable. Towards this end, Malaysia is also anticipating financial, technical and capacity building support from the international community in the development and implementation of its national adaptation plan.

5.4.1 Climate Projection and Sea-Level-Rise Modelling

High-resolution climate change projection scenarios are essential for climate change impact, vulnerability and risk assessment studies at local scales. Since NC2, efforts have been taken to raise the competency level of personnel involved in climate change modelling through extensive training and involvement in collaborative projects with international experts. Through these efforts, the horizontal resolution of climate modelling projection data has improved from 9 km to 6 km. However, capacity is needed in interpreting these data information for adaptation assessment and application in the various sectors.

Detailed sea-level-rise studies have only been conducted at some of the vulnerable coastal

areas. These studies utilised local coastal observation data, satellite data and projections from global climate models to project future vulnerabilities in a 20-year sequence from 2020 to 2100. In addition, research is also needed to better understand and project the interactions between sea-level rise and weather extremes over coastal areas.

5.4.2 Water and Coastal Resources Management

5.4.2.1 Flood Mitigation

The major climate variability impacts that Malaysia faces on a yearly basis are floods and occasional droughts that affect certain areas of the country. With increasing weather extremes, flood mitigation plans are being reassessed to provide more effective responses. As a country with a long coastline, this also requires that adequate attention be placed on the interface between river drainage capacities, sea level rise and stronger storm surges as well as integrity of natural ecosystems.

Flood mitigation programmes have been recurring features of Government expenditure for many decades. During the Tenth Malaysia Plan (2011–2015), 194 flood mitigation projects were implemented and 34 local scale flood hazard maps were developed to facilitate disaster prevention implementation. Despite these cumulative efforts, the country is still prone to extreme weather events. In the extreme flood of 2014, 25 lives were lost, half a million people were affected and damage to public infrastructure amounted to RM2.9 billion.

The average cost borne by the Government to mitigate floods over the past 40 years has risen from about RM3 million per year during the Second Malaysia Plan period (1971-1975) to RM1.3 billion per year during the Tenth Malaysia Plan period (2011-2015).

As part of the efforts to implement integrated flood management (IFM), integrated flood forecasting and early warning systems (EWS) incorporating public participation have been developed for several major river basins. Nevertheless, the coverage needs to be expanded to all river basins, taking into account the role of forests in IFM. To improve the accuracy, lead time and effectiveness of EWS, further refinement of the systems through technology transfer, in particular the numerical weather and flood prediction components, is necessary. To meet the additional human resource needs for IFM, training programmes in IFM, including EWS, will be required.

5.4.2.2 Water Resource Management

As 97% of the water supply in Malaysia is derived from surface water in rivers and reservoirs, management of these vital water catchment areas is crucial to ensure a reliable source of water supply. Increasingly unpredictable climatic conditions, including more extreme dry and wet seasons, abnormally distributed and higher rainfall intensity, unpredictable droughts, increased sedimentation of rivers and rainfall-associated landslides further complicate efforts to develop a sound water management regime.

Apart from the climate-induced constraints, the Federated governance system, which accords management of forests and water resources to the States, continues to pose a challenge in the implementation of comprehensive policy and legislation at the State level in support of the National Water Resources Policy and its component Integrated Water Resource Management, Integrated River Basin Management and Integrated Flood Management plans.

To ensure adequate and safe water supplies, inter-basin water transfer projects are being implemented to supply water to areas that are experiencing water stress due to high economic and population growth and spatial and temporal shifts in rainfall distribution. Although expensive, these multi-billion Ringgit infrastructure investments are necessary to address water resource needs under a future

climate regime. Additionally for urban areas, the feasibility of large-scale rainwater harvesting and utilisation system is being assessed.

Therefore, demand-side management such as minimising loss of non-revenue water, water tariff restructuring along with public awareness building to encourage water conservation needs to be pursued aggressively. Water saving technologies and assessment of the viability of alternative water resources would further require sound technology assistance. Additional funding for research and development in water saving techniques and improving water quality is also needed.

5.4.2.3 Coastal Management

Studies have also been conducted on the impacts of sea-level rise in several coastal localities, including the impacts on groundwater and saline intrusion. However the socio-economic impact has not been assessed. Transfer of the latest modelling capabilities related to sea-level rise is needed in order to be able to obtain more accurate projections. This will enable better analysis of the related effects and the formulation of appropriate adaptation measures.

5.4.3 Infrastructure

Existing essential infrastructure such as roads, railways, seaports and airports, public amenities and private properties are currently constructed without factoring in the impacts of climate change such as increase in weather extremes, sea-level rise and more warm days. Responding and adapting to the impacts of the increase in frequency and severity of weather extremes would need considerable capital investments. The increase in warmer weather also increases the challenges of reducing energy consumption for cooling purposes.

In the coastal areas, expanding population, increase of tourism facilities, reliance on seaports for Malaysia's export-oriented economy and coastal food production areas have amplified the country's vulnerability to sea-level rise, storm surges and associated shoreline erosion. These areas need to increase their resilience and adaptive capacity to increases in extreme weather patterns and sea-level rise.

Other public infrastructure such as power plants, water treatment plants, sewerage systems and municipal waste landfills are becoming more vulnerable with increase in extreme flooding events. Electricity generation and distribution facilities are vulnerable to a myriad of climate change effects. To protect these facilities, significant additional investments are required from the Government and the private sector to ensure continued service.

To prevent disasters from occurring, a comprehensive assessment of the integrity of dams and other hydraulic structures with climate change impacts factored in is necessary. A robust monitoring and detection system on the integrity of these water related structures is also needed.

With rising temperatures, the heat island effects experienced by most cities are expected to worsen. Achieving thermal comfort, particularly in residential buildings, will be a huge challenge to energy conservation and emissions reduction efforts. Aside from the need to ensure thermal comfort of the people, the durability of conventional building materials could be shortened by excessive heat and would require the future use of stronger and adaptive materials. Research on the effects of temperature rise on building materials and incentives to promote the development of durable and less heat-absorbing materials for the construction industry should be considered, if ongoing research determines these to be a necessity to ensure long-term savings and safety of buildings.

5.4.4 Agriculture

Agriculture production faces high risks with changing climatic conditions. The yields of

important crops such as rice, vegetables, cocoa, oil palm and rubber are susceptible to extreme weather patterns during their varying stages of growth. This in turn jeopardises the country's quest to minimise its food imports and enhance food security. Crop modelling activities need to be enhanced in order to predict the impact of climate change on crop yields and farmers' income. It would also be crucial to intensify research into pest and diseases, in anticipation of changing patterns of such incidences dues to climate change.

Crop modelling simulations for paddy show that a temperature increase of 2°C above the threshold temperature will reduce yields by as much as 13%, while floods and droughts during the early stage of the growing season could decrease yields by as much as 80%. Established rice varieties such as MR219 and MR232, which were developed to be cultivated under existing weather conditions may no longer be viable in the near future. In rice farming, research to develop additional rice varieties which are tolerant to floods, drought and extreme temperatures has been initiated. Water-saving aerobic rice farming has been developed and will be gradually implemented nationwide. Simulation studies on shifting planting dates are ongoing.

In addition, breeding programmes for heat- and water-efficient varieties of oil palm and cocoa are being conducted. The use of the Low Intensity Tapping System and of rain gutters in rubber plantations has been also introduced but deployment of these techniques would require substantial efforts to impart the skills to the workforce in this labour-intensive industry.
Smallholders and farmers are slow to adopt good agriculture practices such as water and fertiliser management that could help their farms adapt to the changing climate. It is therefore imperative that serious efforts are made in Malaysia to ensure that the agriculture sector can adapt to climate change and be resilient. The Eleventh Malaysia Plan recognises that strengthening the resilience of the agriculture sector would require greater implementation of good agricultural practices as well as intensifying research and development, especially in agriculture climate-modelling and expansion of good agricultural practices. The strengthening of institutional support and extension services, including training extension officers in managing anticipated climate change impacts, would also be important.

5.4.5 Forestry and Biodiversity

Malaysia is one of most mega-diverse countries in the world. The beneficial role played by forests such as the protection of soil and water resources, conservation of biological diversity, fulfilling aesthetic and recreational needs, regulation of the climate system, and sequestration of atmospheric carbon, most of which have a direct or indirect role in reducing vulnerabilities to climate change, is recognised. However, this rich biological diversity is increasingly under pressure and seriously threatened. The impacts of climate change are expected to affect ecosystem function and further exacerbate biodiversity loss.

However, data and information on the impacts of climate change on both terrestrial and aquatic ecosystems and the species in these spaces remain low due to a lack of research. This has affected the formulation of effective adaptation strategies to build the resilience of ecosystems.

Research on the impacts of climate change on tree phenology, growth rate, carbon fluxes, floristic composition, and so on, is likewise constrained by the lack of modelling tools, comprehensive monitoring and technical capacity. Indicator plots of various forest types should be established to monitor climate change impacts. Climate stations in long-term research plots such as Pasoh and Lambir as well as Danum Valley are well placed to carry out more such research and could be expanded to cover the different forest types.

Technical capacities are also urgently needed to analyse the potential impacts of sea-level rise, sea- and land-temperature rise and precipitation variability on vulnerable habitats, as well as on flora and fauna species, to better inform adaptation planning.

The lack of adequate and sustained financing sources for existing ecosystem protection plans is hampering the progress of conservation efforts to connect vital forest corridors, such as the Central Forest Spine in Peninsular Malaysia, and the Heart of Borneo project in Sabah and Sarawak. Similarly, funds are lacking for the establishment of marine protected areas and to ensure the optimal functions of ex-situ conservation programmes for threatened plants and animals, such as seed banks and captive breeding centres, respectively.

5.4.6 Public Health

Vector-borne diseases such as dengue and malaria are expected to be further exacerbated by rising temperatures and high rainfall. The dengue menace in urban centres has been a constant public health challenge affecting a wide population of all age groups in Malaysia and this is expected to worsen with the impacts of climate change.

The control and prevention of dengue transmission using early test kits and community behavioural intervention as well as exploratory research on alternative medicines are among the efforts being undertaken. An integrated approach to suppressing the mosquito vector population that involves targeted research and high public awareness and participation, while crucial, is still insufficiently implemented. Research on the relationship between dengue transmission and climate change is still in its infancy and will need to be stepped up substantially in order to better understand and manage the effects of climate change.

Malaria is largely confined to the forested interior regions of Malaysia. Nevertheless, constant monitoring of outbreaks is being carried out by rural health services to prevent any geographical spread.

Climate-related disasters are already posing huge challenges to the public disaster management systems. Ensuring clean water supply and optimal sewerage services are particularly difficult during disasters such as flooding, as experienced during the recent year-end massive flooding that affected several states, giving rise to food and water-borne diseases. As extreme weather events are expected to become more frequent, preparedness is needed in addressing public health issues during and after such natural disasters, to ensure that isolated disease events do not escalate into outbreaks.

A significant proportion of the workforce in Malaysia is engaged in outdoor economic activities that are exposed to heat, in both the urban and rural areas. While there has been no incidence of heat-related health issues among the populace, the threat of heat waves has been considered an area for early institutional preparation. Development of specific guidelines and standard operating procedures at primary and tertiary healthcare facilities to deal with heat-related ailments need to be implemented in the near term.

5.5 Research and Systematic Observation

There is insufficient systematic monitoring of climate change in Malaysia. Funding for data collection and basic climate change research has been limited due to competing needs and consequently there is a lack of national capacity for these activities. As such, the necessary information and data references that would strengthen the national climate change response are lacking.

Given the large uncertainties in projecting the impacts of climate change in Malaysia, there is an urgent need to improve climate modelling work including through regional downscaling to enhance vulnerability assessment and adaptation policy development. A

multidisciplinary approach to understand the impacts and identify priority research areas has yet to be carried out for key sectors, particularly water resources, energy, health, food production, economic activities and natural resource protection. These steps are necessary to improve science-based policy interventions and would require developing and enhancing local expertise and transfer of skills and knowledge from international institutions.

The further development of multidisciplinary research and networks of long-term ecological research sites in the forestry sector, marine and other ecological areas is needed to study the interactions of biodiversity, hydrology, carbon fluxes and carbon sequestration with the changing climate. These steps are vital to protect natural carbon sinks and to understand the impacts of climate change on them as well as the extent of services they provide in regulating micro-climates and creating resilience and protecting against the impacts of a changing climate. Furthermore, there is an urgent need to study the linkages and synergies of efforts in mitigation, adaptation, disaster risk reduction as well as to analyse and quantify loss and damage from the impacts of climate change.

CHAPTER 6

OTHER INFORMATION ON ADDRESSING CLIMATE CHANGE

CHAPTER 6: OTHER INFORMATION ON ADDRESSING CLIMATE CHANGE

6.1 Introduction

This chapter provides information on several cross-cutting and other initiatives that are also addressing climate change. These are in addition to the policies and initiatives that are described in Chapter 3.

6.2 National Physical Plan

Malaysia's Second National Physical Plan (2010-2020) provides a long-term strategic framework for national spatial planning and includes measures required to shape the direction and pattern of land use, biodiversity conservation and development in Peninsular Malaysia. It is a set of guidelines for the Federal and State governments to control development and land administration.

6.3 Cities

To further promote sustainable urban development, the National Urbanization Policy 2006 set out clear policies for city development with key objectives including the development of a high-capacity public transport system and implementation of sustainable solid waste management systems.

6.3.1 Low Carbon Cities Framework

The framework of low-carbon or green cities that has been adopted in Malaysia provides an overarching and cross-cutting approach to climate action. The National Green Technology Policy was launched in 2009. One of its social indicators is that there "should be more cities, townships and communities in Malaysia embracing green technology and which are classified as green townships". Subsequently, the Ministry of Energy, Green Technology and Water developed the Low Carbon Cities Framework (LCCF) to guide the implementation of carbon reduction measures in cities and townships. The framework is complemented by an assessment system which allows for the implementation of such measures to be quantified and monitored.

The LCCF attempts to bridge the gap between existing policies and the many building rating tools currently available in the market. By focussing specifically on strategies and measures towards carbon reduction, it aims to help stakeholders in cities and townships define their priorities and develop action plans to reduce their carbon emissions.

The LCCF aims to:

- Create awareness, encourage and promote the concept of green cities in Malaysia;
- Guide city administrators in decision-making towards green solutions for cities and townships;
- Enable cities and townships to measure their current and baseline carbon emissions; and
- Enable cities and townships to define their carbon strategies and subsequently measure the performance of their action.

The LCCF aims to assist users in assessing green practices in cities and townships, and to increase understanding of the design and development of green townships. The goal is developing cities which are continuously reducing carbon emissions and ultimately becoming zero or neutral carbon cities.

The four main urban focus areas are environment, transport, infrastructure and buildings. The assessment system allows the user to calculate the baseline and the reduced carbon emissions. This then translates into a carbon reduction rating for any particular development.

6.3.2 Other Initiatives

The Ministry of Housing and Local Government has also formulated and undertaken strategies, programmes, projects and initiatives to encourage more sustainable cities. For example, it formulated the Guidelines for Green Neighbourhoods in 2011. The Department of Town and Country Planning has established the Malaysian Urban Indicator Network (MURNInets) for use as a tool to monitor the quality and achievement of cities and towns in terms of their sustainability.

The Eleventh Malaysia Plan complements these efforts by proposing to develop city competitiveness master plans for four major cities, namely Kuala Lumpur, Johor Bahru, Kuching and Kota Kinabalu. The principles of the master plans include expanding transit-oriented development to increase use of public transportation and reduce reliance on private vehicles, encouraging green-based development and practices, and optimising resource use. Environmentally friendly practices such as green buildings, green lifestyles, sustainable consumption and production, and efficient waste management are to be embedded within the development plans of these cities.

Several municipal and city councils in Malaysia are also part of the ICLEI – Local Governments for Sustainability network, which aims to support and encourage cities to become more sustainable and to have a lower carbon footprint. Similarly, two local councils have taken part in the WWF Earth Hour City Challenge, a competition among cities to promote renewable energy and prepare for climate change. The cities that participate in this voluntary programme are recognised for their efforts in trying to create more sustainable, resilient cities. Additionally, Local Agenda 21 implementation by some Malaysian cities has resulted in self-initiated strategic endeavours to promote eco-mobility, energy management, environmental education, green-community consciousness, carbon footprint assessment and green technology, amongst others.
Two examples highlighted below – Melaka and Iskandar Malaysia – showcase the efforts undertaken by regional authorities to promote and operationalise low-carbon cities.

6.4 Government Green Procurement and Green Labelling

Government Green Procurement (GGP) is an existing initiative undertaken by the Ministry of Finance and the Ministry of Energy, Green Technology and Water. GGP will be expanded and implemented by all Government ministries and agencies during the Eleventh Malaysia Plan.

GGP is expected to support a switch to more sustainable procurement practices, with

Box 1: Melaka

The Melaka State Government aims to become the country's first green technology city or 'Green' State by 2020. To achieve this aim, Melaka has put in place institutional arrangements, such as the Melaka Green Technology Council to oversee the planning and monitoring of green technology developments in the state in 2011, and the Melaka Green Technology Corporation in 2013.

In 2011, the Melaka Green Technology City State Blueprint (2011-2020) was produced and in 2014, the Melaka Green City Action Plan was developed to further enhance the planning for green development in Melaka.

All local councils have been instructed to set up Green Technology Action Committees, which report to the Melaka State Green Technology Council. The Council is chaired by the Chief Minister of Melaka and comprises State Executive Committee members, local councilors, and related government agencies.

The Melaka Green Technology Corporation functions as the secretariat for the Melaka Green Technology Council. It aims to lead green development initiatives, implement green policies, plan and monitor green technology development, and enhance businesses and investment in green technology in the state.

Various green technology projects and programmes are already being implemented or are planned. These include various solar projects, such as the Melaka World Solar Valley to catalyse the solar industry, a pioneer green city (Hang Tuah Jaya Green City), Melaka River Rehabilitation Project, electric buses and car-charging stations, biodiesel programme, green building ratings and retrofitting, recycling and waste programmes.

Box 2: Iskandar Malaysia

Iskandar Malaysia was established in 2006 as a part of the Southern Economic Corridor under the Ninth Malaysia Plan. It is administered by the Iskandar Regional Development Authority (IRDA), which is a Federal Government statutory body. The development region has a population of around 1.6 million (in 2010) people across five local planning authorities.

IRDA has adopted and applied the Low Carbon Society (LCS) framework. Its objectives are to draw up key policies and strategies to guide the development of Iskandar Malaysia in mitigating carbon emissions, in order to transform the region into a sustainable low-carbon metropolis by adopting green-growth strategies; and to respond to the nation's aspiration for ensuring climate-resilient development for sustainability.

The LCS Blueprint for Iskandar Malaysia 2025 was launched in 2013 to promote low-carbon development and provide the policy framework and supporting technical tools. It outlines 12 actions to reduce carbon emissions, grouped around three themes: Green Environment, Green Economy and Green Community. The 12 actions are: integrated green transportation; green industry; low-carbon urban governance; green buildings and construction; green-energy systems and renewable energy; low-carbon lifestyle; community engagement and consensus building; walkable, safe, liveable city design; smart growth; green and blue infrastructure and rural resources; sustainable waste management; and clean air environment.

Government leading by example. It is envisaged to create the demand for green products and services, such as those produced with or using lower energy consumption. By 2020, the target is for at least 20% of Government procurement to be green.

The efforts to implement further GGP are expected to complement the existing labelling scheme for the certification of green products and services. Under the Eleventh Malaysia Plan, the *MyHijau Mark* programme will be expanded for key product areas such as household products, electronic and electrical appliances. Green rating systems and standards, aligned with international best practices, will also be introduced to promote the greening of industries.

6.5 Carbon and Environmental Reporting

The National Corporate Greenhouse Gas (GHG) Reporting Programme for Malaysia (also known as MyCarbon) is a voluntary reporting mechanism that was launched in December 2013. Its main objective is to establish the framework to support reporting of GHG emissions by the corporate sector in a standardised and internationally recognised manner. By doing so, the programme aims to encourage and facilitate private entities to measure and report their greenhouse gas emissions, from which they can identify actions to reduce emissions. As of January 2015, 26 companies have volunteered to participate in the programme. As an incentive to encourage more companies to participate in the MyCarbon Programme, a tax deduction incentive on the expenses incurred by the participating companies for the preparation of their GHG reports for the period 1 January 2015 to 31 December 2016, has been approved by the Ministry of Finance.

In 2014, Bursa Malaysia launched an Environmental, Social and Governance (ESG) Index. The FTSE4Good Bursa Malaysia (F4GBM) Index was developed in collaboration with the Financial Times Stock Exchange (FTSE) as part of the globally benchmarked FTSE4Good Index Series and was aligned with other leading global ESG frameworks such as the Global Reporting Initiative and the Carbon Disclosure Project. The F4GBM Index will be used to measure the performance of companies demonstrating strong ESG practices. Constituents of the new index must meet internationally benchmarked criteria that measure efforts in environmental conservation, the impact of social responsibility initiatives on the community and the practice of good governance through responsible and ethical decision-making.

6.6 Conclusion

Malaysia intends to continue to pursue sustainable development with the aim of achieving emissions reduction, along with the protection of its vital natural resources to build its resilience to the impacts of climate change. While it has been doing so thus far largely with public funding, additional and timely international assistance in the forms of financing, technology transfer and capacity building, in accordance with the principles and provisions of the UNFCCC, would help shift Malaysia on its path towards low-carbon economic development more quickly and more substantially.

While concrete efforts have been undertaken thus far, real challenges remain in ensuring policy coherence, particularly given several competing needs and priorities for the nation. There is also an urgent need for better coordination across the various Federal Ministries and agencies, given the cross-cutting nature of climate change. In addition, proper implementation of the policies in order to yield concrete results remains a substantial challenge.

Appendix 1: Key Data for 2011 (Malaysia)

Latitude[a]	0° 51' N - 7° 33' N
Longitude[a]	98° 01' E - 119° 30' E
Area	330,183 km^2
Coastline	5,267 km
Mean daily temperature	26-28°C
Average annual rainfall	2,000-4,000 mm
Average daily direct sunlight	6 hours
Forest Cover as % of total land area	54.3%
Population	29.1 million
Population density	88 per km^2
Female life expectancy	76.90 years
Male life expectancy	72.16 years
GDP	RM711,800 million[b]
GNI/capita	RM 22,961[b]
Primary Energy Supply	79,289 ktoe
Energy Demand	43,456 ktoe
Length of roads (Federal and State)	155, 427 km
Motor vehicle registration	21.4 million
Ridership on urban rail network (passenger journeys)	183.3 million
Oil Palm	5,000,110 ha
Rubber	1,027,040 ha
Paddy (Planted Area)	687,940 ha
Cattle	768,710
Swine	1,816,557
Poultry	238,361,891
Marine Fish Landings	1,373,000 tonnes
Aquaculture Production	526,000 tonnes
Solid Waste	33,130 tonnes/day (2012)

[a]Includes territorial waters
[b]2005 constant prices

Appendix 2: Summary of Constraints, Gaps and Recommendations

Thematic Area	Constraint/Gap	Recommendations
GHG Inventory	Limited technical capacity in applying national activity data and proxy data to generate the required data for GHG inventory.	Accelerate capacity building to increase the pool and capability of GHG inventory compilers and data providers.
	Lack of historical data, particularly for the waste and industrial processes sectors.	Enhance collection of identified missing historical activity data from key sectors to meet IPCC requirements.
	Difficulties in understanding different data sets reported in national and international publications.	A centralised data collection and compilation mechanism to ensure the quality, consistency and reliability of inventories is being developed.
	Not all sectors were covered to satisfaction due to technical and data gaps.	Subsectors identified in the GHG Inventory improvement plan as “not yet reported” will be explored for future inclusion. Increase cooperation with data providers especially from the private sector to collate data for additional subsectors.
	Difficulties in moving to higher tiers due to lack of detailed local data and emission factors.	Increase collaboration and cooperation with data providers to improve data disaggregation. Enhance research and development of local emission factors.
	Limited technical capacity in carrying out uncertainty assessments.	Continuous capacity building through participation in national and regional workshops.

Appendix 2: Summary of Constraints, Gaps and Recommendations (continue)

Thematic Area	Constraint/Gap	Recommendations
Mitigation	Limited funding constrains wider deployment of RE through the FiT mechanism.	Enhance access to international financial assistance, capacity development and technology transfer to accelerate RE deployment. Accelerate solar PV technology transfer to further reduce cost of RE.
	Limited financial resources and capacity are the barriers to develop and execute a sound and holistic energy efficiency plan.	National Energy Efficiency Action Plan (NEEAP) (2016-2025) in the final stages of development. NEEAP key initiatives include energy performance standards, promotion of energy-efficient appliances, energy audits and management, and energy-efficient buildings.
	Lack of coordination among relevant local, state, federal agencies for waste management due to restricted applicability of legislation in certain States.	A national committee on sustainable waste management to enhance coordination nationally is proposed under the Eleventh Malaysia Plan.
	Lack of effective coordination has affected the implementation of the 3R (reuse, reduce and recycle) programme.	Enhance awareness/education programmes to inculcate better consumption, waste disposal behaviour and coordination. Promote waste recycling and recovery to reduce dependency on natural resources or, as appropriate, as a viable energy resource.
	Lack of proper assessment tools and skills to enable accurate quantification of GHG emissions.	Develop tools and capacity to use them.
	Competing socio-economic development puts strain on land use patterns while economic valuation of ecosystem services provided by forests remain largely invisible and undervalued.	REDD+ mechanism regarded as viable incentive for sub-national entities to maintain forest cover. Strengthen sustainable forest management and sustainable forest certification systems. Alignment of National Forestry Inventory by 2022 to enhance management of forest cover.
	Land use change affecting peat-lands and associated peat fires, resulting in increased emissions.	Measures include restoring the water table, replanting degraded forests and effective fire monitoring systems.
	Rapid rise in private vehicle ownership has led to significant growth in energy consumption by the transportation sector.	Enhance integrated long-term urban planning for the development of an efficient and integrated public transportation system.
	The promotion of an efficient public transportation system has thus far focussed largely on mass rail connection.	Develop concurrently the bus rapid transit network as identified in the Greater Kuala Lumpur/Klang Valley Public Transport Master Plan. Develop similar bus rapid transit network for other rapidly growing cities that are facing increase in traffic congestion.
	Technology compatibility challenges for certain vehicle engine models in using progressively higher composition of palm oil biofuel in biodiesel blends for vehicles.	Further collaborative testing and refinement with the automotive industry and development of engine models compatible with higher palm oil biodiesel fuel mixes.

Appendix 2: Summary of Constraints, Gaps and Recommendations (continue)

Thematic Area	Constraint/Gap	Recommendations
Vulnerability & Adaptation	Approach to adaptation has been largely on a sectoral basis in response to specific needs, leading to lack of holistic and advanced planning for adaptation to climate change.	Scale up adaptation efforts via a comprehensive and proactive national adaptation plan and strengthen disaster risk management.
	Lack of capacity in interpreting data from high-resolution climate change projection scenarios for adaptation assessment and application in various sectors.	Raise competency of climate change modellers through continued and extensive training and involvement in collaborative projects with international experts.
	Detailed sea-level rise studies have only been conducted at some vulnerable coastal areas.	Expand research to other areas, and conduct further research to better understand and project interactions between sea-level rise and weather extremes over coastal areas.
	Despite cumulative efforts on flood mitigation, impacts of extreme weather events still take a heavy toll on lives, livelihoods and infrastructure.	Reassess flood mitigation plans to provide more effective responses. Pay adequate attention to the interface between river drainage capacities, sea-level rise and stronger storm surges.
	Implementation of integrated flood management (IFM), integrated flood forecasting and early warning systems (EWS), needs to be expanded to all river basins, taking into account the role of forests in IFM.	Further refinement of the EWS through technology transfer, in particular numerical weather and flood prediction components. Conduct training programmes in IFM, including EWS.
	Assessment of impacts of sea-level rise, and its impact on groundwater and saline intrusion, taking into consideration socio-economic effects need to be improved.	Transfer of latest modelling capabilities related to sea-level rise to obtain more accurate projections. Conduct better analysis of the effects and formulation of adaptation measures.
	Essential infrastructure such as roads, railways, seaports and airports, public amenities and private properties are currently constructed without factoring in the impacts of climate change.	Conduct comprehensive assessment on impacts of climate change on essential infrastructure, in particular integrity of dams and other hydraulic structures. Develop a robust monitoring and detection system. Allocate sufficient resources for the improvements of the essential infrastructure including capital investments.
	Increased challenges of reducing energy consumption for cooling purposes, while durability of conventional building materials could be shortened by excessive heat.	Increase research on the effects of temperature rise on durability of building materials and promote development of durable and less heat absorbing materials for the construction industry.
	The yields of crops are susceptible to extreme weather patterns and could affect food security.	Enhance crop modelling activities to predict impact of climate change on crop yields and farmers' income. Intensify research into pests and diseases, in anticipation of changing patterns due to climate change. Increase research on new crop varieties, in particular for rice and oil palm that are tolerant to floods, droughts and extreme temperatures. Gradually implement water-saving aerobic rice farming nationwide. Continue ongoing simulation studies on shifting planting dates for rice cultivation.

Appendix 2: Summary of Constraints, Gaps and Recommendations (continue)

Thematic Area	Constraint/Gap	Recommendations
Vulnerability & Adaptation	Smallholders and farmers slow to adopt good agriculture practices that could help them adapt to climate change.	Strengthen institutional support and extension services, including training extension officers.
	Limited data and information on impacts of climate change on species and terrestrial and aquatic ecosystems.	Enhance observation, data collection and long-term research on impacts of climate change on natural ecosystems.
	Lack of technical capacity to analyse impacts of sea level rise, temperature rise and precipitation variability on vulnerable habitats and species.	Enhance technical capacity to analyse climate change impacts on natural ecosystems.
	Lack of financing for ecosystem protection plans, establishment of marine protected areas and ex-situ conservation programmes.	Access international funds to complement national funds.
	Integrated approach to suppressing mosquito vectors of dengue involving targeted research and high public awareness and participation is still limited.	Control and prevention of dengue using early test kits and enhance community behavioural intervention. Step up research substantially to better understand and manage the effects of climate change on dengue. Increase research on medication for dengue including research on alternative medicines
	Malaria is largely confined to the forested interior regions of Malaysia, but needs to be monitored.	Constant monitoring of outbreaks by rural health services to prevent geographical spread of malaria.
	Ensuring clean water supply and optimal sewerage services are particularly difficult during disasters such as flooding.	Improve preparedness in addressing public health issues during and after natural disasters, to ensure that isolated disease events do not escalate into outbreaks.
	The threat of heat-related health issues has not been sufficiently addressed.	Develop additional guidelines and standard operating procedures (SOP) at healthcare facilities for heat-related issues.
Research & Systematic Observation	Systematic monitoring of climate change and its impacts is insufficient due to limited funding for data collection and basic climate change research, with consequent lack of capacity.	Improve climate modelling including through regional downscaling. Develop and enhance local expertise and transfer skills and knowledge from international institutions.
	Lack of a multidisciplinary approach to understand impacts and identify priority research areas for key sectors.	Develop multidisciplinary research and networks of long-term ecological research sites to study interactions of biodiversity, hydrology, carbon fluxes and sequestration with climate change. Study linkages and synergies of efforts in mitigation, adaptation, disaster risk reduction, and analyse and quantify loss and damage.

TECHNICAL ANNEX 1:

ADDITIONAL INFORMATION ON NATIONAL GREENHOUSE GAS INVENTORY

Table A: Summary of Assumptions and Activity Data Sources

Sector & Sub Sector	Activity data	Assumption	Data source
1. Energy Sector			
1.1 Fuel Combustion 1.1.1 Energy Industries	Fuel Types in Energy Industries (ktoe)	The type of coal used in energy industries is sub-bituminous coal.	National Energy Balance (NEB) 2011
	Petroleum Refining		NEB 2011
	Manufacture of Solid Fuels and Other Energy Industries		NEB 2011
1.1.2 Transport	Fuel Consumption Ratio	The ratio of fuel consumption of domestic aviation to international is 20:80	MAS, Firefly, MAS Wings, Air Asia, NEB 2011
	Fuel Type Used in Road Transport	95.3% of total diesel consumption. 99.9% of total petrol consumption. 100% of natural gas consumption.	NEB 2011
	Railway	0.4 % of total diesel consumption based on survey	*Keretapi Tanah Melayu Berhad* (Malayan Railways)
	Navigation	4 % of total diesel consumption. 100% residual fuel oil consumption. based on survey	*Jabatan Laut Sabah and Sarawak*, NEB 2011 (Marine Department Sabah and Sarawak) NEB 2011
1.1.3 Others	Agriculture/Forestry/Fishing	5% of the fuel consumption is for stationary combustion. 95% of the fuel consumption is for mobile combustion based on survey	NEB 2011
	Others	0.3% and 0.1 % of total diesel and petrol consumption respectively based on survey	
1.2 Fugitive Emissions from Fuels	Coal Mining and Handling of Underground and Surface Mines		Minerals and Geoscience Department Malaysia
	Oil Produced and Refined		NEB 2011
	Natural Gas Produced and Consumed		NEB 2011
	Venting and Flaring from Oil and Gas Production		NEB 2011
2. IP Sector			
2.1 Mineral Products	Cement Production	No calcined Cement Kiln 100% carbonate source is of CaO	Cement and Concrete Association of Malaysia (CNCA)
	Quantity of Limestone and Dolomite Use	Tier 1 approach is applied and Lime Kiln Dust (LKD) is not estimated	Minerals and Geoscience Department Malaysia
	Ammonia Production		United States Geological Survey 2011

Table A: Summary of Assumptions and Activity Data Sources (continue)

Sector & Sub Sector	Activity data	Assumption	Data source
2.2 Chemical Industry	Carbide Production		MCB Industries
	Production of Petrochemicals		Malaysian Petrochemicals Association (MPA) for Ethylene and Styrene; Cabot (M) Sdn Bhd for Carbon Black; Petronas for Methanol.
2.3 Metal Production	Amount of Iron and Steel Produced		Malaysian Iron and Steel Federation (MISIF)
	Amount of Aluminium Produced	All production is based on one facility which uses prebaked Anode Process	United States Geological Survey 2011
2.4 Production of Halocarbons and Sulphur Hexafluoride	Refrigeration and Air-Conditioning	All passenger vehicles are fitted with HFC-134a. Emissions released from scrapped systems (disposal) are not accounted for. Assume default values of 5% assembly loss and 10% annual leakage rate.	Road Transport Department, Ministry of Transport, Malaysian Automotive Association (MAA), Denso (M) Bhd, APM Air Conditioning (M) Sdn Bhd, Sanden International (M) Sdn. Bhd, and Seasonair (M) Sdn Bhd.
	SF_6 Utilization in Power Utilities	Gas Insulated Switchgear has a lifetime of 30 years.	Linde Malaysia Sdn Bhd
3. Agriculture Sector			
3.1 Enteric Fermentation in Domestic Livestock	Fraction of Manure Nitrogen per Animal Waste Management System (AWMS) Anaerobic Lagoons	Data derived based on 3 years average (2010, 2011, 2012) of number of animals 5% of cattle population is dairy cattle Chickens and ducks are classified as poultry	Agrofood Statistics 2014 (MOA)
3.2 Manure Management	Solid Storage and Dry Lot	Non-Dairy Cattle: 30% Dairy Cattle: 30% Poultry: 0% Sheep: 0% Swine: 95%	Agrofood Statistics 2014 (MOA)
	Pasture Range & Paddock	Non-Dairy Cattle: 30% Dairy Cattle: 40% Poultry: 95% Sheep: 50% Swine: 5%	
	Anaerobic Lagoon	Non-Dairy Cattle: 40% Dairy Cattle: 30% Poultry: 5% Sheep: 50% Swine: 0%	

Table A: Summary of Assumptions and Activity Data Sources (continue)

Sector & Sub Sector	Activity data	Assumption	Data source
3.3. Agricultural Soils			
	Direct Soil Emissions		
	i. Fertiliser Consumption by type (kg/year)	% total N content in fertilizer: Ammonium nitrate:33% Ammonium sulphate:21% Calcium ammonium nitrate:21% Diammonium phosphate (DAP):18% Monoammonium phosphate (MAP):11% NPK complex:15% Other nitrogen & phosphates compounds: 20% Total Other nitrogen & phosphorus compounds: 20% Potassium nitrate:13% Urea: 46% Urea and ammonium nitrate solutions: 32%	FAOStat website: faostat.fao.org
	ii. Animal Waste		
	Number of animals	All animal waste is applied back to the field	
	iii. Crop Residue		
	a. Oil Palm Fronds	a. Pruning	
		Estimated 12 tonnes/ hectares (dry weight) during pruning. 75% of the palm trees are of age 7 years and above. Estimated amount is 12 x 0.75 x area planted	Ng, F. Y., Yew, F. K., Basiron, Y., & Sundram, K. (2012). A renewable future driven with Malaysian palm oil-based green technology. *Journal of Oil Palm, Environment and Health (JOPEH), 2*: 1-7.
		b. Replanting	
		Estimated 14 tonnes/ hectares (dry weight) during pruning. 4% of the total planted areas will be replanted annually. Estimated amount 14 x 0.04 x area planted	
	b. Rice Straw	Rice straw generation is 1.4 times of annual rice yield	Paddy Statistics of Malaysia 2013 (DOA)

Table A: Summary of Assumptions and Activity Data Sources (continue)

Sector & Sub Sector	Activity data	Assumption	Data source
	Indirect Emissions a. Synthetic Fertilizer b. Animal Waste	a. Deposition i. 10% from total synthetic fertilizer ii. 20% from animal waste b. Leaching i. 30% from total total synthetic fertilizer ii. 30% from animal waste	FAO Stat website: faostat.fao.org Agrofood Statistics 2014 (MOA)
3.4 Field Burning of Agricultural Residues	Agricultural Residues from Rice Production	No straws are burned in the upland rice An average 20% and 10% of straws are burned in granary and rain-fed areas respectively. No burning for sugarcane and pineapple because the areas are too small and not significant.	Paddy Statistics of Malaysia 2013 (DOA)
4. LULUCF			
4.1 Forest Land	Annual increase in carbon stocks due to biomass growth: Inland Forest Peat Swamp Forest Mangrove State Land Plantation Forest Annual decrease in carbon stocks due to biomass loss:	No change in soil organic matter and dead organic matter (Tier 1 approach)	www.nre.gov.my www.fao.org
4.2 Cropland	Annual increase in carbon stocks due to biomass growth: Total Oil Palm Planted area Total Rubber Planted area Total Cocoa Planted area Oil Palm in Peat-Land Annual decrease in carbon stocks due to biomass loss	Other perennial crops like fruit trees is assumed uptake and harvest is assumed equal	www.mpob.gov.my www.kppk.gov.my Wahid et al (2010)

Table A: Summary of Assumptions and Activity Data Sources (continue)

Sector & Sub Sector	Activity data	Assumption	Data source
4.3 Grassland	Pasture Land	No change in living biomass carbon stocks No change in living biomass carbon stocks	
4.4 Wetlands	Dams, Lakes and Rivers	Wetland includes inland water bodies like rivers, lakes and dams and these areas are not regulated by human activities where no substantial changes in water area due to water level regulation.	
4.5 Settlement	Urban Green Space	No data available	
4.6 Other Land	Forest Land Converted to Other Land	It is assumed is that degazetted forest will be converted within the same year although this may not be the practice. It is assumed that all of the biomass is cleared. No burning takes place after the forest is cleared, as Malaysia practiced no open burning policy since 1997. No tilling of land takes place after the conversion.	Forestry Departments, Peninsular Malaysia, Sabah and Sarawak.
5. Waste			
5.1 Solid Waste Disposal Sites (SWDS)	Fraction of MSW Disposed to SWDS based on Urban Population	70% urban population For methane emission,100% is emitted as there is no recovery or flaring	Department of Statistics
		For nitrous oxide emission, amount of sewage N applied to soils as sewage sludge (kg N/ yr) is assumed 0	
5.2 Domestic and Commercial Wastewater (CH_4)	Domestic Wastewater: Urban Population Data	For methane emission,100% is emitted as there is no recovery or flaring	Department of Statistics
	Commercial: Rubber	For methane emission,100% is emitted as there is no recovery or flaring	Malaysian Rubber Board
	Commercial: Oil Palm	For methane emission,100% is emitted as there is no recovery or flaring	Malaysian Palm Oil Board

Table B: Summary of Activity Data and Emission Factors Used

1. Energy Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA	EMISSION FACTORS				
		CO_2	CH_4	N_2O	NO_X	CO
1.1 Fuel Combustion	(TJ)	(tC/TJ)	(kg/TJ)	(kg/TJ)		
1.1.1 Energy Industries						
a. Public Electricity and Heat Production						
Diesel Oil	49,371.20	20.2	3	0.6		
Residual Fuel Oil	46,149.52	20.0	3	0.6		
Sub-Bituminous Coal	544,463.92	26.2	1	1.4		
Natural Gas	531,284.32	15.3	1	0.1		
b. Petroleum Refining						
Crude Oil	38,032.56	20.0	3	0.6		
c. Manufacture of Solid Fuels and Other Energy Industries						
Natural Gas	410,617.76	15.3	1	0.1		
1.1.2 Manufacturing Industries and Construction						
Gasoline	6,694.40	18.9	2	0.6		
Other Kerosene	376.56	19.6				
Diesel Oil	53,597.04	20.2				
Residual Fuel Oil	13,430.64	21.1				
LPG	9,414.00	17.2				
Sub-Bituminous Coal	73,596.56	26.2	10	1.4		
Natural gas	179,912.00	15.3	5	0.1		
1.1.3 Transport						
a. Domestic Aviation						
Jet Kerosene	21,212.88	19.5	0.5	2		
b. Road Transport						
Natural Gas	11,380.48	15.3	50	0.1		
Gasoline	334,150.98	18.9	20	0.6		
Diesel Oil	246,046.40	20.2	5	0.6		
c. Rail Transport						
Diesel Oil	1,146.42	20.2	5	0.6		
d. National Navigation						
Diesel Oil	9,464.63	20.2	5	0.6		
Residual Fuel Oil	1,631.76	21.1	5	0.6		
1.1.4 Other Sectors						
a. Commercial/Institutional						
Diesel Oil	16,317.60	20.2	10	0.6		
Residual Fuel Oil	1,548.08	21.1	10	0.6		
LPG	24,769.28	17.2	10	0.6		
Natural Gas	1,297.04	15.3	5	0.1		
b. Residential						
Other Kerosene	418.40	19.6	10	0.6		
LPG	32,677.04	17.2	10	0.6		
Natural Gas	251.04	15.3	5	0.1		

Table B: Summary of Activity Data and Emission Factors Used (continue)

1. Energy Sector

c. Agriculture/Forestry/Fisheries						
i. Stationary						
Diesel Oil	34,700.00	20.2	10	0.6		
Residual Fuel Oil	675.72	21.1	10	0.6		
ii. Mobile						
Diesel Oil	1,826.32	20.2	5	0.6		
Residual Fuel Oil	35.56	21.1	5	0.6		
1.1.5 Other (Not Specified Elsewhere)						
Mobile Other use						
Gasoline	359.82	18.9	20	0.6		
Jet Kerosene	1,831.76	19.5	0.5	2		
Gas/Diesel Oil	1,260.64	20.2	5	0.6		
1.2 Fugitive Emissions from Fuels	**Million tonnes**	**CO_2**	**CH_4 (m^3 CH_4/t)**	**N_2O**		
1.2.1 Solid Fuels						
Coal Mining and Handling						
Underground Mines						
Mining	0.183556		10			
Post Mining	0.161468		2.45			
Surface Mines						
Mining	2.732233		0.3			
Post Mining	2.740009		0.1			
1.2.2. Oil and Natural Gas	**PJ**		**kgCH_4/PJ**			
Oil						
Production/Processing	1,185.12		2,650			
Refining	1,032.57		745			
Storage	1,032.57		135			
Natural Gas						
Production/Processing	2922.48		71,000			
Transmission/Distribution	2922.48		203,000			
Other Leakage						
Non-Residential Gas	406.85		87,500			
Residential Gas	58.99		43,500			
Venting and Flaring (Oil)	1,185.12		2,000			
Venting and Flaring (Natural Gas)	2922.48		192,000			

Table B: Summary of Activity Data and Emission Factors Used (continue)

2. Industrial Processes Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA (tonnes)	EMISSION FACTORS					
		CO_2	CH_4	N_2O	HFCs	PFCs	SF_6
2.1 Mineral Products		(tonnes CO_2/tonnes production)	(kg CH_4/t chemical)				
2.1.1 Cement Production	150,800,00	0.515					
2.1.2 Lime Production	185,593.21	0.75					
2.1.3 Limestone	11,663,839.49	440 kg CO_2/ tonnes limestone					
Dolomite Use	42,104	477 kg CO_2/ tonnes dolomite					
2.2. Chemical Industry							
2.2.1 Ammonia Production	950,000	1.5					
2.2.2 Production of Petrochemicals	1,487,000 (Ethylene) 240,000 (Styrene) 1,021,207 (Methanol) 56,603 (Carbon Black)	NA	1 (Ethylene) 4 (Styrene) 2 (Methanol) 11 (Carbon Black)				
2.2.3 Carbide Production	32,923	0.76					
2.3 Metal Production							
2.3.1 Iron and Steel Production	2,877,000 (Direct Reduced Iron) 5,941,000 (Electric Arc Furnace for Steel) 52,159.88 (Basic Oxygen Furnace for Steel)	0.7 (DRI) 0.08 (EAF) 1.46 (BOF)					
2.3.2 Aluminium Production	80,000	1.5				0.31 kg CF_4/t Al 0.04 kg C_2F_6/t Al	
2.4 Production of Halocarbons and SF_6	NE						
2.5 Consumption of Halocarbons and SF_6	330.89 (Emission during charging – assembly) 5,079.44 (Emission during use – operation)				5% Assembly Loss, 10% Annual Leakage Rate		
SF_6 Utilization in Power Utilities	58 (For SF_6)						0.01 (Loss Factor SF_6)

Table B: Summary of Activity Data and Emission Factors Used (continue)

3. Agriculture Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA	EMISSION FACTORS				
		CO_2	CH_4	N_2O	NO_X	CO
3.1 Enteric fermentation	**Numbers** Dairy Cattle: 39,166 Non Dairy Cattle: 744,149 Buffalo: 127,689 Sheep: 127,270 Goat: 480,113 Horse: 3,903 Swine: 1,866,535 Poultry: 241,529,593		**Kg/Head/Year** Dairy: 56 Non-Dairy: 44 Buffalo: 55 Sheep: 5 Goat: 5 Horse: 18 Swine: 1 Poultry: 0			
3.2 Manure Management			**Kg/Head/Year**			
3.2.1 Anaerobic Lagoons			Dairy Cattle: 27	0.001		
3.2.2 Liquid Systems			Non-Dairy Cattle: 2	NA		
3.2.3 Solid Storage and Dry Lot			Buffalo: 3	0.02		
3.2.4 Other Animal Waste Management System (AWMS)			Sheep: 0.21 Goat: 0.22 Horse: 2.2 Swine: 7 Poultry: 0.023	NA		
3.3. Rice Cultivation						
3.3.1 Irrigated	Continuously Flooded 476,950 ha		Scaling factors: 1 EF = 16 g/m^2			
3.3.2 Rainfed	Flood Prone 68,150 ha Drought Prone 68,150 ha		Scaling factors: 0.8 EF = 16 g/m^2 Scaling factors: 0.468 EF = 16 g/m^2			

Table B: Summary of Activity Data and Emission Factors Used (continue)

3. Agriculture Sector

3.4. Agricultural Soils						
3.4.1 Direct Soil Emissions	Amount of N input Synthetic Fertiliser N 803,092,550 kg N/yr Animal waste: 208,425,475.80 kg N/yr Crop Residue: Oil Palm : 23,900,521,020 kg DM/yr Paddy: 1,635,296,750 kg DM/yr			0.0125 0.0125 0.0125		
3.4.2 Indirect Emissions	Deposition Synthetic Fertiliser Applied to Soil: 803,092,550 kg N/yr Animal Waste 208,425,475.80 kg N/yr Leaching Synthetic Fertiliser 240,927,765 kg N/yr Animal Waste 62,671,105.23 kg N/yr			0.01 0.025		
3.5 Field Burning of Agricultural Residues	Granary: 1824.47 Gg Non Granary: 668.84		0.005	0.007	0.121	0.06

Table B : Summary of Activity Data and Emission Factors Used (continue)

4. LULUCF Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA	EMISSION FACTORS				
		C	CH_4	N_2O	NO_x	CO
4.1 Forest Land	**ha**	**(tC/ha)**	**g/kg d.m**	**g/kg d.m**	**g/kg d.m**	**g/kg d.m**
4.1.1 Forest Land remaining Forest Land	Inland Forest: 12.51 million ha	4.65				
	Peat Swamp: 500,000 ha	4.6				
	Mangrove: 440,000 ha	5.5				
	State Land 1.02 mil ha	2.15				
	Totally Protected Areas: 1.89 mil ha	2.15				
	Plantation Forest	2.65				
	Root shoot ratio	0.18				
	Root shoot ratio (mangrove)	0.49				
	Forest Fires 10 ha	14	2	0.11	4	58
4.2 Cropland						
4.2.1 Cropland Remaining Cropland	MAI:					
	Rubber : 1,020,000 ha	2.6				
	Oil palm : 5,000,000 ha	6.0				
	Cocoa : 21,000 ha	2.6				
	Harvest: Rubber Oil palm Cocoa	1.21 4.42 0.26				
	Oil Palm Cultivated in Peat-Lands 666,038 ha	7.5				
4.3 Other Land						
4.3.1 Forest Land Converted to Other Land	Permanent Reserved Forest 7000 ha	97				

Table B : Summary of Activity Data and Emission Factors Used (continue)

5. Waste Sector

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	AGGREGATE ACTIVITY DATA	EMISSION FACTOR				
		CO_2	CH_4	N_2O	NO_x	CO
5.1 Solid Waste Disposal on Land						
5.1.1 Uncategorised SWDS	Urban Population = 20,606,500		0.20 Kg CH_4/Kg MSW			
5.2 Waste Water Handling						
5.2.1 Industrial Wastewater						
Palm Oil Mills	Total Industrial Output = 18,912,721 t/yr		0.25 kg CH_4 / kg COD			
Natural Rubber (SMR)	Total Industrial Output = 916,270 t/yr		0.25 kg CH_4 / kg COD			
Natural Rubber (Latex)	Total Industrial Output = 79,940 t/yr		0.25 kg CH_4 / kg COD			
5.2.2 Domestic and Commercial Waste Water	Total Urban Population (1000 persons) 20,606.50		0.01875Kg CH_4/Kg BOD			
	Total Population = 29,062,000			0.01 kg N_2O-N / kg sewage-N produced		

Table C: Summary of National GHG Emissions by Sources and Removals by Sinks for 2011

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
Total national emissions and removals	208,257.70	-262,946.41	3,215.80	43.789	NE	NE	NE	NE
1. Energy	188,575.12		1,421.37	1.579	NE	NE	NE	NE
A. Fuel combustion (sectoral approach)	188,575.12		12.68	1.579	NE	NE	NE	NE
1. Energy industries	113,567.05		1.36	0.937	NE	NE	NE	NE
2. Manufacturing industries and construction	23,003.97		1.8	0.171	NE	NE	NE	NE
3. Transport	44,006.54		8.55	0.399	NE	NE	NE	NE
4. Other sectors	7,750.78		0.96	0.068	NE	NE	NE	NE
5. Other	246.78		0.01	0.005	NE	NE	NE	NE
B. Fugitive emissions from fuels	NE		1,408.69		NE	NE	NE	NE
1. Solid fuels			2.23		NE	NE	NE	NE
2. Oil and natural gas			1,406.46		NE	NE	NE	NE
2. Industrial Processes	17,192.91		5.11	NE,NA	NE	NE	NE	NE
A. Mineral products	13,057.56				NE	NE	NE	NE
B. Chemical Industries	1,450.02		5.11	NE	NE	NE	NE	NE
C. Metal production	2,685.33		NA	NA	NE	NE	NE	NE
D. Other production	NE		NE	NE	NE	NE	NE	NE
E. Production of halocarbons and sulphur hexafluoride								
F. Consumption of halocarbons and sulphur hexafluoride								
G. Other	NA		NA	NA	NA	NA	NA	NA
3. Solvent and other product use								
4. Agriculture			159.27	40.100	26.15	1.04	NE,NO	
A. Enteric fermentation			46.93					
B. Manure management			21.69	4.768			NE	
C. Rice cultivation			89.40				NE	
D. Agricultural soils			NE	35.303			NE	
E. Prescribed burning of savannahs			NO	NO	NO	NO	NO	
F. Field burning of agricultural residues			1.25	0.029	26.15	1.04	NE	
G. Other (please specify)			NA	NE	NE	NE	NE	
5. Land-use change and forestry	2,489.67	-262,946.41	0.00	0.00	0.00	0.00		
A. Forest land remaining forest land		-247,475.41	0.00	0.00	0.00	0.00		
B. Crop land remaining crop land		-15,471.00	NA	NA	NA	NA		
C. Grass land remaining grass land	NA	NA	NA	NA	NA	NA		

Table C: Summary of National GHG Emissions by Sources and Removals by Sinks for 2011 (continue)

Greenhouse gas source and sink categories	CO_2 emissions (Gg)	CO_2 removals (Gg)	CH_4 (Gg)	N_2O (Gg)	CO (Gg)	NO_x (Gg)	NMVOCs (Gg)	SO_x (Gg)
D. Wetlands remaining wetlands	NA	NA	NA	NA	NA	NA		
E. Settlement remaining settlement	NA	NA	NA	NA	NA	NA		
F. Forest land converted to other land	2,489.67		NA	NA	NA	NA		
6. Waste			1,630.05	2.110	NE,NA	NE,NA	NE,NA	NE,NA
A. Solid waste disposal on land			1,482.28	NE	NE	NE	NE	
B. Waste-water handling			147.77	2.110	NE	NE	NE	
C. Waste incineration					NE	NE	NE	NE
D. Other			NE	NE	NE	NE	NE	NE
7. Other	NA	NA	NA	NA	NA	NA	NA	NA
Memo items								
International bunkers	6,572.08		NE	NE	NE	NE	NE	NE
Aviation	5,929.86		NE	NE	NE	NE	NE	NE
Marine	642.22		NE	NE	NE	NE	NE	NE
CO_2 emissions from biomass	13.55							

Note: Shaded cells do not require entries.

The following standard indicators are used:

NO (not occurring) for activities or processes that do not occur for a particular gas or source/sink category within a country;

NE (not estimated) for existing emissions and removals which have not been estimated;

NA (not applicable) for activities in a given source/sink category which do not result in emissions or removals of a specific gas.

Table D: Summary of National Anthropogenic Emissions of HFCs, PFCs and SF_6 for 2011

Greenhouse gas source and sink categories	HFCs[a]			PFCs[a] (Gg)			SF_6[a] (Gg)
	HFC - 23	HFC - 134	Other	CF_4	C_2F_6	Other	
Total national emissions and removals	NA,NE	0.5244	NA,NE	0.0248	0.000992	NA,NE	0.00058
1. Energy							
A. Fuel combustion (sectoral approach)							
1. Energy industries							
2. Manufacturing industries and construction							
3. Transport							
4. Other sectors							
5. Other (please specify)							
B. Fugitive emissions from fuels							
1. Solid fuels							
2. Oil and natural gas							
2. Industrial Processes	NA	0.5244	NA	0.0248	0.000992	NA	0.00058
A. Mineral products							
B. Chemical Industries							
C. Metal production	NA	NA	NA	0.0248	0.000992	NA	NA
D. Other production							
E. Production of halocarbons and sulphur hexafluoride	NA	NA	NA	NA	NA	NA	NA
F. Consumption of halocarbons and sulphur hexafluoride	NE	0.5244	NE	NE	NE	NE	0.00058
G. Other (please specify)							
3. Solvent and other product use							
4. Agriculture							
A. Enteric fermentation							
B. Manure management							
C. Rice cultivation							
D. Agricultural soils							
E. Prescribed burning of savannahs							
F. Field burning of agricultural residues							
G. Other							
5. Land-use change and forestry							
A. Forest land remaining forest land							
B. Crop land remaining crop land							
C. Grass land remaining grass land							
D. Wetlands remaining wetlands							
E. Settlement remaining settlement							
F. Forest land converted to other land							

Table D: Summary of National Anthropogenic Emissions of HFCs, PFCs and SF_6 for 2011 (continue)

Greenhouse gas source and sink categories	HFCs[a]			PFCs[a] (Gg)			SF_6[a] (Gg)
	HFC - 23	HFC - 134	Other	CF_4	C_2F_6	Other	
6. Waste							
A. Solid waste disposal on land							
B. Waste-water handling							
C. Waste incineration							
D. Other							
7. Other							
Memo items							
International bunkers							
Aviation							
Marine							
CO_2 emissions from biomass							

[a] Potential emissions were estimated using the tier 1 approach.

Table E.1: Summary of Emission Trends by Sector and Gas

GREENHOUSE GAS EMISSIONS	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
CO_2 emissions including net CO_2 from LULUCF	-185,330.73	-152,207.90	-114,220.82	-152,726.56	-4,209.63	-144,173.76	-103,712.36	-130,472.56	-137,846.38	-148,875.46	-91,580.65	-89,223.52	-103,098.19	-95,618.88	-66,961.13	-39,554.06	-64,409.03	-25,610.70	-46,563.62	-50,337.76	-44,729.55	-54,688.71
CO_2 emissions excluding net CO_2 from LULUCF	52,140.60	62,312.47	67,718.14	73,579.67	82,935.43	83,210.91	97,941.99	113,400.44	103,147.98	113,773.33	136,987.07	146,115.82	152,580.96	165,746.23	179,143.37	192,573.73	192,109.54	205,552.49	209,530.03	201,065.20	217,972.69	205,768.03
CH_4 emissions including CH_4 from LULUCF	9,964.91	26,472.72	27,866.28	31,781.64	33,588.62	35,304.62	39,159.76	42,083.90	43,813.90	46,828.57	49,116.57	50,703.88	50,966.26	51,879.89	54,653.11	58,182.59	60,520.05	61,759.12	64,087.67	63,688.27	67,342.38	67,532.02
CH_4 emissions excluding CH_4 from LULUCF	9,964.91	26,472.72	27,866.28	31,781.64	33,588.62	35,304.62	39,159.76	42,083.90	43,813.90	46,828.57	49,116.57	50,703.88	50,966.26	51,879.89	54,653.11	58,182.59	60,520.05	61,759.12	64,087.67	63,688.27	67,342.38	67,532.02
N_2O emissions including N_2O from LULUCF	5,262.38	5,805.77	6,453.99	7,220.30	7,063.77	6,489.77	6,554.02	8,343.31	8,891.20	8,751.60	9,455.84	7,826.23	9,145.56	9,369.82	10,669.66	11,788.83	10,877.00	11,976.95	14,097.08	14,722.58	15,050.27	13,574.35
N_2O emissions excluding N_2O from LULUCF	5,262.38	5,805.77	6,453.99	7,220.30	7,063.77	6,489.77	6,554.02	8,343.31	8,891.20	8,751.60	9,455.84	7,826.23	9,145.56	9,369.82	10,669.66	11,788.83	10,877.00	11,976.95	14,097.08	14,722.58	15,050.27	13,574.35
HFCs	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	NE,NO	137.62	338.52	430.43	262.02	372.97	435.76	429.00	481.00	546.00	585.00	624.00	681.72
PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	170.33
SF_6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	6.21	1.91	2.39	2.39	2.87	15.54	9.56	7.63	7.62	10.11	11.77	13.86
Total (including LULUCF)	-170,103.44	-119,929.41	-79,900.55	-113,724.62	36,442.76	-102,379.37	-57,998.58	-80,045.35	-85,141.27	-93,295.28	-32,864.41	-30,352.98	-42,553.55	-34,104.77	-1,262.53	30,868.66	7,426.58	48,614.01	32,174.75	28,668.21	38,298.88	27,283.57
Total (excluding LULUCF)	67,367.89	94,590.97	102,038.41	112,581.62	123,587.82	125,005.30	143,655.77	163,827.65	155,853.09	169,353.50	195,703.31	204,986.36	213,125.61	227,260.34	244,841.97	262,996.45	263,945.15	279,777.20	288,268.40	280,071.17	301,001.11	287,740.31

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	58,951.14	70,345.48	76,313.81	85,212.72	90,890.33	97,597.58	114,702.12	132,384.62	122,431.97	134,213.10	147,472.09	154,657.80	161,059.81	173,761.68	190,099.57	205,100.14	203,784.42	218,432.26	222,490.80	213,100.82	233,736.97	218,913.63
2. Industrial Processes	NE	NE	NE	NE	4,805.41	NE	NE	NE	NE	NE	12,416.23	15,034.32	14,921.78	15,514.91	14,822.46	16,115.77	16,851.44	16,134.94	17,184.69	16,756.76	15,964.37	18,166.34
3. Solvent and Other Product Use																						
4. Agriculture	8,416.75	8,647.65	9,280.14	10,053.26	9,886.82	9,277.62	9,274.21	10,990.37	11,501.96	11,275.36	11,699.11	10,153.99	11,411.32	11,538.01	12,751.24	13,845.81	13,039.42	14,064.24	16,255.84	16,987.40	17,214.83	15,775.30
5. Land Use, Land-Use Change and Forestry	-237,471.33	-214,520.38	-181,938.96	-226,306.24	-87,145.06	-227,384.67	-201,654.35	-243,873.00	-240,994.36	-262,648.79	-228,567.73	-235,339.34	-255,679.16	-261,365.11	-246,104.50	-232,127.79	-256,518.57	-231,163.19	-256,093.65	-251,402.96	-262,702.24	-260,456.74
6. Waste	NE	15,597.84	16,444.46	17,315.64	18,005.26	18,130.10	19,679.44	20,452.66	21,919.16	23,865.04	24,115.89	25,140.25	25,732.70	26,445.74	27,168.70	27,934.73	30,269.87	31,145.77	32,336.80	33,226.12	34,084.98	34,885.04
7. Other	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO	NA,NO
Total (including LULUCF)	-170,103.44	-119,929.41	-79,900.55	-113,724.62	36,442.76	-102,379.37	-57,998.58	-80,045.35	-85,141.27	-93,295.28	-32,864.41	-30,352.98	-42,553.55	-34,104.77	-1,262.53	30,868.66	7,426.58	48,614.02	32,174.47	28,668.14	38,298.91	27,283.57

The following standard indicators are used:
NO (not occurring) for activities or processes that do not occur for a particular gas or source/sink category within a country;
NE (not estimated) for existing emissions and removals which have not been estimated;
NA (not applicable) for activities in a given source/sink category which do not result in emissions or removals of a specific gas;
IE (include elsewhere) for emissions and removals estimated but included elsewhere in the inventory.

Table E.2: Emission Trends for CO_2

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	52,140.60	62,312.47	67,718.14	73,579.67	78,130.02	83,210.91	97,941.99	113,400.44	103,147.98	113,773.33	125,004.74	131,604.66	138,333.05	150,762.17	164,981.73	177,225.36	175,971.42	190,200.97	193,127.64	185,015.27	202,762.94	188,575.12
A. Fuel Combustion (Sectoral Approach)	52,140.60	62,312.47	67,718.14	73,579.67	78,130.02	83,210.91	97,941.99	113,400.44	103,147.98	113,773.33	125,004.74	131,604.66	138,333.05	150,762.17	164,981.73	177,225.36	175,971.42	190,200.97	193,127.64	185,015.27	202,762.94	188,575.12
1) Energy Industries	20,085.12	27,275.94	29,156.77	33,726.07	34,420.52	35,740.76	42,317.84	55,354.43	47,071.51	53,409.01	58,486.28	61,567.54	64,804.60	74,037.65	80,976.33	91,035.56	88,463.47	93,274.00	95,671.88	101,264.28	118,691.23	113,567.05
2) Manufacturing Industries and Construction	14,079.18	15,458.38	16,802.41	17,849.09	18,043.40	19,712.22	23,008.01	23,541.95	23,347.91	22,729.84	26,104.01	26,553.65	28,720.32	29,918.28	33,673.28	35,516.81	38,296.67	43,776.23	42,866.81	30,692.18	24,735.60	23,003.97
3) Transport	15,892.24	17,129.71	18,376.37	19,315.27	21,359.64	23,004.31	26,295.68	30,043.18	28,712.79	33,453.11	35,586.79	38,754.84	39,643.88	42,090.13	45,374.53	45,281.57	43,673.33	46,182.54	48,151.83	47,309.01	49,266.06	44,006.54
4) Other Sectors	2,084.05	2,448.45	3,382.59	2,689.25	4,306.46	4,753.63	6,320.46	4,460.88	4,015.77	4,181.37	4,784.94	4,689.69	5,099.50	4,542.57	4,750.87	5,115.04	5,226.35	6,721.37	6,152.64	5,476.79	9,759.41	7,750.78
5) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	42.71	38.94	64.74	173.54	206.72	276.37	311.61	246.83	284.50	273.00	310.64	246.78
B. Fugitive Emissions from Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
1) Solid Fuels	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2) Oil and Natural Gas	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
2. Industrial Processes	NE	NE	NE	NE	4,805.41	NE	NE	NE	NE	NE	11,982.34	14,511.16	14,247.92	14,984.05	14,161.64	15,348.37	16,138.11	15,351.52	16,402.39	16,049.93	15,209.75	17,192.91
A) Mineral Products	NE	NE	NE	NE	4,805.41	NE	NE	NE	NE	NE	9,775.86	11,872.75	11,529.94	11,942.56	11,197.10	11,995.38	13,310.54	12,023.27	13,051.69	12,483.06	11,614.36	13,057.56
B) Chemical Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	1,118.08	1,681.61	1,717.68	1,617.49	1,447.71	1,836.15	1,466.95	1,466.95	1,466.95	1,466.95	1,466.95	1,450.02
C) Metal Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	1,088.40	956.80	1,000.30	1,424.00	1,516.84	1,516.84	1,360.62	1,861.30	1,883.74	2,099.92	2,128.44	2,685.33
D) Other Production	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E) Production of Halocarbons and SF_6																						
F) Consumption of Halocarbons and SF_6																						
G) Other	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
3. Solvent and Other Product Use																						
4. Agriculture																						
A) Enteric Fermentation																						
B) Manure Management																						
C) Rice Cultivation																						
D) Agricultural Soils																						
E) Prescribed Burning of Savannas																						
F) Field Burning of Agricultural Residues																						
G) Other																						

Table E.2: Emission Trends for CO_2 (continue)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
5. Land Use, Land-Use Change and Forestry	-237,471.33	-214,520.38	-181,938.96	-226,306.24	-87,145.06	-227,384.67	-201,654.35	-243,873.00	-240,994.36	-262,648.79	-228,567.73	-235,339.34	-255,679.16	-261,365.11	-246,104.50	-232,127.79	-256,518.57	-231,163.19	-256,093.65	-251,402.96	-262,702.24	-260,456.74
A) Forest Land	-217,739.09	-213,817.69	-195,065.32	-219,341.40	-220,432.40	-220,109.99	-213,518.09	-221,753.08	-238,411.37	-238,916.39	-231,260.45	-240,768.87	-250,875.30	-247,455.29	-241,308.13	-240,800.06	-244,635.20	-237,609.76	-246,966.17	-243,260.57	-246,873.96	-247,475.41
B) Cropland	-19,732.24	-20,073.32	-20,471.31	-20,421.50	-20,682.70	-20,589.08	-21,136.26	-22,119.92	-22,766.96	-23,732.40	-19,667.06	-20,102.39	-20,940.47	-20,276.26	-18,743.90	-16,994.40	-17,044.94	-17,823.83	-17,872.49	-18,042.39	-19,064.84	-15,471.00
C) Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D) Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E) Settlements	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
F) Other Land	NE	19,370.63	33,597.67	13,456.67	153,970.04	13,314.40	33,000.00	0.00	20,183.97	0.00	22,359.79	25,531.92	16,136.61	6,366.43	13,947.52	25,666.67	5,161.57	24,270.40	8,745.00	9,900.00	3,236.57	2,489.67
G) Other	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
6. Waste																						
A) Solid Waste Disposal on Land																						
B) Waste-Water Handling																						
C) Waste Incineration																						
D) Other																						
Total CO_2 emissions including net CO_2 from LULUCF	-185,330.73	-152,207.90	-114,220.82	-152,726.56	-4,209.63	-144,173.76	-103,712.36	-130,472.56	-137,846.38	-148,875.46	-91,580.65	-89,223.52	-103,098.19	-95,618.88	-66,961.13	-39,554.06	-64,409.03	-25,610.70	-46,563.62	-50,337.76	-44,729.55	-54,688.71
Total CO_2 emissions excluding net CO_2 from LULUCF	52,140.60	62,312.47	67,718.14	73,579.67	82,935.43	83,210.91	97,941.99	113,400.44	103,147.98	113,773.33	136,987.07	146,115.82	152,580.96	165,746.23	179,143.37	192,573.73	192,109.54	205,552.49	209,530.03	201,065.20	217,972.69	205,768.03
More Items:																						
International Bunkers	285.71	346.68	234.83	195.44	775.24	519.37	585.31	531.17	1,413.03	1,263.38	670.35	482.03	276.99	222.38	261.24	182.43	270.91	204.21	188.46	133.63	173.44	6,572.08
Aviation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	5,929.86
Marine	285.71	346.68	234.83	195.44	775.24	519.37	585.31	531.17	1,413.03	1,263.38	670.35	482.03	276.99	222.38	261.24	182.43	270.91	204.21	188.46	133.63	173.44	642.22
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO

Table E.3: Emission Trends for CH_4

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	6,669.97	7,878.20	8,428.15	11,457.83	12,578.64	14,190.44	16,533.61	18,726.70	19,048.25	20,193.35	22,185.71	22,764.24	22,411.23	22,641.62	24,683.12	27,418.63	27,387.28	27,761.26	28,879.58	27,593.86	30,398.95	29,848.98
A. Fuel Combustion (Sectoral Approach)	90.25	99.17	107.74	114.05	125.01	134.93	160.12	174.67	169.46	192.32	205.01	211.08	224.31	238.82	275.24	293.14	273.55	303.13	316.64	297.22	317.92	266.49
1) Energy Industries	11.84	14.10	15.18	17.35	15.95	16.46	20.34	28.48	21.50	22.87	27.94	26.10	29.99	34.02	53.67	61.33	45.51	45.74	47.17	50.74	56.16	28.56
2) Manufacturing Industries and Construction	12.61	14.04	15.86	14.91	15.51	17.46	21.29	21.54	22.71	22.73	28.21	30.29	34.92	37.59	42.52	44.95	51.76	58.15	61.53	41.93	37.94	37.80
3) Transport	59.25	63.94	68.01	73.51	82.63	89.00	102.21	112.78	113.86	133.74	135.08	141.19	144.55	153.83	164.75	171.37	160.18	178.99	187.10	185.94	199.09	179.76
4) Other Sectors	6.55	7.09	8.69	8.29	10.93	12.01	16.27	11.88	11.39	13.00	13.63	13.38	14.65	13.01	13.86	14.92	15.44	19.70	20.23	18.09	24.16	20.16
5) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.13	0.12	0.20	0.37	0.44	0.58	0.66	0.55	0.61	0.52	0.58	0.21
B. Fugitive Emissions from Fuels	6,579.72	7,779.03	8,320.41	11,343.78	12,453.63	14,055.51	16,373.49	18,552.03	18,878.79	20,001.03	21,980.70	22,553.16	22,186.92	22,402.80	24,407.88	27,125.49	27,113.73	27,458.13	28,562.94	27,296.64	30,081.03	29,582.49
1) Solid Fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	5.88	6.30	5.04	5.25	10.71	19.32	18.69	26.25	27.93	29.19	27.51	46.83
2) Oil and Natural Gas	6,579.72	7,779.03	8,320.41	11,343.78	12,453.63	14,055.51	16,373.49	18,552.03	18,878.79	20,001.03	21,974.82	22,546.86	22,181.88	22,397.55	24,397.17	27,106.17	27,095.04	27,431.88	28,535.01	27,267.45	30,053.52	29,535.66
2. Industrial Processes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	86.73	83.75	112.14	67.47	76.46	97.80	98.07	96.37	98.49	111.79	118.82	107.52
A) Mineral Products																						
B) Chemical Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	86.73	83.75	112.14	67.47	76.46	97.80	98.07	96.37	98.49	111.79	118.82	107.52
C) Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D) Other Production																						
E) Production of Halocarbons and SF_6																						
F) Consumption of Halocarbons and SF_6																						
G) Other	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE	NA,NE
3. Solvent and Other Product Use																						
4. Agriculture	3,294.94	3,331.48	3,356.37	3,398.77	3,417.02	3,418.08	3,399.31	3,378.84	3,326.99	3,269.28	3,230.45	3,233.34	3,240.29	3,267.55	3,285.93	3,311.13	3,363.13	3,363.32	3,383.50	3,379.61	3,375.13	3,344.58
A) Enteric Fermentation	994.94	1,003.77	1,011.52	1,007.87	993.78	974.20	951.30	943.01	936.46	936.76	934.18	927.96	931.38	943.09	966.62	985.10	1,043.17	1,043.17	1,064.20	1,057.36	1,024.49	985.58
B) Manure Management	471.28	507.71	517.15	543.31	565.20	581.10	580.54	566.47	512.03	449.86	414.11	430.67	451.48	465.64	465.93	462.83	445.91	445.91	441.26	441.07	449.18	455.50
C) Rice Cultivation	1,809.82	1,800.32	1,807.24	1,826.57	1,836.57	1,840.89	1,845.51	1,847.82	1,857.51	1,861.72	1,861.03	1,853.18	1,835.45	1,836.24	1,830.36	1,840.53	1,851.04	1,851.04	1,853.46	1,856.16	1,875.56	1,877.35
D) Agricultural Soils	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
E) Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F) Field Burning of Agricultural Residues	18.90	19.68	20.46	21.02	21.47	21.89	21.96	21.54	20.99	20.94	21.13	21.53	21.98	22.58	23.02	22.67	23.01	23.20	24.58	25.02	25.90	26.15
G) Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA

Table E.3: Emission Trends for CH_4 (continue)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
5. Land Use, Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A) Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B) Cropland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
C) Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D) Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E) Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F) Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G) Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	NE	15,263.04	16,081.76	16,925.04	17,592.96	17,696.10	19,226.84	19,978.36	21,438.66	23,365.94	23,613.69	24,622.55	25,202.60	25,903.24	26,607.60	27,355.03	29,671.57	30,538.17	31,726.10	32,603.02	33,449.48	34,230.94
A) Solid Waste Disposal on Land	NE	14,172.74	14,959.77	15,645.53	16,340.30	16,352.60	17,789.03	18,441.56	20,022.77	21,605.03	21,797.40	22,658.06	23,220.00	23,686.29	24,276.72	24,872.04	27,028.40	27,908.77	28,804.84	29,722.07	30,651.08	31,127.82
B) Waste-Water Handling - Domestic	NE	33.71	35.58	37.21	38.86	38.89	42.31	43.86	47.62	51.38	51.84	53.89	55.22	56.33	57.74	59.15	64.28	66.37	68.50	70.69	72.90	74.03
C) Waste-Water Handling - Industrial	NE	1,056.59	1,086.41	1,242.30	1,213.80	1,304.61	1,395.50	1,492.94	1,368.27	1,709.53	1,764.45	1,910.60	1,927.38	2,160.62	2,273.14	2,423.84	2,578.89	2,563.03	2,852.76	2,810.26	2,725.50	3,029.09
D) Waste Incineration																						
E) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Total CH_4 emissions including CH_4 from LULUCF	9,964.91	26,472.72	27,866.28	31,781.64	33,588.62	35,304.62	39,159.76	42,083.90	43,813.90	46,828.57	49,116.57	50,703.88	50,966.26	51,879.89	54,653.11	58,182.59	60,520.05	61,759.12	64,087.67	63,688.27	67,342.38	67,532.02
Total CH_4 emissions excluding CH_4 from LULUCF	9,964.91	26,472.72	27,866.28	31,781.64	33,588.62	35,304.62	39,159.76	42,083.90	43,813.90	46,828.57	49,116.57	50,703.88	50,966.26	51,879.89	54,653.11	58,182.59	60,520.05	61,759.12	64,087.67	63,688.27	67,342.38	67,532.02
More Items:																						
International Bunkers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aviation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass																						

Table E.4: Emission Trends for N_2O

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
1. Energy	140.57	154.80	167.52	175.21	181.67	196.23	226.52	257.48	235.73	246.42	281.64	288.91	315.53	357.88	434.73	456.15	425.71	470.03	483.57	491.69	575.07	489.53
A. Fuel Combustion (Sectoral Approach)	140.57	154.80	167.52	175.21	181.67	196.23	226.52	257.48	235.73	246.42	281.64	288.91	315.53	357.88	434.73	456.15	425.71	470.03	483.57	491.69	575.07	489.53
1) Energy Industries	44.51	49.49	52.10	54.87	49.19	50.59	59.93	79.09	60.21	66.36	76.85	81.33	101.89	135.66	192.78	211.15	183.37	208.00	216.39	242.31	317.87	290.34
2) Manufacturing Industries and Construction	36.99	40.90	43.96	45.90	47.47	52.07	57.48	60.51	58.69	53.69	62.13	60.53	62.69	64.91	71.59	74.54	73.35	82.58	83.07	69.71	59.94	53.05
3) Transport	53.36	57.71	62.33	66.92	74.24	81.94	93.86	105.47	105.58	114.49	129.46	134.12	136.80	144.39	156.66	155.57	153.64	160.46	164.57	162.31	172.43	123.70
4) Other Sectors	5.71	6.70	9.14	7.52	10.77	11.62	15.25	12.41	11.26	11.89	13.06	12.82	13.98	12.46	13.16	14.17	14.54	18.35	18.81	16.65	24.03	21.00
5) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	0.157	0.101	0.168	0.454	0.540	0.718	0.809	0.644	0.739	0.706	0.807	1.440
B. Fugitive Emissions from Fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
1) Solid Fuels	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2) Oil and Natural Gas	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
2. Industrial Processes	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	203.33	98.97	128.90	198.98	208.52	218.30	176.70	198.40	130.47	0.00	0.00	0.00
A) Mineral Products																						
B) Chemical Industry	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	203.33	98.97	128.90	198.98	208.52	218.30	176.70	198.40	130.47	0.00	0.00	0.00
C) Metal Production	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D) Other Production																						
E) Production of Halocarbons and SF_6																						
F) Consumption of Halocarbons and SF_6																						
G) Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
3. Solvent and Other Product Use																						
4. Agriculture	5,121.81	5,316.17	5,923.77	6,654.49	6,469.80	5,859.54	5,874.90	7,611.53	8,174.97	8,006.08	8,468.66	6,920.65	8,171.03	8,270.46	9,465.31	10,534.68	9,676.29	10,700.92	12,872.34	13,607.79	13,839.70	12,430.72
A) Enteric Fermentation																						
B) Manure Management	486.43	622.87	704.17	755.62	821.21	870.74	911.90	929.85	943.60	965.52	1,031.00	1,103.55	1,193.44	1,270.63	1,263.82	1,238.85	1,227.29	1,227.29	1,270.44	1,322.62	1,389.90	1,477.98
C) Rice Cultivation																						
D) Agricultural Soils	4,628.93	4,686.59	5,212.62	5,891.70	5,641.27	4,981.34	4,955.51	6,674.33	7,224.21	7,033.42	7,430.45	5,809.76	6,970.09	6,992.13	8,193.64	9,288.10	8,441.15	9,465.72	11,593.52	12,276.64	12,440.97	10,943.82
E) Prescribed Burning of Savannas	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
F) Field Burning of Agricultural Residues	6.45	6.71	6.98	7.17	7.32	7.46	7.49	7.35	7.16	7.14	7.21	7.34	7.50	7.70	7.85	7.73	7.85	7.91	8.38	8.53	8.83	8.92
G) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Table E.4: Emission Trends for N_2O (continue)

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
5. Land Use, Land-Use Change and Forestry	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
A) Forest Land	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
B) Cropland	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE	NA,IE
C) Grassland	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
D) Wetlands	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
E) Settlements	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
F) Other Land	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
G) Other	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA	NA
6. Waste	NE	334.80	362.70	390.60	412.30	434.00	452.60	474.30	480.50	499.10	502.20	517.70	530.10	542.50	561.10	579.70	598.30	607.60	610.70	623.10	635.50	654.10
A) Solid Waste Disposal on Land																						
B) Waste Water Handling - Domestic	NE	334.80	362.70	390.60	412.30	434.00	452.60	474.30	480.50	499.10	502.20	517.70	530.10	542.50	561.10	579.70	598.30	607.60	610.70	623.10	635.50	654.10
C) Waste-Water Handling - Industrial	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
D) Waste Incineration																						
E) Other	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE

Total N_2O emissions including N_2O from LULUCF	5,262.38	5,805.77	6,453.99	7,220.30	7,063.77	6,489.77	6,554.02	8,343.31	8,891.20	8,751.60	9,455.84	7,826.23	9,145.56	9,369.82	10,669.66	11,788.83	10,877.00	11,976.95	14,097.08	14,722.58	15,050.27	13,574.35
Total N_2O emissions excluding N_2O from LULUCF	5,262.38	5,805.77	6,453.99	7,220.30	7,063.77	6,489.77	6,554.02	8,343.31	8,891.20	8,751.60	9,455.84	7,826.23	9,145.56	9,369.82	10,669.66	11,788.83	10,877.00	11,976.95	14,097.08	14,722.58	15,050.27	13,574.35

More Items:																						
International Bunkers	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Aviation	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Marine	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE
Multilateral Operations	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
CO_2 Emissions from Biomass																						

Table E.5: Emission Trends for HFCs, PFCs and SF_6

GREENHOUSE GAS SOURCE AND SINK CATEGORIES	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq	kt CO_2eq
Emissions of HFCs	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	137.62	338.52	430.43	262.02	372.97	435.76	429.00	481.00	546.00	585.00	624.00	681.72
HFC-23	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-32	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-41	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-43-10mee	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-125	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-134a	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	137.62	338.52	430.43	262.02	372.97	435.76	429.00	481.00	546.00	585.00	624.00	681.72
HFC-152a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-143a	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-227ea	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-236fa	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
HFC-245ca	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed HFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	170.33
CF_4	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	161.20
C_2F_6	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	9.13
C_3F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_4F_{10}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
c-C_4F_8	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_5F_{12}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
C_6F_{14}	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Unspecified mix of listed PFCs	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO	NO
Emissions of SF_6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	6.21	1.91	2.39	2.39	2.87	15.54	9.56	7.63	7.62	10.11	11.77	13.86
SF_6	NE	NE	NE	NE	NE	NE	NE	NE	NE	NE	6.21	1.91	2.39	2.39	2.87	15.54	9.56	7.63	7.62	10.11	11.77	13.86

TECHNICAL ANNEX 2:

SEEKING TO OBTAIN AND RECEIVE PAYMENTS FOR REDD+ RESULTS-BASED ACTIONS (DECISION 14/CP.19)

Following Decisions 13/CP.19, paragraph 2, and 14/CP.19, paragraphs 7 and 8, Malaysia submits the Technical Annex for REDD+ results for the purpose of obtaining and receiving payments. The submission is done on a voluntary basis.

1. Summary information from the final report containing each corresponding assessed forest reference emission level and/or forest reference level, which includes:

Decision 12/CP.17 is recalled where a step-wise approach to the development of national forest reference emission level and/or forest reference level is agreed while noting the importance of adequate and predictable support for the improvement of methodologies and additional pools. Malaysia understands that the forest reference level would include activities, conservation of forest carbon stocks, sustainable management of forests and enhancement of forest carbon stocks while forest reference emission level refers to reducing emissions from deforestation and reducing emissions from forest degradation activities.

Following this understanding, Malaysia's forest reference level addressed the improved forest management post 2005. The improvement includes a cap on cutting limits, implementation of Malaysian criteria and indicators for sustainable forest management.

Malaysia undertook a step wise approach in the improvement of the commercial harvesting protocol and the implementation of reduced impact logging from 1990 to 2003. The maximum harvest limit of 85m^3 is based on the findings from 1990-2003 and the change in forest management. Reducing the cutting limit, affected the income of the State while increasing the cost of forest management. Hence, in the construction of the Forest Reference Level (FRL), Malaysia used historical data from 1992-2010 to capture step-wise improvements and implementation phases.

Based on our forest management goal, Malaysia proposes a reference level for sustainable management of forest for result-based payment for REDD+ activity. The Permanent Reserved Forest (PRF) are managed under sustainable forest management principles and remains forested as far as possible and therefore considered in the construction of the FRL. PRF is also degazetted in some cases for gazettement as Totally Protected Areas (TPA). No logging activity is conducted in the Totally Protected Area/Protected Area.

Annual coupe were determined by the respective State Forestry Departments following the forest management used, Malayan Uniform System or Selective Management System for Production forests and monitored at State levels. States are required to provide monthly reports to be validated against the levy and royalty collection. Hence, it is a two-way tracking system from the revenue as well as production side. From 1996 onwards, the National Forestry Council sets and monitors the annual coupe. Degazetted forests may not be subjected to logging or land clearing immediately. PRFs are usually first degazetted into State land forest before being converted to other land or TPA. The commercial harvesting is also monitored through the forest certification where third party auditors would do ground verification. In addition, peer review is also done. The annual reporting of the commercial harvest is verified against these reports.

Reducing the rate of deforestation and degradation is currently being addressed through the Central Forest Spine and Heart of Borneo projects under the Tenth Malaysian Plan. Malaysia may construct a forest reference emission level when deforestation data can be separated from the forest management activities. Additional data and information is being collected from State land Forest.

2. Results in tonnes of CO_2eq per year, consistent with the assessed forest reference emission level and/or forest reference level.

The results are shown in Table 1 where, the net uptake is minus from the FRL. The total results achieved from sustainable management of forest for period 2006-2010 was -97.47 million tonnes CO_2 against the FRL. These values were included in the forest reference level submission and assessed.

3. Demonstration that the methodologies used to produce the results referred to in paragraph 2 above are consistent with those used to establish the assessed forest reference emission level and/or forest reference level.

The IPCC 2006 Guidelines were used to calculate the removal by sinks and emissions. Subtracting the biomass carbon loss from the biomass carbon increment for the reporting year makes the calculation. The forest reference level only considered CO_2 emission while non-CO_2 emissions are normally associated with the burning of tree residues or with wild fires are not included. None of these activities are common in the PRF. The carbon pools and greenhouse gas sources considered are shown in Tables 2 and 3.

Tier 1 approach was used where, the dead wood and litter carbon stocks are in equilibrium so that the changes in carbon stock in the dead organic matter pools are assumed to be zero. Likewise, soil carbon stocks do not

Table 1: Total Removal and Uptake and REDD+ Results-based Actions

Year	Uptake (million tonnes CO_2)	Emission (million tonnes CO_2)	Net Uptake (million tonnes CO_2)	FRL (million tonnes CO_2)	REDD+ Results based actions (million tonnes CO_2)
1992	-238.66	92.90	-145.76	-183.55	
1993	-237.77	79.58	-158.19	-183.55	
1994	-241.38	76.16	-165.22	-183.55	
1995	-240.11	67.99	-172.12	-183.55	
1996	-238.23	64.25	-173.98	-183.55	
1997	-241.64	66.55	-175.09	-183.55	
1998	-238.79	46.33	-192.46	-183.55	
1999	-240.44	46.61	-193.83	-183.55	
2000	-237.45	49.26	-188.19	-183.55	
2001	-235.56	40.40	-195.17	-183.55	
2002	-249.94	44.95	-204.99	-183.55	
2003	-248.90	45.97	-202.92	-183.55	
2004	-248.27	47.06	-201.21	-183.55	
2005	-248.24	47.74	-200.50	-183.55	
2006	-248.28	46.74	-201.54	46.74	-18.00
2007	-246.37	47.08	-199.29	47.08	-15.74
2008	-250.27	43.26	-207.01	43.26	-23.47
2009	-242.47	39.10	-203.37	39.10	-19.82
2010	-241.99	38.01	-203.98	38.01	-20.44
Total					-97.47

Table 2: Activity Data and Emission Factor Used in the Reference Level

Activity	Activity Data	Emission factor
Annual increase in carbon stocks due to biomass growth	Area of PRF obtained	Data on annual growth rate obtained from National Forest Inventory and recent publications For below ground biomass, root shoot ratio was applied.
Annual decrease in carbon stocks due to biomass loss	Total commercial harvest	Data on commercial harvest and allometric volume functions for total biomass loss

Table 3: Changes In Carbon Pools Included In The Reference Level

Above ground biomass	Below ground biomass	Litter	Deadwood	Soil Organic carbon
√	√	No	No	No

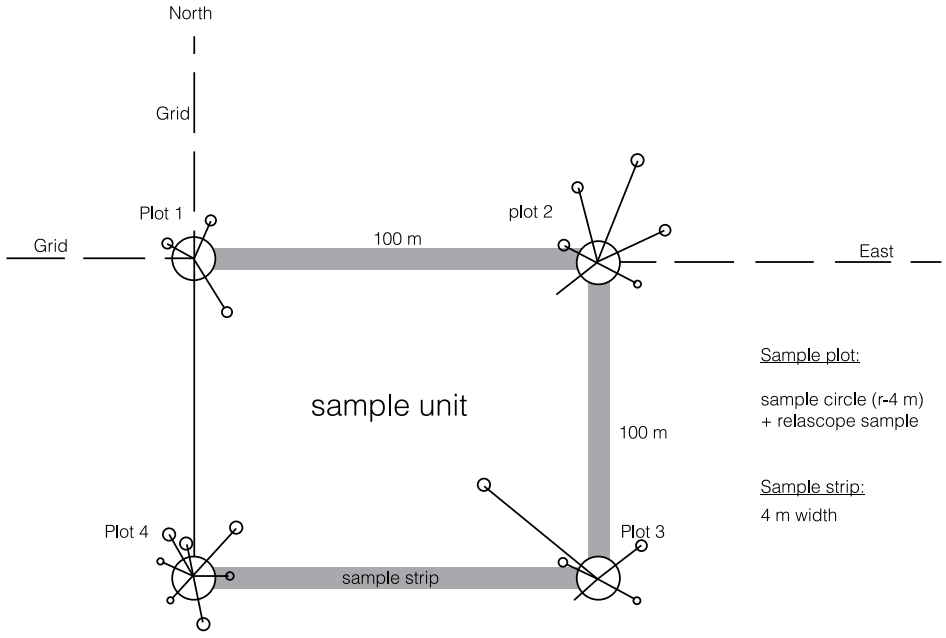
change with forest management. The IPCC 2006 Software applies a Tier 1 assumption for litter carbon stocks.

Only sustainably managed forest where commercial harvest is undertaken as part of the management plan is considered, covering a total area of about 12 million ha of forest. The FRL considers all sustainable managed forest and national data, which includes Peninsular Malaysia, Sabah and Sarawak. The Protected Areas/Totally Protected Areas were not considered because no logging activities are carried out in these areas.

Historical emission estimates are developed based on official statistics on the commercial harvest of logs from PRF. 1990 was used as the time of the FRL historic period because of a series of improvements in forest management started from 1978 onwards. Hence, time series from 1992-2010 was used to generate the reference level. The baseline is recalculated every 5 years, for period 2006-2010, historic emissions from 1992-2005; and 2011-2015, historic emission from 1997-2010 respectively.

Emission factors were generated from the National Forest Inventory (NFI), growth and yield plots and publications. The Fourth and Fifth NFI design is described as a stratified satellite based on randomly distributed permanent sample units. The sampling design consists of permanent sample units (satellites) of square shape with one sample plot in each corner. Each sample plot consists of a sample circle for small size trees and a point sample. Each sample unit consists of four (4) sample plots and three (3) sample strips. Each sample plot is a combination of a fixed sample circle of 4 m in radius and a point reference. The distance between the sample plot is 100 m. The total sample area is 0.12 hectare. Within the sample circle only commercial trees <10 cm dbh and >1.5 m in height and some key medicinal plants are assessed. The strip sample area is about 0.02 hectare resulting in total sample area at 0.14 hectare. For growth and yield plots, the diameter of all free-standing trees ≥ 10 cm diameter at breast height (dbh) was measured at least twice, using standard protocols.

Figure 1: Layout of sampling unit



Tree diameter growth was checked for all stems, and outliers were treated. Tree diameter and height was measured for all trees per hectare, using a standardized stratified-random sampling approach whereby trees were randomly selected from four size classes (10–20, 20–30, 30–40 and > 40 cm diameter). The stratification are based on forest type and post logging years. Based on the National Forest Inventory, the biomass increment for forest logged between 1-10 years, 11-20 years and 20-30 years is between 9.2–12 t/ha/yr. However, a significant decline is noted after 30 years to 4.3 t/ha/yr. Hence, Malaysia sets its logging cycle of 25-30 years, based on these figures.

Above-ground biomass (AGB) increments cannot be directly measured but estimated by applying allometric relationships relating stem diameter, height and wood density to AGB. The increment was calculated by comparing the growth difference in AGB. The increment was determined for each diameter class and forest stratification between 2002 and 2012 inventory cycle. For means of comparison, biomass increment was also calculated using the equation presented by Brown (1997), as follows:

$$Y = 42.69 - 12.8 \times (D) + 1.242(D^2)$$

Y= biomass tonne

Biomass density of a strata is estimated using the equation above. Number of trees/ha is obtained from the forest inventories and the mid point of biomass class is determined. Biomass of tree at mid point is determined using the equation above and biomass of all trees is determined by multiplying the number of trees with the biomass of tree at mid point.

For the analyses of individual trees, both diameter growth and above ground biomass were calculated using the census interval that was > 5 year to reduce noise associated with inter-annual differences and that minimized the difference from the median date for all censuses.

For mangrove, Ong and Gong (1993) were used. Allometric techniques, were also used to estimate the mean annual increment based on age of the forest. National studies were undertaken between 2011-2015 to assess the growth of mangroves and the reports are being finalised. The initial reports indicated that the growth rates for mangrove forest are between 10–17 t/ha/yr. The equation is as follows: $Y = 0.0277dbh^{2.1668}$

Mangrove forest had the lowest mortality, at 0.9 percent while inland forest had highest. The total gain by tree growth is subtracted by the mortality. The mortality rates were based on the number of standing dead trees and tree fall.

4. A description of national forest monitoring systems and the institutional roles and responsibilities for measuring, reporting and verifying the results.

Malaysia's National Forest Monitoring System consists of a short and long term monitoring. Biennial geospatial images are used to monitor changes in forest while National Forest Inventory is conducted every ten years.

Forest Monitoring System Using Remote Sensing (FMRS) is a web-based application system using geospatial data generated and remote sensing satellite images. Malaysian Remote Sensing Agency (MRSA) and Forestry Departments have developed the system by in-house expertise. The objective of the system is to enhance the effectiveness of monitoring of forest resource including logging activities.

FMRS has been operated by the Forestry Departments. The existence of the FMRS online has revolutionized monitoring of forest compared to the periodic ground monitoring, which is often time-consuming, expensive, complicated and difficult to access. The system developed, has changed the monitoring programme to be more focussed, improve the efficiency and effectiveness. In addition, FMRS system can also be used to estimate forest degradation, illegal encroachment in forest

area, reducing the need for ground monitoring. FMRS was developed in phases, starting in 2008, where it was first tested in Peninsular Malaysia and is being expanded to Sabah and Sarawak. The system now uses SPOT 5 images from 2009 onwards while LANDSAT was used from 1990-2005.

Additionally ground assessment through NFI is conducted every 10 years once. NFI provides the information on the state and trends of the forest resources, their goods and services, and other related variables that supports monitoring activities in the PRF. Forest Inventories have been conducted in Peninsular Malaysia since 1972 with a variety of objectives and methods. National Forest Inventories are conducted to obtain information on the stands of forest districts to provide information for management decisions. National Forest inventories were aimed at providing data for large scale planning. Due to the geographical composition of Malaysia, different inventory efforts have taken place in Peninsular Malaysia and in the states of Sabah and Sarawak. However, methodologies and objectives have often overlapped. Sabah and Sarawak conducted their forest inventories between 1969-1972 and 1986-1987 respectively. Permanent plots and growth plots have also been established in Sabah and Sarawak and assessments are done periodically. Malaysia will harmonise the National Forest Inventory between the three regions by 2022. Efforts are underway to secure additional funds for forest inventories to be conducted in Sabah and Sarawak.

The NFI has undergone improvement where more forest categories, medicinal plants and biodiversity are included. The NFI records the number of trees following the diameter class, volume, basal area, carbon stocks.

Institutional arrangement for measurement, reporting and verification is shown in Table 4.

Table 4: Institutional Arrangement for Measurement, Reporting and Verification

	Institution	Role
Measurement	Forest Research Institute Malaysia Forestry Department Peninsular Malaysia Sabah Forestry Department Sarawak Forest Department	Periodic ground based measurement through National Forest Inventory; Growth and Yield Plots and research plots; Technical advisory on reference level/emission factors; Verification.
Monitoring	Remote Sensing Department Forestry Department Peninsular Malaysia Sabah Forestry Department Sarawak Forest Department Departments of Agriculture	National Forest Monitoring System - Land use maps
Reporting	Ministry of Natural Resources and Environment Forest Research Institute Malaysia Forestry Department Peninsular Malaysia Sabah Forestry Department Sarawak Forest Department	Reference level and periodic submissions to UNFCCC; Technical annex for results based payments.
Verification BUR-ICA Process	Malaysia Timber Certification Council (MTCC) LULUCF Experts Working Group UNFCCC	Implement domestic verification process through the forest certification; Verification of results.

5. Necessary information that allows for the reconstruction of the results.

Decision 12/CP.17 requires that the forest reference emission levels shall maintain consistency with anthropogenic forest related greenhouse gas emissions by sources and removals by sinks as contained in the country's national greenhouse gas inventory. This implied that the same methodologies and consistent data sets are used to estimate the removal and emissions from sustainable forest management activities in the construction of reference level and in the national greenhouse gas inventory.

Consistent activity data and emission factors have been used throughout the construction of FRL and is consistent with the activity data and emission factors in the national greenhouse gas inventory. Activity data and emission factors used shown in Tables 5, 6 and 7.

Table 5: Activity Data and Emission Factors Used in the Construction of FRL

Forest type	Growth rate	Reference
Inland	9.3 tdm/ha/yr	Fifth NFI and Banin et at (2014)
Peat swamp	9.2 tdm/ha/yr	Fifth NFI and National Reports
Mangrove	11 tdm/ha/yr	Ong (1993)
Root: shoot ratio Mangrove	0.18 0.49	Niiyama et al (2010), IPCC, Wetlands Supplementary
Biomass conversion expansion factor (commercial harvest)	1.05 t biomass of volume/ (m^3)	IPCC, 2006 Guidelines

Table 6: Total Production Forest within Permanent Reserved Forest for Malaysia

MALAYSIA				
Production Forest (million ha)				
Year	Inland/Hill	Peat Swamp	Mangrove	Total
1990	10.91	1.04	0.47	12.42
1991	10.94	1.05	0.47	12.46
1992	10.94	1.01	0.46	12.41
1993	10.92	0.99	0.45	12.36
1994	11.15	0.96	0.44	12.55
1995	11.11	0.94	0.44	12.49
1996	11.12	0.83	0.44	12.39
1997	11.27	0.86	0.44	12.57
1998	11.14	0.84	0.44	12.42
1999	11.19	0.88	0.44	12.51
2000	11.13	0.78	0.44	12.35
2001	11.12	0.69	0.44	12.25
2002	11.87	0.70	0.44	13.01
2003	11.83	0.70	0.43	12.96
2004	11.82	0.68	0.43	12.92
2005	11.82	0.65	0.44	12.91
2006	11.81	0.66	0.45	12.92
2007	11.70	0.67	0.44	12.81
2008	11.92	0.66	0.44	13.03
2009	11.69	0.49	0.43	12.61
2010	11.66	0.50	0.43	12.59
2011	11.52	0.50	0.43	12.45
2012	11.42	0.51	0.43	12.36

Table 7: Total Commercial Harvest for Malaysia

Malaysia	
Year	**Commercial harvest (million m^3)**
1990	40.10
1991	39.86
1992	43.51
1993	37.27
1994	35.67
1995	31.84
1996	30.09
1997	31.17
1998	21.70
1999	21.83
2000	23.07
2001	18.92
2002	21.05
2003	21.53
2004	22.04
2005	22.36
2006	21.89
2007	22.05
2008	20.26
2009	18.31
2010	17.80
2011	16.08
2012	15.89

6. A description of how the elements contained in decision 4/CP.15, paragraph 1(c) and (d), have been taken into account.

Decision 4/CP.15, paragraph 1(c) and (d) are reflected in No 3, 4 and 5.

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