ISKANDAR MALAYSIA GREENHOUSE GAS INVENTORY 2016

FINAL REPORT

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ISKANDAR MALAYSIA GREENHOUSE GAS INVENTORY 2016

Final Report

FOREWORD

Global warming and climate change is one of the most daunting issues faced by our generation. It is a challenge which calls upon everyone to play their part to deal with global warming. Malaysia recognises our part in taking on the challenge together with the rest of the world.

Malaysia had committed to a voluntary reduction of our nation's greenhouse gas emissions intensity of GDP by 40% by 2020 at the 15th Conference of the Parties (COP15). In 2015, Malaysia submitted its Intended Nationally Determined Contribution (INDC) to the United Nations Framework Convention on Climate Change (UNFCCC) with a target reduction of greenhouse gas emissions intensity by 45% by 2030.

This was followed with the submission of our first Biennial Update Report (BUR) to the UNFCCC in 2016. Later the same year, we signed and ratified the Paris Agreement, a landmark comprehensive climate agreement, which has since come into force for Malaysia. In the coming years, we would be submitting our 3rd National Communication (TNC/NC3) to the UNFCCC.

The Government had introduced various initiatives at the national level to foster sustainability in key economic sectors to mitigate the negative impact to the environment. One of the main strategic thrusts in the 11th Malaysia Plan is the pursuit of green growth for sustainability and resilience, further reinforcing our commitment to clean and sustainable development in this country.

Iskandar Malaysia, since its conception, has placed sustainability at the forefront of the economic region's development. Iskandar Regional Development Authority (IRDA) has consistently maintained its efforts in implementing and promoting initiatives and policies, which encourages social and economic development that are environmentally conscious and clean. With this 2nd Greenhouse Gas Inventory, I am pleased to note that IRDA continues to show the way forward for Iskandar Malaysia, setting an excellent example for sustainable development in the country and in the ASEAN region.

YAB DATO' SRI MOHD NAJIB TUN ABDUL RAZAK

Prime Minister of Malaysia
Co-Chairman of Iskandar Regional Development Authority

FOREWORD

The state of Johor has always held firmly to its tenets of advancing the well-being of its people, as well as attaining social and economic development that truly benefit all who live in it.

To that aim, the state has placed its highest commitment to the pursuit of social and economic development without sacrificing our precious natural environment. At its very core is the Johor Sustainability Policy, which I have championed to ensure that developments in the state would be green and sustainable.

Iskandar Malaysia, since its launch 11 years ago under the leadership of the IRDA, has achieved many remarkable milestones over the years. Among them is the global launching of the Low Carbon Society Blueprint for Iskandar Malaysia at COP 18, Doha, Qatar, which emphasises sustainability for the economic region in South Johor.

Another significant milestone was achieved last year with the release of Iskandar Malaysia's inaugural greenhouse gas inventory for 2015. These achievements would never have been possible without the strong support of key stakeholders including the federal government, strategic partners and local communities.

As Johor continues to pursue sustainable development for the benefit of all, I sincerely hope that we continue to face any challenges that might come our way with diligence and integrity.

YAB DATO' MOHAMED KHALED NORDIN

Menteri Besar of Johor
Co-Chairman of Iskandar Regional Development Authority

FOREWORD

The global release of Iskandar Malaysia's inaugural greenhouse gas emissions inventory for 2015 at COP22, in Marrakech, Morocco marks an important milestone for the development of a carbon monitoring and tracking framework for the economic region. I believe that we are the first economic region in the world to adopt the respected Global Protocol for Community-scale Greenhouse Gas Emission Inventories (GPC) to monitor and account for carbon emissions. We chose the GPC as our reporting framework because our goal is to strive for clear and credible information to help us realise the Iskandar Malaysia vision and ambition. This is also aligned at the Johor State level, specifically with Thrust 3: Greening the economy of the Johor Sustainability Policy 2017-2021.

The Low Carbon Society Blueprint which was launched globally at COP18, in Doha, Qatar in 2012 has set out a target to achieve greenhouse gas emission reductions of 58% (related to GDP) and 40% (absolute) by 2025. IRDA is determined to continually track our progress towards meeting our 2025 emission reduction targets. Based on estimates, Iskandar Malaysia will need to achieve 8% average annual reduction in greenhouse gas emissions from 2016 to 2025 in order to meet the Low Carbon Society Blueprint targets. The targets are ambitious, aggressive, audacious and a significant challenge. However, I believe that with the support of all key stakeholders, we will be able to rise to the occasion and achieve them.

I wish to thank the World Resources Institute, Universiti Teknologi Malaysia, Eco-Ideal Consulting Sdn. Bhd. and my staff team who have worked hard in putting together the *Iskandar Malaysia Greenhouse Gas Inventory 2016*.

Y. BHG DATUK ISMAIL IBRAHIM

Chief Executive Officer
Iskandar Regional Development Authority

ISKANDAR MALAYSIA GREENHOUSE GAS INVENTORY 2016

Key Messages:

1. Increase of greenhouse gas emissions from 2010 to 2016 due to healthy and robust economic growth.
2. Increase in absolute emissions from 2015, corresponding to high GDP growth of the region.
3. Emission intensity reduction of 10.7% from 2010 to 2016.
4. The rate of emissions intensity reduction did not meet the required average yearly reduction rate needed to meet the GHG reduction goal by 2025.
5. Iskandar Malaysia will need to attract more climate-friendly investments and adopt high impact policies and actions to realise the 2025 reduction goal.

To meet the targeted emission intensity reduction of 58% of base year (2010) emissions by 2025, **8.0%** is the **average yearly reduction rate** required from 2017 onwards.

Emissions Intensity (2010-base year)

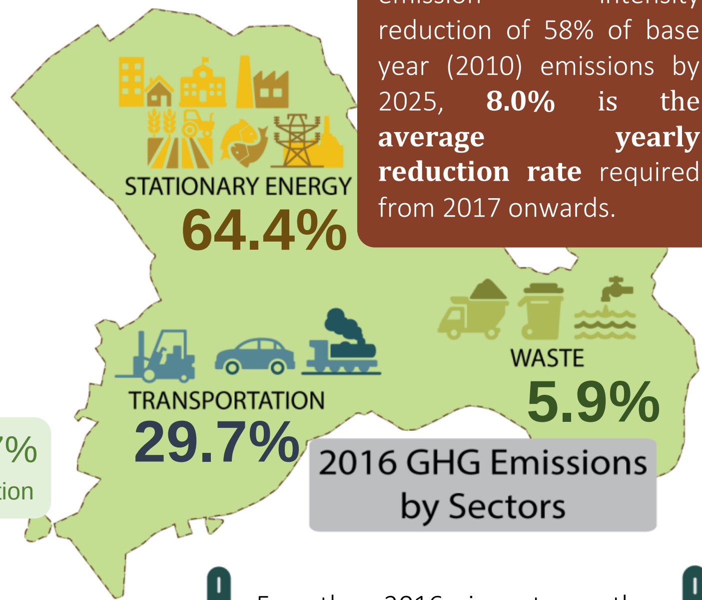
2010 **0.2483** $ktCO_2e$/RM million GDP

10.5% reduction

2015 **0.2221** $ktCO_2e$/RM million GDP

10.7% reduction

2016 **0.2217** $ktCO_2e$/RM million GDP



2016 GHG Emissions by Sectors

2016 BASIC
Absolute GHG Emissions
15.56
million tCO_2e

For the 2016 inventory, the **base year has been changed to 2010** to better reflect changes in the economic conditions for Iskandar Malaysia. Previous year's inventory for 2015 had used 2005 as the base year.

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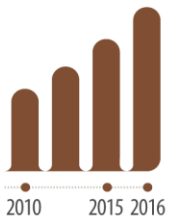
There have been **updates to data and assumptions** since the release of previous year's inventory; calculations and figures have been revised accordingly in this inventory.

Absolute BASIC Greenhouse Gas Emissions



(2015-2016) ↑ **7.1%**

(2010-2016) ↑ **31.5%**

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ABBREVIATION

AFOLU	Agriculture, Forestry, and Other Land Use
AR	Assessment Report
BUR	Biennial Update Report
BOD	Biochemical Oxygen Demand
CDP	Carbon Disclosure Project
CH_4	Methane
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
COP	Conference of the Parties
DB	Sludge Drying Bed
DOC	Degradable Organic Carbon
DOE	Department of Environment
DOSM	Department of Statistics Malaysia
DTRO	Disc Tube Reverse Osmosis
EF	Emission Factor
EFB	Empty Fruit Bunches
EPU	Economic Planning Unit
EV	Electric vehicle
FGD	Focus Group Discussion
FiT	Feed-in Tariff
FOD	First Order Decay
GAIA	Green Accord Initiative Award
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GPC	Global Protocol for Community Scale Greenhouse Gas Emissions Inventories
GTALCC	Green Technology Application for the Development of Low Carbon Cities
GWP	Global Warming Potential
INDC	Intended Nationally Determined Contribution
IPCC	Intergovernmental Panel on Climate Change
IPP	Individual Power Plant
IPPU	Industrial Processes and Product Use
IRDA	Iskandar Regional Development Authority
IMELC	Iskandar Malaysia Eco-Life Challenge
IMUO	Iskandar Malaysia Urban Observatory
IWK	Indah Water Konsortium Sdn. Bhd.

JICA	Japan International Cooperation Agency
JPNJ	Jabatan Pendidikan Negeri Johor
JST	Japan Science and Technology Agency
KPDNKK	Ministry of Domestic Trade, Co-operatives and Consumerism
KeTTHA	Ministry of Energy, Green Technology and Water
KTMB	Keretapi Tanah Melayu Berhad
ktoe	kilo tonnes of oil equivalent
LCS	Low Carbon Society
LCSBPIM	Low Carbon Society Blueprint for Iskandar Malaysia
LFG	Landfill Gas
MARDI	Malaysian Agricultural Research and Development Institute
MBJB	Majlis Bandaraya Johor Bahru
MCF	Methane Correction Factor
MDP	Majlis Daerah Pontian
MGTC	Malaysian Green Technology Corporation
MIM	Medini Iskandar Malaysia Sdn. Bhd.
MNRE	Ministry of Natural Resources and Environment
MOH	Ministry of Health
MPJBT	Majlis Perbandaran Johor Bahru Tengah
MPKu	Majlis Perbandaran Kulai
MPOB	Malaysian Palm Oil Board
MPPG	Majlis Perbandaran Pasir Gudang
MW	Megawatts
N_2O	Nitrous Oxide
NC2	National Communication 2
NCV	Net Calorific Value
NEB	National Energy Balance
NGO	Non-Governmental Organisation
NIES	National Institute for Environmental Studies
OPF	Oil Palm Fronds
OPT	Oil Palm Trunks
OX	Oxidation Factor
PAJ	Perbadanan Pengangkutan Awam Johor
RE	Renewable Energy
SATREPS	Science and Technology Research Partnership for Sustainable Development
SEDA	Sustainable Energy Development Authority
SIRIM	Standards and Industrial Research Institute of Malaysia
SL	Sludge Lagoon
SME Corp.	Small and Medium Enterprise Corporation Malaysia

SMR	Standard Malaysia Rubber
SPAN	Suruhanjaya Perkhidmatan Air Negara
SRF	Sludge Reception Facility
ST	Energy Commission (Suruhanjaya Tenaga)
SWCorp	Solid Waste Management and Public Cleansing Corporation
tCO_2e	tonne carbon dioxide equivalent
TNB	Tenaga Nasional Berhad
TNC	Third National Communication
TOW	Total Organic in Wastewater
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organisation
UNITEN	Universiti Tenaga Nasional
UPENJ	Johor Economic Planning Unit
UTM	Universiti Teknologi Malaysia
WRI	World Resources Institute

1 INTRODUCTION

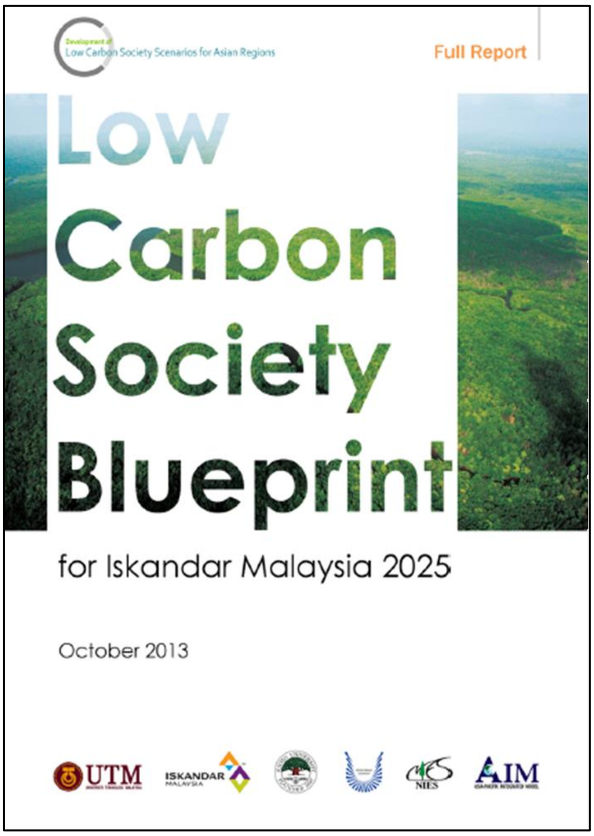
Background

Iskandar Malaysia recognises the importance of sustainable development and has placed much emphasis on promoting a green economy within the economic region. Under the leadership of Iskandar Regional Development Authority (IRDA), Iskandar Malaysia released in 2016 its inaugural comprehensive greenhouse gas (GHG) inventory for 2015. The inventory established a basis for assessing greenhouse gas emissions in Iskandar Malaysia, which also provides information on mitigation efforts in the economic region.

Iskandar Malaysia was the first in the nation to adopt the respected Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC)

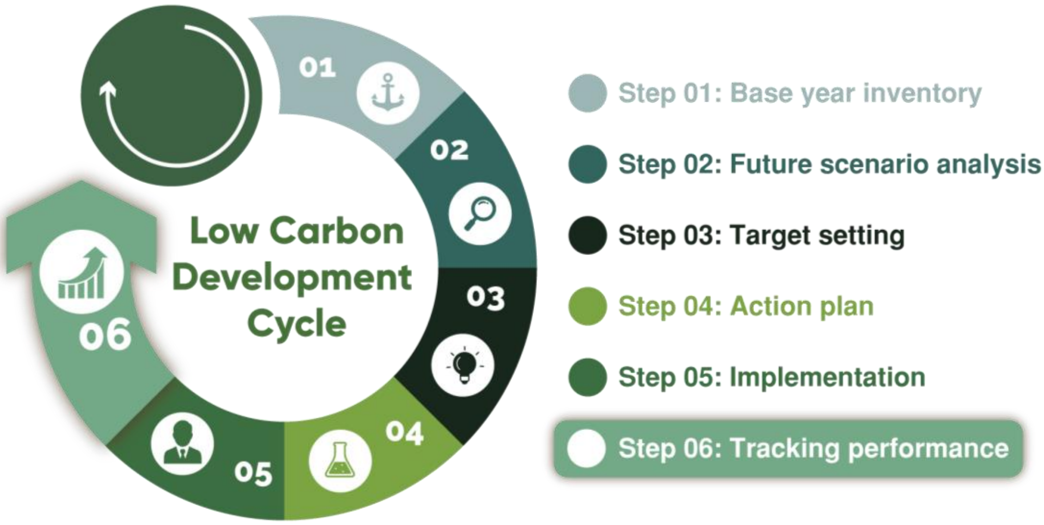
Iskandar Malaysia was the first in the nation to adopt the respected Global Protocol for Community-Scale Greenhouse Gas Emission Inventories (GPC) to account for its greenhouse gas emissions. The GPC BASIC reporting compliant inventory was also shared at the 22nd United Nations Framework Convention on Climate Change (UNFCCC) Conference of Parties (COP22) which was held in Marrakech, Morocco from 7 to 18 November 2016.

Following the inaugural GHG inventory, IRDA is determined to continually update and report Iskandar Malaysia's greenhouse gas emissions. This will enable annual tracking of emissions and document the progress of mitigation efforts towards reducing greenhouse gas emissions. This is in line with the Johor Sustainability Policy 2017-2021, under one of the main thrusts, where one of the goals is to develop a carbon monitoring and auditing framework for the state of Johor. More specifically for Iskandar Malaysia, the reporting of greenhouse gas emissions complements the Low Carbon Society Blueprint, a comprehensive programme towards realisation of a low carbon society in the economic region.



The Low Carbon Society Blueprint for Iskandar Malaysia 2025 (LCSBPIM2025) – officially launched by the Prime Minister of Malaysia and adopted by the Iskandar Regional Development Authority (IRDA) in 2012, outlines a total of 281 implementation programmes (grouped around three themes – Green Environment, Green Economy, and Green Community) which are projected to reduce Iskandar Malaysia's carbon emissions intensity by 58% in 2025 compared to 2005 levels. Several strategic programmes outlined in the LCSBPIM2025 have been implemented since 2013.

The LCSBPIM2025 is a research output of Japan's Science and Technology Research Partnership for Sustainable Development (SATREPS) project called "The Development of Low Carbon Society Scenarios for Asian Region" sponsored by Japan International Cooperation Agency (JICA) and the Japan Science and Technology Agency (JST). The main research institutions involved in this collaboration are Universiti Teknologi Malaysia (UTM), Kyoto University, National Institute for Environmental Studies (NIES), and Okayama University.



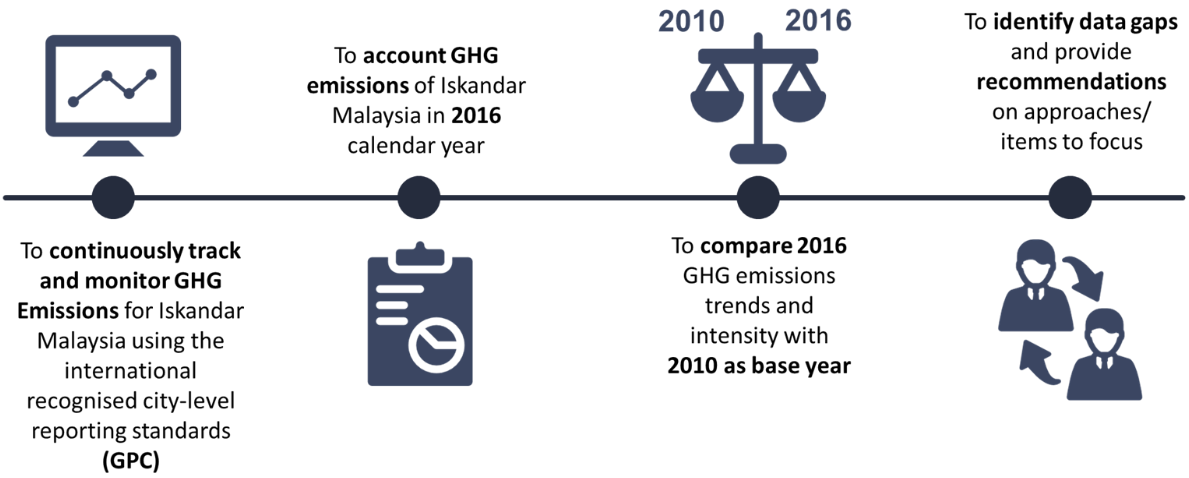
Iskandar Malaysia has now completed 6 out of 6 stages of the Low Carbon Development Cycle and the Environment Division of Iskandar Malaysia Regional Development Authority (IRDA) has been actively tracking the performance of implemented LCS programmes since 2015.

It is important to ensure continuous measuring of the carbon emissions in Iskandar Malaysia to track the progress of efforts made towards achieving the emissions reduction goal in 2025. Tracking LCS programmes will help IRDA to monitor current carbon emissions in Iskandar Malaysia and guide future strategic planning decisions.

Iskandar Malaysia – Greenhouse Gases (GHG) Emissions Reporting Objectives

The core objective of greenhouse gas emissions reporting for Iskandar Malaysia is to enable regular and continuous monitoring of greenhouse gas emissions arising from the economic region. The reporting of Iskandar Malaysia's greenhouse gas emissions will be according to the GPC, a respected international standard for the accounting of community-scale greenhouse gas inventory.

The monitoring and reporting of greenhouse gas emissions is crucial in order to track the progress of carbon emissions reduction efforts within Iskandar Malaysia. The tracking of carbon emissions is also complementary to the implementation of the Low Carbon Society Blueprint through the provision of insights into greenhouse gas emission trends in Iskandar Malaysia.



For the 2016 inventory, the specific objectives are:

- Accounting for Iskandar Malaysia's greenhouse gas emissions for 2016 calendar year;
- Comparison of 2016 greenhouse gas emissions trends and intensity with 2010 as base year; and
- Identification of gaps in data for the accounting of greenhouse gas emissions and make recommendations on areas for improvement.

The specific objectives aim to provide clear and credible information concerning Iskandar Malaysia's greenhouse gas emissions inventory from 2010 to 2016 including trends over the years. This will provide policymakers and government authorities with updated greenhouse gas emissions data for Iskandar Malaysia. Furthermore, in accord with GPC's principle, this inventory seeks to identify data gaps for continuous improvement and refinement of data availability and quality.

Background Information on Iskandar Malaysia

COUNTRY
Malaysia

YEAR OF INVENTORY
2016

CLIMATE
Tropical Rainforest

DATE OF ESTABLISHMENT
8 November 2006

ADMINISTERED
Iskandar Regional Development Authority (IRDA)

POPULATION
2.02 million

LAND AREA
2,300km²

GDP
RM 70,210 million
(USD 16,918 million) for 2016 at 2010 constant price

COMPOSITION OF ECONOMY
9 promoted sectors*

* 9 promoted sectors:
(i) Electrical & Electronics (ii) Petro Chemical and Oil & Gas (iii) Food & Agro processing (iv) Logistics (v) Tourism
(vi) Finance, Insurance, Real Estate & Business Services (FIREBS) (vii) Creative (viii) Health Services (ix) Education Services

Reporting Framework

This inventory continues to adopt GPC as the standard to account for emissions in Iskandar Malaysia occurring in 2016. This inventory is based on the GPC BASIC requirements. As required by the GPC, the territorial emissions from Iskandar Malaysia are accounted and reported according to the GPC scopes framework.

Greenhouse gases accounted

- ☑ Carbon Dioxide
- ☑ Methane
- ☑ Nitrous Oxide

For the conversion of individual greenhouse gas emissions into carbon dioxide equivalents (CO_2e), the latest Global Warming Potentials (GWPs) in the Intergovernmental Panel on Climate Change (IPCC) Assessment Report (AR), the Fifth AR (AR5) have been used in this inventory as recommended in the GPC. It should be noted that the latest national inventory, the Biennial Update Report (BUR) to the United Nations Framework Convention on Climate Change (UNFCCC) 2016 published by the Ministry of Natural Resources and Environment (MNRE) in 2016, had referenced GWPs in accordance with the IPCC Fourth Assessment Report (AR4). For ease of comparison with the latest national level inventory, conversions of Iskandar Malaysia's greenhouse gas emissions to CO_2e units were also calculated using GWPs according to the IPCC AR4 for reference.

The Scopes and City-induced Framework – BASIC Level

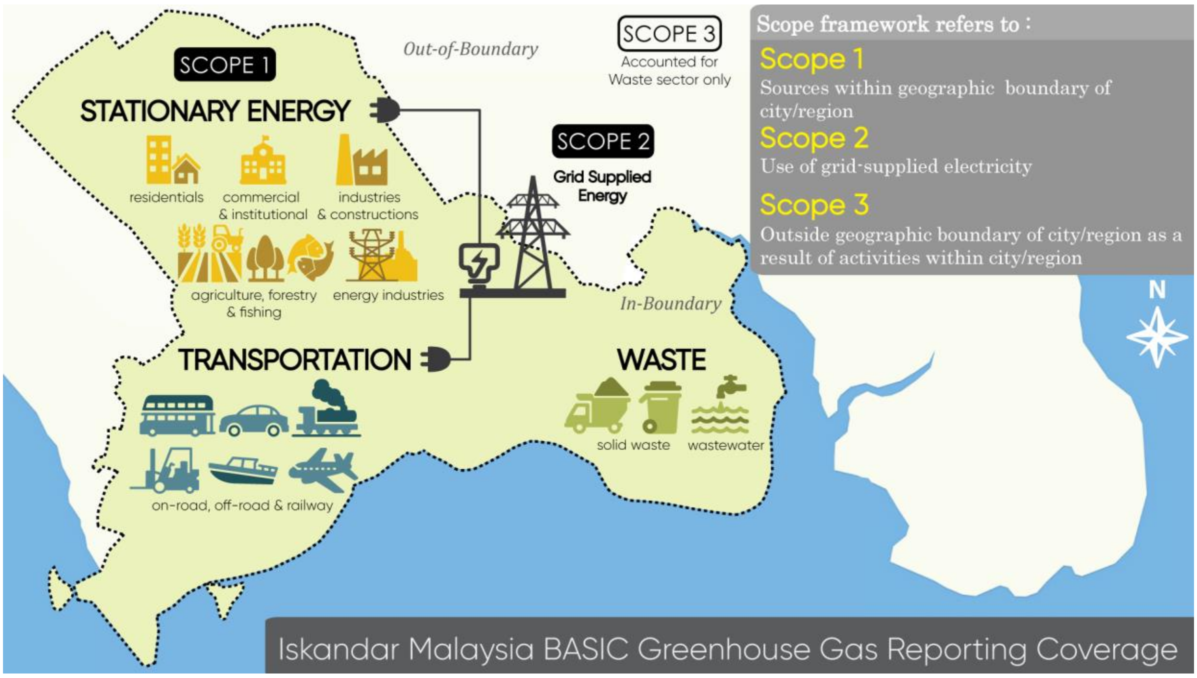


Figure 1: Coverage of Iskandar Malaysia's BASIC greenhouse gas reporting

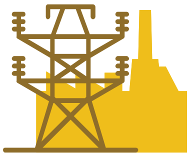
Data Quality Assurance

In the process of developing the Iskandar Malaysia Greenhouse Gas Inventory 2016, several engagements were conducted to ensure the success of the inventory as well as for data quality assurance. This inventory was prepared in close consideration of national level reporting (National Communication (NC)/ Biennial Update Report (BUR)) to the United Nations.

METHODOLOGIES & APPROACHES 2

Methodologies

With reference to GPC, the coverage of subsectors under Stationary Energy, Transportation and Waste sector for this inventory were accounted as shown in Figure 1.

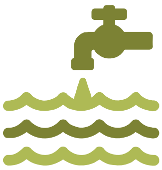


The coverage of sub-sectors under Stationary Energy sector for this inventory included emissions from residential buildings, commercial and institutional buildings and facilities, manufacturing industries and construction, energy industries, and agriculture, forestry and fishing activities within Iskandar Malaysia region.

Fugitive emissions from fuel were not accounted in this inventory as there are no mining, processing, storage and transportation of coal activity nor oil and natural gas systems within the economic regional boundary.

The Transportation sector covered emissions from fossil fuel and electricity consumption of on-road transportation, off-road transportation and railways within the economic regional boundary.

Emissions from waterborne navigation and aviation were excluded due to the lack of such information and it was believed that the number of trips for waterborne navigation and aviation that originate and terminate within the economic region boundary were insignificant.



As for the Waste sector, this inventory included the emissions from municipal solid waste, domestic wastewater and sludge, and industrial wastewater (from palm oil mills and rubber mill only). The emissions from other industrial wastewater such as manufacturing industries were excluded due to unavailability of data.

Calculations Approaches

2006 IPCC Guidelines for National Greenhouse Gas Inventories

Approaches

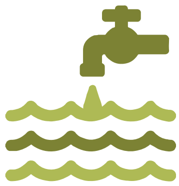
Primary data on fossil fuel and electricity consumption of Energy Industries were collected from respective power plants while secondary data on electicity consumption were obtained from Energy Commission Malaysia (ST).

Secondary data on fuel consumption by other sub-sectors in Stationary Energy sector were extracted from National Energy Balance (NEB) 2010-2015. These data were scaled down to Iskandar Malaysia economic region, either using population or industrial GDP (depending on sub-sectors). The fossil fuel consumption for 2016 were projected based on the average growth rate of fossil fuels consumption from 2010 – 2015, extracted from NEB 2015.

The latest grid emission factor for Peninsular Malaysia was sourced from Malaysia Green Technology Corporation (MGTC) while other relevant emission factors were sourced from 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories.

Primary data on railways (i.e. number of trips per year, diesel consumption per trip and train distance per trip) were collected from Keretapi Tanah Melayu Berhad (KTMB), while fuel consumption by off-road transportation were collected respectively from the ports and airport authorities.

Secondary data of fuel sales for on-road transportation were extracted from NEB 2010-2015 and scaled down by population to the economic region boundary. Projection of fuel sales 2016 were estimated based on average growth rate of fossil fuels consumption from 2010 – 2015, extracteed from NEB 2015. The relevant emission factors were sourced from 2006 IPCC Guidelines for National Greenhouse Gas Inventories.



Primary data on municipal solid waste, domestic wastewater and sludge, and industrial wastewater generated and treated within Iskandar Malaysia boundary were collected from landfill operators, wastewater treatment plant operators or owners and also from relevant authorities. Parameters such as population and disposal rate were used as the basis for extrapolation when specific data were unavailable. Emissions for both solid waste disposal[1] and wastewater treatment plants[2] were calculated based on Tier 2 calculation methodologies.

[1] Emissions from solid waste disposal were calculated based on First Order Decay (FOD) model (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3).
[2] Emissions from wastewater were calculated based on the Total Organic in Wastewater (TOW) calculation (2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6).

RESULTS 3

Summary of Iskandar Malaysia Greenhouse Gas Inventory 2016

Sector		Total by Scope (million tCO_2e)			Total by City-Induced Reporting Level (million tCO_2e)
		Scope 1 (territorial)	Scope 2	Scope 3 included in BASIC	BASIC
Stationary Energy	Energy use	3.15	6.87	-	10.02
	Energy generation supplied to the grid	10.58			
Transportation		4.63	IE	-	4.63
Waste	Generated in the city	0.91		NE for Solid Waste NO for Wastewater	0.91
	Generated outside city	0.05			
Total	**Territorial Emissions**	**19.33**			**15.56**
				BASIC Emissions	

Notation Keys:

NE – Not Estimated NO – Not Occurring IE – Included Elsewhere

– Sources required for BASIC reporting + – Sources required for BASIC+ reporting

– Sources required for territorial total but not for BASIC/ BASIC+ reporting (*italic*)

–Non-applicable emissions

For ease of reference with national level reporting, the greenhouse gas emissions for Iskandar Malaysia 2016 were also calculated based on GWP from AR4: Territorial total emissions were 19.23 million tCO_2e and total BASIC emissions were 15.47 million tCO_2e.

Detailed 2016 Iskandar Malaysia Greenhouse Gas Inventory

GHG Emissions Source (By Sector and Sub-sector)	Notation keys	Gases (in tonnes)					Data Quality		Explanatory comments (i.e. description of methods or notation keys used)
		CO_2	CH_4	N_2O	Total CO_2e	CO_2(b)	AD	EF	
STATIONARY ENERGY									
Residential buildings									
Scope 1 Emissions from fuel combustion within the city boundary		150,235	12	0.24	150,631		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		1,470,228			1,470,228		M	H	Scaled down from secondary data based on population ratio
Commercial, institutional buildings & facilities									
Scope 1 Emissions from fuel combustion within the city boundary		173,098	15	0.46	173,650		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		2,111,117			2,111,117		M	H	Scaled down from secondary data based on population ratio
Manufacturing and construction									
Scope 1 Emissions from fuel combustion within the city boundary		1,836,872	68	10.15	1,841,469		M	L	Scaled down from secondary data based on industrial GDP
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		3,237,609			3,237,609		M	H	Scaled down from secondary data based on industrial GDP
Energy industries									
Scope 1 Emissions from energy used in power plant auxiliary operations within the city boundary		808,899			808,899		H	L	Primary data from power plants
Scope 2 Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary									Included elsewhere under Scope 2 Stationary Energy
Scope 1 Emissions from energy generation supplied to the grid		10,535,875	125	164.81	10,583,055		H	L	Primary data from power plants
Agriculture, forestry and fishing activities									
Scope 1 Emissions from fuel combustion within the city boundary		174,868	24	1.42	175,910		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		54,896			54,896		M	H	Scaled down from secondary data based on population ratio
TRANSPORTATION									
On-road transportation									
Scope 1 Emissions from fuel combustion on-road transportation occurring within the city boundary		4,456,170	1,564	213.53	4,507,253	49,283	M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary for on-road transportation	IE								Included elsewhere under Stationary Energy Scope 2
Railways									
Scope 1 Emissions from fuel combustion for railway transportation occurring within the city boundary		14,515	1	5.60	16,022		H	L	Primary data from operator
Scope 2 Emissions from grid-supplied energy consumed within the city boundary for railways	NO								Not occurring as the railway transportation in Iskandar Malaysia Economic Region consume diesel only
Waterborne navigation									
Scope 1 Emissions from fuel combustion for waterborne navigation occurring within the city boundary	NE								Not estimated as lack of such information and it is believed that the number of waterborne navigation trips made within the boundary are insignificant
Scope 2 Emissions from grid-supplied energy consumed within the city boundary for waterborne navigation	NE								Not estimated as lack of such information and it is believed that the number of waterborne navigation trips made within the boundary are insignificant
Aviation									
Scope 1 Emissions from fuel combustion for aviation occurring within the city boundary	NE								Not estimated as lack of such information and it is believed that the number of aviation trips made within the boundary are insignificant
Scope 2 Emissions from grid-supplied energy consumed within the city boundary for aviation	NE								Not estimated as lack of such information and it is believed that the number of aviation trips made within the boundary are insignificant
Off-road transportation									
Scope 1 Emissions from fuel combustion for off-road transportation occurring within the city boundary		92,783	5	35.81	102,419		H	L	Primary data from authorities
Scope 2 Emissions from grid-supplied energy consumed within the city boundary for off-road transportation	IE								Included elsewhere under Stationary Energy Scope 2
WASTE									
Solid waste disposal									
Scope 1 Emissions from solid waste generated within the city boundary and disposed in landfills or open dumps within the city boundary			22,111		619,109		H	-	Primary data from authorities/operators and extrapolation made based on population and waste discarded rate when data are not available
Scope 3 Emissions from solid waste generated within the city boundary but disposed in landfills or open dumps outside the city boundary	NE								Not estimated due to lack of such information
Scope 1 Emissions from solid waste generated outside the city boundary and disposed in landfills or open dumps within the city boundary			1,884		52,755		M	-	Accounted for solid waste generated in Pontian area (outside Iskandar Malaysia boundary) as the waste are sent to Pekan Nenas Landfill in Iskandar Malaysia boundary
Wastewater treatment and discharge									
Scope 1 Emissions from wastewater generated and treated within the city boundary			10,526	0.35	294,821		H	-	Primary data from operators and extrapolation made based on population when data are not available.
Scope 3 Emissions from wastewater generated within the city boundary but treated outside of the city boundary	NO								Not occurring in Iskandar Malaysia Economic Region
Scope 1 Emissions from wastewater generated outside the city boundary but treated within the city boundary			14	0.00	386		M	-	Accounted for wastewater generated in Kota Tinggi and Mersing which send their wastewater to wastewater treatment plants in Iskandar Malaysia boundary
TOTAL	ALL TERRITORIAL EMISSIONS				**19,326,379**				
	ALL BASIC EMISSIONS				**15,564,033**				

GPC BASIC Framework

In 2016, the total greenhouse gas emissions produced as a consequence of the economic region's activities were 15.56 million tonnes carbon dioxide equivalent (tCO_2e) whereas the territorial total greenhouse gas emissions occurring within the geographical boundary of Iskandar Malaysia were 19.33 million tCO_2e. The BASIC framework only accounts for greenhouse gas emissions that occurred as a consequence of the activities within the geographic boundary. More specifically for BASIC level reporting, greenhouse gas emissions from Stationary Energy (Scope 1 and Scope 2), Transportation (Scope 1 and Scope 2) and Waste (Scope 1 and Scope 3) are accounted for. The reporting of greenhouse gas emissions from Industrial Processes and Product Use (IPPU) and Agriculture, Forestry and Other Land Use (AFOLU) are not required under BASIC level reporting and are thus omitted in this inventory. The territorial total for Iskandar Malaysia's greenhouse gas emissions consists of Scope 1 emissions for Stationary Energy, Transportation and Waste sectors.

Emission Trends 2010-2016

Under the BASIC reporting level, the greenhouse gas emissions were 11.84 million tCO_2e in 2010. The greenhouse gas emissions were 15.56 million tCO_2e in 2016, an increase of 31.5% (Figure 2). The average annual growth rate for BASIC emissions is 4.7%.

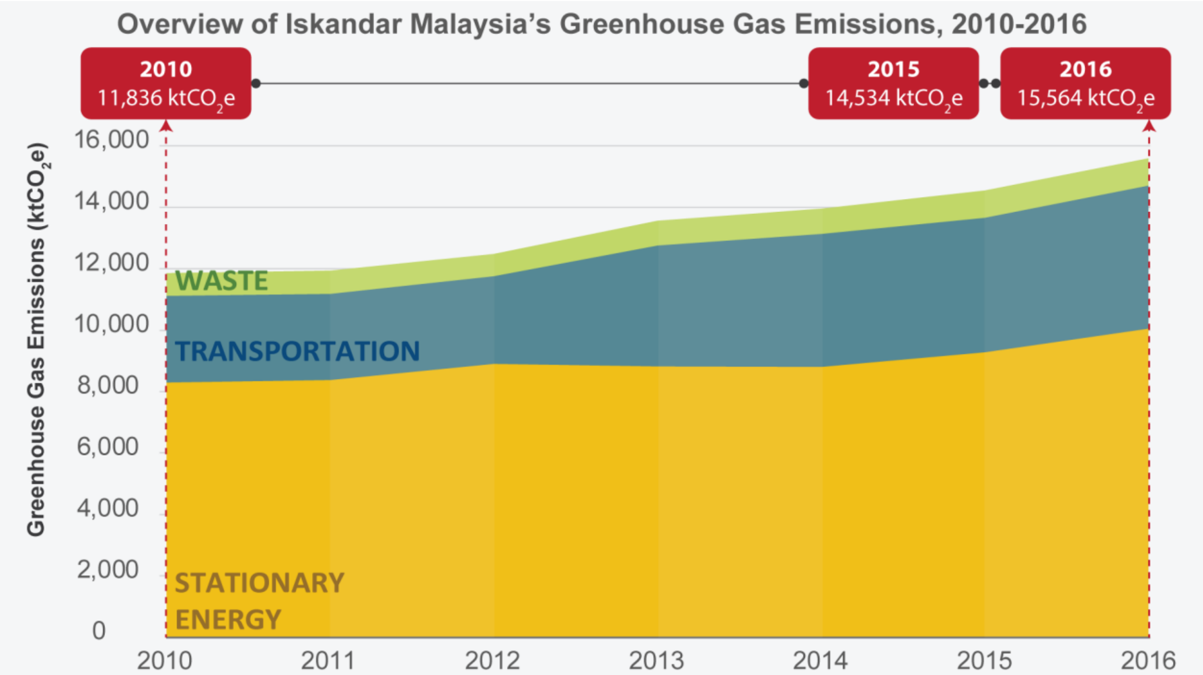


Figure 2: Overview of Iskandar Malaysia's greenhouse gas emissions 2010-2016

The trend broadly reflects the development of Iskandar Malaysia as an economic region since its launch in 2010 by the federal government. From 2010 to 2016, the GDP of Iskandar Malaysia had increased by 47.3%, with an average annual growth rate of 6.7%.

Sector Trends 2010-2016

In Iskandar Malaysia, the Stationary Energy and Transportation sectors has historically been the largest contributors of greenhouse gas emissions. The greenhouse gas emissions contribution from the Waste sector is relatively small compared to the three sectors reported in this inventory.

Stationary Energy sector was the largest contributor of greenhouse gas emissions at 10.02 million tCO_2e which is 64.4% of BASIC level emissions. This was followed by the Transportation sector at 4.63 million tCO_2e which is 29.7% of BASIC level emissions. The Waste sector contributed 0.91 million tCO_2e of greenhouse gas emissions which is only 5.9% of BASIC level emissions (Figure 3).

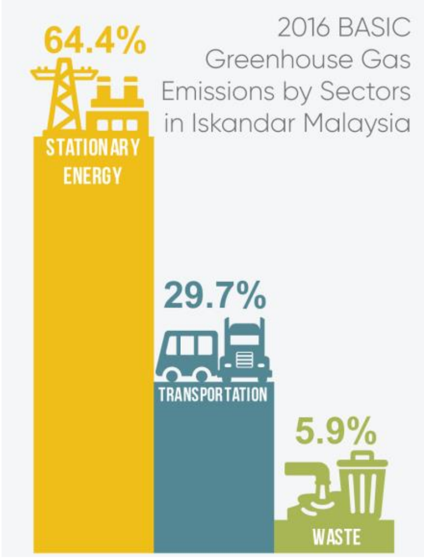


Figure 3: Percentage of greenhouse gas emissions by sectors in Iskandar Malaysia

Stationary Energy

The Stationary Energy sector covers greenhouse gas emissions from five subsectors as illustrated in Figure 4. For each subsector, except the Energy industries, greenhouse gas emissions from fuel use i.e. combustion of fossil fuels such as petroleum products, natural gas and emissions from grid supplied electricity were accounted. For the Energy industries subsector, greenhouse gas emissions from power plant auxiliary operations energy use and emissions from generation of grid-supplied energy were accounted.

Manufacturing industries and construction were the main contributor, which took up 51% of the greenhouse gas emissions from Stationary Energy sector. This was followed by the Commercial and institutional buildings and facilities at 23%, 16% Residential buildings, 8% Energy industries and a mere 2% from Agriculture, forestry and fishing activities (Figure 5).

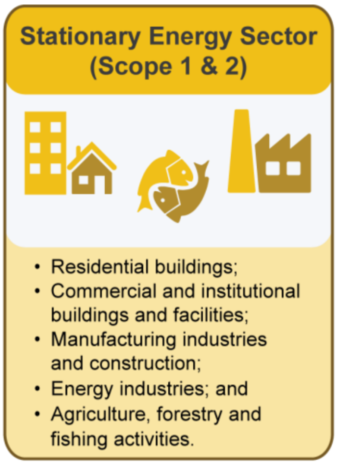


Figure 4: Coverage of Stationary Energy Sector

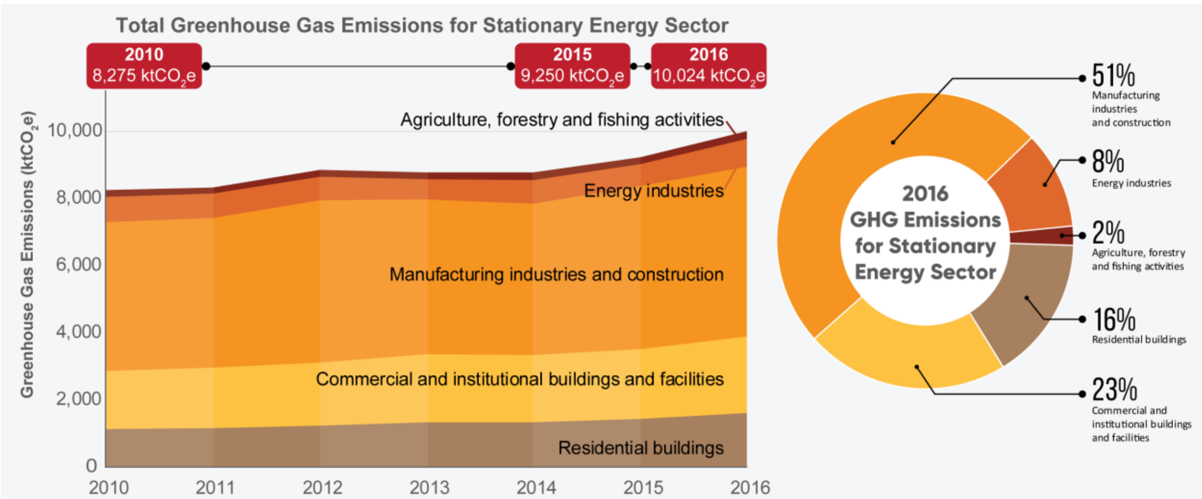


Figure 5: Greenhouse gas emissions for Stationary Energy Sector

Greenhouse Gas Emissions from Fuel/Energy Use

The emissions from fuel combustion for all Stationary Energy subsectors (energy use for auxiliary operations for Energy industries subsector) have remained largely consistent from 2010 to 2016 (Figure 6). Greenhouse gas emissions from fuel use in Manufacturing industries and construction appear to cycle upwards and downwards every 2 to 3 years. This reflects the fluctuations of industrial GDP within Iskandar Malaysia. Greenhouse gas emissions from the Energy Industries subsector for energy use for auxiliary operations also appear to fluctuate slightly between the years 2010 and 2016. The variation is most likely due to the occurrence of power plant outages leading to decreased power generation activity, hence lower emissions. However, there is a significant increase in greenhouse gas emissions from 2015 to 2016. The increase can largely be attributed to the operations of a new 1,000MW coal-fired power plant, Tanjung Bin Energy located within the region.

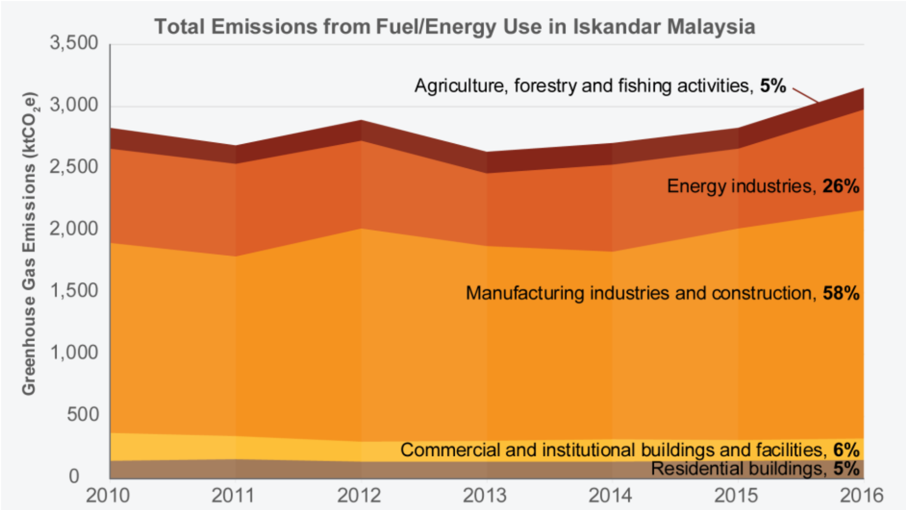


Figure 6: Greenhouse gas emissions from fuel/energy use by Stationary Energy Sector

From 2010 to 2016, the greenhouse gas emissions from fuel use for Commercial and institutional buildings and facilities have shown a decreasing trend. Fuel use emissions for Residential buildings and Agriculture, forestry and fishing activities meanwhile, have not shown significant variation from 2010 to 2016.

Greenhouse Gas Emissions from Consumption of Grid-supplied Energy

The greenhouse gas emissions from consumption of grid-supplied energy have historically accounted for a significant amount of emissions for the Stationary Energy sector (Figure 7).

From 2010 to 2016, the emissions from consumption of grid-supplied energy had shown tremendous growth across all subsectors. The average annual growth rate of emissions from grid-

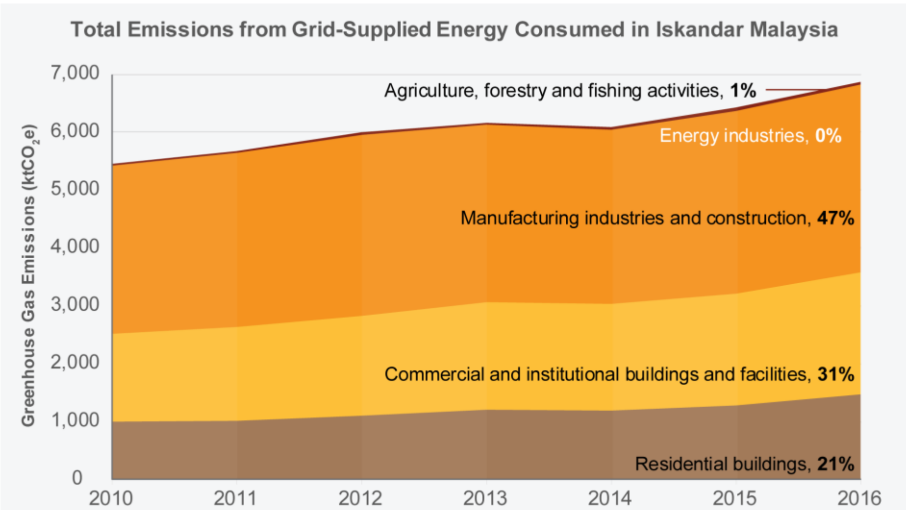


Figure 7: Greenhouse gas emissions from grid-supplied energy consumed by Stationary Energy subsectors

supplied energy consumption is 6.7% for Residential buildings, 5.6% for Commercial and institutional buildings and facilities, 1.8% for Manufacturing industries and construction, and 12.7% for Agriculture, forestry and fishing activities.

There are likely to be multiple factors behind the rapid growth of greenhouse gas emissions from consumption of grid-supplied energy among the Stationary Energy subsectors. It should be noted that a detailed study concerning this phenomenon would be advantageous for policymakers to gain more information concerning the significant increase in emissions associated with grid-supplied energy consumption over the past years. In this inventory, we suggest that population growth, improvements in living standards, and climate change are the three big factors that most likely are largely responsible for the rapid growth in grid supplied energy use emissions.

The population growth in Iskandar Malaysia had averaged 3.8% each year from 2010 to 2016. **The population growth rate of Iskandar Malaysia had been higher compared to the population growth in Peninsular Malaysia** which averaged 1.6% each year from 2010 to 2016. However, the growth rate of greenhouse gas emissions from grid-supplied energy within Iskandar Malaysia far outpaces the economic region's population growth. Population growth alone is not sufficient as an explanation for the rise in grid-supplied energy consumption emissions but is a contributing factor.

The other possible significant factor could be the improvements in living standards for people living in Iskandar Malaysia. This is challenging to account for quantitatively. However, GDP data could be used as an indication of the relative wealth in Iskandar Malaysia. From 2010 to 2016, Iskandar Malaysia's GDP had grown each year at an average rate of 6.7%. GDP per capita meanwhile had grown at an average annual rate of 2.8%. In 2010, the GDP per capita was RM29,515. By 2016, GDP per capita had increased by 17.8% to RM34,757. Note that GDP data is in 2010 (base year) constant price.

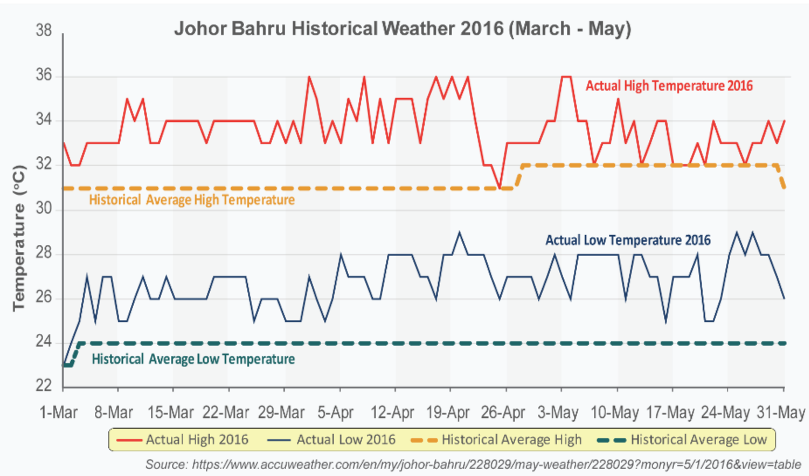


Figure 8: Unusually high ambient temperature recorded in 2016 compared to historical records

The third possible factor is climate change, specifically the increase in ambient temperature and heatwave events which led to higher electricity consumption for cooling and ventilation purposes. According to the historical weather data, unusually high ambient temperatures were recorded from March to May 2016 (Figure 8).

In addition, the El-Nino effect had led to hot and dry weather in Peninsular Malaysia starting at the end of 2015 which Tenaga Nasional Berhad (TNB) alleged caused a spike in demand for electricity. TNB had a record demand for electricity in April 2016 hitting 17,788 MW due to heatwaves in the country (Figure 9)[3].

[3] New Straits Times (2016), *New record for electricity demand in Peninsular Malaysia,* https://www.nst.com.my/news/2016/04/140695/new-record-electricity-demand-peninsular-malaysia

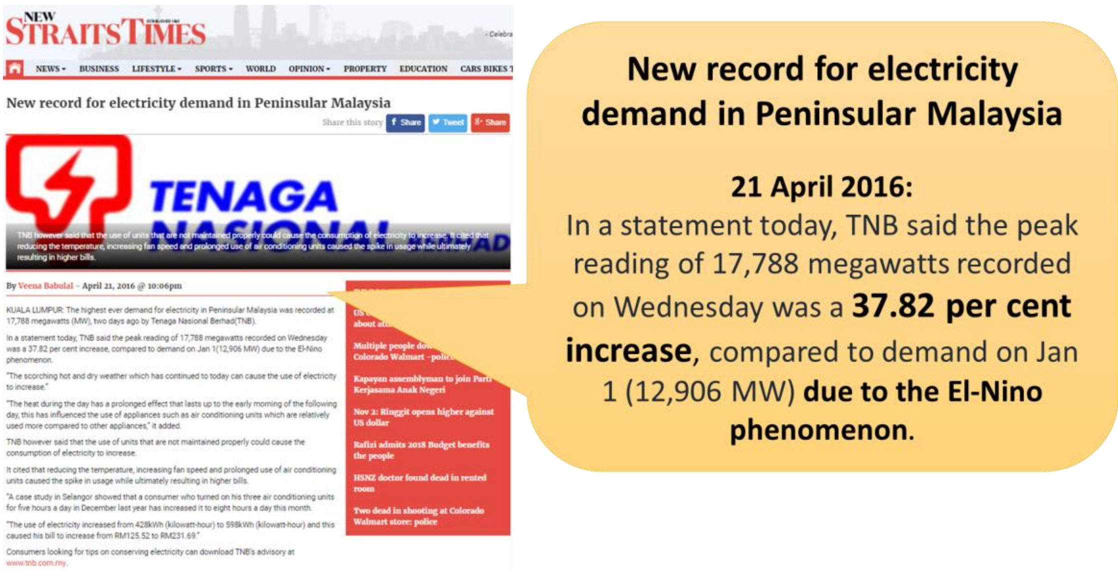


Figure 9: News from New Straits Times regarding new record for electricity demand in Peninsular Malaysia

Greenhouse Gas Emissions from the Energy Industries Subsector

The greenhouse gas emissions from the Energy Industries subsector comprises greenhouse gas emissions from fuel use and consumption of grid-supplied energy for power plant auxiliary operations, and the emissions from power generation supplied to the grid. According to GPC, only auxiliary operations' fuel use i.e. not used directly for energy generation were accounted in this BASIC reporting inventory. The emissions from power generation supplied to grid were calculated and accounted separately under territorial total greenhouse gas emissions.

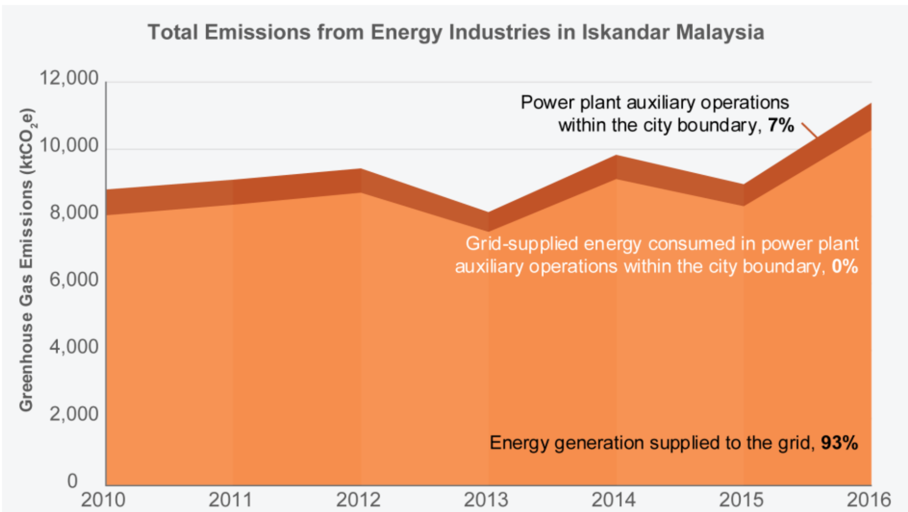


Figure 10: Greenhouse gas emissions for Energy Industries subsector

The greenhouse gas emissions from auxiliary operations appear to be stagnant over the years when compared to the emissions from energy generation supplied to the grid (Figure 10). From 2010 to 2015, the emissions from energy generation supplied to the grid had remained largely consistent ranging between 7.55 and 9.12 million tCO_2e, averaging 8.35 million tCO_2e. This was exceeded in 2016 when greenhouse gas emissions from power generation supplied to the grid amounted to 10.58 million tCO_2e. The increase represented an increase of 27.4% from 2015.

It should also be noted that although a natural gas-fired power plant (YTL Power Station) had been de-commissioned in September 2015, a new 1,000MW coal-fired power plant (Tanjung Bin Energy) had in fact come on-line in March 2016. This is likely the reason for the increase in greenhouse gas emissions for this subsector.

Transportation

The Transportation sector covers greenhouse gas emissions from three subsectors as shown in Figure 11. For each subsector, the emissions originate from fuel combustion e.g. natural gas and petroleum products. It should be noted that emissions from grid supplied electricity for the On-road and Off-road transportation subsectors have been included elsewhere (under Stationary Energy) while such emissions are non-occurring for the Railways subsector.

Figure 11: Coverage of Transportation Sector

On-road transportation is the main contributing subsector to Transportation emissions, which stands at 97.4% of the total emissions from 2016. From 2010 to 2016, the greenhouse gas emissions from the **On-road transportation subsector had seen rapid annual growth at an average rate of 8.9%**. Meanwhile, greenhouse gas emissions from Railways and Off-road transportation had remained relatively stable over the years, and only contribute a minimal of 0.3% and 2.2% respectively for emissions in 2016.

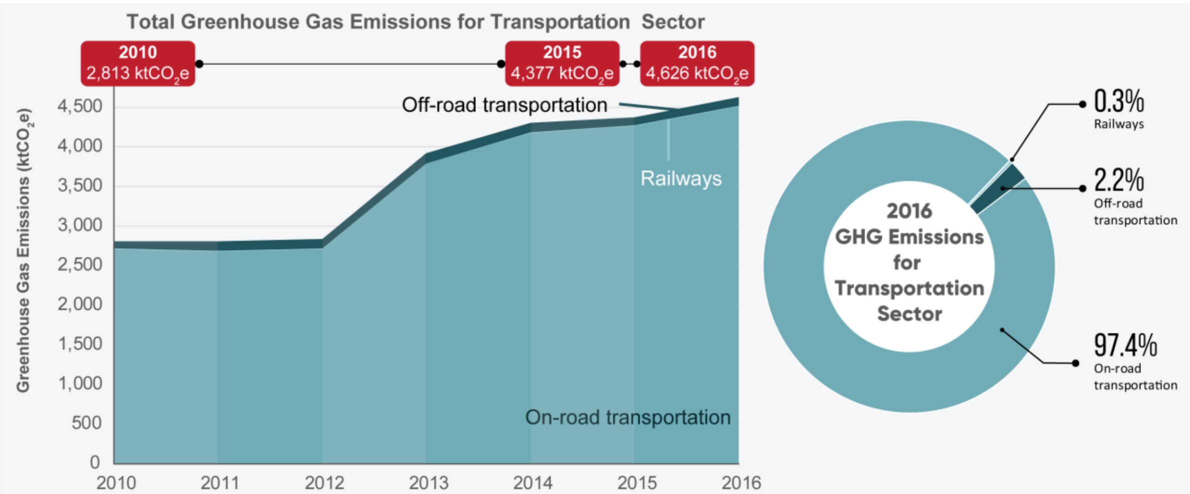


Figure 12: Greenhouse gas emissions for Transportation Sector

In 2016, the greenhouse gas emissions from On-road transportation were 4.51 million tCO_2e, the highest for the past 6 years (Figure 12). This was also an increase of 5.7% compared to the previous year's inventory. The increase in emissions may be due to a combination of factors including the unusual heat wave mentioned above (higher fuel consumption due to higher usage of air-conditioners), population growth in Iskandar Malaysia as well as significantly cheaper fuel prices throughout 2016 compared to 2015.

Waste

The Waste sector covers greenhouse gas emissions from two subsectors as shown in Figure 13. The greenhouse gas emissions contribution from the Waste sector is relatively small compared to the Stationary Energy and Transportation sector. In 2016, the total of 914 $ktCO_2e$ of greenhouse gas emissions from Waste sector were constituted of 68% emissions from solid waste disposal and 32% emissions from wastewater treatment and discharge.

From 2010 to 2016, the average annual growth rate of greenhouse gas emissions generated from solid waste disposed within Iskandar Malaysia is 4.5%. This rate of increase roughly corresponds to the average population growth in Iskandar Malaysia.

Figure 13: Coverage of Waste Sector

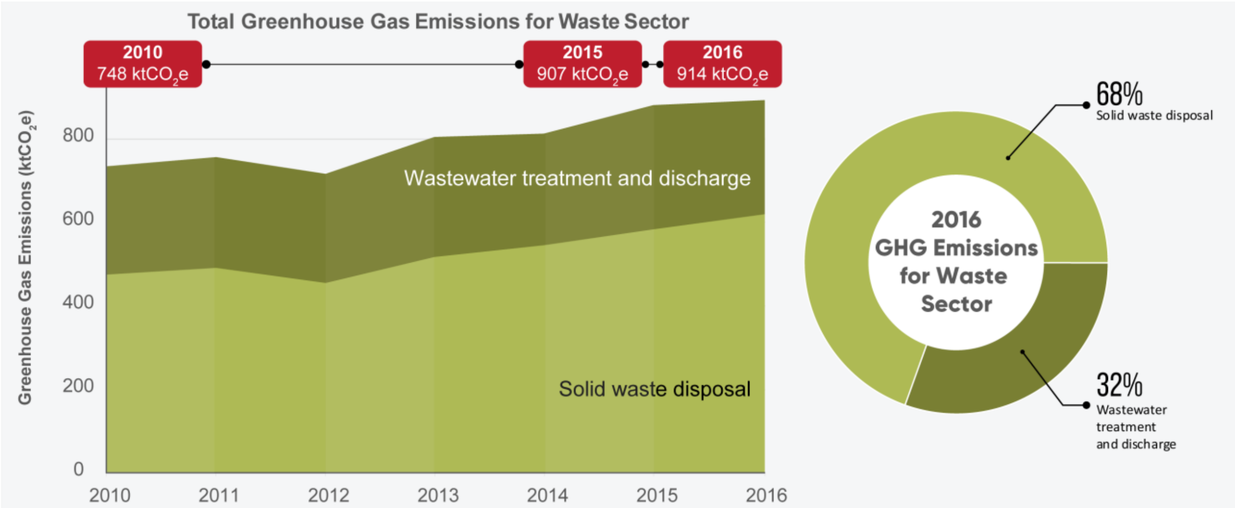


Figure 14: Greenhouse gas emissions from Waste Sector

The greenhouse gas emissions from wastewater treatment has remained largely unchanged from 2010 to 2016 (Figure 14). The average growth rate in emissions associated with wastewater treatment is 1.3%.

In 2016, the emissions from wastewater treatment decreased by 8.9% to 0.29 million tCO_2e compared to the previous year's inventory. The likely reason for the decrease is the upgrade in wastewater treatment technology used by the local councils. According to data obtained from 3 local councils, the use of centralised aerobic treatment plant had increased while treatment methods using anaerobic reactors and anaerobic shallow lagoons had decreased between 2015 and 2016.

Emissions Intensity

In 2016, the emissions intensity by GDP of Iskandar Malaysia was 0.2217 ktCO_2e/RM million (2010 constant price). This is a slight decrease of 0.2% from the 2015 emissions intensity of 0.2221 ktCO_2e/RM million (Figure 15).

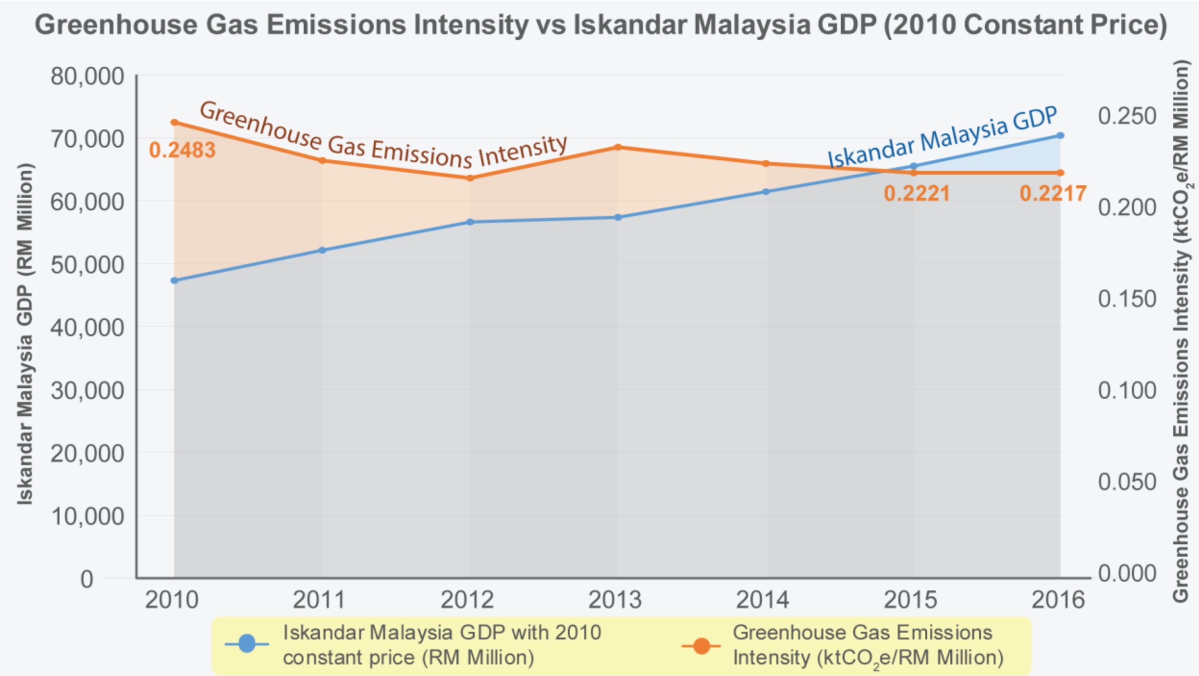
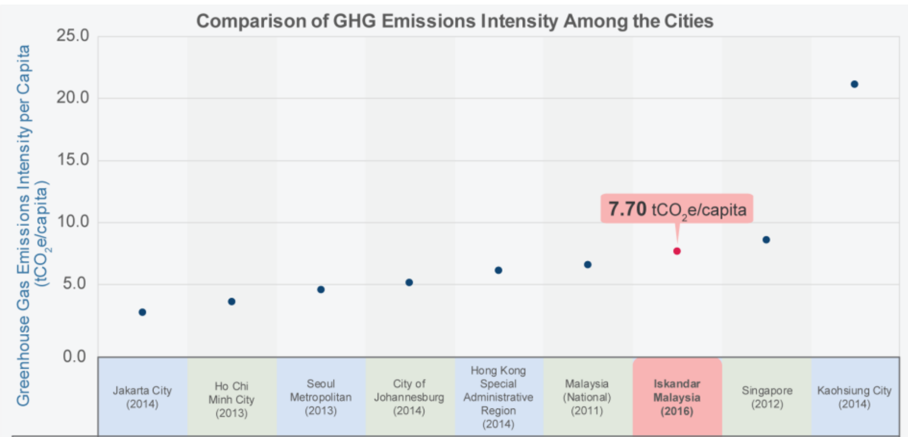


Figure 15: All BASIC emissions intensity vs Iskandar Malaysia GDP (at 2010 constant price)

Benchmarking

A comparison of greenhouse gas emissions was made between selected cities which have disclosed their greenhouse gas inventory to CDP[4]. These cities measured GHG emissions between years the 2011 to 2016 (Figure 16).



	Jakarta City (2014)	Ho Chi Minh City (2013)	Seoul Metropolitan (2013)	City of Johannesburg (2014)	Hong Kong Special Administrative Region (2014)	Malaysia (National) (2011)	Iskandar Malaysia (2016)	Singapore (2012)	Kaohsiung City (2014)
Current Population	10,075,300	8,244,400	10,297,138	4,764,381	7,336,600	29,100,000	2,020,000	5,600,000	2,778,729
Land area (km2)	662	2,095	605	1,645	1,105	330,803	2,300	719	2,947

Figure 16: Benchmarking with other cities

Iskandar Malaysia greenhouse gas emissions intensity falls in the third higher range among the 9 selected cities. The greenhouse gas emissions intensity per capita (7.70 tCO_2e/capita) for emissions year 2016 were higher compared to other cities as Iskandar Malaysia is a developing city-

[4] CDP, formerly the Carbon Disclosure Project, runs the global disclosure system that enables companies, cities, states and regions to measure and manage their environmental impacts. For more information about CDP, please visit to https://www.cdp.net/en

region thus the population was relatively lower compared with others. It should be noted that the comparison above should be treated as indicative only due to the lack of publicly available reports (at detailed reporting level) for other countries in the sample. Greenhouse gas emissions for Iskandar Malaysia were measured based on GPC BASIC reporting and used the 2006 IPCC Guidelines for National Greenhouse Gas Inventories for its calculation methodologies. The other cities' inventories might have different coverage and different calculation methodologies.

Greenhouse Gas Emissions Reduction Initiatives

For 2016, Iskandar Malaysia had continued to strive to implement initiatives that promote a low carbon society in the economic region. Among the various initiatives include policies, guidelines, renewable energy projects (under SEDA) as well as community programmes that seek to raise awareness and recognition of the importance of sustainability in the development of Iskandar Malaysia. More importantly, beyond immediate and short-term impacts, these initiatives seek to bring about long-term and lasting impact on greenhouse gas emissions in Iskandar Malaysia.

The initiatives that were launched or carried out in 2016 are:

- Johor Sustainability Policy 2017-2021
- Green Economy Guidelines Manual 2014
- Green Accord Initiative Award (GAIA)
- Iskandar Malaysia Eco-Life Challenge (IMELC) School Project
- Electric vehicle (EV) and EV charging points
- Hutan Kita Iskandar Malaysia – Tree Planting Programme
- Iskandar Malaysia Urban Farming Programme

Green Economy Guidelines Manual 2014

The Green Economy Guidelines seek to provide guidance for businesses to implement sustainable practices in business with a focus on seven key areas:

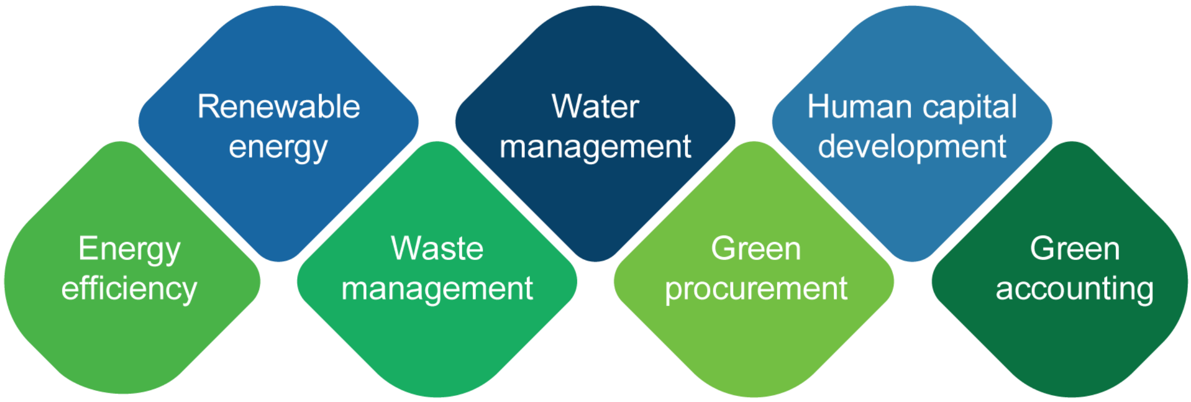


Figure 17: Seven key areas in practicing sustainability in businesses

The guidelines cover nine promoted sectors within Iskandar Malaysia including creative industry, education industry, electrical and electronics industry, financial services and real estate industry, food and agro-processing industry, healthcare industry, logistics industry, oil, gas and petrochemical industry and tourism industry.

Green Accord Initiative Award (GAIA)

The Green Accord Initiative Award (GAIA) by IRDA focuses particularly on the built environment. The initiative rewards organisations that have adopted sustainable design, planning, retrofitting and operation in their buildings. The guiding measures of the GAIA initiative are:

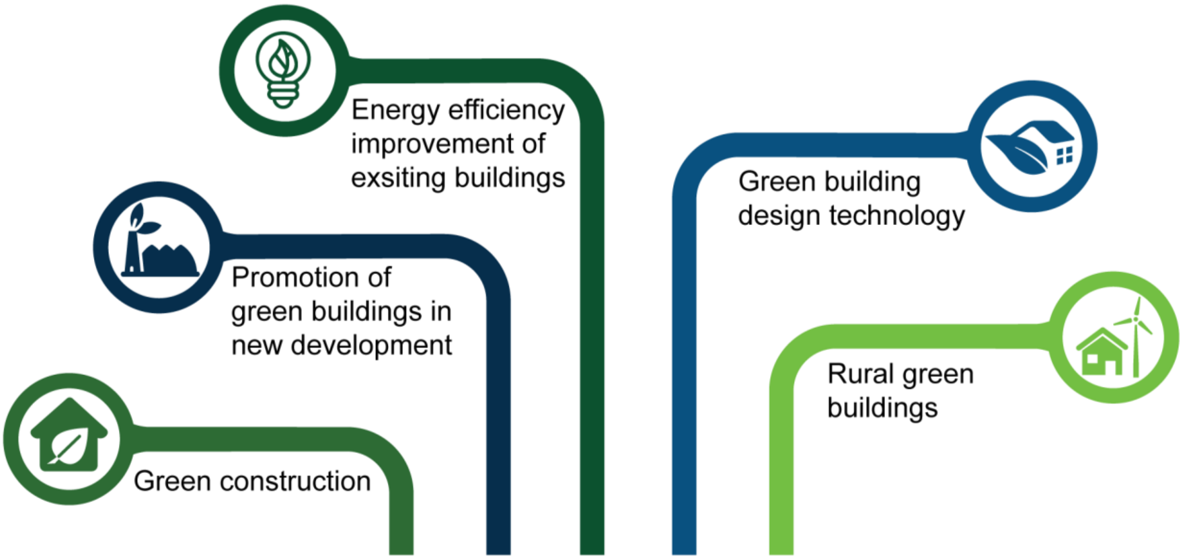


Figure 18: Guiding measures of the GAIA initiative

Iskandar Malaysia Eco-Life Challenge (IMELC) School Project

Figure 19: Initiative of IRDA in educating the youngsters on sustainability and ecological awareness

The Iskandar Malaysia Eco-Life Challenge (IMELC) School Project is an activity for all primary year 6 students in schools within Iskandar Malaysia. The project, implemented through cross collaboration between different governmental bodies, authorities and institutions, aims to educate the next generation on sustainability and ecological awareness. The parties involved in its implementation include IRDA, UTM, Jabatan Pendidikan Negeri Johor (JPNJ) and Medini Iskandar Malaysia Sdn Bhd (MIM)[5]. In 2016, the project was participated by 27,125 Year 6 students from 231 primary schools.

[5] The ISKANDARIAN, Iskandar Malaysia's Official Newspaper (2016), *Iskandar Malaysia to achieve its Carbon Reduction Targets by Year 2025*, https://www.theiskandarian.com/web/iskandar-malaysia-to-achieve-its-carbon-reduction-targets-by-year-2025/

Electric vehicle (EV) and EV charging points

IRDA together with Greentech Malaysia have been building critical charging infrastructure needed to support the use of electric vehicles in the economic region. Currently, there are 12 locations in Iskandar Malaysia where charging stations can be found.

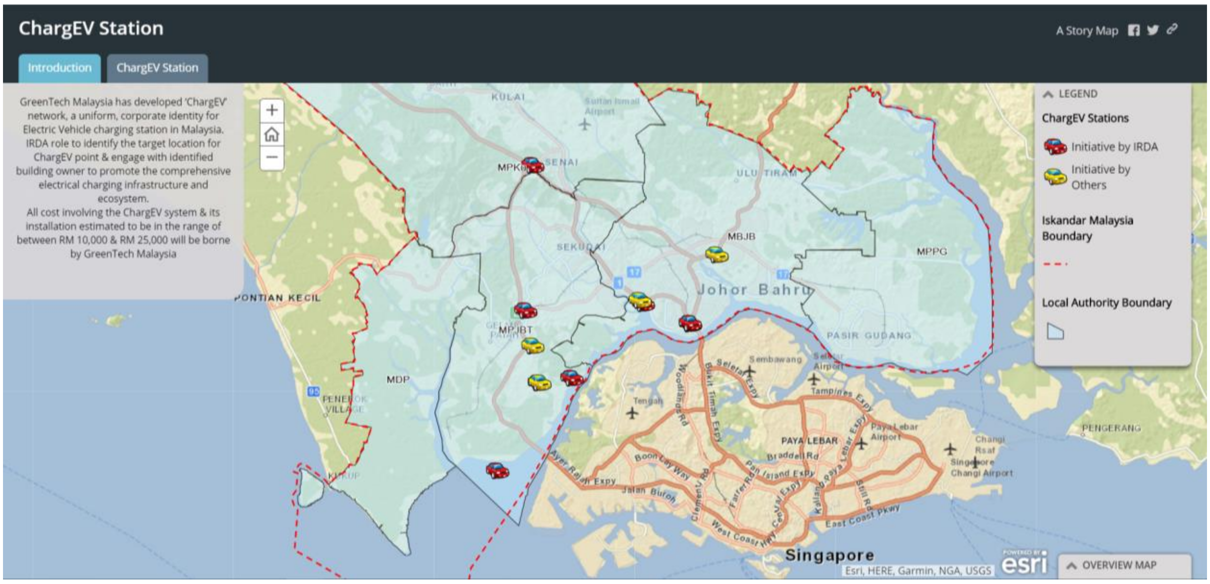


Figure 20: Electric vehicle charging points in Iskandar Malaysia

Figure 21: Charging points at IRDA office (Left) and charging point at Forest City (Right)

Hutan Kita Iskandar Malaysia – Tree Planting Programme

Through the Hutan Kita Iskandar Malaysia tree planting programme, a total of 1,000 trees of various species were planted in 2016 at Iskandar Puteri. The programme was jointly carried out by IRDA, Johor Bahru Central Municipal Council, Medini Iskandar Malaysia Sdn. Bhd. and Landskap Malaysia.[6]

Figure 22: Green effort shown by tree planting programme at Iskandar Puteri

Renewable Energy Installations

In 2016, Iskandar Malaysia saw the addition of 86 renewable energy installations with a total installed capacity of 4.77 MW This brings the total installed capacity of renewable energy installations within the economic region to 14.41 MW (424 projects in total). The projects are predominantly solar photovoltaic (PV) installations with biogas installations taking up a very small share. The contribution of power generation from renewable energy, specifically PV and biogas continues to grow significantly since the start of SEDA's feed-in-tariff scheme in 2012.

From 2012 to 2016, electricity generated by renewable energy installations saw significant growth at an average annual growth rate of 97%. In 2016, a total of 10,433,034 kWh of electricity was generated from renewable energy installation (Figure 23). This is sufficient to provide power to more than 2,800 households for an entire year. The contribution of renewable energy installations to power generation in Iskandar Malaysia is expected to continue to grow in the coming years given a steady pipeline of projects under developments in 2017.

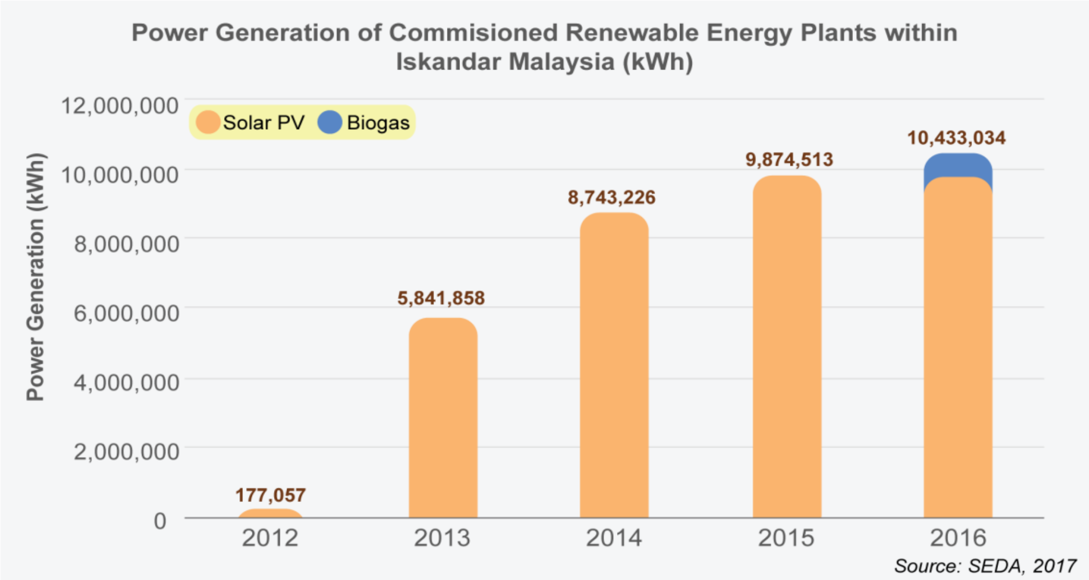


Figure 23: Power generation of Commissioned RE plants within Iskandar Malaysia (kWh)

[6] The Star Online (2016), *A green effort*, https://www.thestar.com.my/metro/community/2016/06/06/a-green-effort-programme-aims-to-develop-more-recreational-areas-of-international-standard-and-impro/

CONCLUDING REMARKS & WAY FORWARD 4

Conclusion

In 2016, Iskandar Malaysia's territorial greenhouse gas emissions were 19.33 million tCO_2e while BASIC greenhouse gas emissions were 15.56 million tCO_2e. This was an increase from 2015 greenhouse gas emissions. The increase corresponds to the significant economic growth seen in the economic region from 2015 to 2016. GDP growth from 2015 to 2016 was estimated to be 7.3%[7] while Iskandar Malaysia's GDP per capita was RM 34,757 in 2016.

The base year 2010 emissions intensity of GDP was 0.2483 $ktCO_2e$/RM million. From 2010 to 2016, the emissions intensity of GDP had decreased by a significant 10.7% to 0.2217 $ktCO_2e$/RM million.

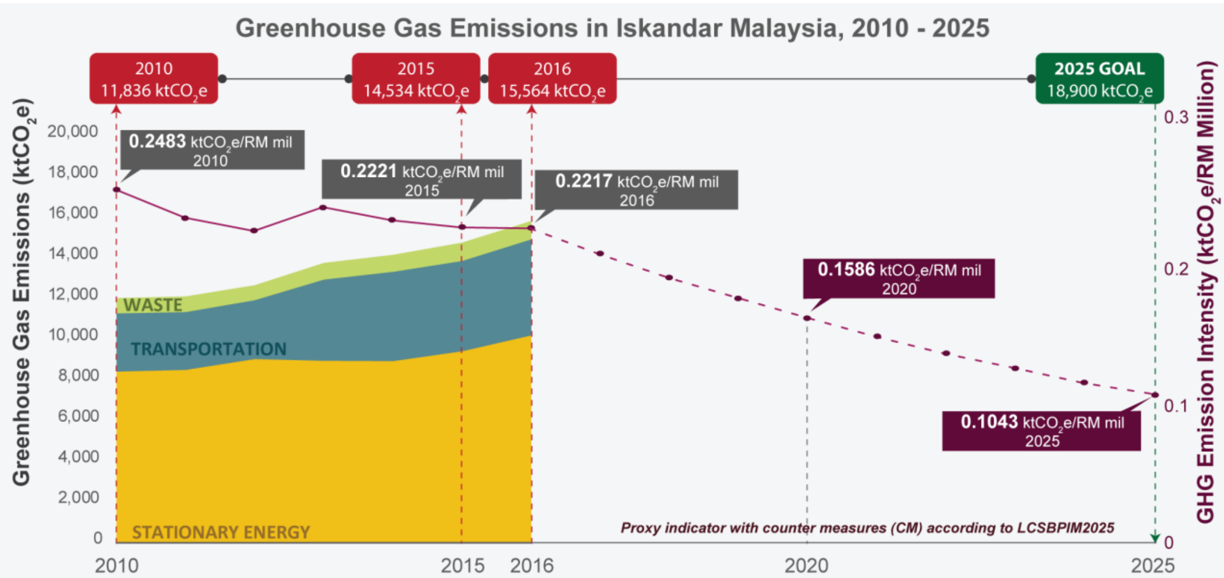


Figure 24: Towards achieving greenhouse gas emissions reductions target

[7] GDP growth performance: Malaysia, Johor and Iskandar Malaysia, 2017 IM BizWatch Regional Scan

The emissions intensity of GDP for 2016 was 0.2217 $ktCO_2e$/RM million a marginal decrease of 0.2% from 0.2221 $ktCO_2e$/RM million in 2015 (Figure 24). The Low Carbon Society Blueprint had set out an emissions intensity reduction goal of 58% from base year by 2025. The base year 2010 emissions intensity of GDP was 0.2483 $ktCO_2e$/RM million. In order to realise the emissions intensity reduction goal, the emissions intensity at 2025 would need to be 0.1043 $ktCO_2e$/RM million. The required average annual rate of reduction to meet the emissions intensity reduction goal is 8.0% from 2017 onwards.

Iskandar Malaysia is a rapidly developing economic region and is poised to see continued high growth in the coming years leading to 2025. Increasing levels of greenhouse gas emissions from the region would therefore be unavoidable corresponding with the increasing levels of development. Efforts towards emissions intensity reduction will need to be significantly stepped up in order to meet the 58% reduction by 2025. Iskandar Malaysia would need to attract more low carbon investments and adopt high impact policies and actions to reduce total greenhouse gas emissions from the region. Iskandar Malaysia could also consider the use of carbon offsets by entities operating within the economic region to neutralise their greenhouse gas emissions.

This 2016 inventory is the second greenhouse gas inventory for Iskandar Malaysia and adopted recommendations from the previous year's findings. The year 2010 was set as the base year to better reflect Iskandar Malaysia's development as an economic region over the years. Previous year's inventory had used 2005 as the base year and as such emissions intensity figures from that inventory are no longer comparable. Various improvements in data and methodologies have also been implemented for this inventory.

Figure 25: The second Focus Group Discussion held in November 2017 attended by policymakers and stakeholders in Iskandar Malaysia

Based on the findings of this 2016 inventory, we recommend that policymakers and stakeholders conduct an in-depth review of the progress towards reduction of greenhouse gas emissions intensity including the setting of emissions target. The inventory seeks to provide a starting point for the further development of policies and targeted action plans towards meeting Iskandar Malaysia's greenhouse gas emissions mitigation goal.

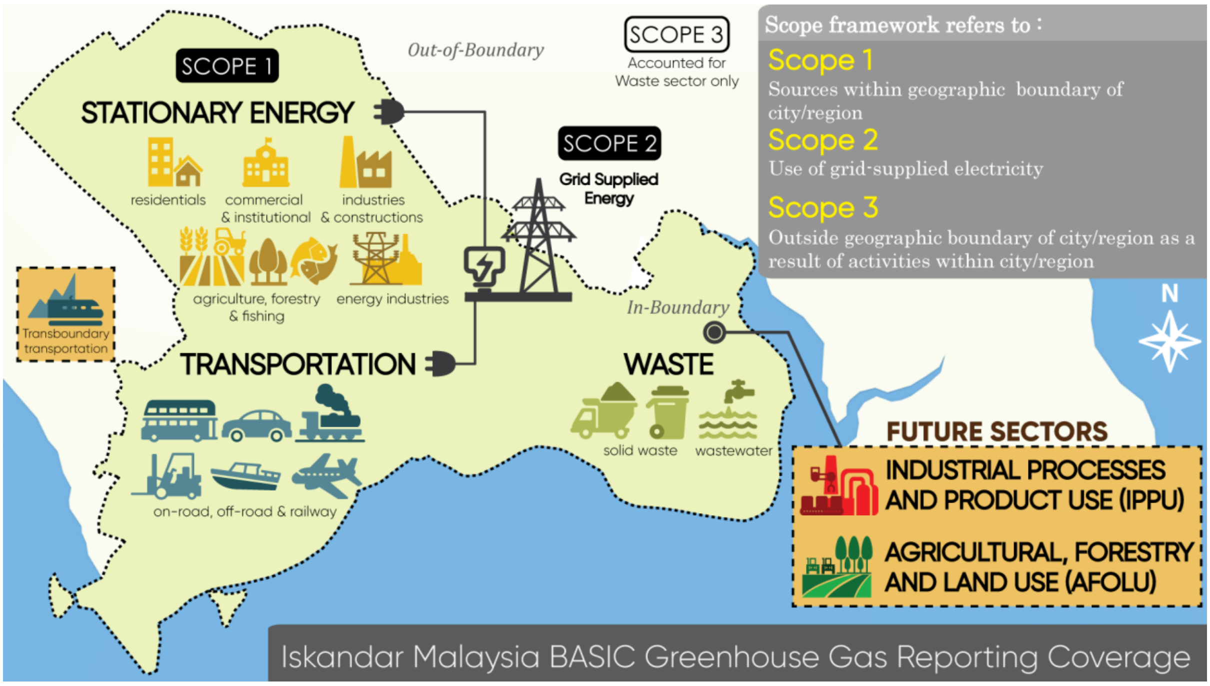


Figure 26: Recommended future coverage for GPC BASIC+ compliant

Moving forward, it is recommended that future inventories should be GPC BASIC+ compliant which further includes greenhouse gas emissions from:

(i) Industrial Processes and Product Use (IPPU)
(ii) Agricultural, Forestry and Land Use (AFOLU)
(iii) Transboundary transportation

The BASIC+ reporting level would provide a more detailed understanding of greenhouse gas emissions from Iskandar Malaysia to better track and monitor progress of mitigation efforts in the future.

Disclaimer

The findings, interpretations and conclusions expressed in this inventory were based, in whole or in part, on information and data provided (including third party data) and made available, which is beyond the control of IRDA and its Consultant. The team has used its best endeavour to process data, information and observations in the most professional and qualified manner but does not give warranty whatsoever, including without limitation, as to the availability, accuracy, completeness or reliability of the information or data included in this inventory, and expressly disclaim all liability for any damage or loss resulting from usage of, or reliance on this inventory or the information and data provided via this inventory.

DEFAULT VALUES AND EMISSION FACTORS

General Data

1. **Population**

Population (million)	2010	2011	2012	2013	2014	2015	2016
Malaysia	28.59	29.06	29.51	30.21	30.71	31.19	31.63
Peninsular Malaysia	22.8	23.1	23.4	23.9	24.3	24.7	25.0
Johor	3.36	3.40	3.45	3.47	3.56	3.61	3.65
Iskandar Malaysia	1.62	1.68	1.74	1.81	1.87	1.95	2.02

Source:

1. *Malaysia, Peninsular Malaysia & Johor Population 2010 – 2016: Department of Statistics Malaysia, http://pqi.stats.gov.my/searchBI.php*
2. *Iskandar Malaysia Population 2010 – 2016: Unit Perancang Ekonomi Negeri Johor (UPENJ)*

3. **GDP at constant price 2010**

Year	2010	2011	2012	2013	2014	2015	2016
Total GDP (RM Million)							
Peninsular Malaysia	672,787	709,029	752,858	789,216	838,940	881,462	920,164
Johor	74,102	78,946	84,050	87,974	93,654	98,889	104,480
Iskandar Malaysia	47,667	52,256	56,731	57,431	61,370	65,433	70,210
Industrial GDP (RM Million)							
Peninsular Malaysia	294,877	304,571	320,975	331,438	350,082	366,559	376,304
Johor	38,968	40,912	43,319	45,051	48,226	51,235	53,669
Iskandar Malaysia	21,533	23,147	25,177	25,026	27,159	29,036	31,083

Source:

1. *Peninsular Malaysia & Johor GDP 2010 – 2016: Department of Statistics Malaysia, https://www.dosm.gov.my/v1/uploads/files/1_Articles_By_Themes/National%20Accounts/GDPbyState/Table%20Publication%20GDP%202010-2016.pdf*
2. *Iskandar Malaysia GDP 2010 – 2015: Unit Perancang Ekonomi Negeri Johor (UPENJ)*
3. *Iskandar Malaysia GDP 2016: UPENJ, Johor Economic Report 2015 – 2016, Page 88, Table 4.6*

Note:

1. *GDP for Peninsular Malaysia including Supra State (Supra State covers production activities that are beyond the centre of predominant economic interest for any state)*
2. *The added total may differ due to rounding*
3. *GDP for Iskandar Malaysia 2010 - 2012 are adjusted to 2010 constant price to ensure consistency in data, with Consumer Price Index obtained from Bank Negara Malaysia*

Default Values

1. Net Calorific Value (NCV)

Type of Fuel	Net Calorific Value (NCV) (TJ/Gg)
Natural Gas	48.0
Petrol	44.3
Diesel	43.0
Fuel Oil	40.4
LPG	47.3
Kerosene	43.8
Coal & Coke	18.9
Biodiesel	27.0

Assumption:

1. *Source of fuel for fuel oil is assumed to be residual fuel oil*
2. *Source of fuel for kerosene is assumed to be other kerosene*
3. *Source of fuel for coal & coke is assumed to be sub-bituminous coal*

Source:

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.18 – 1.19, Table 1.2

2. Global Warming Potential (GWP)

Type of Gas	Global Warming Potential (GWP)
CO_2	1
CH_4	28
N_2O	265

Source:

IPCC Fifth Assessment Report 2014 (AR5)

3. Default Values for Industrial Wastewater

Parameter	Value Applied
Maximum Methane Producing Capacity (B_o) for anaerobic deep lagoon (depth > 2m)	0.25 kg CH_4/kg COD
Methane Correction Factor (MCF)	0.8

Source:

1. *Maximum methane producing capacity (B_o): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2*
2. *Methane Correction Factor (MCF): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.21, Table 6.8*

4. Default Values for Solid Waste

Parameter	Value Applied
Methane Generation Rate Constant (k)	
-k $_{\text{paper/textile}}$	0.07
-k $_{\text{wood}}$	0.035
-k $_{\text{garden/park waste}}$	0.17
-k $_{\text{food waste/sewage sludge}}$	0.4
Oxidation Factor (OX)	
-Managed landfill	0.1
-Unmanaged landfill	0.0
Fraction of Methane (CH_4)	0.5
Fraction of Degradable Organic Carbon ($DOC_{f,y}$)	0.5
Methane Correction Factor (MCF)	
- Managed landfill	1.0
- Unmanaged landfill	0.8
Degradable Organic Carbon (DOC)	
-Wood and wood products	43%
-Pulp, paper and cardboard (other than sludge)	40%
-Food, food waste, beverages and tobacco (other than sludge)	15%
-Textiles	24%
-Garden, yard and park waste	20%
-Glass, plastic, metal, other inert waste	0%
-Nappies	24%

Source:

1. *Methane generation rate constant (k): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.17, Table 3.3, Default value for Tropical (MAT > 20°C), Moist and Wet (MAP ≥ 1000mm)*
2. *Oxidation factor (OX): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.17, Table 3.25*
3. *Degradable Organic Carbon (DOC): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 2, Page 2.14, Table 2.4*
4. *Fraction of Methane (CH_4): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.26*
5. *Fraction of Degradable Organic Carbon ($DOC_{f,y}$): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.13*
6. *Methane Correction Factor (MCF): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.14, Table 3.1*

5. Default Values for Domestic Wastewater

Parameter	Value Applied
Maximum Methane Producing Capacity (B_o)	
-Centralized, aerobic treatment plant	0.6
-Anaerobic reactor	0.6
-Anaerobic shallow lagoon	0.6
-Sludge Drying Bed (DB)	0.6
-Sludge Lagoon (SL)	0.6
-Sludge Reception Facility (SRF)	0.6
Methane Correction Factor (MCF)	
-Centralized, aerobic treatment plant	0.0
-Anaerobic reactor	0.8
-Anaerobic shallow lagoon	0.2
-Sludge Drying Bed (DB)	0.2
-Sludge Lagoon (SL)	0.8
-Sludge Reception Facility (SRF)	0.0
Actual influent BOD in sewage sludge	668 mg/L
Correction factor for industrial BOD discharge in sewers	1
Fraction of Nitrogen in protein (FNPR)	0.16 kg N/kg protein
Fraction of non-consumption protein (FNON-CON)	1.4
Fraction of industrial and commercial co-discharged protein (FIND-COM)	1.25
Nitrogen removed with sludge (NSLUDGE) default value	0
Emission factor for N_2O	0.005 kg N_2O-N/kg N
Emissions from wastewater plants default value for N_2O	0 kgN_2O/year
Actual Influent TKN Concentration in sewage sludge	84 mg/L
Nitrogen removed with sludge	0 kg

Source:

1. *Maximum methane producing capacity (B_o) for domestic wastewater: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2*
2. *Methane Correction Factor (MCF): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.21, Table 6.8*
3. *Actual influent BOD in sewage sludge: UiTM's sampling & analysis*
4. *Fraction of Nitrogen in protein (FNPR): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, volume 5, Chapter 6, Page 6.25, Equation 6.8*
5. *Fraction of non-consumption protein (FNON-CON): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.27, Table 6.11*
6. *Fraction of industrial and commercial co-discharged protein (FIND-COM): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.27, Table 6.11*
7. *Emission factor for N_2O: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.27, Table 6.11*
8. *Actual influent TKN concentration in sewage sludge: UiTM's sampling & analysis*

Emission Factors

1. Stationary Energy

Type of Fuel	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)
Residential and Agriculture/Forestry/Fishing/Fishing Farms			
Natural Gas	56,100	5.0	0.1
Petrol	69,300	10.0	0.6
Diesel	74,100	10.0	0.6
Fuel Oil	77,400	10.0	0.6
LPG	63,100	5.0	0.1
Kerosene	71,900	10.0	0.6
Commercial / Institutional			
Natural Gas	56,100	5.0	0.1
Diesel	74,100	10.0	0.6
Fuel Oil	77,400	10.0	0.6
LPG	63,100	5.0	0.1
Manufacturing Industries & Construction			
Natural Gas	56,100	1.0	0.1
Petrol	69,300	3.0	0.6
Diesel	74,100	3.0	0.6
Fuel Oil	77,400	3.0	0.6
LPG	63,100	1.0	0.1
Kerosene	71,900	3.0	0.6
Coal & Coke	96,100	10.0	1.5
Energy Industries			
Natural Gas	56,100	1.0	0.1
Diesel	74,100	3.0	0.6
Fuel Oil	77,400	3.0	0.6
Coal & Coke	96,100	1.0	1.5

Assumption:

1. *Source of fuel for petrol is assumed to be motor gasoline*
2. *Source of fuel for fuel oil is assumed to be residual fuel oil*
3. *Source of fuel for kerosene is assumed to be other kerosene*
4. *Source of fuel for coal & coke is assumed to be sub-bituminous coal*

Source:

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 2, Page 2.16 – 2.23, Table 2.2 – 2.5

2. Transportation

Type of Fuel	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)
On-road Transportation			
Natural Gas	56,100	92.0	3.0
Petrol	69,300	33.0	3.2
Diesel Oil	74,100	3.9	3.9
Fuel Oil	77,400	3.0	0.6
Biodiesel	70,800	3.0	0.6

Assumption:

1. *Source of fuel for petrol is assumed to be motor gasoline (uncontrolled for CH_4 & N_2O)*
2. *Source of fuel for fuel oil is assumed to be residual fuel oil*
3. *CH_4 and N_2O emission factor of fuel oil and biodiesel are assumed to be the same as Stationary Combustion emission factors*

Source:

1. *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.23 – 1.24, Table 1.4*
2. *2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 3, Page 3.21, Table 3.2.2*

3. Grid

Year	Grid Emission Factor (tCO_2e/MWh)
2010	0.760
2011	0.747
2012	0.741
2013	0.742
2014	0.694
2015	0.694
2016	0.694

Assumption:

2015 and 2016 grid emission factor are assumed to be the same as 2014, as 2014 is the latest grid emission factor available

Source:

National grid EF from Grid Connected Electricity Baselines in Malaysia: 2013 & 2014, NCCDM 2-2015, Malaysian Green Technology Corporation

Appendix 1: Calculation Remarks

Data input and assumptions used for the calculation are tabulated below:

<table>
<tr><th>GPC Ref.</th><th>Scope</th><th>Basic Reporting</th><th>Activities</th><th>Remarks
(i.e. Data Input / Assumptions / Notation Key)</th></tr>
<tr><td>I</td><td colspan="4">Stationary Energy</td></tr>
<tr><td>I.1</td><td colspan="4">Residential Buildings</td></tr>
<tr><td>I.1.1</td><td>1</td><td>✓</td><td>Emissions from fuel combustion</td><td><u>Data Input:</u>
1. Natural gas, petroleum products and coal consumption data for Peninsular Malaysia was extracted from National Energy Balance 2010 - 2015. Data for 2016 was projected using average annual growth rate of fuel consumption from National Energy Balance 2015, Page 68, Table 26.
2. Fuel consumption for Iskandar Malaysia was estimated from the consumption of Peninsular Malaysia, using population as a scale down factor.
3. Fuel consumption by sectors in Peninsular Malaysia was estimated using the formula:
$$\begin{aligned}&\textbf{Fuel consumption}\\ &= \frac{Consumption\ of\ product\ in\ Peninsular\ Malaysia\ (thousand\ barrels)}{Consumption\ of\ product\ in\ Malaysia\ (thousand\ barrels)}\\ &\quad \times Consumption\ of\ product\ for\ all\ sectors\ in\ Malaysia\ (ktoe)\\ &\times \frac{Consumption\ of\ product\ for\ the\ particular\ sector\ in\ Malaysia\ (ktoe)}{Consumption\ of\ product\ for\ all\ sectors\ in\ Malaysia\ (ktoe)}\end{aligned}$$
4. Fuel GHG emissions was calculated using the formula:
$$\begin{aligned}&\textbf{Fuel GHG Emissions}\\ &\quad = Fuel\ consumption \times Emission\ factor\ of\ the\ fuel\ (CO_2, CH_4\ and\ N_2O)\\ &\qquad \times NCV\ of\ the\ fuel\end{aligned}$$</td></tr>
</table>

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				Assumption: 5. Fuel emission factors and NCV for: a. Petrol is assumed to be motor gasoline b. Fuel oil is assumed to be residual fuel oil c. Kerosene is assumed to be other kerosene d. Coal & coke is assumed to be sub-bituminous coal Source: 6. Fuel consumption data for Peninsular Malaysia 2010 – 2015: NEB 2010 – 2015 7. Malaysia, Peninsular Malaysia, Johor population 2010 – 2016: Department of Statistics Malaysia (DoSM), http://pqi.stats.gov.my/searchBI.php 8. Iskandar Malaysia population 2010 – 2016: Unit Perancang Ekonomi Negeri Johor (UPENJ) 9. Fuel emission factors: 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines for National Greenhouse Gas Inventories, Page 2.22 – 2.23, Table 2.5 10. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Page 1.18 – 1.19, Table 1.2 11. Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)
I.1.2	2	✓	Grid-supplied energy consumed	Data Input: 1. Grid-supplied energy consumption data was obtained from Suruhanjaya Tenaga (ST) for the whole Johor State. 2. Grid-supplied energy consumption for Iskandar Malaysia was estimated from the consumption of Johor, using population as a scale down factor. 3. GHG emissions from grid-supplied energy consumption was calculated using the formula: $\boldsymbol{Grid\ GHG\ emissions} = Grid\ consumption \times Grid\ emission\ factor\ for\ Peninsular\ Malaysia$

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				Assumption: 4. Grid emission factor for 2015 and 2016 were assumed to be the same as 2014, as 2014 is the latest grid emission factor available. Source: 5. Grid-supplied energy consumption Johor 2010 – 2016: ST 6. Johor population 2010 – 2016: DoSM, http://pqi.stats.gov.my/searchBI.php 7. Iskandar Malaysia population 2010 – 2016: UPENJ 8. Grid emission factor for Peninsular Malaysia 2010 – 2014: Malaysia Green Technology Corporation (MGTC)
I.1.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted under BASIC Reporting
I.2	**Commercial and Institutional Buildings and Facilities**			
I.2.1	1	✓	Emissions from fuel combustion	Same as I.1.1 Residential Buildings
I.2.2	2	✓	Grid-supplied energy consumed	Same as I.1.2 Residential Buildings
I.2.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted under BASIC Reporting
I.3	**Manufacturing Industries and Construction**			
I.3.1	1	✓	Emissions from fuel combustion	Data Input: 1. Natural gas, petroleum products and coal consumption data for Peninsular Malaysia was extracted from National Energy Balance 2010 - 2015. Data for 2016 was projected using average annual growth rate of fuel consumption from National Energy Balance 2015, Page 68, Table 26. 2. Fuel consumption for Iskandar Malaysia was estimated from the consumption of Peninsular Malaysia, using industrial GDP as a scale down factor.

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				3. Fuel consumption by sectors in Iskandar Malaysia was estimated using the formula: $\boldsymbol{Fuel\ consumption} = Fuel\ consumption\ of\ Peninsular\ Malaysia \times \frac{Iskandar\ Malaysia\ Industrial\ GDP\ at\ 2010\ constant\ price}{PeninsularMalaysia\ Industrial\ GDP\ at\ 2010\ constant\ price}$ 4. Fuel GHG emissions in Iskandar Malaysia was calculated using the formula: $\boldsymbol{Fuel\ GHG\ Emissions} = Fuel\ consumption \times Emission\ factor\ of\ the\ fuel \times NCV\ of\ the\ fuel$ <u>Assumption:</u> 5. Fuel emission factors and NCV for: a. Petrol is assumed to be motor gasoline b. Fuel oil is assumed to be residual fuel oil c. Kerosene is assumed to be other kerosene d. Coal & coke is assumed to be sub-bituminous coal 6. Iskandar Malaysia GDP 2010 – 2012 were adjusted to constant price 2010 to ensure consistency in data, using Consumer Price Index obtained from Bank Negara Malaysia. <u>Source:</u> 7. Fuel consumption data for Peninsular Malaysia 2010 – 2015: NEB 2010 - 2015 8. Malaysia GDP by state and kind of economic activity 2010 – 2016: DoSM, https://www.dosm.gov.my/v1/uploads/files/1_Articles_By_Themes/National%20Accounts/GDPbyState/Table%20Publication%20GDP%202010-2016.pdf 9. Iskandar Malaysia GDP by kind of economic activity 2010 – 2015: UPENJ 10. Iskandar Malaysia GDP by kind of economic activity 2016: UPENJ, Johor Economic Report 2015 – 2016, Page 88, Table 4.6

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				11. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Page 2.22 – 2.23, Table 2.5 12. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Page 1.18 – 1.19, Table 1.2 13. Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)
I.3.2	2	✓	Grid-supplied energy consumed	Data Input: 1. Grid-supplied energy consumption data was obtained from Suruhanjaya Tenaga (ST) for the whole Johor State. 2. Grid-supplied energy consumption for Iskandar Malaysia was estimated from the consumption of Johor, using industrial GDP as a scale down factor. 3. GHG emissions from grid-supplied energy consumption was calculated using the formula: $\boldsymbol{Grid\ GHG\ emissions} = Grid\ consumption \times Grid\ emission\ factor\ for\ Peninsular\ Malaysia$ Assumption: 4. Grid emission factor for 2015 and 2016 were assumed to be the same as 2014, as 2014 is the latest grid emission factor available. Source: 5. Grid-supplied energy consumption Johor 2010 – 2016: ST 6. Malaysia GDP by state and kind of economic activity 2010 – 2016: DoSM, https://www.dosm.gov.my/v1/uploads/files/1_Articles_By_Themes/National%20Accounts/GDPbyState/Table%20Publication%20GDP%202010-2016.pdf 7. Iskandar Malaysia GDP by kind of economic activity 2010 – 2015: UPENJ 8. Iskandar Malaysia GDP by kind of economic activity 2016: UPENJ, Johor Economic Report 2015 – 2016, Page 88, Table 4.6 9. Grid emission factor for Peninsular Malaysia 2010 – 2014: Malaysia Green Technology Corporation (MGTC)

<table>
<tr><th>GPC Ref.</th><th>Scope</th><th>Basic Reporting</th><th>Activities</th><th>Remarks
(i.e. Data Input / Assumptions / Notation Key)</th></tr>
<tr><td>I.3.3</td><td>3</td><td>×</td><td>Transmission and distribution losses from grid-supply energy</td><td>Not accounted under BASIC Reporting</td></tr>
<tr><td>I.4</td><td colspan="4">Energy Industries</td></tr>
<tr><td>I.4.1</td><td>1</td><td>✓</td><td>Emissions from energy used in power plant auxiliary operations</td><td><u>Data Input/Notes:</u>
1. Auxiliary electricity consumption for each power plants were obtained from the operators respectively.
2. GHG emissions from energy used in power plant auxiliary operations was calculated using the formula:
$\boldsymbol{GHG\ emissions\ from\ energy\ used\ in\ power\ plant\ auxiliary\ operation} = Auxiliary\ electricity\ consumptions \times Grid\ emission\ factor$
<u>Assumptions:</u>
3. It was assumed that all power plants obtained their auxiliary electricity consumption from their own generation, and not from grid-supplied energy.
4. Due to data unavailability of auxiliary electricity consumption for Sultan Iskandar Power Station, it is assumed that the power plant efficiency to be 47% and its auxiliary consumption is 9.92% of its gross energy generation consumption.
5. It is assumed that the emission factor for power plant is the same as grid emission factor due to data unavailability. Note that this assumption is conservative.
6. Grid emission factor for 2015 and 2016 were assumed to be the same as 2014, as 2014 is the latest grid emission factor available.

<u>Source:</u>
7. Efficiency and auxiliary consumption of Sultan Iskandar Power Plant estimated using power generation and unit sold to TNB: 2014 Performance and Statistical Information on Electricity Supply Industry in Malaysia, Page 11, Table 2.</td></tr>
<tr><td>I.4.2</td><td>2</td><td>✓</td><td>Emissions from grid-supplied energy consumed in power plant auxiliary operations</td><td>IE under Scope 2 Stationary Energy sector</td></tr>
</table>

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
I.4.3	3	×	Transmission and distribution losses from grid-supplied energy used in power plant auxiliary operations	Not accounted under BASIC Reporting
I.4.4	1	✓	Emission from energy generation supplied to the grid	<u>Data Input:</u> 1. Fuel consumption by each power plants were obtained from the operators respectively. 2. YTL Power Station in Pasir Gudang was not in operation since October 2015 due to expired PPA, hence there are no fuel consumption for energy generation since then. 3. Average annual growth rate of fuel consumption from National Energy Balance 2015, Page 68, Table 26 was used for backcasting when data was not available. 4. Total GHG emissions for Energy Industries in Iskandar Malaysia was calculated using the formula: $\boldsymbol{Fuel\ GHG\ Emissions} = (Fuel\ consumption\ of\ power\ plants\ in\ Iskandar\ Malaysia \times Emission\ factor\ of\ fuel \times NCV\ of\ fuel \times GWP) - (GHG\ emissions\ from\ energy\ used\ in\ power\ plant\ auxiliary\ operation)$ <u>Source:</u> 5. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Page 2.22 – 2.23, Table 2.5 6. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Page 1.18 – 1.19, Table 1.2 7. Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
I.5	**Agriculture, Forestry and Fishing Activities**			
I.5.1	1	✓	Emissions from fuel combustion	Same as I.1.1 Residential Buildings
I.5.2	2	✓	Grid-supplied energy consumed	Same as I.1.2 Residential Buildings
I.5.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted under BASIC Reporting
I.6	**Non-Specified Sources**			
I.6.1	1	✓	Emissions from fuel combustion	NE
I.6.2	2	✓	Grid-supplied energy consumed	NE
I.6.3	3	×	Emissions from transmission and distribution losses from grid-supply energy	Not accounted under BASIC Reporting
I.7	**Fugitive Emissions from Mining, Processing, Storage and Transportation of Coal**			
I.7.1	1	✓	Fugitive emission from mining, processing, storage and transportation of coal within the boundary	NO

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
I.8	**Fugitive Emissions from Oil and Natural Gas System**			
I.8.1	1	✓	Fugitive emissions from oil and natural gas system within the city boundary	NO
II	**Transportation**			
II.1	**On-road Transportation**			
II.1.1	1	✓	Emissions from fuel combustion	<u>Data Input:</u> 1. Natural gas and petroleum products consumption data for Peninsular Malaysia was extracted from National Energy Balance 2010 - 2015. Data for 2016 was projected using average annual growth rate of fuel consumption from National Energy Balance 2015, Page 68, Table 26. 2. Fuel consumption for Iskandar Malaysia was estimated from the consumption of Peninsular Malaysia, using population as a scale down factor. 3. Fuel consumption by sectors in Iskandar Malaysia was estimated using the formula: $\boldsymbol{Fuel\ consumption\ in\ Iskandar\ Malaysia} = Fuel\ consumption\ of\ Peninsular\ Malaysia \times \left(\frac{Iskandar\ Malaysia\ Population}{Peninsular\ Malaysia\ Population}\right)$ 4. Fuel GHG emissions in Iskandar Malaysia was calculated using the formula: $\boldsymbol{Fuel\ GHG\ Emissions} = (Fuel\ consumption\ of\ Iskandar\ Malaysia \times Emission\ factor\ of\ fuel \times NCV\ of\ fuel \times GWP)$

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				Assumption: 5. Fuel emission factors and NCV for: a. Petrol is assumed to be motor gasoline (CH_4 and N_2O are assumed to be uncontrolled) b. Fuel oil is assumed to be residual fuel oil c. CH_4 and N_2O emission factor of fuel oil and biodiesel are assumed to be the same as Stationary combustion emission factor Source: 6. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.23 – 1.24, Table 1.4 7. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 3, Page 3.21, Table 3.2.2 8. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.18 – 1.19, Table 1.2 9. Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)
II.1.2	2	✓	Grid-supplied energy consumed	IE under Scope 2 Stationary Energy sector
II.1.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted under BASIC Reporting
II.2	**Railways**			
II.2.1	1	✓	Emissions from fuel combustion	Data Input: 1. Number of trip for cargo and intercity train, diesel consumption and train distance for 2011 – 2016 were obtained from KTMB. 2. Data for 2010 were backcasted using the percentage growth of no. of trip annually.

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				3. Fuel GHG emissions was calculated using the formula: $$\textbf{Fuel GHG Emissions} = (Fuel\ consumption\ of\ Railways \times Emission\ factor\ of\ fuel \times NCV\ of\ fuel \times GWP)$$ <u>Assumption:</u> 1. It was assumed that the diesel consumption and train distance are the same as 2011 – 2015 data. <u>Source:</u> 1. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 3, Page 3.36, Table 3.3.1 2. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.18 – 1.19, Table 1.2 3. Density of diesel: http://www.sabenajadi.com/downloads/PETRONAS%20HIGH%20SPEED%20DIESEL.pdf 4. Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)
II.2.2	2	✓	Grid-supplied energy consumed	NO as the railways in Iskandar Malaysia consume diesel as fuel only.
II.2.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted under BASIC Reporting
II.3	**Waterborne Navigation**			
II.3.1	1	✓	Emissions from fuel combustion	NE as lack of such information and it is believed that the number of waterborne navigation trips made within the boundary are insignificant

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
II.3.2	2	✓	Grid-supplied energy consumed	NE as lack of such information and it is believed that the number of waterborne navigation trips made within the boundary are insignificant
II.3.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted under BASIC Reporting
II.4	**Aviation**			
II.4.1	1	✓	Emissions from fuel combustion	NE as lack of such information and it is believed that the number of aviation trips made within the boundary are insignificant
II.4.2	2	✓	Grid-supplied energy consumed	NE as lack of such information and it is believed that the number of aviation trips made within the boundary are insignificant
II.4.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting
II.5	**Off-road Transportation**			
II.5.1	1	✓	Emissions from fuel combustion	Data Input: 1. Fuel consumption was obtained from Johor Port, Tanjung Pelepas Port and Senai Airport for their off-road transportation consumption. 2. Fuel GHG emissions was calculated using the formula: $\mathbf{Fuel\ GHG\ Emissions} = (Fuel\ consumption\ of\ OffRoad \times Emission\ factor\ of\ fuel \times NCV\ of\ fuel \times GWP)$

GPC Ref.	Scope	Basic Reporting	Activities	Remarks (i.e. Data Input / Assumptions / Notation Key)
				Source: 1. Fuel emission factors: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 3, Page 3.36, Table 3.3.1 2. Net Calorific Value (NCV): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 2, Chapter 1, Page 1.18 – 1.19, Table 1.2 3. Density of diesel: http://www.sabenajadi.com/downloads/PETRONAS%20HIGH%20SPEED%20DIESEL.pdf *4.* Global Warming Potential (GWP): IPCC Fourth Assessment Report 2007 (AR4) & IPCC Fifth Assessment Report 2014 (AR5)
II.5.2	2	✓	Grid-supplied energy consumed	IE under Scope 2 of Stationary Energy sector
II.5.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting
III	**Waste**			
III.1	**Solid Waste Disposal**			
III.1.1	1	✓	Emissions from solid waste generated in the city and disposed in landfills/open dumps within the city	Data Input: 1. Waste composition data for Tapak Pelupusan (TP) Seelong for 2015 was obtained from SWCorp. 2. Amount of waste received in TP Seelong and TP Pekan Nanas (2010 – 2016) was obtained from SWM Sdn Bhd and SWCorp. 3. Amount of waste received in TP Tanjung Langsat (2010 – 2016) was obtained from MPPG. 4. Municipal waste disposal rate (1970 – 2009) for respective landfill was calculated from the actual disposal rate from 2010 - 2016. 5. Growth rate for the municipal waste disposal rate is assumed to increase 2% every 3 years.

6. Annual total amount of waste discarded to landfill for TP Ulu Tiram, TP Kempas, TP Lima Kedai, TP Mega Ria, and TP Tahana were estimated using the formula:

$$\textit{Total amount of waste discarded} = \textit{Population in Iskandar Malaysia} \times \textit{Waste disposal rate } (kg/capita/day)$$

7. All the solid waste was assumed to be discarded at landfills.
8. Waste composition at all landfills was assumed to be the same as TP Seelong.
9. The emissions from waste disposal model the actual emissions generated in each reporting year. This includes emissions from both operating and closed landfills.
10. GHG emissions was calculated based on Tier 2 First Order Decay (FOD) method from IPCC 2006, Volume 5, Chapter 3.
11. Zero delay where average decomposition started at the beginning of month 7 was assumed.

<u>Source:</u>

12. Default values for Degradable Organic Carbon (DOC) in disposal year: 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 2, Page 2.14, Table 2.4.
13. Default value of the fraction of Degradable Organic Carbon which decomposes (DOC_f): 2006 IPCC Guidelines for GHG Inventories, Volume 5, Chapter 3, Page 3.13
14. Default values of Methane Correction Factors (MCF): 2006 IPCC Guidelines for GHG Inventories, Volume 5, Chapter 3, Page 3.14, Table 3.1
15. Default value of CH_4 in generated landfill gas (F): 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Page 3.15
16. Default values of oxidation factor (OX): 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.15, Table 3.2
17. Default values of methane generation rate (k): 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Page 3.17, Table 3.3, Default value for Tropical (MAT > 20°C, Moist and Wet (MAP ≥ 1000mm)
18. GWP: IPCC Fifth AR5 2014

III.1.2	3	✓	Emissions from solid waste generated in the city but disposed in landfills/open dumps outside the city	NO
III.1.3	1	✓	Emissions from waste generated outside the city and disposed in landfills/open dumps within the city	Same as III.1.1 Solid Waste Disposal for solid waste from MDP (77% of the area is outside Iskandar Malaysia boundary) as the waste are sent to Pekan Nenas landfill which is in Iskandar Malaysia boundary
III.2	**Biological Treatment of Waste**			
III.2.1	1	✓	Emissions from solid waste generated in the city that is treated biologically in the city	NO
III.2.2	3	✓	Emissions from solid waste generated in the city that is treated biologically outside the city	NO
III.2.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	NE
III.3	**Incineration and Open Burning**			
III.3.1	1	✓	Emissions from waste generated and treated within the city	NE
III.3.2	3	✓	Emissions from waste generated within but treated outside the city	NE

III.3.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	NE
III.4	**Wastewater Treatment and Discharge**			
III.4.1	1	✓	Emissions from wastewater generated and treated within the city	<u>Data Input:</u> <u>Municipal Wastewater</u> 1. Emissions from municipal wastewater were estimated based on the total volume of wastewater treated by each public treatment plants. 2. CO_2, CH_4 and N_2O were accounted for WWTP for Scope 1, but CO_2 emissions were excluded because they are considered as biogenic origin and are not required to be included in the total emissions. 3. The available data on population for each of the Local Authorities are for year 2010. Therefore, the population in each Local Authorities for 2005 – 2009 and 2011 – 2015 were calculated using the ratio of population in 2010. 4. It was assumed that only 23% of population under MDP is within Iskandar Malaysia Region (calculated using the total population in Pontian 2010 with the total population in Pontian under IM 2010). 5. To calculate CH_4 emissions: a. Organically degradable material in domestic wastewater were estimated b. Methane emission factor for domestic wastewater were estimated c. CH_4 emissions from domestic wastewater were estimated 6. To calculate N_2O emissions: a. Nitrogen in effluent were estimated 7. Emission factor and emissions of indirect N_2O emissions from wastewater were estimated. <u>Source:</u> 8. Data of population equivalent, BOD and treatment methods: IWK for MPKu, MPJBT and MDP. 9. Data of population equivalent, and type of STP (2016): MBJB and MPPG 10. Default value of correction factor for industrial BOD discharged in sewers – uncollected: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.14.

				11. Default maximum CH_4 producing capacity for domestic wastewater: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2. 12. Default values for Methane Correction Factor (MCF) for domestic wastewater: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.13, Table 6.3 <u>Industrial Wastewater</u> 13. Emissions from industrial wastewater treatment were estimated based on industrial production data and wastewater outflows treated by each treatment plant. 14. Only emissions from palm oil mills and one of the rubber mill in Iskandar Malaysia region were taken into account of this inventory due to data unavailability. 15. Data of FFB, capacity, volume of POME and organic loading BOD. COD were obtained from the palm oil mills (Hadapan Palm Oil Mill, Masai Palm Oil Mill, Sedenak Palm Oil Mill, Kulai Oil Palm Mill) and rubber mill (Chip Hong Rubber Sdn. Bhd.) respectively. Where there is no COD data from Masai POM and Kulai POM, it was assumed that the degradable organic component for COD is 51,000 mg/L[8] <u>Source:</u> 16. Default value for density of CH_4, Fraction of CH_4 in the biogas: Tools for Project and Leakage Emissions from Anaerobic Digesters (Version 01.0.0). 17. Default Maximum CH_4 producing capacity (B_o) for industrial wastewater: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2. 18. Methane Correction Factor (MCF) for industrial wastewater – anaerobic deep lagoon: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.21, Table 6.8 19. The COD for wastewater from rubber processing was assumed to be 8,750mg/L[9]

[8] http://www.mpob.gov.my/palm-info/environment/520-achievements#Mill
[9] http://www.ajol.info/index.php/ajb/article/download/92237/81690

				<u>Municipal Wastewater and Industrial Wastewater</u> 20. When accounting for CH_4 emissions, information needed are: a. Quantity of wastewater generated b. Wastewater and sewage treatment method c. Source of wastewater and its organic content (For municipal wastewater, it is estimated based on population of Iskandar Malaysia served. For industrial wastewater, it is estimated based on industrial sector of Iskandar Malaysia) 21. Formula used in calculation for CH_4 is as follow: $CH_4\ emissions\ =\ \sum i\ [(TOW_i - S_i)EF_i\ -\ R_i]^{10^{-3}}$ At where **TOW_i** = organic content in wastewater For domestic wastewater: total organics in wastewater in inventory year, kg BOD/ yr For industrial wastewater: total organically degradable material in wastewater from industry I in inventory year, kg COD/yr **EF_i** = emission factor, kg CH_4 per kg BOD/ kg CH_4 per kg COD **S_i** = organic component removed as sludge in inventory year, kg COD/yr or kg BOD/yr **R_i** = amount of CH_4 recovered in inventory year, kg CH_4/yr **i** = type of wastewater *For domestic wastewater: income group for each wastewater treatment and handling system* *For industrial wastewater: total organically degradable material in wastewater from industry in i inventory year, kg COD/yr* $TOW_i\ =\ P\ x\ BOD\ x\ I\ x\ 365$ $EF_i\ =\ B_o\ x\ MCF_i\ x\ U_i\ x\ T_{i.j}$ At where **TOW_i =** For domestic wastewater: total organics in wastewater in inventory year, kg BOD/yr **P =** City's population in inventory year (person)

BOD = City-specific per capita BOD in inventory year, g/person/day

I = Correction factor for additional industrial BOD discharged into sewers

EF_i = Emission factor for each treatment and handling system

B_o = Maximum CH_4 producing capacity

MCF_j = Methane correction factor (fraction)

U_i = Fraction of population in income group i in inventory year

$T_{i,j}$ = Degree of utilisation (ratio) of treatment/discharge pathway or system, j, for each income group fraction i in inventory year

22. Formula used in calculation for N_2O emissions is as follow:

$$N_2O\ emissions = [(P \times Protein \times F_{NPR} \times F_{NON-CON} \times F_{IND-COM}) - N_{SLUDGE}] \times EF_{EFFLUENT} \times \left(\frac{44}{28}\right)^{10^{-3}}$$

At where

P = Total population served by the water treatment plant

Protein = Annual per capita protein consumption, kg/person/yr

$F_{NON-CON}$ = Factor adjust for non-consumed protein

F_{NPR} = Factor of nitrogen in protein

$F_{IND-COM}$ = Factor for industrial and commercial co-discharged protein into the sewer system

N_{SLUDGE} = Nitrogen removed with sludge, kg N/yr

$EF_{EFFLUENT}$ = Emission factor for N_2O emissions from discharged to wastewater in kg N_2O-N per kg N_2O

44/28 = The conversion of kg N_2O-N into kg N_2O

23. GWP is obtained from IPCC AR5, GHG Protocol

<u>Municipal Sludge</u>

24. Emissions from municipal sludge treatment were estimated based on the total volume of sludge treated by each treatment plant.
25. Three different types of sludge treatment processes were accounted in this inventory: Sludge Drying Bed (DB), Sludge Lagoon (SL) and Sludge Reception Facility (SRF).
26. The fraction of population in income group in inventory year for each STP, U = 1.

				27. The degree of utilisation of treatment/discharge pathway or system for each income group fraction in inventory year for each STP, T = 1 28. It was assumed that there is no CH_4 recovered in all treatment system and all sludge facilities did not have ammoniacal nitrogen removal facility. According to DEU (2006), 0.04kg of BOD is removed as sludge from a person a day. <u>Source:</u> 29. Emission factors for each treatment methods: IPCC 2006. 30. Total volume of sludge by treatment methods within Johor: IWK (2014 – 2016). 31. Default values for MCF for domestic sludge: 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.13, Table 6.3
III.4.2	3	✓	Emissions from wastewater generated within but treated outside the city	NO
III.4.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	Same as III.4.1 Wastewater Treatment and Discharge for wastewater generated in Kota Tinggi and Mersing which send their wastewater to wastewater treatment plants in Iskandar Malaysia boundary
IV	**Industrial Processes and Product Uses (IPPU)**			
IV.1	1	×	Emissions from industrial processes occurring in the city boundary	NE
IV.2	1	×	Emissions from product use occurring within the city boundary	NE

V	**Agriculture, Forestry and Other Land Use (AFOLU)**			
V.1	1	×	Emissions from livestock	NE
V.2	1	×	Emissions from land	NE
V.3	1	×	Emissions from aggregate sources and non-CO_2 emission sources on land	NE
VI	**Other Scope 3**			
VI.1	1	×	Other Scope 3	NE

Appendix 2: Focus Group Discussion

A Focus Group Discussion (FGD) on Iskandar Malaysia GHG Inventory 2016 was held on 6th November 2017 at DoubleTree by Hilton Hotel, Johor Bahru. The discussion was actively attended by some 50 participants from government agencies, university, NGO, as well as private sectors such as utilities, ports, power plants and palm oil mills.

The main objective of this FGD was to share and discuss with key stakeholders on Iskandar Malaysia's GHG emissions and also to obtain inputs and feedbacks for this inventory. Aside from discussion, Dr Fong Wee Kean of WRI also shared on global perspective of city/region GHG accounting and reporting at the event.

Discussion and inputs from FGD are summarised as below:

Topic	Inputs
Stationary Energy sector emissions	• Emissions from Stationary Energy sector increased 8% from 2015 to 2016, to look into EPU data if it corresponds with increases in sectoral GDP. • Attendees concur that El-Nino may be one of the causes for the increase in electricity consumption.
Transportation sector emissions	• Transportation sector emissions increase, maybe could consider if there is any correlation with number of registered vehicles.
Solid waste data collection & clarification	• Solid waste historical data is not available, and not feasible to measure on site. Backcasting is an acceptable method to estimate solid waste amount. • It has been clarified that in 2015, there was fire at the Tanjung Langsat Landfill. Thus for 6 months' the solid waste was diverted to Seelong Sanitary Landfill. Total waste amount should be twice the provided figure. • It has been clarified that for 2016, waste amount for Pekan Nanas Landfill is about 67,000 tonnes and this number is preferred over 42,311 tonnes provided by SWCorp. Unsure why is there a significant decrease from 2015 to 2016, suggested to cross check with population based projection.
Wastewater data collection & clarification	• IWK data may not be representative as private premises and certain institutions (e.g. hotels, schools, army camp etc.) have their own treatment system and do not fall under IWK. IWK does not have data for MBJB and MPPG as these sewage treatment plants in these municipalities are not under IWK control. Should remark that data in this inventory is only for public sewage treatment plants and do not include private and certain institutional sewage treatment plants. Suggest to request from MOH data on all sewage treatment plants within Iskandar Malaysia including private sewage treatment plants and primitive treatment systems (in rural areas). • For industrial wastewater, all factories will need to submit approval application for their wastewater treatment system, can request the data from SPAN.

Topic	Inputs
	• For volume of sewage treated, DOE Johor can provide data for other plants (those not under IWK) but would be total volume of treated sewage and not disaggregated by premises due to confidentiality of such data.
Grid Emission Factor	• More appropriate to use the latest available data i.e. 2014 grid emission factors as this would be the most current reflection of the energy mix of the grid. Using averages of past year's data would be an estimation. • MNRE is revising all historical grid emission factors. Might need final data from MNRE for calculation of Stationary Energy emissions for Iskandar Malaysia • Averaging past years' emission factors may give a better reflection of grid emission factors due to occurrence of scheduled outages and forced outages. For 2014, the Tanjung Bin Power Plant experienced a lot of outages. • Iskandar Malaysia inventory should match its emission factors with the national inventory.
Future data collection, data availability and data quality	• Suggestion to create a data management system or institutionalise the process rather than current approach used. E.g. create data collection working group which meets few times (e.g. twice or three times) a year for the process of data collection. This approach could also improve data consistency. • Dr. Fong's suggestion is to create a taskforce or platform where data can be shared. This can be under Iskandar Malaysia Urban Observatory (IMUO). The other possible platform is UTM Low Carbon Asia Research Centre but IRDA needs to have their own data platform. • Energy Commission is carrying out data improvement initiatives based on subsectors. For 2017, improvements for manufacturing, residential and commercial. For 2018, to carry out surveys for Transportation sector (whole Malaysia) which will be shared to all. • State level data for electricity is available but liquid fuels is an issue, current submission of data to Energy Commission is voluntary. Energy Commission currently working with the Ministry of Domestic Trade, Co-operatives and Consumerism (KPDNKK) to get petrol station level data. • Energy Commission can propose Energy Balance committee to produce state level data. • Energy Commission will publish carbon emissions data for the Stationary Energy sector in 2018. • TNB Research is looking into emission factors for each power plant in Malaysia. • National level data for Transportation sector published by UNITEN can be used for Iskandar Malaysia inventory. Can work closely with UNITEN to collect relevant data.

Topic	Inputs
	• Need to work with Chamber of Commerce to improve data quality – fuel/petrol consumption data for Transportation sector in Iskandar Malaysia. • DOSM Johor can provide data by district and the time series data are compiled every 5 years.
Future reporting / BASIC+ reporting	• IRDA's carbon reporting efforts – need to make sure federal agencies are on-board and also aligned with national level reporting. • Carbon sink inclusion from BASIC+ may be significant for Iskandar Malaysia. • IPPU emissions, NAMA data for steel and concrete industries may be helpful.
Iskandar Malaysia GHG emission trends	• Longer term trend is more important than year-by-year variation, expect emissions to peak until 2020. 5 years to meet 2025 target will be an issue. Suggest to review 2025 carbon target. • The 2025 target is ambitious, requiring annual average reduction of 8%. To consider how to meet the target and highlight pathways to achieve the target reduction. To review sectors and emissions reduction initiatives for each sector to estimate the impact.
Use of findings from inventory	• To consider how the findings of the inventory can be synthesized and used to develop action or policies for reduction of emissions.

Programme

Date : 6 November 2017 (Monday)

Time : 9.00 am - 2.00 pm

Venue : DoubleTree by Hilton Hotel, Johor Bahru

Time	Programme
0900 – 0930	Registration and Welcoming Refreshment
0930 – 0940	Welcoming remarks by Head of Environment Division, IRDA - Mr. Boyd Dionysius Joeman
0940 – 1000	City/Region GHG Accounting and Reporting – A Global Perspective - Dr. Fong Wee Kean, World Resources Institute (WRI)
1000 – 1020	Draft Iskandar Malaysia GHG Inventory 2016 by Eco-Ideal Consulting Sdn. Bhd. (Consultant) - Engr. Soon Hun Yang (Team Leader)
1020 – 1150	Focus Group Discussion - Stationary Energy - Transportation - Waste - Challenges & Obstacles - Improvements
1150 – 1230	Summary of Discussion and Way Forward
1230 – 0200	Lunch and End of Event

Attendance List

Name	Organisation
Government Agency	
1. Faridah Binti Ahmad	BAKAJ
2. Deep Kumar	GTALCC
3. Norazean Mohd Nor	GTALCC
4. Suzlin Tajuddin	DOE Johor
5. Ishak Bin Adanan	DOSM Johor
6. Norhaniza Binti Hashim	DOA Johor
7. Norshida Binti Sulaiman	DOA Johor
8. Dayang Ratnasari Abu Bakar	KeTTHA
9. Omar Nazari Bin Othman	KTM Johor
10. Mohammad Hariz B. Abdul Rahman	MARDI
11. Haji Abdul Jalil Bin Tasliman	MBJB
12. Md Naharudin Md Alimi	MPJBT
13. Mohamad Zul Feka Bin Kamri	MPJBT
14. Nur Diyana Binti Azzeham	MPKu
15. Muhammad Razif Bin Ramlan	MPPG
16. Nur Syuhada Binti Kosnan	MPPG
17. Uzaini B. Md Zain	MPOB – Southern Region
18. Nabihah Ahmad Baharuddin	PAJ
19. Nurul Nadia Mahat	PAJ
20. Zaharin Zulkifli	ST
21. Norazlina Bahari	SWCorp Johor
22. Gurpreet Singh Dholiwal	UPENJ
Private	
23. Wani Mastura Binti Mohamad	IWK, HQ
24. Ir. Noor Wahyu Ngadimin	IWK, Southern Planning Department
25. Siti Kamariah Md Shahrin	Johor Port Berhad
26. Izzat Bin Mohamad Adnan	Keck Seng (Malaysia) Berhad
27. Mohd Radzi Bin Muhamad Dul	Kilang Kelapa Sawit Sedenak
28. Azlan Mohd	Malakoff Power Berhad
29. Moh Nurhafifi Bin Mastakin	Senai Airport Terminal Services Sdn. Bhd.
30. Muhammad Zahari Sukimi Bin Mat Zaid	Tanjung Bin Energy Power Plant
31. Shahrul Izam Bin Abas	Tanjung Langsat Port Sdn. Bhd.
Non-Governmental Organisation (NGO)	
32. Nasha Lee	UNDP

Project Team	
33. Adam Ong	Eco-Ideal Consulting Sdn. Bhd.
34. Chen Saw Ling	Eco-Ideal Consulting Sdn. Bhd.
35. Chua Ming Yin	Eco-Ideal Consulting Sdn. Bhd.
36. Nurul Athirah	Eco-Ideal Consulting Sdn. Bhd.
37. Nurul Hidayah Binti Zulkipli	Eco-Ideal Consulting Sdn. Bhd.
38. Soon Hun Yang	Eco-Ideal Consulting Sdn. Bhd.
39. Boyd Dionysius Joeman	IRDA
40. Choo Hui Hong	IRDA
41. Nuzul Farisya	IRDA
42. Pang Chee Hong	IRDA
43. Sharifah Shahidah Syed Ahmad	IRDA
44. Siti Nurulainni Atan	IRDA
45. Prof. Dr. Ho Chin Siong	UTM Low Carbon Asia Research Centre
46. Dr. Fong Wee Kean	World Resources Institute

Appendix 3: Project Implementation

Project Team

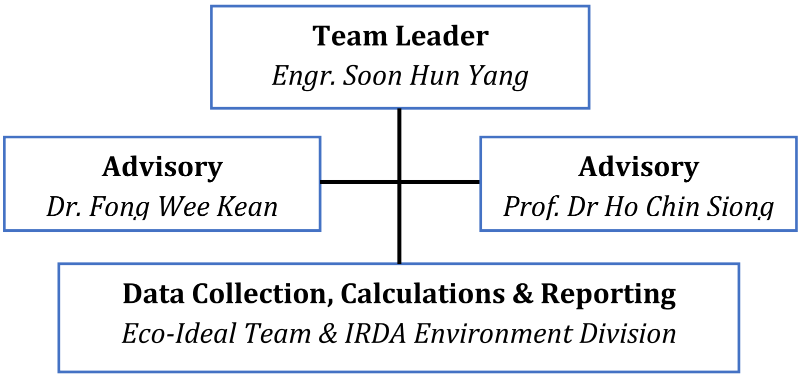
A project team which comprised of a consortium of multi-disciplinary experts with relevant international and local experiences was set up during the inception phase. The team consisted of planners, engineers as well as environmental scientists who had direct carbon management experiences.

Eco-Ideal is the overall lead of the project and will be overall responsible in establishing the GHG inventory and reporting.

Dr. Fong Wee Kean from WRI is appointed as the advisor and will perform quality assurance (QA) for compliance with GPC standard.

Professor Dr. Ho Chin Siong from UTM is also appointed as advisor to provide advices and reliable input from LCS according to GPC's data requirements, and also involves in stakeholder engagement process.

The project team organisation and the role are illustrated below:



Organisation	Key Roles & Responsibilities
Eco-Ideal Consulting	• Lead, plan and ensure compliance with delivery timeline. • Overall responsible to develop the data sets template, calculations methodologies and worksheets in accordance with GPC. • Coordinate among the 3 parties (Eco-Ideal, Dr. Fong and Professor Dr. Ho) and report to IRDA. • Data review and analysis. • Justification of exclusions. • Prepare City Level Report based on GPC for Iskandar Economic Region for year 2016 with inputs from Dr. Fong WK & Professor Dr. Ho CS, where relevant.
Dr. Fong Wee Kean	• Advisor role – advice on compliance with GPC. • QA on compliance with GPC. • Attend key meetings and discussions.

Organisation	Key Roles & Responsibilities
Professor Dr. Ho. Chin Siong	• Based on GPC's data requirement, advices and provide necessary and reliable input from LCS. • Contribute to reporting where relevant. • Attend key meetings and discussions.

Data Collection and Stakeholders Engagement

As this project is the continuation of Iskandar Malaysia GHG Inventory 2015, the stakeholder consultation workshop has been substituted by individual stakeholder engagement which has been carried out respectively before 11 September 2017, due to time constraint. Engagements with the following personnel has been conducted:

- Dato' Yap Kok Seng from MNRE for the latest national grid emission factor and National Energy Balance 2015;
- Dr. Fong Wee Kean from WRI for the updates of GPC's standard and methodology; and
- Pn Radin Diana from TNBR on power plants emission factor study.

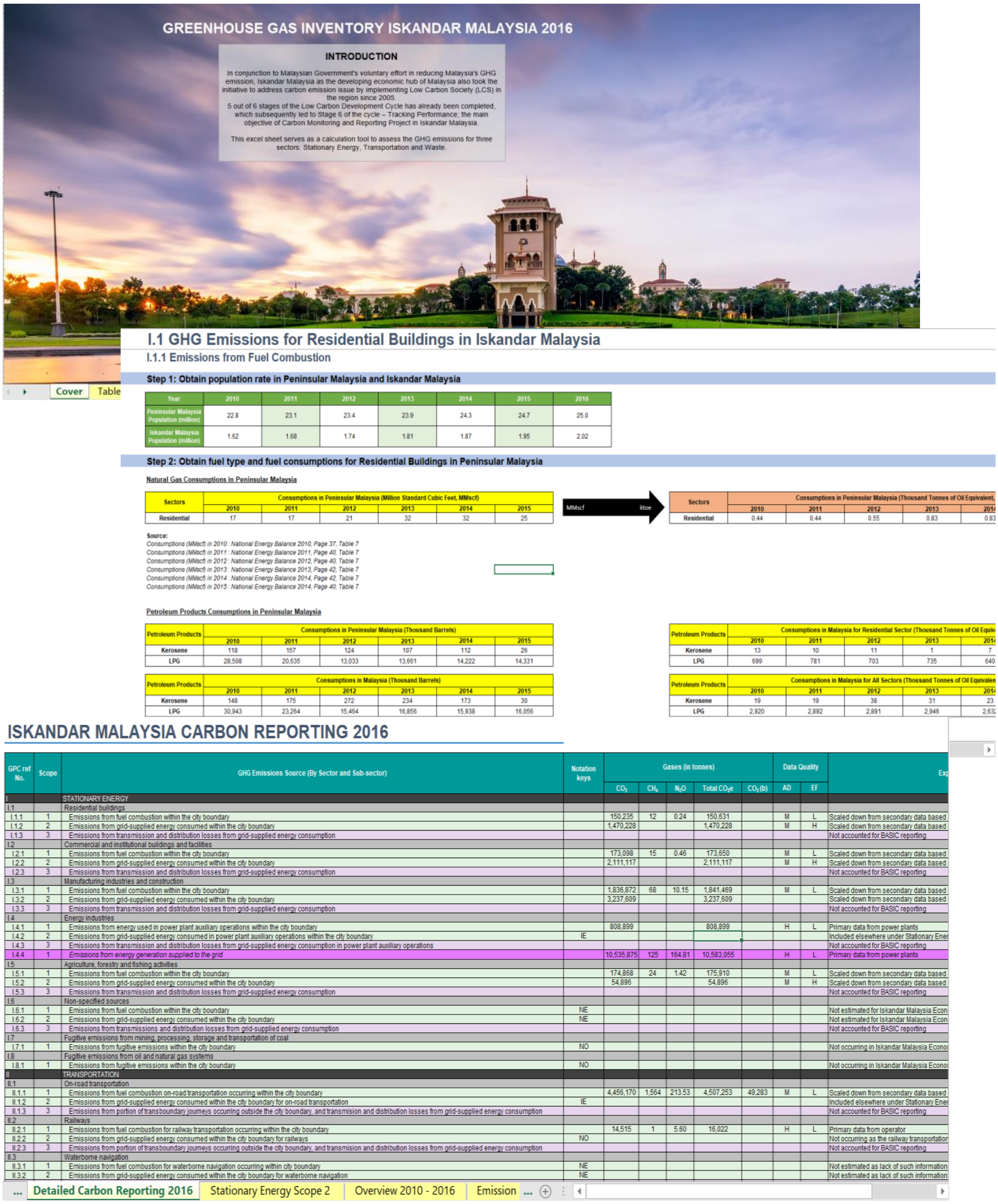
Kick-off meeting with IRDA has been conducted on 11 September 2017 to introduce the team and also to kick-start with the project. On top of that, data request letters have been sent out to various data providers, i.e. KTMB, Johor Port Berhad, Pelabuhan Tanjung Pelepas Sdn. Bhd., Senai Airport, MBJB, MPJBBT, MPPG, MDP, SWCorp, Hadapan Palm Oil Mill, Sedenak Palm Oil Mill and etc.

As of 19 September 2017, data have been received from 5 data providers i.e. Pelabuhan Tanjung Pelepas Sdn. Bhd., MDP, Kulai Palm Oil Mill, Chip Hong Rubber Sdn. Bhd. as well as YTL Power Sdn. Bhd. (the plant is not generating power but is still running, therefore fuel consumption for auxiliary use of power plant is still needed).

Calculation Sheet

A user-friendly digital template based on Microsoft Excel has been developed for the previous 2015 inventory, thus for Iskandar Malaysia GHG Inventory 2016, the template has been refined and updated accordingly to ensure its feasibility.

Screenshots of refined template:



GREENHOUSE GAS INVENTORY ISKANDAR MALAYSIA 2016

INTRODUCTION

In conjunction to Malaysian Government's voluntary effort in reducing Malaysia's GHG emission, Iskandar Malaysia as the developing economic hub of Malaysia also took the initiative to address carbon emission issue by implementing Low Carbon Society (LCS) in the region since 2005.
5 out of 6 stages of the Low Carbon Development Cycle has already been completed, which subsequently led to Stage 6 of the cycle – Tracking Performance; the main objective of Carbon Monitoring and Reporting Project in Iskandar Malaysia.

This excel sheet serves as a calculation tool to assess the GHG emissions for three sectors: Stationary Energy, Transportation and Waste.

Cover | Table

I.1 GHG Emissions for Residential Buildings in Iskandar Malaysia

I.1.1 Emissions from Fuel Combustion

Step 1: Obtain population rate in Peninsular Malaysia and Iskandar Malaysia

Year	2010	2011	2012	2013	2014	2015	2016
Peninsular Malaysia Population (million)	22.8	23.1	23.4	23.9	24.3	24.7	25.0
Iskandar Malaysia Population (million)	1.62	1.68	1.74	1.81	1.87	1.95	2.02

Step 2: Obtain fuel type and fuel consumptions for Residential Buildings in Peninsular Malaysia

Natural Gas Consumptions in Peninsular Malaysia

Sectors	Consumptions in Peninsular Malaysia (Million Standard Cubic Feet, MMscf)					
	2010	2011	2012	2013	2014	2015
Residential	17	17	21	32	32	25

MMscf → ktoe

Sectors	Consumptions in Peninsular Malaysia (Thousand Tonnes of Oil Equivalent,				
	2010	2011	2012	2013	201
Residential	0.44	0.44	0.55	0.83	0.83

Source:
Consumptions (MMscf) in 2010 : National Energy Balance 2010, Page 37, Table 7
Consumptions (MMscf) in 2011 : National Energy Balance 2011, Page 40, Table 7
Consumptions (MMscf) in 2012 : National Energy Balance 2012, Page 40, Table 7
Consumptions (MMscf) in 2013 : National Energy Balance 2013, Page 42, Table 7
Consumptions (MMscf) in 2014 : National Energy Balance 2014, Page 42, Table 7
Consumptions (MMscf) in 2015 : National Energy Balance 2014, Page 40, Table 7

Petroleum Products Consumptions in Peninsular Malaysia

Petroleum Products	Consumptions in Peninsular Malaysia (Thousand Barrels)					
	2010	2011	2012	2013	2014	2015
Kerosene	118	157	124	107	112	26
LPG	28,508	20,635	13,033	13,661	14,222	14,331

Petroleum Products	Consumptions in Malaysia for Residential Sector (Thousand Tonnes of Oil Equiv				
	2010	2011	2012	2013	201
Kerosene	13	10	11	1	7
LPG	699	781	703	735	640

Petroleum Products	Consumptions in Malaysia (Thousand Barrels)					
	2010	2011	2012	2013	2014	2015
Kerosene	148	175	272	234	173	30
LPG	30,943	23,264	15,464	16,856	15,938	16,056

Petroleum Products	Consumptions in Malaysia for All Sectors (Thousand Tonnes of Oil Equivalen				
	2010	2011	2012	2013	201
Kerosene	19	19	38	31	23
LPG	2,920	2,892	2,891	2,946	2,63

ISKANDAR MALAYSIA CARBON REPORTING 2016

GPC ref No.	Scope	GHG Emissions Source (By Sector and Sub-sector)	Notation keys	Gases (in tonnes)					Data Quality		Exp
				CO_2	CH_4	N_2O	Total CO_2e	CO_2 (b)	AD	EF	
I		STATIONARY ENERGY									
I.1		Residential buildings									
I.1.1	1	Emissions from fuel combustion within the city boundary		150,235	12	0.24	150,631		M	L	Scaled down from secondary data based
I.1.2	2	Emissions from grid-supplied energy consumed within the city boundary		1,470,228			1,470,228		M	H	Scaled down from secondary data based
I.1.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
I.2		Commercial and institutional buildings and facilities									
I.2.1	1	Emissions from fuel combustion within the city boundary		173,098	15	0.46	173,650		M	L	Scaled down from secondary data based
I.2.2	2	Emissions from grid-supplied energy consumed within the city boundary		2,111,117			2,111,117		M	H	Scaled down from secondary data based
I.2.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
I.3		Manufacturing industries and construction									
I.3.1	1	Emissions from fuel combustion within the city boundary		1,836,872	68	10.15	1,841,469		M	L	Scaled down from secondary data based
I.3.2	2	Emissions from grid-supplied energy consumed within the city boundary		3,237,609			3,237,609				Scaled down from secondary data based
I.3.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
I.4		Energy industries									
I.4.1	1	Emissions from energy used in power plant auxiliary operations within the city boundary		808,899			808,899		H	L	Primary data from power plants
I.4.2	2	Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary	IE								Included elsewhere under Stationary Ener
I.4.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption in power plant auxiliary operations									Not accounted for BASIC reporting
I.4.4	1	*Emissions from energy generation supplied to the grid*		10,535,875	125	164.81	10,583,055		H	L	Primary data from power plants
I.5		Agriculture, forestry and fishing activities									
I.5.1	1	Emissions from fuel combustion within the city boundary		174,868	24	1.42	175,910		M	L	Scaled down from secondary data based
I.5.2	2	Emissions from grid-supplied energy consumed within the city boundary		54,896			54,896		M	H	Scaled down from secondary data based
I.5.3	3	Emissions from transmission and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
I.6		Non-specified sources									
I.6.1	1	Emissions from fuel combustion within the city boundary	NE								Not estimated for Iskandar Malaysia Econ
I.6.2	2	Emissions from grid-supplied energy consumed within the city boundary	NE								Not estimated for Iskandar Malaysia Econ
I.6.3	3	Emissions from transmissions and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
I.7		Fugitive emissions from mining, processing, storage and transportation of coal									
I.7.1	1	Emissions from fugitive emissions within the city boundary	NO								Not occurring in Iskandar Malaysia Econo
I.8		Fugitive emissions from oil and natural gas systems									
I.8.1	1	Emissions from fugitive emissions within the city boundary	NO								Not occurring in Iskandar Malaysia Econo
II		TRANSPORTATION									
II.1		On-road transportation									
II.1.1	1	Emissions from fuel combustion on-road transportation occurring within the city boundary		4,456,170	1,564	213.53	4,507,253	49,283	M	L	Scaled down from secondary data based
II.1.2	2	Emissions from grid-supplied energy consumed within the city boundary for on-road transportation	IE								Included elsewhere under Stationary Ener
II.1.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmision and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
II.2		Railways									
II.2.1	1	Emissions from fuel combustion for railway transportation occurring within the city boundary		14,515	1	5.60	16,022		H	L	Primary data from operator
II.2.2	2	Emissions from grid-supplied energy consumed within the city boundary for railways	NO								Not occurring as the railway transportation
II.2.3	3	Emissions from portion of transboundary journeys occurring outside the city boundary, and transmision and distribution losses from grid-supplied energy consumption									Not accounted for BASIC reporting
II.3		Waterborne navigation									
II.3.1	1	Emissions from fuel combustion for waterborne navigation occurring within city boundary	NE								Not estimated as lack of such information
II.3.2	2	Emissions from grid-supplied energy consumed within the city boundary for waterborne navigation	NE								Not estimated as lack of such information

... | Detailed Carbon Reporting 2016 | Stationary Energy Scope 2 | Overview 2010 - 2016 | Emission ...

Project Timeline

Report/Week	1	2	3	4	5	6	7	8	9	10	11	12
	Sep 17			Oct 17			Nov 17			Dec 17		
Issuance of LOA												
Kick-off/ Progress Meeting												
Data Collection												
Data Analysis and Calculation												
Stakeholder Engagement												
Capacity Building Sessions												
Submission of Inception Report												
Submission of Interim Report												
Submission of Draft Executive Summary & Final Report												
Focus Group Discussion												
Submission of Final Executive Summary & Report												

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- Johor Port Berhad
- Keretapi Tanah Melayu Berhad (KTMB)
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- Kilang Kelapa Sawit Kulai
- Kilang Kelapa Sawit Masai
- Kilang Kelapa Sawit Sedenak
- Lotte Chemical Titan (M) Sdn. Bhd.
- Majlis Bandaraya Johor Bahru (MBJB)
- Majlis Daerah Pontian (MDP)
- Majlis Perbandaran Johor Bahru Tengah (MPJBT)
- Majlis Perbandaran Kulai (MPKu)
- Majlis Perbandaran Pasir Gudang (MPPG)
- Ministry of Natural Resources and Environment (MNRE)
- National Communication/ Biennial Update Reports Team
- Pelabuhan Tanjung Langsat
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- State Government of Johor
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- SWM Environment Sdn Bhd
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- Tanjung Bin Power Plant, Malakoff Corporation Berhad
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ISKANDAR MALAYSIA GREENHOUSE GAS INVENTORY 2016

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Environment
Iskandar Regional Development Authority
#G-01, Block 8,
Danga Bay, Jalan Skudai,
80200 Johor Bahru, Johor,
MALAYSIA