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ISKANDAR MALAYSIA

ISKANDAR MALAYSIA
GREENHOUSE GAS INVENTORY
2015

FINAL REPORT

ISKANDAR MALAYSIA

GREENHOUSE GASES INVENTORY

2015

Final Report

Foreword

The issues of climate change and its intensifying impacts have been seen and experienced in many parts of the world – even in Malaysia, with occurrences of devastating extreme weather phenomena within our country. For the benefits of current and future generations, and to ensure the continued growth and prosperity of our nation, we must act together decisively against the threats of climate change. We have a mandate to reduce our GHG intensity emissions by 45% by 2030, which I had announced at COP21 in Paris in December 2015.

Iskandar Regional Development Authority (IRDA), through various initiatives notably under the Low Carbon Society Blueprint for Iskandar Malaysia 2025, has been leading the way in efforts to address climate change while pursuing social and economic development for the economic development corridor in South Johor Malaysia. The success of Iskandar Malaysia under the leadership of IRDA deserves recognition and I commend them for their continued efforts in leading the way forward for sustainable development regionally and nationally.

Dato' Sri Mohd Najib Tun Abdul Razak
Prime Minister of Malaysia
Co-Chairman of Iskandar Regional Development Authority

Foreword

The State of Johor and Iskandar Malaysia are committed to improving the people's quality of life and we will continue to pursue social and economic development without compromising sustainability and the protection of the natural environment. I firmly believe that development and sustainability are not mutually exclusive goals.

Iskandar Malaysia – the economic development corridor in South Johor, Malaysia - under the leadership of Iskandar Regional Development Authority (IRDA), has proven to be a successful example of this paradigm. At State level, we have also prepared the Johor Sustainability Policy, which reflects our seriousness in ensuring that developments are sustainable.

As the state of Johor and Iskandar Malaysia embark on the path of sustainable development, the contribution of key stakeholders and the support of local communities are paramount in ensuring the realisation of our development goals for a better quality of life.

I would like to express my sincere thanks to IRDA for its strong commitment to the development of Iskandar Malaysia through its Low Carbon Society Blueprint. This inaugural GHG Inventory document is an important start in ensuring that IRDA monitors its emissions as the economic region develops further over the next decade.

Dato' Seri Mohamed Khaled Nordin
Menteri Besar of Johor
Co-Chairman of Iskandar Regional Development Authority

Foreword

The preparation of the Iskandar Malaysia Greenhouse Gas Inventory 2015 marks a significant milestone for Iskandar Regional Development Authority (IRDA), in its ambition to make Iskandar Malaysia a **strong and sustainable metropolis of international standing** by 2025.

Iskandar Malaysia is first in the region to use an internationally recognised standard – the Global Protocol for Community-scale Greenhouse Gas Emissions Inventory (GPC) – to account for greenhouse gas (GHG) emissions within the boundary of the economic development corridor. The findings from the Iskandar Malaysia Greenhouse Gas Inventory 2015 is a valuable measure of IRDA's progress and commitment in the implementation of the Low Carbon Society Blueprint, which it launched globally at COP18, in Doha, Qatar in 2012. This Blueprint provides reliable guidance for policy-makers, businesses and others on how we can work together towards achieving GHG emission reductions of 50% (related to GDP) and 40% (absolute) by 2025. From the very beginning, IRDA has championed the vision of a sustainable green economy for Iskandar Malaysia and IRDA will continue to provide leadership and guidance towards realisation of its vision for Iskandar Malaysia.

I wish to thank Universiti Teknologi Malaysia, Eco-Ideal Consulting Sdn. Bhd. and my staff team who have worked very hard in putting together Iskandar Malaysia's inaugural GHG inventory.

Datuk Ismail Ibrahim
Chief Executive
Iskandar Regional Development Authority

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ABBREVIATION

AFOLU	Agriculture, Forestry, and Other Land Use
AR	Assessment Report
BRT	Bus Rapid Transit
BUR	Biennial Update Report
CASBEE	Comprehensive Assessment Systems for Built Environment Efficiency
CASO	Compressed Air Systems Optimisation
CDM	Clean Development Mechanism
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
DTRO	Disc Tube Reverse Osmosis
EFB	Empty Fruit Bunches
EPU	Economic Planning Unit
FiT	Feed-in Tariff
FMM	Federation of Malaysian Manufacturers
FOD	First Order Decay
GDP	Gross Domestic Product
GEF	Global Environment Facility
GHG	Greenhouse Gas
GPC	Global Protocol for Community Scale Greenhouse Gas Emissions Inventories
GWP	Global Warming Potential
IBEC	Institute for Building Environment and Energy Conservation
ICLEI	International Council for Local Environmental Initiatives
IEEMMS	Industrial Energy Efficiency for Malaysian Manufacturing Sector
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
IWK	Indah Water Konsortium Sdn Bhd
JICA	Japan International Cooperation Agency
JST	Japan Science and Technology Agency

KeTTHA	Ministry of Energy, Green Technology and Water
ktoe	kilo tonnes of oil equivalent
LCS	Low Carbon Society
LCSBPIM	Low Carbon Society Blueprint for Iskandar Malaysia
LFG	Landfill Gas
MBJB	Majlis Bandaraya Johor Bahru
MDP	Majlis Daerah Pontian
MF	Mesocarp Fiber
MGTC	Malaysian Green Technology Corporation
MIDA	Malaysian Industrial Development Authority
MITI	Ministry of International Trade and Industry
MPJBT	Majlis Perbandaran Johor Bahru Tengah
MPKu	Majlis Perbandaran Kulai
MPPG	Majlis Perbandaran Pasir Gudang
N_2O	Nitrous Oxide
NC2	National Communication 2
NCV	Net Calorific Value
NEB	National Energy Balance
NIES	National Institute for Environmental Studies
OPF	Oil Palm Fronds
OPT	Oil Palm Trunks
PAJ	Perbadanan Pengangkutan Awam Johor
PCOC	IOI Pan-Century Oleo Chemicals
PKS	Palm Kernel Shell
POME	Palm Oil Mill Effluent
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
SMIDEC	Small and Medium Industries Development Corporation
SMR	Standard Malaysia Rubber
SRF	Sludge Reception Facility
SSL	Seelong Sanitary landfill
SSO	Steam Systems Optimisation
ST	Energy Commission (Suruhanjaya Tenaga)
SWCorp	Solid Waste Management and Public Cleansing Corporation

TNC	Third National Communication
UFDC	Iskandar Malaysia Urban Farming Development Centre
UNEP	United Nations Environment Programme
UNFCCC	United Nations Framework Convention on Climate Change
UNIDO	United Nations Industrial Development Organization
UPENJ	Johor Economic Planning Unit
UTM	Universiti Teknologi Malaysia
WRI	World Resources Institute

EXECUTIVE SUMMARY

1.0 PREAMBLE

Photo credits: IRDA

Climate Change – A Real and Present Issue

Over the past few decades, climate change has become an increasingly evident reality in our world. Some aspects of the changing world climate such as sea level rise, unusual and prolonged dry season, disastrous landslides, flooding, and tropical storms are indications of climate change. Nevertheless, the global average surface temperature is the parameter that most clearly defines global climate change.

On 12 December 2015, a global climate agreement, namely the Paris Agreement was adopted at the 21st session of the Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, France. This agreement brings together all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects[1].

Malaysia's Involvement and Commitment

As the issue on climate change gains greater attention, mandatory and voluntary efforts in reducing Greenhouse Gas (GHG) emissions are observed in many countries around the globe, including Malaysia. During the 15th Conference of the Parties (COP 15) by UNFCCC in December 2009 at Copenhagen, Denmark, the Prime Minister of Malaysia announced Malaysia's voluntary initiative to achieve up to 40% reduction in emissions intensity of its Gross Domestic Product (GDP) by 2020 based on the 2005 level. This target is to be achieved under the condition that technology transfer and financial support are provided from developed countries. International policy on green technology ownership, technological transfer and technology development cooperation and assistance are vital in enabling Malaysia to address the challenges due to climate change. This indicator is one of the measures of the nation's success in efforts to develop sustainably.

More recently in 2015, Malaysia has released its **Intended Nationally Determined Contribution (INDC)** of achieving **45% emissions intensity by GDP by year 2030** as compared to year 2005 level, under the same condition of receiving technology transfer and support, reaffirming Malaysia's stand and commitment in fighting climate change. As announced[2] by the Minister of Natural Resources and Environment, Malaysia is set to ratify the Paris Agreement 2015 before end of year 2016.

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[1] http://unfccc.int/paris_agreement/items/9485.php
[2] http://www.thestar.com.my/news/nation/2016/09/19/malaysia-to-ratify-climate-change-accord-soon/

Iskandar Malaysia – Taking the Lead for Malaysia

In conjunction with the Malaysian Government's voluntary GHG emission reduction effort, Iskandar Malaysia, a developing economic hub, took the initiative to address carbon emissions in its jurisdiction. This proactive stance also reflects the ultimate target of Iskandar Malaysia to be "**A Strong and Sustainable Metropolis of International Standing**" by the year of 2025.

Low Carbon Society Blueprint for Iskandar Malaysia 2025

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 on the Development of Low Carbon Society Scenarios for Asian Region sponsored by Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST). The main research institutes involved in this collaboration are Universiti Teknologi Malaysia (UTM), Kyoto University, National Institute for Environmental Studies (NIES), and Okayama University. There is also strong involvement in the preparation of the LCSBPIM2025 from IRDA and the 5 Local Authorities - Majlis Bandaraya Johor Bahru (MBJB), Majlis Perbandaran Johor Bahru Tengah (MPJBT), Majlis Perbandaran Pasir Gudang (MPPG), Majlis Perbandaran Kulai (MPKu), and Majlis Daerah Pontian (MDP).

To further accelerate the realisation of LCS in Iskandar Malaysia at the local level, 5 LCS Action Plans are formulated. These Local Authority-Level LCS Action Plans are crucial to ensure effective implementation of the LCSBPIM2025 as each LCS Action Plan recognises and responds to the distinctive economic, social and environmental characteristics, as well as the strengths, potentials and issues unique to each Local Authority. By adopting their respective LCS Action Plan, the Local Authorities are in fact adopting LCS policies and programmes within the regional level framework of the LCSBPIM2025 that are suitable to their socioeconomic and environmental contexts.

The Iskandar Malaysia Low Carbon Society Blueprint was launched at COP18 in DOHA, 2012

Photo credits: IRDA

Monitoring and reporting is a crucial step in tracking the progress and path towards the goals and targets set. Iskandar Malaysia has completed 5 out of 6 stages of the Low Carbon Development Cycle and currently is in stage 6 - tracking performance of implemented LCS programmes (Figure 14).

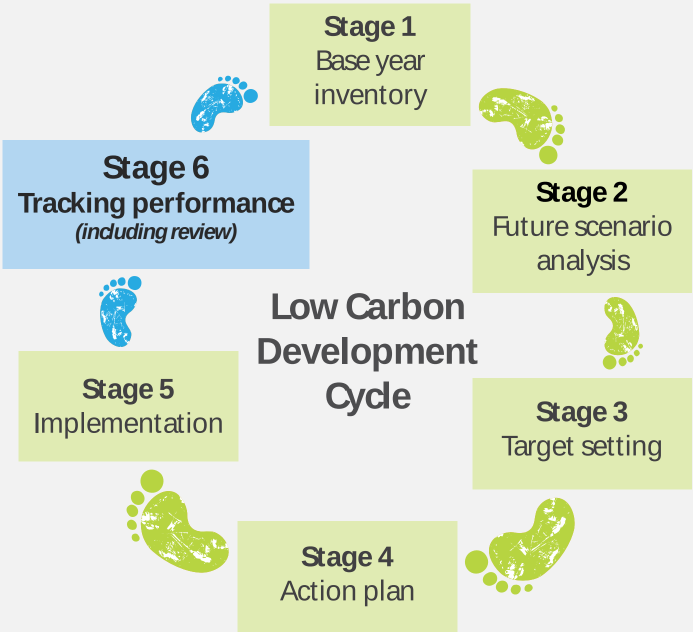


Figure 1: Low Carbon Development Cycle

The Environment Division of Iskandar Regional Development Authority (IRDA) is responsible for tracking the implementation of the LCSBPIM2025, and more importantly, the carbon emissions of Iskandar Malaysia. It is essential to measure the progress of the efforts within Iskandar Malaysia towards achieving the Iskandar Malaysia emissions reduction. The tracking will benefit the IRDA in terms of making future strategic planning decisions.

In order to track and manage the performance of carbon emissions over time, the **Global Protocol for Community Scale Greenhouse Gas Emissions Inventories (GPC) - an internationally-recognised carbon monitoring and reporting framework** has been adopted for this study.

Why GPC?

The GPC was launched in 2014 by its lead authors, WRI, the C40 Cities Climate Leadership Group and International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability as the first internationally accepted standard for measuring city-scale GHG emissions (Figure 15).

Currently, through the Compact of Mayors, there are about 600 cities across the globe that have committed to report their emissions using GPC (Figure 16).

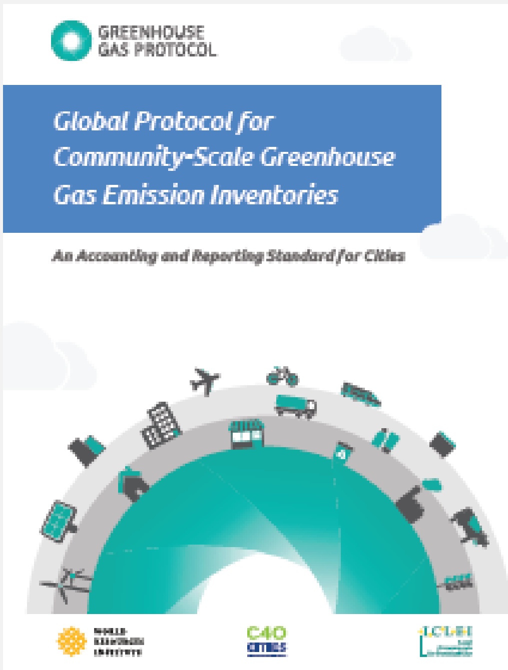


Figure 2: GPC

Figure 3: Cities committed to the Compact of Mayors[3]

The advantages of adopting the GPC for emissions reporting can be summarised in Figure 17.

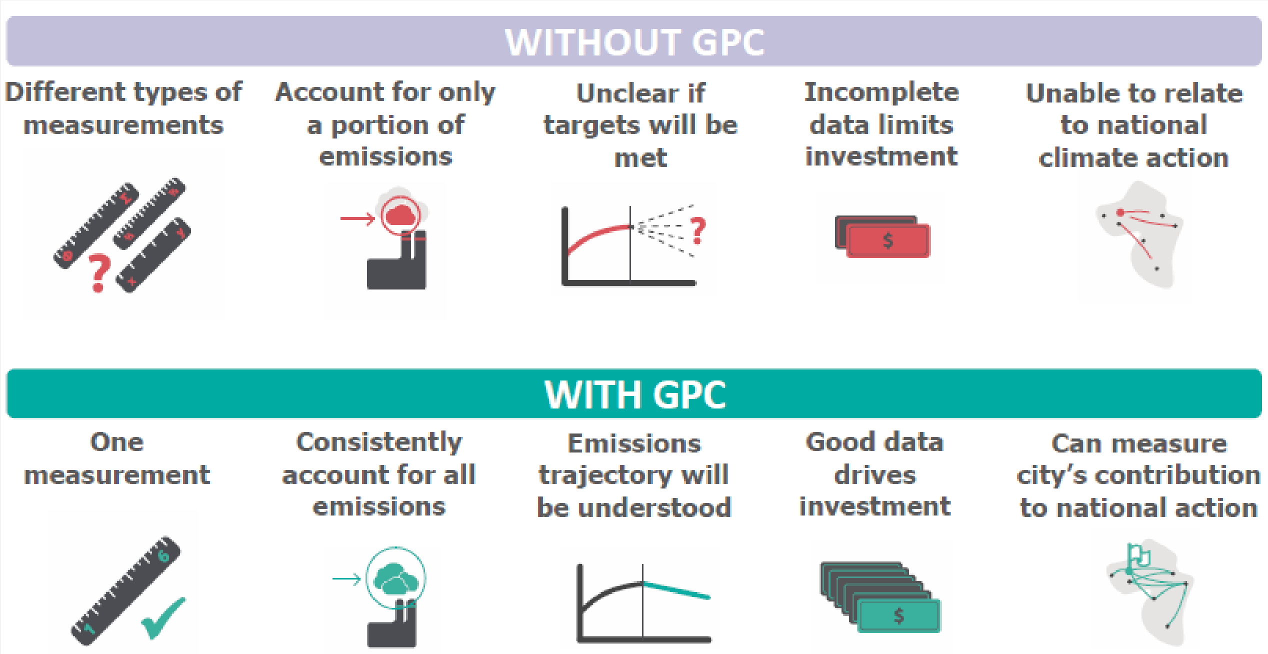


Figure 4: Advantages of GPC[4]

[3] Source: https://www.compactofmayors.org/cities/
[4] Source: GPC Infographic, http://www.ghgprotocol.org/files/ghgp/GPC_infographic_printready.pdf

Inventory City Information

Inventory boundary	City information
Name of city	Iskandar Malaysia Economic Region
Country	Malaysia
City established	8 November 2006 (region formalised)
Administered	Iskandar Regional Development Authority (IRDA)
Inventory year	2015
Geographical boundary	 Southern tip of Peninsular Malaysia. Comprise 5 Local Authorities: Majlis Bandaraya Johor Bahru (MBJB), Majlis Perbandaran Johor Bahru Tengah (MPJBT), Majlis Perbandaran Pasir Gudang (MPPG), Majlis Perbandaran Kulai (MPKu) and part of Majlis Daerah Pontian (MDP)
Land area	2,300 km^2 (12% of Johor State)
Resident population	1.89 million
GDP	RM 56,772 million (USD 13,847 million) @ 2005 constant price
Composition of economy	Industry and manufacturing
Climate	Tropical rainforest

GHG Inventory Reporting Framework

GPC reporting level	BASIC
GHG included in inventory	Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)
GWP	IPCC Fifth Assessment Report 2014 (AR5)
Description of overall methodologies and tools used	GPC, 2006 IPCC Guidelines

The Scopes and City-induced Framework – BASIC Level

In GPC, city-induced reporting framework seeks to account for emissions as a result of activities in the city.

Considering the inaugural attempt and limitations of data for Iskandar Malaysia to establish its GHG inventory using GPC, the Iskandar Malaysia GHG emissions accounting and reporting for 2015 is limited to the BASIC level. Iskandar Malaysia GHG emissions accounting and reporting at the BASIC level covers the following sectors:

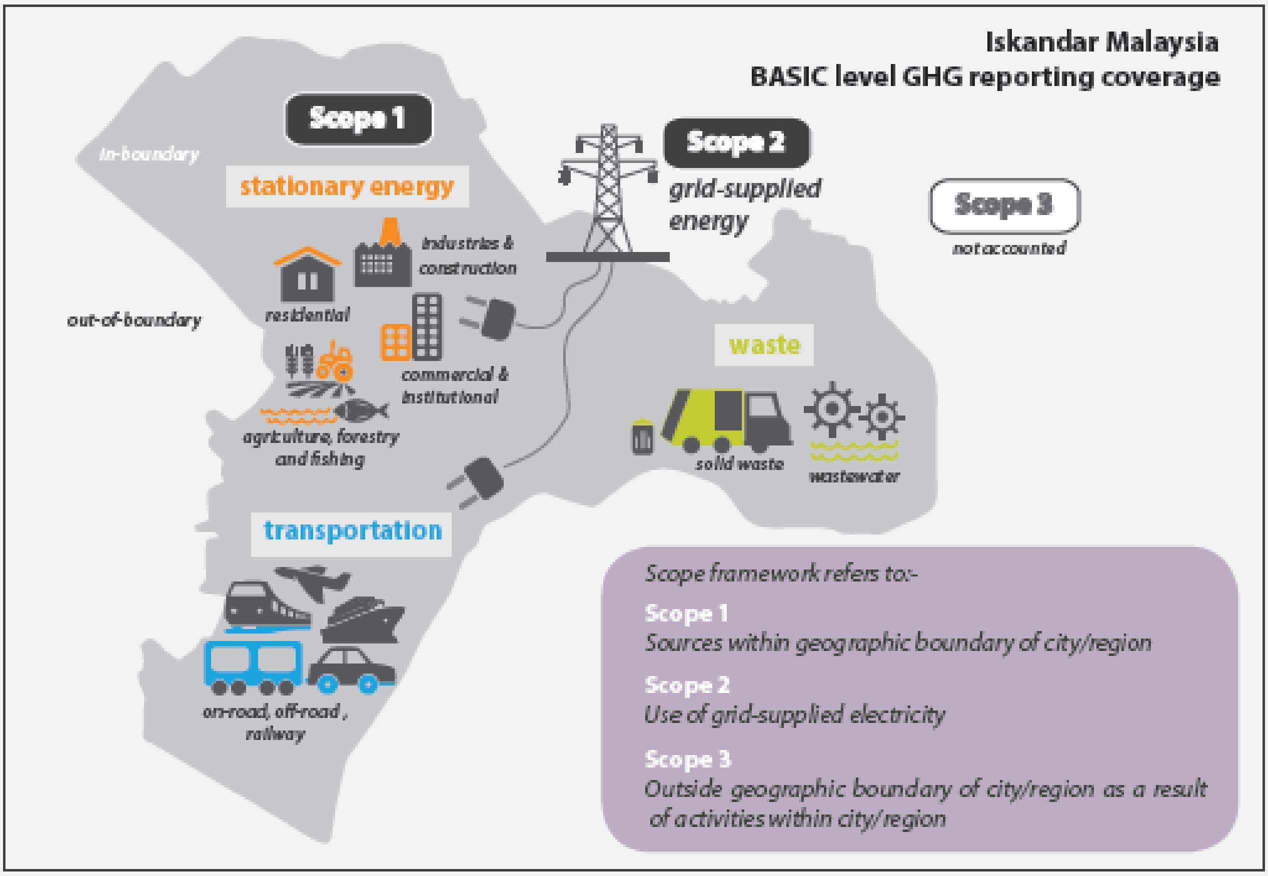


Figure 5: Coverage of Iskandar Malaysia's BASIC level GHG reporting

Data Quality Assurance

In the process of developing the Iskandar Malaysia GHG Inventory 2015, a number of engagements have been conducted to ensure the success of the inventories 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.

2.0 METHODOLOGIES AND APPROACHES

Photo credits: IRDA

Stationary Energy

With reference to GPC, fuel (Scope 1 emissions) and electricity (Scope 2 emissions) consumption within Iskandar Malaysia region from the sub-sectors below were accounted in this inventory:

- residential buildings;
- commercial and institutional buildings and facilities;
- manufacturing industries and construction;
- energy industries; and
- agriculture, forestry and fishing activities.

Data Source and Calculation Approach

Primary and secondary data for electricity consumption and energy consumption were collected respectively from the Energy Commission (ST) and Individual Power Plants (IPPs).

As there were no specific data available on other fuel consumption within Iskandar Malaysia, the secondary data were extracted from National Energy Balance (NEB) 2005-2014 and scaled down either using population or industrial GDP (depending on sub-sectors) to obtain data which relate to Iskandar Malaysia.

The relevant emission factors were sourced from 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines, Volume 2 , Chapter 2.

The emission factors for Peninsular Malaysia's grid electricity were sourced from Malaysian Green Technology Corporation (MGTC).

Coals
Photo credits: FreeImages.com/zachh reinhart

Natural gas
Photo credits: FreeImages.com/Jayesh Nair

Petroleum
Photo credits: FreeImages.com/Matthew Maaskant

Transportation

Emissions from fuel consumption for on-road and off-road transportations and railways occurring within the city were also accounted for in this inventory.

According to the GPC, only emissions from aviation and waterborne navigation that originate and terminate within the city boundary are accounted for – under Scope 1 emissions. Therefore, emissions from aviation and waterborne navigation were not estimated in this inventory. The reasons for exclusion were the lack of such information and it is believed that the number of aviation and waterborne navigation trips made within the city boundary were insignificant.

Data Source and Calculation Approach

On-road transportation

Due to lack of primary data (i.e. fuel consumption), secondary data on Malaysia fuel sales were extracted from NEB 2005-2014 and scaled down by population to estimate the fuel consumption for on-road transportation in Iskandar Malaysia.

Off-road transportation

Emissions from off-road transportation were calculated based on the primary data (i.e. fuel consumption) provided by the port authorities and airport authority.

Railways

Emissions from railways were calculated based on the primary data (i.e. number of trips per year, diesel consumption per trip and train distance per trip) provided by railway operator.

On-road transportation

Photo credits: www.pinterest.com/pin/28499410112673254

Waste

Emissions from domestic waste, sludge, and industrial wastewater were accounted in this inventory. The emissions from industrial wastewater calculated cover only POME and rubber manufacturing for primary rubber product. Industrial wastewater from other manufacturing industries was excluded due to unavailability of data.

Data Source and Calculation Approach

Primary data on domestic waste generated and landfills within the economic region were obtained from the Solid Waste Management and Public Cleansing Corporation (SWCorp), Local Authorities and landfill operator. The GHG emission from solid waste was calculated based on the 2006 IPCC Guidelines – Tier 2 First Order Decay (FOD) method (2006 IPCC Guidelines, Volume 5, Chapter 3).

Primary data of domestic wastewater volume and treatment method were provided by some of the operators. Where primary data of wastewater volumes were not available for a particular year or local authority, the data required for calculating the GHG emissions were extrapolated from the available primary data of other Local Authorities using population as a scaling factor. The GHG emissions were estimated using the 2006 IPCC Guidelines Tier 2 emissions calculation methodology (2006 IPCC Guidelines, Volume 5, Chapter 6). Emission factors for each of the relevant treatment methods were sourced from 2006 IPCC Guidelines.

Emissions from industrial wastewater treatment were estimated based on the industrial production data and wastewater outflows treated by each treatment plant using the 2006 IPCC Guidelines Tier 2 emissions calculation methodology. As mentioned previously, the emissions from industrial wastewater calculated under this inventory only cover the emissions from palm oil mill industry (i.e. POME) and rubber mills.

Emissions from municipal sludge treatment were estimated based on the total volume of sludge treated by each treatment plant. There are 3 different types of sludge treatment processes, i.e. Sludge Drying Bed (DB), Sludge Lagoon (SL) and Sludge Reception Facility (SRF). Emission factors for each of the relevant treatment methods were sourced from 2006 IPCC Guidelines.

Amount of sludge treated and treatment methods were provided by some of the operators. Where data of sludge volumes were not available, sludge volumes were extrapolated from the sludge volumes of other Local Authorities using population as a scaling factor.

Wastewater treatement plant

Photo credits: Eco-Ideal Consulting Sdn Bhd

3.0 RESULTS

Summary of Iskandar Malaysia GHG Inventory 2015

Table 1: GHG emissions summary of Iskandar Malaysia for 2015

Sector		Total by Scope (million tCO_2e)		Total by city-induced reporting level (million tCO_2e)
		Scope 1	Scope 2	BASIC
Stationary Energy	Energy use	3.42	6.79	10.21
	Energy generation supplied to the grid	12.59		
Transportation		4.45	IE (energy use)	4.45
Waste	Generated in the city	0.81		0.81
	Generated outside city	NO		
Total	**All Territorial Emissions**	**28.06**		
		All BASIC Emissions		**15.47**

Notation Keys:

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

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

● – Non-applicable emissions

Scope 3, IPPU and AFOLU sectors only applicable for BASIC+ reporting.

The total emissions value in Table 2 is based on GWP value from the AR5. Following the GWP used in the National GHG Inventory (AR4), the total of all territorial emissions (by scope) is 28.07 million tonnes of CO_2 equivalent (tCO_2e) and all BASIC emissions is 15.47 million tCO_2e.

Iskandar Malaysia GHG Emissions 2015

The total of all BASIC emissions in Iskandar Malaysia for year 2015 is 15.47 million tonnes of carbon dioxide equivalent (tCO_2e).

The largest contributor is the stationary energy sector with 10.2million tCO_2e (66%), followed by the transportation sector with 4.5 million tCO_2e (29%), and waste sector with 0.8 million tCO_2e (5%).

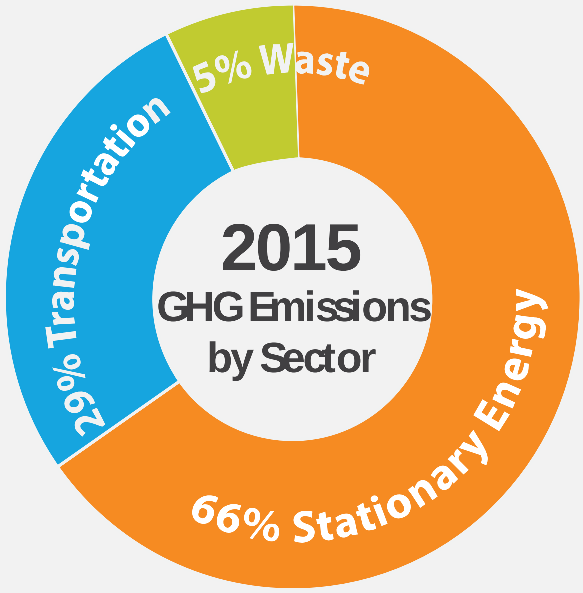


Figure 6: All BASIC emissions in 2015

Iskandar Malaysia GHG Emissions 2005 – 2015

Iskandar Malaysia GHG emissions reflect the rapid growth for all 3 sectors over the last 10 years as shown in Figure 7. In year 2007, there was a sharp growth in emissions from stationary energy sector due high energy consumption by the manufacturing industries and construction sub-sector (Figure 27).

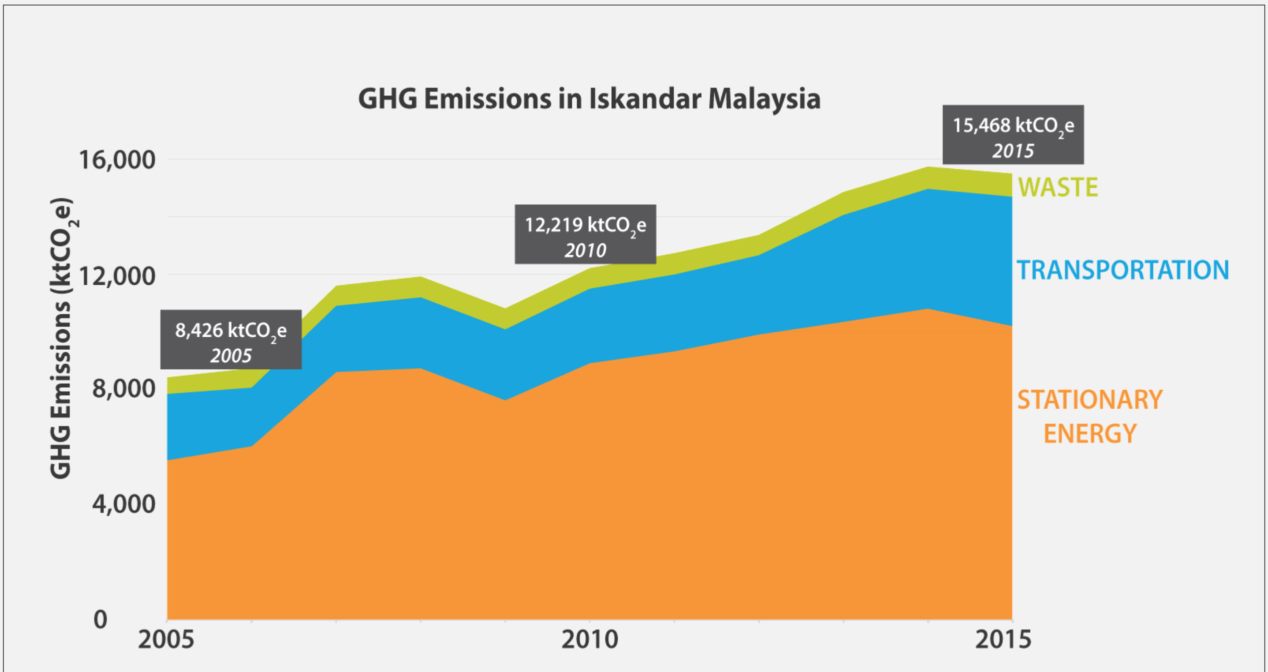


Figure 7: Total GHG emissions of Iskandar Malaysia

Sectorial Emission Analysis

Stationary Energy

Out of all the sub-sectors under Stationary Energy (refer to Figure 8), the **the manufacturing industries and constructions sub-sector accounted for highest GHG emissions in Iskandar Malaysia**. Manufacturing industries and construction of Iskandar Malaysia contributed about 43%

of total Iskandar Malaysia GDP in 2015[5], a large portion of the industrial GDP is derived from electrical and electronics, chemicals and chemical products and food processing sub-sectors[6].

The second highest sub-sector is the energy industries, contributing 21% of the total stationary energy GHG emissions. These emissions are from all 6 power plants in Iskandar Malaysia, with a total capacity of 3,323MW. As mentioned in the previous chapter, all the power plants consume natural gas as fuel, except for Tanjung Bin IPP which consumes coal as its main fuel. Under the energy industries sub-sector, only auxiliary fuel use i.e. not used directly for energy generation were accounted in this inventory (BASIC reporting). The emissions for energy generation supplied to the grid were calculated separately and accounted for in the territorial total. **The emissions for energy generation supplied to the grid (GPC reference no. I.4.4) for the 6 power plants were calculated to be 12.59 million tCO_2e.** Commercial, institutional buildings and facilities sub-sector contributed 20%, while residential buildings sub-sector contributed 14%. The agriculture, forestry and fishing activities sub-sector contributed 2%.

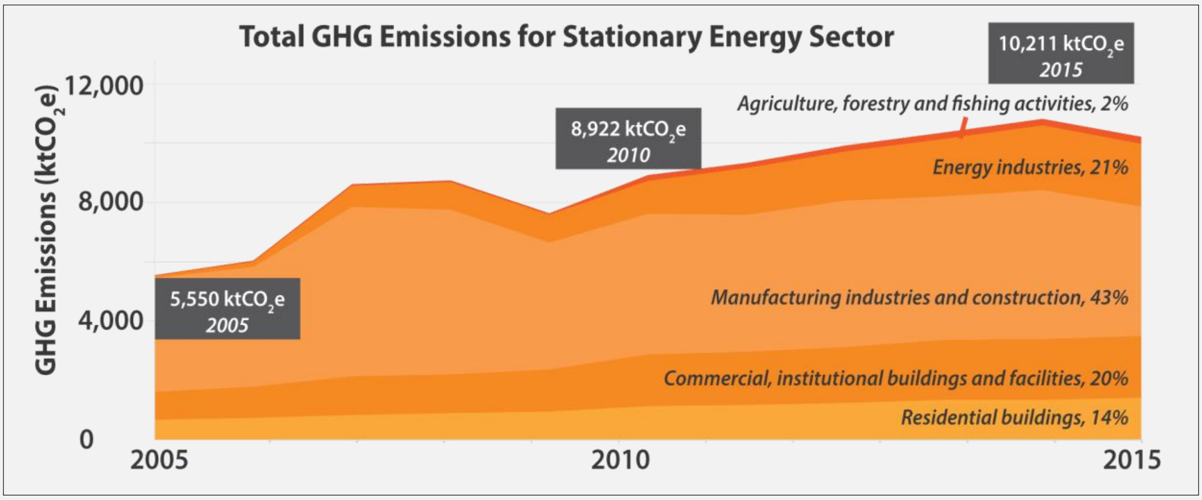


Figure 8: GHG emissions from stationary sub-sectors

Transportation

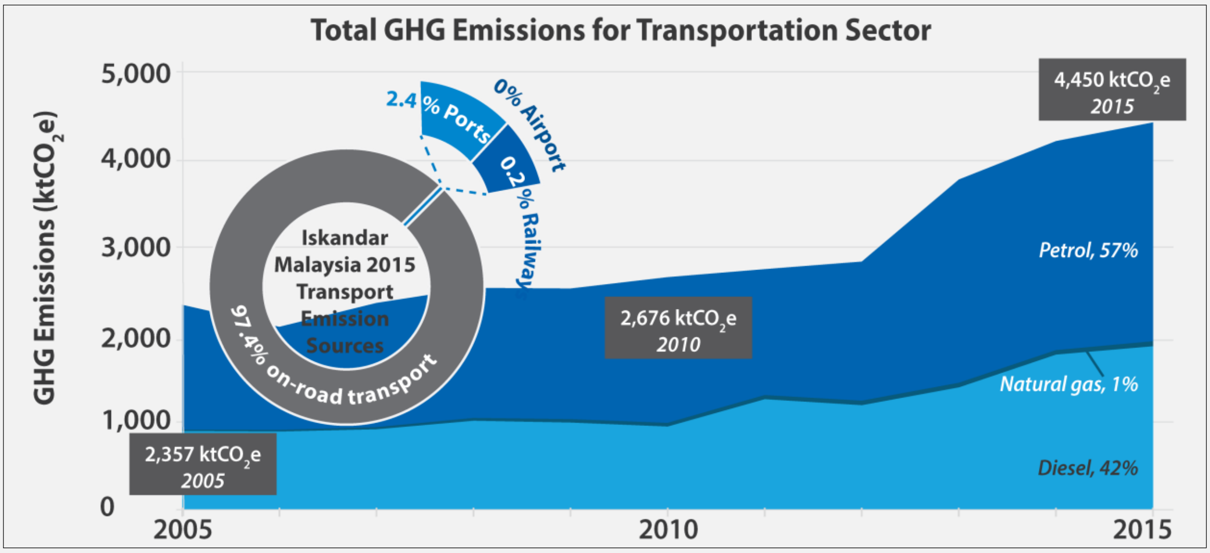


Figure 9: GHG emissions from transportation sub-sectors

[5] Projected data using data provided by Unit Perancang Ekonomi Negeri Johor (UPENJ) from 2007-2014
[6] Retrieved from http://iskandarmalaysia.com.my/promoted-sectors/

97.4 % of the total emissions from the transportation sector of Iskandar Malaysia is contributed by **on-road transportation** (**Error! Reference source not found.**). Among all the different fuel types, petrol consumption is the highest, followed by diesel. Emissions from railway and off-road transportation sub-sectors were 0.2% and 2.4% respectively.

With reference to GPC, emissions from biodiesel, biogenic origin materials shall be reported separately from the scopes and other gases. Therefore, emissions from biodiesel consumption in Iskandar Malaysia were calculated and reported under column CO_2(b) at 0.04 million tCO_2e.

Waste

Solid waste disposal is the main contributor of emissions in the waste sector at 76% followed by wastewater treatment and discharge at 24%. Operating landfills are the main contributor of emissions in the waste sector at about 63%, followed by industrial wastewater (from POME and rubber mill) at 25%. Closed landfills and domestic wastewater contribute 8% and 4% respectively to the emissions in the waste sector. Emissions from sludge is very minimal (Figure 10).

As mentioned in previous chapter, emissions from biomass shall be reported under AFOLU sector. Based on the available data, the emissions from stockpile of biomass in oil palm estate such as EFB, OPT and OPF were calculated at 0.19 million tCO_2e which is about 23% of the emissions of waste sector.

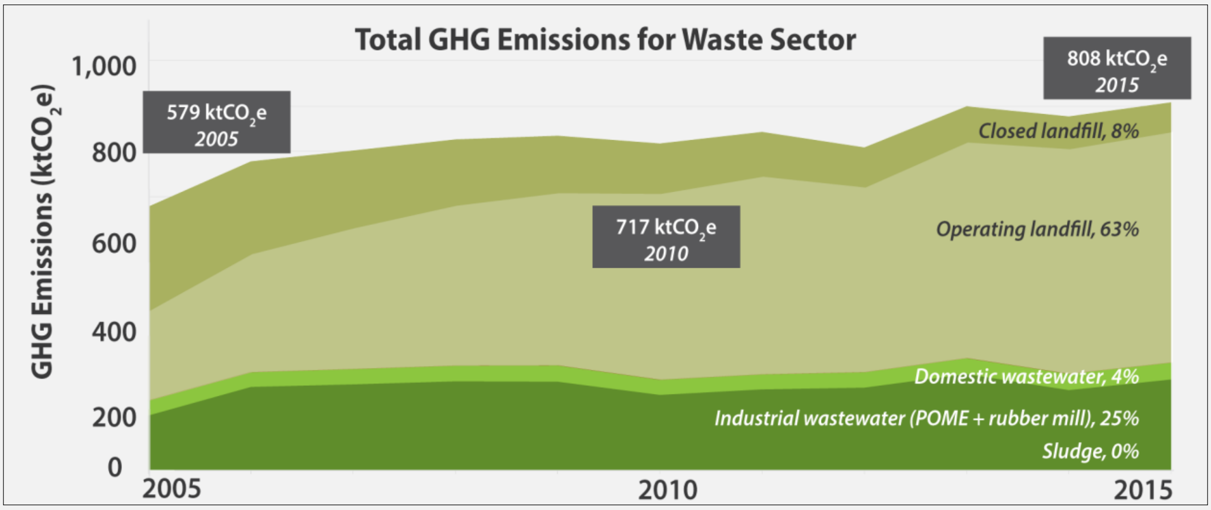


Figure 10: GHG emissions from waste sub-sectors

Iskandar Malaysia Emissions Intensity

The GHG emission intensity of Iskandar Malaysia for 2015 is reported at 0.27 $ktCO_2e$/RM million. The emission intensity was calculated using GDP based on 2005 constant price. This is consistent with the national GHG emissions reporting approach.

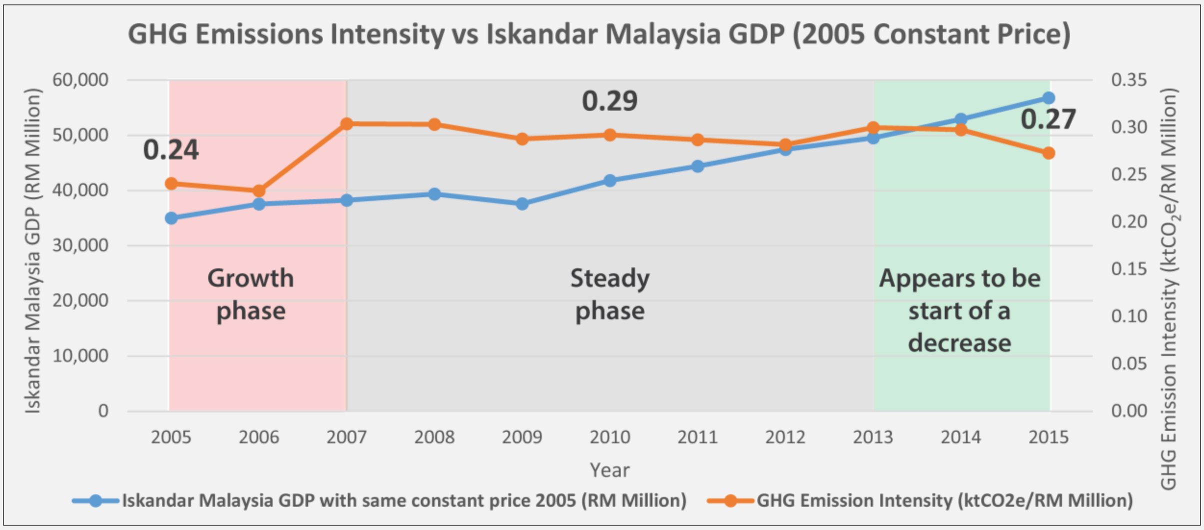


Figure 11: All BASIC emissions intensity vs Iskandar Malaysia GDP (at 2005 constant price)

The GHG emission intensity of Iskandar Malaysia for 2015 is reported at 0.27 $ktCO_2e$/RM million. The emission intensity was calculated using GDP based on 2005 constant price. This is consistent with the national GHG emissions reporting approach.

Interestingly, the GHG intensity from 2005 to 2015 appears to progress through 3 phases:

- 2005 – 2007 Growth phase
- 2008 - 2013 Steady phase
- 2014 - 2015 Appears to be start of a *decrease* (but not conclusive)

However, it should be noted that at this stage, it is too early to conclude that the GHG intensity of Iskandar Malaysia is on a decreasing trend for the coming years. This is because the economic region is still developing for which there will be uncertainties to consider.

Benchmarking

A comparison of Iskandar Malaysia's emission intensity per capita was made between cities which have adopted GPC as their reporting methodology. These cities measured emissions between years 2012 to 2015.

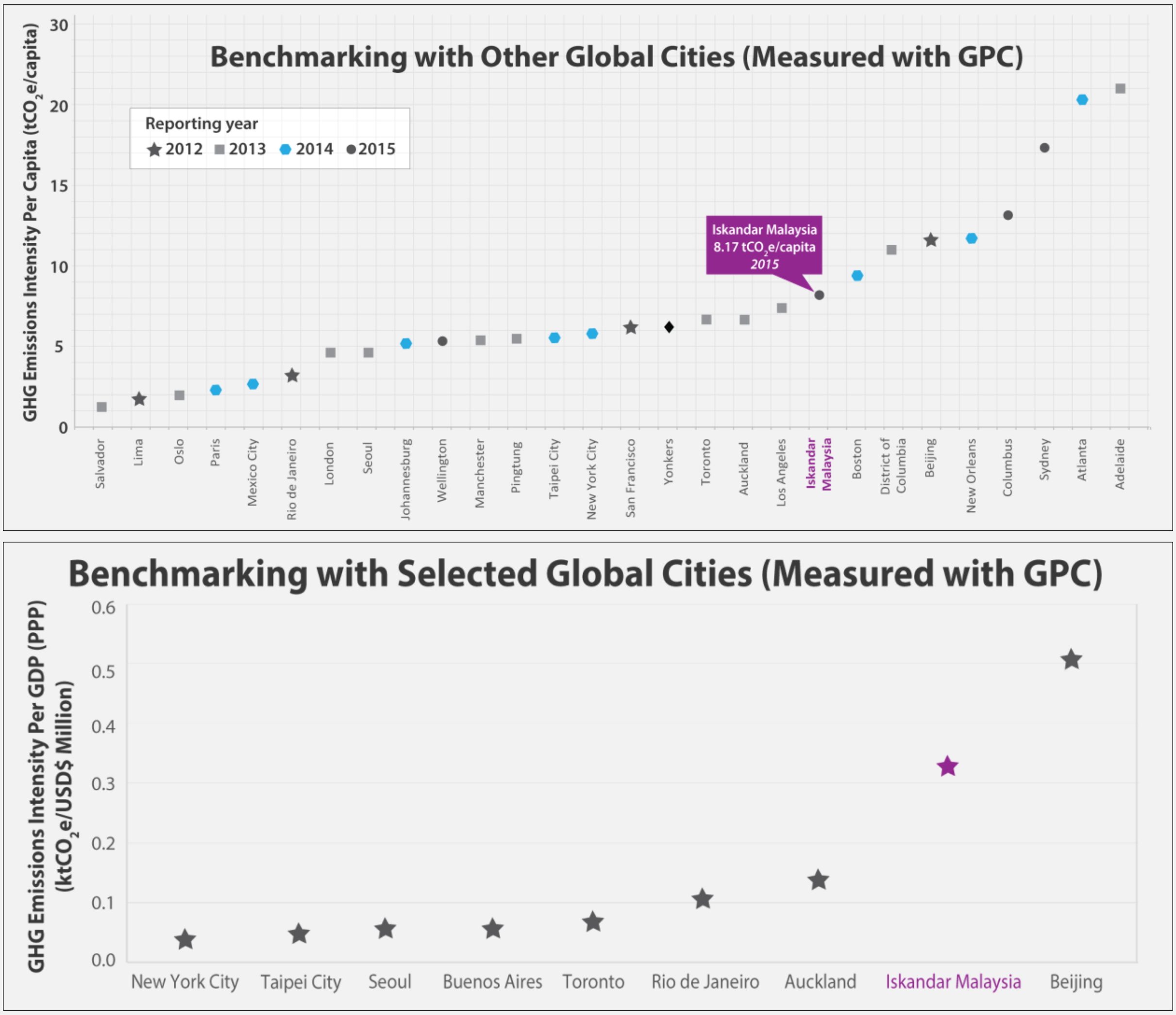


Figure 12: Benchmarking with others global cities measured with GPC

As illustrated in Figure 12, GHG emissions per capita ranged from 1.27tCO_2e per capita (Salvador, Brazil with population of 2.9 million) to 21.00tCO_2e per capita (Adelaide, Australia with population of 0.49 million) whereas Iskandar Malaysia falls in the middle of the range on a global city-scale with emissions of 8.17tCO_2e per capita.

In terms of GHG emissions intensity per GDP, Iskandar Malaysia is among the second highest compared with other cities which have reported their emissions using GPC. It should be noted that Iskandar Malaysia is a developing city-region and the emissions intensity as such would be higher compared to these selected cities which are mostly developed cities.

Iskandar Malaysia had measured its GHG emissions based on GPC BASIC level reporting and with reference to 2006 IPCC Guidelines for its calculation methodologies. The other cities might have adopted BASIC+ level reporting with different calculation methodologies. Thus, the comparisons presented above should be treated as indicative only due to the lack of publicly available reports (at detailed reporting level) for other countries.

4.0 CONCLUDING REMARKS AND WAY FORWARD

Photo credits: IRDA

The GHG inventory 2015 for Iskandar Malaysia is the first regional/city level GHG reporting performed in Malaysia using an internationally recognised reporting standard (i.e. GPC). The report aims to provide a sound basis for assessing the GHG emissions of Iskandar Malaysia over the past 10 years and identification of the major GHG emission sources which should be the focus of mitigation efforts. Most importantly, through the work of preparing the GHG Inventory 2015, a monitoring and reporting framework for tracking the GHG emission performance for Iskandar Malaysia has been successfully developed.

This GHG Inventory would be an instrumental launching pad for future tracking and setting of emissions reduction target. The information on major emission sources within Iskandar Malaysia provides important data for development of strategic action plans with maximum impact on reduction of emissions. It is recommended that the GHG inventory be **updated on a yearly basis**.

Applying the same 58% reduction of GHG emission intensity but with 2010 as base year the emission intensity, the target emission intensity by year 2025 would be 0.12 $ktCO_2e$/RM million GDP (Figure 13). In 2015, the emission intensity of Iskandar Malaysia stands at 0.27 $ktCO_2e$/RM million GDP. To meet the 2025 emission intensity reduction target, it is estimated that an average annual GHG emission reduction rate of 7.7% is required from year 2015 onwards.

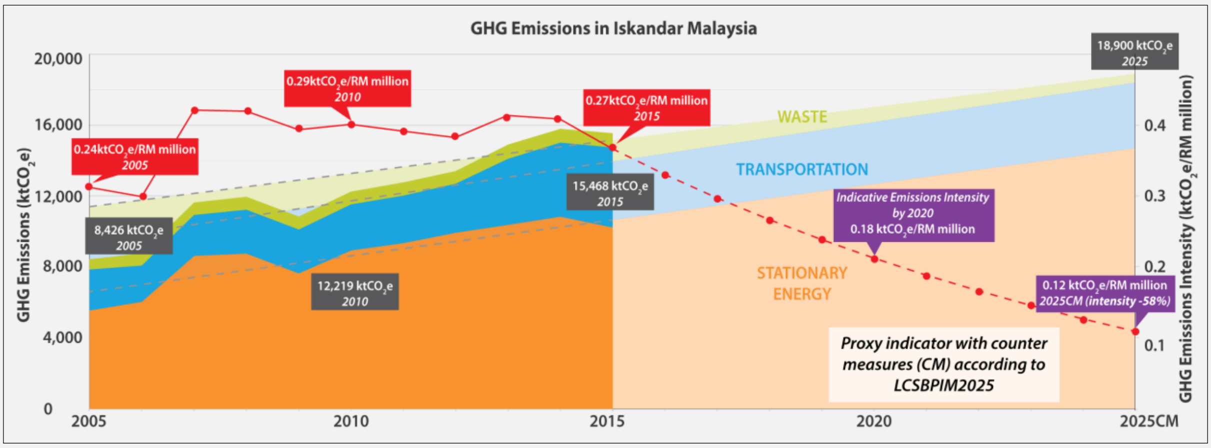


Figure 13: Towards achieving GHG emissions reductions target

No city inventory is perfect. All cities/regions would have gaps in their data and have to make estimations for parts of their emissions inventories. This inventory has been compiled using the best available data and methodologies, however there remains potential for improvement.

Subsequent inventories should seek to build on the work done here, and improve the accuracy, reliability, and coverage of data.

Going forward, IRDA shall seek to address the 3 broad areas set out below in its effort to improve its inventory. It identifies some priority areas and some recommended actions.

Develop	• Sector specific emisson targets • Review emission reduction action plan • Set up a GHG Inventory unit in IRDA
Improve	• Data availability specific to Iskandar Malaysia • Expand reporting coverage and scope
Report	• Iskandar Malaysia GHG Inventory for tracking of emissions • Benchmark against similar city/ region

Dataran Tanjung Emas

Photo credits: Bali Mie [balimie@loulpop

Detailed 2015 Iskandar Malaysia GHG 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		142,105	11	0.23	142,484		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		1,269,737			1,269,737		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		192,805	17	0.74	193,474		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		1,899,120			1,899,120		M	H	Scaled down from secondary data based on population ratio
Manufacturing and construction									
Scope 1 Emissions from fuel combustion within the city boundary		1,754,847	73	11.41	1,759,907		M	L	Scaled down from secondary data based on industrial GDP
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		2,595,434			2,595,434		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		1,138,895	20	2.03	1,140,002		H	L	Primary data from power plants. Assumed auxiliary operations are 5% of the total grid-supplied energy consumption when data are not available
Scope 2 Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary		973,082			973,082		H	H	Primary data from power plants
Scope 1 Emissions from energy generation supplied to the grid		12,580,539	224	22.43	12,592,761		H	L	
Agriculture, forestry and fishing activities									
Scope 1 Emissions from fuel combustion within the city boundary		189,208	26	2.89	189,931		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		47,713			47,713		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		4,242,439	1,344	207.52	4,335,052	35,231	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	NE								Not estimated as there are only 2 units of pilot electrical vehicles available in Iskandar Malaysia
Railways									
Scope 1 Emissions from fuel combustion for railway transportation occurring within the city boundary		8,802	0	3.40	9,716		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		52,719	87	7.96	104,796		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 Scope 2 of 'Commercial and insitutional buildings and facilities' sub-sector
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			20,437		572,237		M	L	Primary data from authorities/operators and extrapolation made based on population and waste generation 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	NO								Not occurring in Iskandar Malaysia Economic Region
Scope 1 Emissions from solid waste generated outside the city boundary and disposed in landfills or open dumps within the city boundary	NO								Not occurring in Iskandar Malaysia Economic Region
Wastewater treatment and discharge									
Scope 1 Emissions from wastewater generated and treated within the city boundary			8,416	0.39	235,739		M	L	Primary data from operators and extrapolation made based on population and waste generation rate 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	NO								Not occurring in Iskandar Malaysia Economic Region
TOTAL	**ALL TERRITORIAL EMISSION**				**28,061,186**				
	ALL BASIC EMISSION				**15,468,425**				

Detailed 2015 Iskandar Malaysia Inventory by Scope

GHG Emissions Source (By Sector and Sub-sector)	Type of Scope (tCO_2e)		Total by city-induced reporting level (tCO_2e)
	Scope 1	Scope 2	BASIC
STATIONARY ENERGY			
Residential buildings	142,484	1,269,737	1,412,221
Commercial, institutional buildings & facilities	193,474	1,899,120	2,092,594
Manufacturing and construction	1,759,907	2,595,434	4,355,341
Energy industries	1,140,002	973,082	2,113,084
Energy industries	12,580,539		
Agriculture, forestry and fishing activities	189,931	47,713	237,644
TRANSPORTATION			
On-road transportation	4,334,052	NE	4,335,052
Railways	9,716	NO	9,716
Waterborne navigation	NE	NE	NE
Aviation	NE	NE	NE
Off-road transportation	104,796	IE	104,796
WASTE			
Solid waste disposal	572,237	NO	572,237
Solid waste disposal	NO		
Wastewater treatment and discharge	235,739	NO	234,739
Wastewater treatment and discharge	NO		
TOTAL	**ALL TERRITORIAL EMISSION**		**28,061,186**
	ALL BASIC EMISSION		**15,468,425**

Notation Keys:

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

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

● – Non-applicable emissions

Scope 3, IPPU and AFOLU sectors only applicable for BASIC+ reporting.

Data Quality Assessment

Data Quality	Activity Data (AD)	Emission Factor (EF)
High (H)	Detailed activity data	Specific emission factors
Medium (M)	Modeled activity data using robust assumptions	More general emission factors
Low (L)	Highly-modeled or uncertain activity data	Default emission factors

1.0 PREAMBLE

1.1. Climate Change – A Real and Present Issue

Over the past few decades, climate change has become an increasingly evident reality in our world. Some aspects of the changing world climate such as sea level rise, unusual and prolonged dry season, disastrous landslides, flooding, and tropical storms are indications of climate change. Nevertheless, the global average surface temperature is the parameter that most clearly defines global climate change.

Rapid urbanisation and accelerating development of human activities have led to unprecedented warming globally with severe impacts to the environment. Urbanisation is accompanied by change in lifestyles, increased energy demand, transportation, infrastructure etc. It therefore exerts considerable pressure on the existing city resources.

It is highly unlikely that climate change can be reversed or stopped in the near future. The issue of intensifying climate change has sparked serious concerns from communities, governments and business leaders at all levels – whether local, national or international stage. Fighting climate change is an on-going effort that must be led by the Government and undertaken and supported by everyone in the country.

On 12 December 2015, a global climate agreement, namely the Paris Agreement was adopted at the 21st session of the Conference of the Parties (COP 21) to the United Nations Framework Convention on Climate Change (UNFCCC) held in Paris, France. This agreement brings together all nations into a common cause to undertake ambitious efforts to combat climate change and adapt to its effects[7].

The Paris Agreement is the world's biggest leap forward in climate change policy in history. Over 190 countries have agreed to commit to reduce GHG emissions with the aim of keeping global average temperature rise well below 2^{o}C, and drive efforts to limit the increase even further to 1.5^{o}C above pre-industrial levels. As of 24 November 2016, the agreement has been ratified by 113 countries, representing about 79% of global emissions. Symbolically, the agreement shows something that never has been apparent before: The world is united on this issue. The Paris Agreement sets in place a process for countries to cut emissions, report on their progress and are held responsible to each other.

[7] http://unfccc.int/paris_agreement/items/9485.php

1.2. Malaysia's Involvement and Commitment

As the issue on climate change gains greater attention, mandatory and voluntary efforts in reducing Greenhouse Gas (GHG) emissions are observed in many countries around the globe, including Malaysia. During the 15th Conference of the Parties (COP 15) by UNFCCC in December 2009 at Copenhagen, Denmark, the Prime Minister of Malaysia announced Malaysia's voluntary initiative to achieve up to 40% reduction in emissions intensity of its Gross Domestic Product (GDP) by 2020 based on the 2005 level. This target is to be achieved under the condition that technology transfer and financial support are provided from developed countries. International policy on green technology ownership, technological transfer and technology development cooperation and assistance are vital in enabling Malaysia to address the challenges due to climate change. This indicator is one of the measures of the nation's success in efforts to develop sustainably.

More recently in 2015, Malaysia has released its **Intended Nationally Determined Contribution (INDC)** of achieving **45% emissions intensity by GDP by year 2030** as compared to year 2005 level, under the same condition of receiving technology transfer and support, reaffirming Malaysia's stand and commitment in fighting climate change. As announced[8] by the Minister of Natural Resources and Environment, Malaysia is set to ratify the Paris Agreement 2015 before end of year 2016.

1.3. Iskandar Malaysia – Taking the Lead for Malaysia

In conjunction with the Malaysian Government's voluntary GHG emission reduction effort, Iskandar Malaysia, a developing economic hub, took the initiative to address carbon emissions in its jurisdiction. This proactive stance also reflects the ultimate target of Iskandar Malaysia to be "**A Strong and Sustainable Metropolis of International Standing**" by the year of 2025.

As the number of people residing in cities increases rapidly, the impacts on climate change from human activities and vice versa are significant and should not be underestimated. Therefore, city-scale GHG accounting and management had gained close attention from relevant organisations and parties. Organisations such as the United Nations Environment Programme (UNEP), International Council for Local Environmental Initiatives (ICLEI), C40 Cities, CDP (formerly the Carbon Disclosure Project), World Mayors Council on Climate Change, World Resources Institute (WRI), and Carbon Cities Climate Registry are all championing city-scale GHG accounting and mitigation activities for cities all over the globe.

The first step in managing GHG emissions effectively at the city/region scale and making informed decisions to contribute to global mitigation efforts, is to have a good understanding of these emissions – the major sources, activities and relative contributions of different activities.

1.4. Low Carbon Society Blueprint for Iskandar Malaysia 2025

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**.

[8] http://www.thestar.com.my/news/nation/2016/09/19/malaysia-to-ratify-climate-change-accord-soon/

The LCSBPIM2025 is a research output of Japan's Science and Technology Research Partnership for Sustainable Development (SATREPS) project on the Development of Low Carbon Society Scenarios for Asian Region sponsored by Japan International Cooperation Agency (JICA) and Japan Science and Technology Agency (JST). The main research institutes involved in this collaboration are Universiti Teknologi Malaysia (UTM), Kyoto University, National Institute for Environmental Studies (NIES), and Okayama University. There is also strong involvement in the preparation of the LCSBPIM2025 from IRDA and the 5 Local Authorities - Majlis Bandaraya Johor Bahru (MBJB), Majlis Perbandaran Johor Bahru Tengah (MPJBT), Majlis Perbandaran Pasir Gudang (MPPG), Majlis Perbandaran Kulai (MPKu), and Majlis Daerah Pontian (MDP).

IRDA has adopted and applied the Low Carbon Society Blueprint (LCS) in its jurisdiction over Iskandar Malaysia. The main objectives of adopting and applying LCS are to draw up key policies and strategies to guide the development of Iskandar Malaysia in mitigating their GHG emissions, in order to transform the economic hub into a sustainable low-carbon metropolis by adopting green-growth strategies; and to respond to the nation's aspiration for ensuring climate-resilient development for sustainability.

To further accelerate the realisation of LCS in Iskandar Malaysia at the local level, 5 LCS Action Plans are formulated. These Local Authority-Level LCS Action Plans are crucial to ensure effective implementation of the LCSBPIM2025 as each LCS Action Plan recognises and responds to the distinctive economic, social and environmental characteristics, as well as the strengths, potentials and issues unique to each Local Authority. By adopting their respective LCS Action Plan, the Local Authorities are in fact adopting LCS policies and programmes within the regional level framework of the LCSBPIM2025 that are suitable to their socioeconomic and environmental contexts.

The Iskandar Malaysia Low Carbon Society Blueprint was launched at COP18 in DOHA, 2012
Photo credits: IRDA

1.5. Iskandar Malaysia – Greenhouse Gases (GHG) Emissions Reporting Objectives

Monitoring and reporting is a crucial step in tracking the progress and path towards the goals and targets set. Iskandar Malaysia has completed 5 out of 6 stages of the Low Carbon Development Cycle and currently is in stage 6 - tracking performance of implemented LCS programmes (Figure 14).

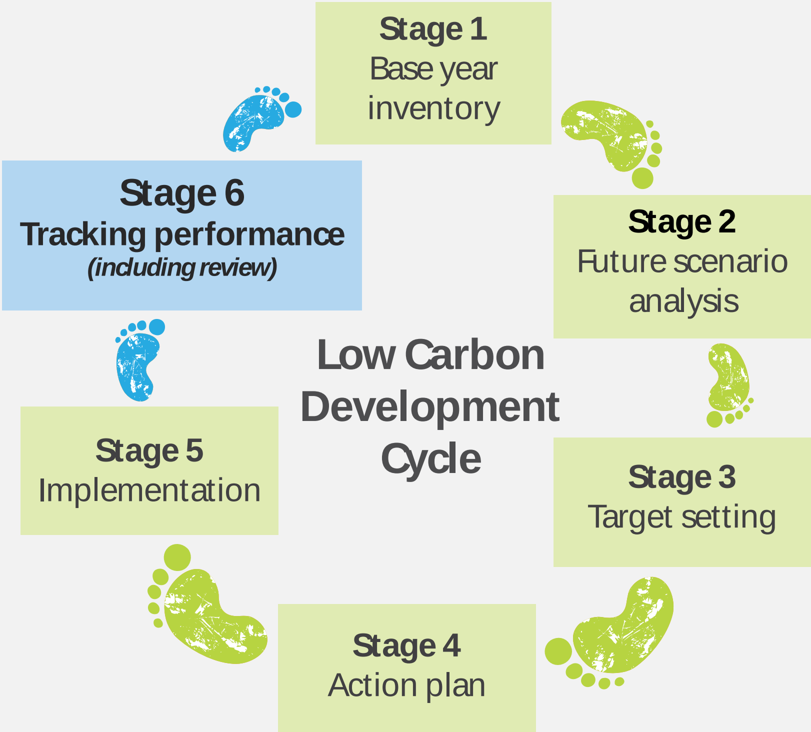


Figure 14: Low Carbon Development Cycle

The Environment Division of Iskandar Regional Development Authority (IRDA) is responsible for tracking the implementation of the LCSBPIM2025, and more importantly, the carbon emissions of Iskandar Malaysia. It is essential to measure the progress of the efforts within Iskandar Malaysia towards achieving the Iskandar Malaysia emissions reduction. The tracking will benefit the IRDA in terms of making future strategic planning decisions.

In order to track and manage the performance of carbon emissions over time, the **Global Protocol for Community Scale Greenhouse Gas Emissions Inventories (GPC) - an internationally-recognised carbon monitoring and reporting framework** has been adopted for this study.

1.6. Why GPC?

There are various inventory methods available for city-scale GHG inventory with different reporting coverages (i.e. covers different emissions sources and type of GHG). These inconsistencies introduce significant difficulties in comparing emissions between cities which might be using different inventory method. Besides, data quality and aggregation of local, sub-national and national government GHG emissions data are also obstacles for comparison. Therefore, credible reporting, meaningful benchmarking and aggregation of climate data for greater consistency in GHG accounting is required. In response to this challenge, the GPC offers a robust and clear framework that builds on existing methodologies for calculating and reporting city-scale GHG emissions.

The GPC was launched in 2014 by its lead authors, WRI, the C40 Cities Climate Leadership Group and International Council for Local Environmental Initiatives (ICLEI) – Local Governments for Sustainability as the first internationally accepted standard for measuring city-scale GHG emissions (Figure 15). Although GPC is primarily designed for cities, the accounting framework can also be used for boroughs or wards within a city, towns, districts, counties, prefectures, provinces, and states. In this document, the term "city" is used to refer to all of these jurisdictions, unless otherwise specified. However, the GPC does not define what geographic boundary constitutes a "city". Similarly, the terms "community-scale" is used to refer to inventories encompassing any of these geographic designations, and is used interchangeably with "city-scale" or "city-wide" inventories[9].

Figure 15: GPC

The GPC establishes credible emissions accounting and reporting practices that help cities to develop emissions baselines, set mitigation goals, create more targeted climate action plans and track progress over time, as well as strengthen opportunities for cities to partner with other levels of governments and in some cases, increase access to funding, local or abroad. The GPC has been adopted as a central component of the Compact of Mayors (largest cooperative effort among mayors and city officials) to reduce GHG emissions, track progress, and prepare for the impacts of climate change. Currently, through the Compact of Mayors, there are about 600 cities across the globe that have committed to report their emissions using GPC (Figure 16).

Figure 16: Cities committed to the Compact of Mayors[10]

The GPC provides overarching and sector specific reporting guidelines for sourcing data and calculating emissions, as well as appropriate methodologies based on purpose of their inventory, availability of data and consistency with their country's national inventory and/or other measurements and reporting programme in which they participate. The advantages of adopting the GPC for emissions reporting can be summarised in Figure 17.

[9] GPC
[10] Source: https://www.compactofmayors.org/cities/

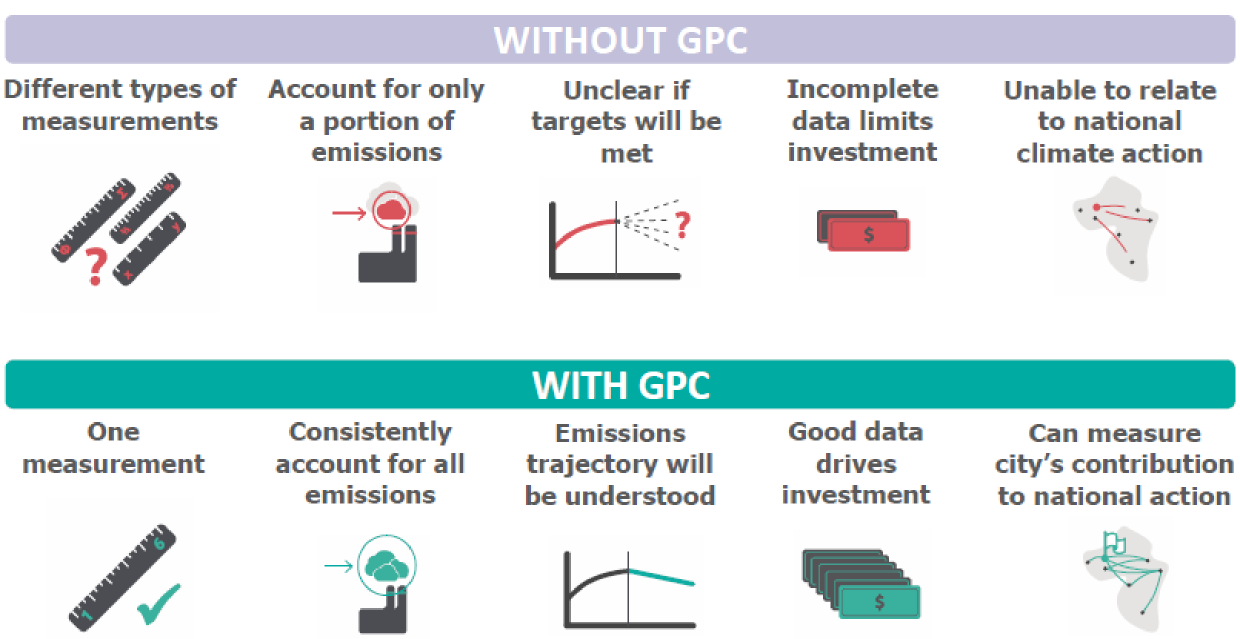
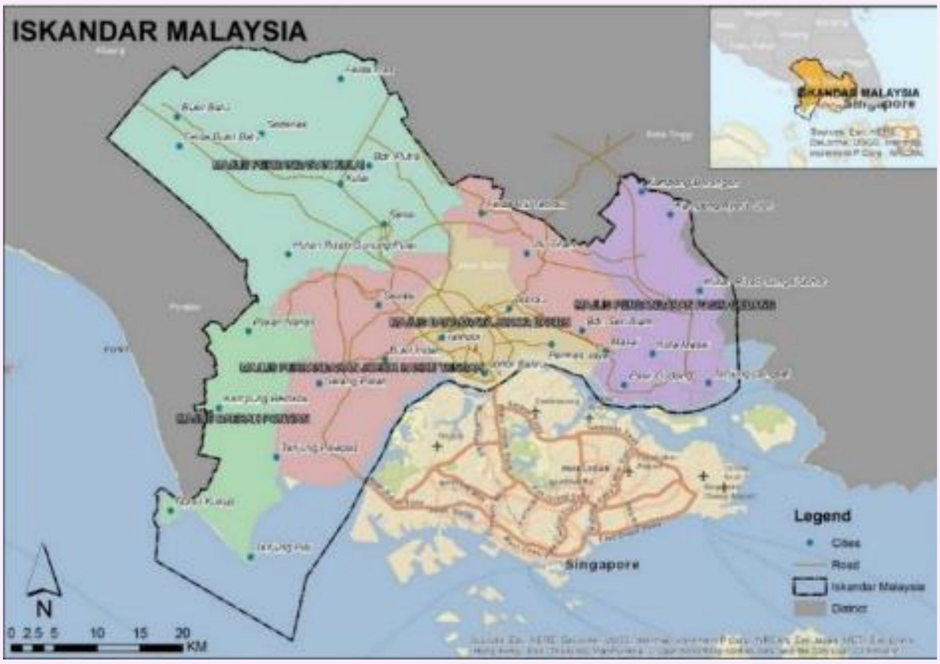


Figure 17: Advantages of GPC[11]

[11] Souce: GPC Infographic, http://www.ghgprotocol.org/files/ghgp/GPC_infographic_printready.pdf

1.7. Inventory City Information

Inventory boundary	City information
Name of city	Iskandar Malaysia Economic Region
Country	Malaysia
City established	8 November 2006 (region formalised)
Administered	Iskandar Regional Development Authority (IRDA)
Inventory year	2015
Geographical boundary	 Southern tip of Peninsular Malaysia. Comprise 5 Local Authorities: Majlis Bandaraya Johor Bahru (MBJB), Majlis Perbandaran Johor Bahru Tengah (MPJBT), Majlis Perbandaran Pasir Gudang (MPPG), Majlis Perbandaran Kulai (MPKu) and part of Majlis Daerah Pontian (MDP)
Land area	2,300 km^2 (12% of Johor State)
Resident population	1.89 million
GDP	RM 56,772 million (USD 13,847 million) @ 2005 constant price
Composition of economy	Industry and manufacturing
Climate	Tropical rainforest

1.8. GHG Inventory Reporting Framework

The Iskandar Malaysia (refers as reporting city) GHG inventory follows as closely as possible to the GPC, which emphasises city-scale emissions.

The GHG emissions will be reported in metric tonnes of each GHG and CO_2 equivalent (CO_2e). The CO_2 equivalent can be determined by multiplying each gas by its respective global warming potential (GWP).

The 2015 GHG Inventory Reporting Framework for Iskandar Malaysia is summarised as below:

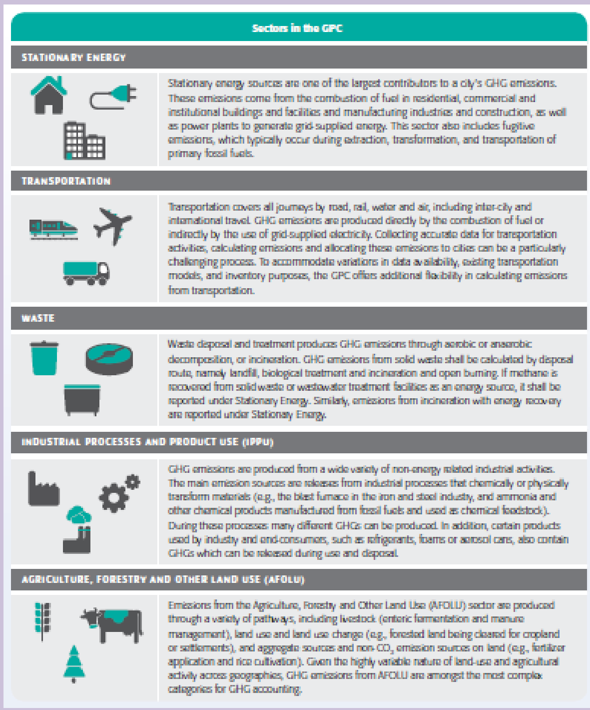
GPC reporting level	BASIC
GHG included in inventory	Carbon dioxide (CO_2), methane (CH_4) and nitrous oxide (N_2O)
GWP	IPCC Fifth Assessment Report 2014 (AR5)
Description of overall methodologies and tools used	GPC, 2006 IPCC Guidelines

As recommended by GPC, this report has adopted the latest GWP, AR5 for its calculation. However, the national emissions are calculated based on AR4, therefore, another set of results are calculated based on AR4 to align with national level for comparable results.

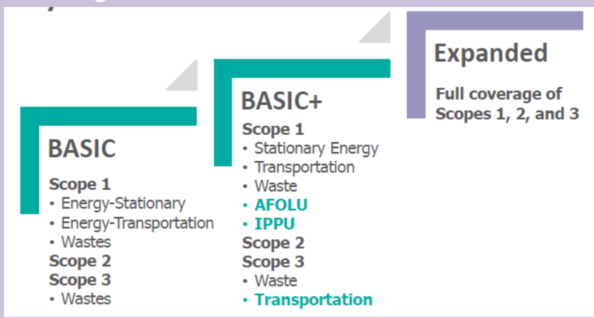
Comparisons of GWP IPCC AR4 and AR5:

Gas	GWP Values	
	IPCC AR4 (CO_2e)	IPCC AR5 (CO_2e)
CO_2	1	1
CH_4	25	28
N_2O	298	265

The 6 emission source sectors in GPC:



GPC city-included framework and its' coverage:



Figures adopted from GPC

1.8.1. The Scopes and City-induced Framework – BASIC Level

In GPC, city-induced reporting framework seeks to account for emissions as a result of activities in the city. There are 2 reporting levels/options for cities to select for their city-induced framework, namely BASIC and BASIC+.

Considering the inaugural attempt and limitations of data for Iskandar Malaysia to establish its GHG inventory using GPC, the Iskandar Malaysia GHG emissions accounting and reporting for 2015 is limited to the BASIC level. Iskandar Malaysia will continue with increasing level of reporting for the next phase.

Iskandar Malaysia GHG emissions accounting and reporting at the BASIC level covers the following sectors:

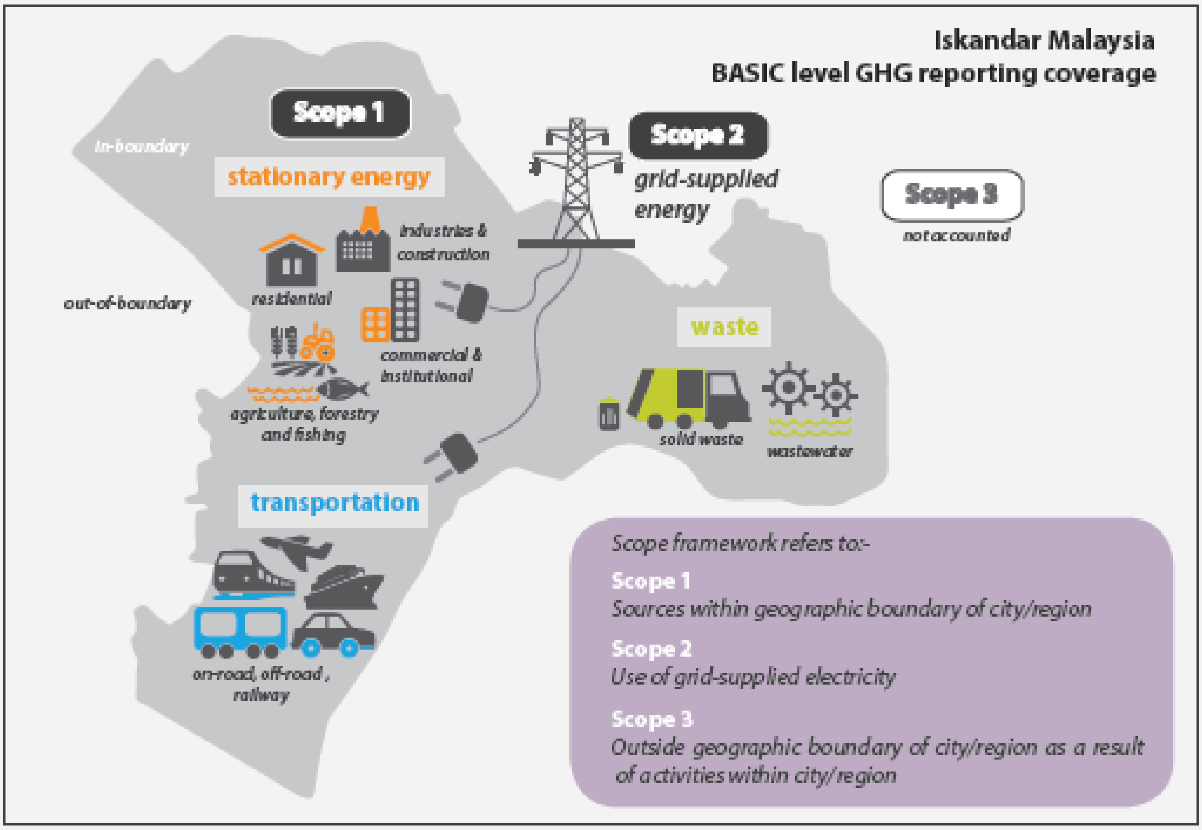


Figure 18: Coverage of Iskandar Malaysia's BASIC level GHG reporting

1.9. Data Quality Assurance

In the process of developing the Iskandar Malaysia GHG Inventory 2015, a number of engagements have been conducted to ensure the success of the inventories as well as for data quality assurance. Other than the consultation with Third National Communication (TNC)/ Biennial Update Report (BUR) team, the project team also engaged data suppliers through stakeholder consultations and focus group discussion workshops. Stakeholders' consultation workshop was conducted once before data collection to introduce these inventories and assess data availability and accessibility level. Also, a number of engagements have been carried out throughout the data collection phase to ensure most accurate data have been obtained and used. A focus group discussion workshop was held to discuss the assumptions that have been made during the inventories and calculations (Appendix 1). The way forward for future data collection was also discussed in the focus group discussion.

2.0 METHODOLOGIES AND APPROACHES

GPC encourages cities to select the most appropriate methodologies based on the purpose of their inventory, availability of data, and alignment with their country's national inventory and/or other measurement and reporting programmes in which they participate. Therefore, a number of discussions with relevant agencies especially parties involved in the TNC/BUR was carried out during the process of preparing this IM GHG Inventory 2015 to ensure consistency in data sources, emission factors and coverage.

Iskandar Malaysia has adopted the 2006 Intergovernmental Panel on Climate Change (IPCC) guidelines as its calculations methodology as suggested in GPC. The IPCC guidelines provide 3 hierarchies of methodological complexity for the calculation of each emission source. In general, Tier 1 emissions calculation methodology is calculated based on the activity data (e.g. fuel use) and default emissions factors. Tier 2 emissions calculation methodology requires more detailed activity data and national/regional specific emissions factors. Calculating emissions according to Tier 3 emissions calculation methodology requires an even higher level of detail and specific information regarding the combustion technology, control technology etc.

Considering the limited project timeframe and the availability of region-specific data/ information, Tier 1 approach had been selected for most of the calculations while Tier 2 and Tier 3 approaches had been set as target for some of the calculations.

The 3 main sectors covered in this inventory were (1) stationary energy, (2) transportation, and (3) waste.

2.1. Stationary Energy

Owing to its strategic location, Iskandar Malaysia has become an investment haven-in-the-making since its inauguration in 2006. With its rapid economic development, Iskandar Malaysia's GDP of RM 56,772 million in 2015 contributed a significant 67% of Johor's GDP[12] for the year. This tremendous growth demonstrates its potential to be one of the world' fastest growing economic regions in the next 10 years.

[12] GDP at different constant price obtained from Johor Economic Planning Unit (UPENJ) and Economic Planning Unit (EPU) Malaysia. The GDP has been adjusted at a 2005 constant price.

Aside from the active economic growth, Iskandar Malaysia's population has also increased from 1.34 million[13] to 1.89 million[14] in merely 10 years since 2005, marking a growth of 41%. The residential land area of Iskandar Malaysia has grown from 9,725 hectares in 2005 to 13,164 hectares in 2013, while the industrial area increased 68% from 4,047 hectares to 6,785 hectares[15]. With all these socio-economic advancements taking place in the economic region, energy consumption is undoubtedly also growing in parallel. Thus, it can be concluded that stationary energy sector is indeed a significant contributor to Iskandar Malaysia's GHG emissions.

With reference to the GPC, stationary energy sources are one of the largest contributors to a city's GHG emissions. These emissions come from fuel combustion, fugitive emissions released in the process of generating, delivering and consuming useful forms of energy such as electricity or heat. Fuel (Scope 1 emissions) and electricity (Scope 2 emissions) consumption within Iskandar Malaysia region from the sub-sectors below were accounted in this inventory:

- residential buildings;
- commercial and institutional buildings and facilities;
- manufacturing industries and construction;
- energy industries; and
- agriculture, forestry and fishing activities.

2.1.1. Data Source and Calculation Approach

The GHG emissions sources accounted for each scope are summarised below.

GHG Emission Source	Scope 1	Scope 2	Scope 3
STATIONARY ENERGY	Emissions from fuel combustion and fugitive emissions within the city boundary	Emissions from consumption of grid-supplied energy consumed within the city boundary	Transmission and distribution losses from the use of grid-supplied energy
Residential buildings	✓	✓	
Commercial and instituitional buildings and facilities	✓	✓	
Manufacturing industries and construction	✓	✓	
Energy industries	✓	✓	
Energy generation supplied to the grid	✓		
Agriculture, forestry and fishing activities	✓	✓	
Non-specified sources	NO	NO	
Fugitive emissions from mining, processing, storage and transportation of coal	NO		
Fugitive emissions from oil and natural gas systems	NO		

Notation key

(light green)	Sources required for BASIC reporting
(magenta)	Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)
(lilac) + (light green)	Sources required for BASIC + reporting
(peach)	Sources included in Other Scope 3
(grey)	Non-applicable emissions
NE	Not Estimated
NO	Not Occurring
IE	Included Elsewhere
✓	Sources accounted in this inventory

The GHG emissions from stationary energy were calculated based on Tier 1 and Tier 2 emissions calculation methodologies. Primary and secondary data for electricity consumption and energy consumption were collected respectively from the Energy Commission (ST) and IPPs.

[13] Unit Perancang Ekonomi Negeri Johor (UPENJ)
[14] Projection figure based on Johor's population growth
[15] CDPii 2014 - 2025 page 188

As there were no specific data available on other fuel consumption within Iskandar Malaysia, the secondary data were extracted from National Energy Balance (NEB) 2005-2014 and scaled down either using population or industrial GDP (depending on sub-sectors) to obtain data which relate to Iskandar Malaysia as illustrated in Figure 19. Only data for *manufacturing industries and construction* sub-sector were scaled down based on industrial GDP. Industrial GDP is defined as the total GDP for agriculture, forestry and fishing, mining and quarrying, manufacturing and construction sub-sectors[16].

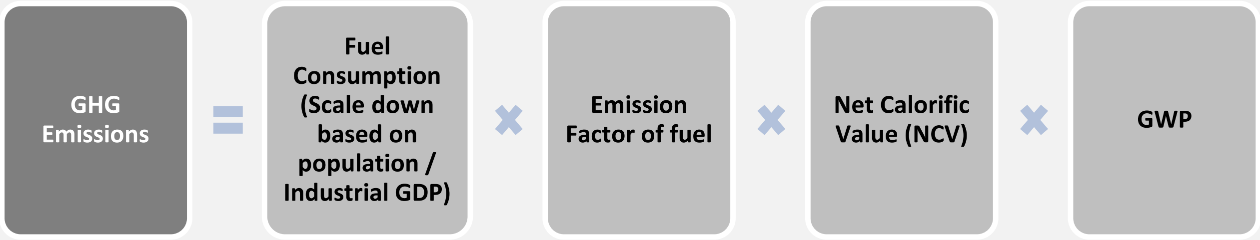


Figure 19: Formula for calculating GHG emission from stationary energy sector

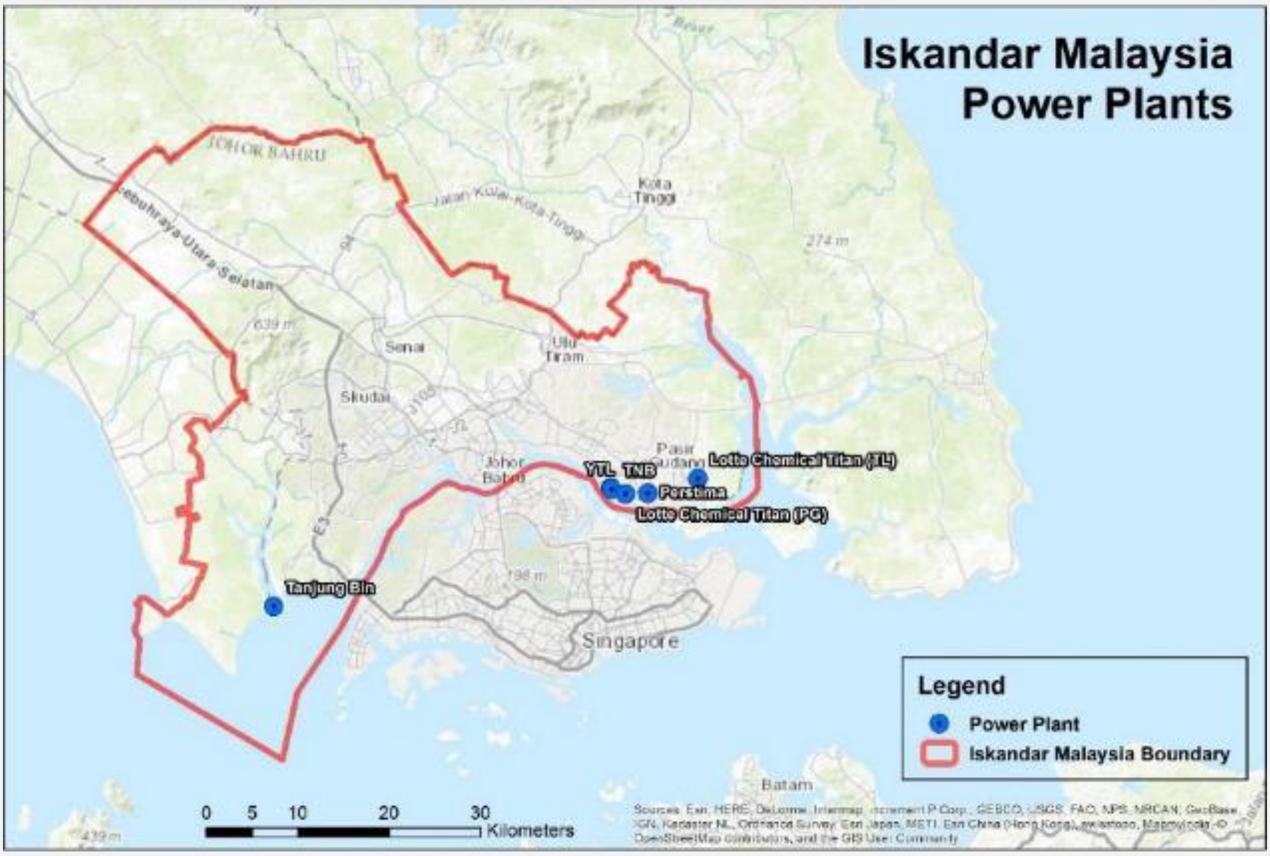


Figure 20: Power plants in Iskandar Malaysia

There are 6 power plants in the economic region which has a total capacity of 3,323 MW (Figure 20). All the power plants consume natural gas as fuel, except for Tanjung Bin Independent Power Producer (IPP) which consumes coal as its main fuel. According to GPC, only emissions from power plant auxiliary operations from energy industries is accounted for BASIC level reporting while the emissions from energy generation supplied to the grid is required for territorial total. Therefore, the emissions from energy industries had been calculated separately.

[16] National Energy Balance 2014, Page 69, Table 25

The relevant emission factors were sourced from 2006 Intergovernmental Panel on Climate Change (IPCC) Guidelines, Volume 2 , Chapter 2.

The emission factors for Peninsular Malaysia's grid electricity were sourced from Malaysian Green Technology Corporation (MGTC).

Sultan Iskandar Power Plant

Photo credit: Thomasllp, photobucket

2.2. Transportation

In Iskandar Malaysia, rapid growth in the transportation sector is foreseen in upcoming years due to the strong economic activities and rising population. The growth in the intra- and inter-regional transportation demand is inevitable as Iskandar Malaysia is a fast-developing urbanised region. Well-serviced by road and highway networks, Iskandar Malaysia has about 835km of roads and 96km of rail. In addition, an airport and 3 main ports within the region serve the air and marine transport sub-sectors (Figure 21).

Based on the projections using data extracted from Transport Statistics Malaysia, approximately 3.6 million on-road vehicles were registered in Johor in the year of 2015. Given that the population of Iskandar Malaysia is about 53% of the population of Johor State, the registered vehicles in Iskandar Malaysia is estimated to be 1.91 million. GHG emissions from transportation sector is considerable and could not be neglected.

Figure 21: Transportation in Iskandar Malaysia

Emissions from fuel consumption for on-road and off-road transportations and railways occurring within the city were also accounted for in this inventory.

According to the GPC, only emissions from aviation and waterborne navigation that originate and terminate within the city boundary are accounted for – under Scope 1 emissions. Therefore, emissions from aviation and waterborne navigation were not estimated in this inventory. The reasons for exclusion were the lack of such information and it is believed that the number of aviation and waterborne navigation trips made within the city boundary were insignificant.

2.2.1. Data Source and Calculation Approach

The GHG emissions sources accounted for each scope are summarised below.

GHG Emission Source	Scope 1	Scope 2	Scope 3
TRANSPORTATION	Emissions from fuel combustion for transportation occurring in the city	Emissions from consumption of grid-supplied energy for in-boundary transportation	Emissions from portion of transboundary journeys occurring outside the city, and transmission and distribution losses from grid-supplied energy
On-road	✓	✓	
Railways	✓	✓	
Waterborne navigation	NE	NE	
Aviation	NE	NE	
Off-road	✓	✓	

Notation key

(light green)	Sources required for BASIC reporting
(purple)	Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)
(light purple) + (light green)	Sources required for BASIC + reporting
(light orange)	Sources included in Other Scope 3
(grey)	Non-applicable emissions
NE	Not Estimated
NO	Not Occurring
IE	Included Elsewhere
✓	Sources accounted in this inventory

Similar to stationary energy sector, Tier 1 and Tier 3 emissions calculation methodologies had been used to calculate the GHG emissions from transportation sector.

Due to lack of primary data (i.e. fuel consumption), secondary data on Malaysia fuel sales were extracted from NEB 2005-2014 and scaled down by population to estimate the fuel consumption for on-road transportation in Iskandar Malaysia.

Emissions from off-road transportation were calculated based on the primary data (i.e. fuel consumption) provided by the port authorities and airport authority.

Emissions from railways were calculated based on the primary data (i.e. number of trips per year, diesel consumption per trip and train distance per trip) provided by railway operator.

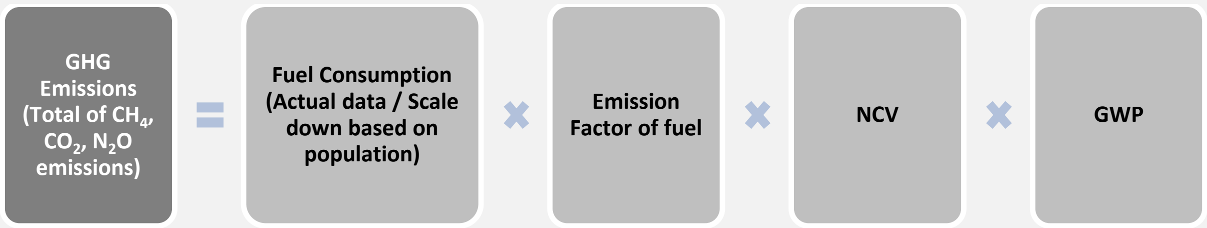


Figure 22: Formula for calculating GHG emission from transportation sector

The relevant emission factors were sourced from 2006 IPCC Guidelines, Volume 2, Chapter 3.

2.3. Waste

With reference to GPC, GHG emission from solid waste and wastewater is categorised under the waste sector. There are about 453,237[17] residences in Iskandar Malaysia and they generated approximately 2,140 metric tonne of waste per day and also 74 cubic meter of sewage per day in 2015.

Currently all the municipal solid waste, commercial and industrial waste that are similar to domestic waste generated in Iskandar Malaysia are collected by its concessionaire and disposed to the landfills within the economic region. There are 8 landfills in Iskandar Malaysia – 3 are still in operation and 5 are closed as illustrated in Figure 23.

Figure 23: Landfills in Iskandar Malaysia

All the municipal wastewater in Iskandar Malaysia are handled by the Local Authorities themselves (i.e. MBJB and MPPG) or concessionaire (i.e. Indah Water Konsortium (IWK)). The emissions from industrial wastewater calculated cover only palm oil mills effluents (POME) and rubber manufacturing for primary rubber product, while the industrial wastewater is handled by the respective premises.

The total oil palm plantation in Iskandar Malaysia covers around 96,678 hectares, with 135 – 145 trees[18] per hectare. During the production process, the solid waste generated are empty fruit bunches (EFB), palm kernel shell (PKS), and mesocarp fiber (MF).

[17] Calculated based on 4.17 person per household in Johor 2010: https://www.statistics.gov.my/mycensus2010/images/stories/files/Laporan_Kiraan_Permulaan2010.pdf
[18] http://www2.gec.jp/gec/en/Activities/FY2009/ietc/wab/wab_day2-3.pdf

In current practice, PKS and MF wastes are used extensively as fuel for steam production in palm oil mills. EFB is currently not being utilised and left to degrade in the fields as mulch. Oil palm trunks (OPT), and oil palm fronds (OPF) are generated after oil palm fruits harvesting, or during oil palm trees replantation. About 75% of the wastes in form of OPT and OPF are left to rot in the plantation for mulching and nutrient recycling purposes[19].

Wastewater is generated from extraction of palm oil through the wet process in a decanter and combined with the wastes from cooling water and steriliser. The wastewater produced is also commonly known as Palm Oil Mill Effluent or POME.

All biomass waste generated from the palm oil mill should be accounted under the Agriculture, Forestry and Other Land Use (AFOLU) sector which only required for BASIC+ reporting.

The rubber products accounted in this inventory include fresh latex and block rubber. Fresh latex refers to latex that is collected from rubber trees, and transported to rubber processing mills. Block rubber refers to Standard Malaysia Rubber (i.e. SMR20). There are 2 rubber manufacturing industries for SMR identified within the Iskandar Malaysia boundary[20].

Emissions from domestic waste, sludge, and industrial wastewater were accounted in this inventory. The emissions from industrial wastewater calculated cover only POME and rubber manufacturing for primary rubber product. Industrial wastewater from other manufacturing industries was excluded due to unavailability of data.

2.3.1. Data Source and Calculation Approach

The GHG emissions sources accounted for under each scope are summarised below.

GHG Emission Source	Scope 1	Scope 2	Scope 3
WASTE	Emissions from in-boundary waste treatment		Emissions from waste generated in the city but treated out-of-boundary
Disposal of solid waste generated in the city	✓		✓
Disposal of solid waste generated outside the city	NO		
Biological treatment of waste generated in the city	✓		✓
Biological treatment of waste generated outside the city	NO		
Incineration and open burning of waste generated in the city	✓		✓
Incineration and open burning of waste generated outside the city	NO		
Wastewater generated in the city	✓		✓
Wastewater generated outside the city	NO		

Notation key

	Sources required for BASIC reporting
	Sources required for territorial total but not for BASIC/BASIC+ reporting (*italics*)
+	Sources required for BASIC + reporting
	Sources included in Other Scope 3
	Non-applicable emissions
NE	Not Estimated
NO	Not Occurring
IE	Included Elsewhere
✓	Sources accounted in this inventory

Tier 2 emissions calculation methodologies have been used to calculate the GHG emissions from waste sector.

Primary data on domestic waste generated and landfills within the economic region were obtained from the Solid Waste Management and Public Cleansing Corporation (SWCorp), Local Authorities

19 https://www.researchgate.net/publication/281789310_An_overview_of_the_oil_palm_industry_in_Malaysia_and_its_waste_utilization_through_thermochemical_conversion_specifically_via_liquefaction

20 Data source: DOE GIS

and landfill operator. The GHG emission from solid waste was calculated based on the 2006 IPCC Guidelines – Tier 2 First Order Decay (FOD) method (2006 IPCC Guidelines, Volume 5, Chapter 3).

Primary data of domestic wastewater volume and treatment method were provided by some of the operators. Where primary data of wastewater volumes were not available for a particular year or local authority, the data required for calculating the GHG emissions were extrapolated from the available primary data of other Local Authorities using population as a scaling factor. The GHG emissions were estimated using the 2006 IPCC Guidelines Tier 2 emissions calculation methodology (2006 IPCC Guidelines, Volume 5, Chapter 6). Emission factors for each of the relevant treatment methods were sourced from 2006 IPCC Guidelines.

Emissions from industrial wastewater treatment were estimated based on the industrial production data and wastewater outflows treated by each treatment plant using the 2006 IPCC Guidelines Tier 2 emissions calculation methodology. As mentioned previously, the emissions from industrial wastewater calculated under this inventory only cover the emissions from palm oil mill industry (i.e. POME) and rubber mills (Figure 24).

Figure 24: Palm oil and rubber mills in Iskandar Malaysia

Emissions from municipal sludge treatment were estimated based on the total volume of sludge treated by each treatment plant. There are 3 different types of sludge treatment processes, i.e. Sludge Drying Bed (DB), Sludge Lagoon (SL) and Sludge Reception Facility (SRF). Emission factors for each of the relevant treatment methods were sourced from 2006 IPCC Guidelines.

Amount of sludge treated and treatment methods were provided by some of the operators. Where data of sludge volumes were not available, sludge volumes were extrapolated from the sludge volumes of other Local Authorities using population as a scaling factor.

2.4. Industrial Processes and Product Use (IPPU)

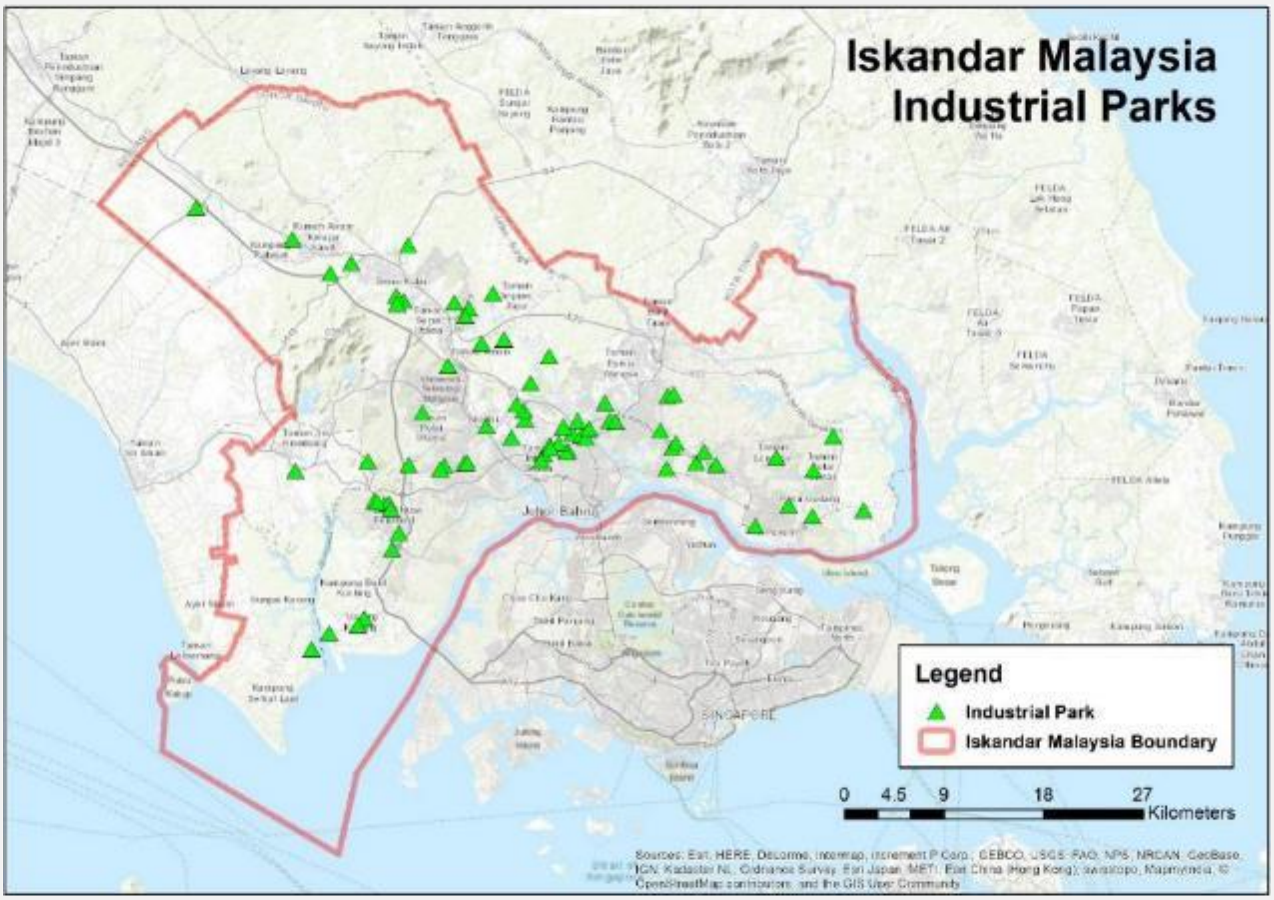


Figure 25: Industrial parks in Iskandar Malaysia

Industrial processes and product use (IPPU) sector includes the GHG emissions from a range of activities. All GHG emissions occurring from industrial processes, product use, and non-energy uses of fossil fuel, shall be assessed and reported under IPPU.

With reference to the GPC and 2006 IPCC Guidelines, “fuel combustion” in an industrial process context is defined as: “the intentional oxidation of material within an apparatus that is designed to provide heat or mechanical work to a process or for use away from the apparatus”[21]. Therefore, only when the combustion emissions from fuels are obtained directly or indirectly from the feedstock, and also when heat is released form a chemical reaction, the emissions shall be allocated to IPPU. For fuels that are combusted for energy use and derived fuels that are transferred for combustion in another source category, the emissions shall be reported under Stationary Energy[22].

In Iskandar Malaysia about 16% of the industries are metal manufacturing industries, followed by 12% of chemical industries, 10% plastic industries, and 9% electric and electronic industries[23]. Other industrial processes such as metal fabrication, food and beverage, wood industries, and the others add up the remaining percentage of IPPU sector.

Other than emissions from industrial processes, emissions from non-energy fossil fuel emission are also accounted under IPPU sector.

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[21] Source: 2006 IPCC Guidelines for National GHG Inventories, Volume 3 IPPU, Chapter 1 Introduction, Box 1.1

[22] GPC, Page 106

[23] Source: DoE, Sistem Maklumat Geografi Alam Sekitar, http://gis.doe.gov.my/flex/GISappV2/cindex.html

2.5. Agriculture, Forestry, and Other Land Use (AFOLU)

AFOLU stands for agriculture, forestry and other land use. The emission sources in this section mainly consist of livestock, land, and aggregate sources and non-CO_2 emission sources on land.

AFOLU includes GHG emissions and removals from agriculture as well as land use and forestry. Agricultural activities contribute directly to emissions of GHG through a variety of processes. Methane (CH_4) and nitrous oxide (N_2O) are the primary GHGs emitted by agricultural activities. The non-CO_2 emissions source categories include enteric fermentation in domestic livestock; livestock manure management, rice cultivation, agricultural soil management and field burning of agricultural residues.[24]

With reference to the GPC, this sector is only required for BASIC+ reporting, thus it is not accounted in this inventory. For the agriculture sub-sector, only GHG emissions from wastewater and energy consumption were accounted for in this inventory and reported under waste and stationary energy sector respectively.

Photo credits: Eco-Ideal Consulting Sdn Bhd

[24] US-GHG-Inventory-2016-Chapter-5-Agriculture

Photo credits: IRDA

3.0 RESULTS

3.1. Summary of Iskandar Malaysia GHG Inventory 2015

Table 2 sets out the Iskandar Malaysia's GHG emissions for 2015.

Table 2: GHG emissions summary of Iskandar Malaysia for 2015

Sector		Total by Scope (million tCO_2e)		Total by city-induced reporting level (million tCO_2e)
		Scope 1	Scope 2	BASIC
Stationary Energy	Energy use	3.42	6.79	10.21
	Energy generation supplied to the grid	12.59		
Transportation		4.45	IE (energy use)	4.45
Waste	Generated in the city	0.81		0.81
	Generated outside city	NO		
Total	**All Territorial Emissions**	**28.06**		**15.47**
		All BASIC Emissions		

Notation Keys:

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

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

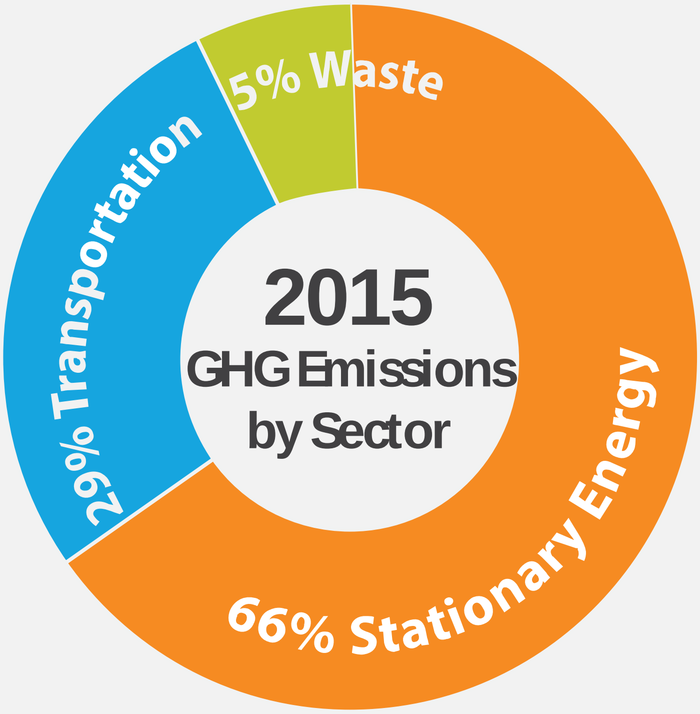
– Non-applicable emissions

Scope 3, IPPU and AFOLU sectors only applicable for BASIC+ reporting.

The total emissions value in Table 2 is based on GWP value from the AR5. Following the GWP used in the National GHG Inventory (AR4), the total of all territorial emissions (by scope) is 28.07 million tonnes of CO_2 equivalent (tCO_2e) and all BASIC emissions is 15.47 million tCO_2e.

3.2. Iskandar Malaysia GHG Emissions 2015

The total of all BASIC emissions in Iskandar Malaysia for year 2015 is 15.47 million tCO_2e. The largest contributor is the stationary energy sector with 10.2million tCO_2e (66%), followed by the transportation sector with 4.5 million tCO_2e (29%), and waste sector with 0.8 million tCO_2e (5%). Emissions for IPPU and AFOLU sectors were not included in the inventory as these sectors are to be included in future BASIC+ reporting.



3.3. Iskandar Malaysia GHG Emissions 2005 – 2015

Iskandar Malaysia GHG emissions reflect the rapid growth for all 3 sectors over the last 10 years as shown in Figure 26. In year 2007, there was a sharp growth in emissions from stationary energy sector due high energy consumption by the manufacturing industries and construction sub-sector (Figure 27).

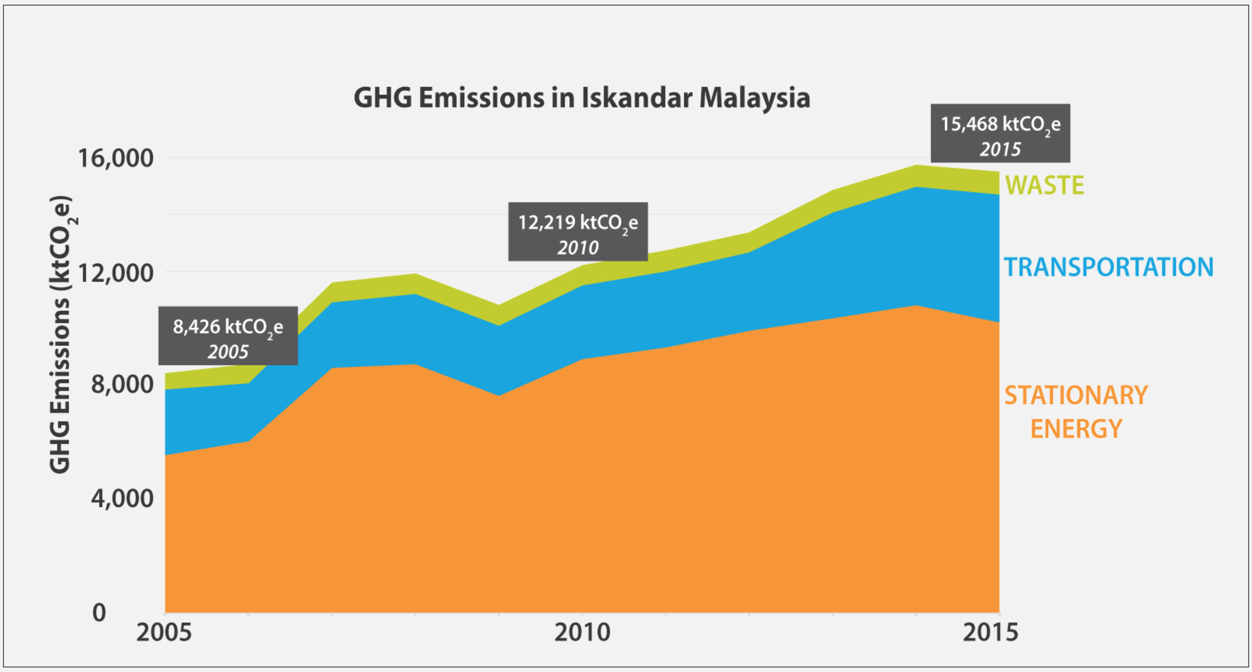


Figure 26: Total GHG emissions of Iskandar Malaysia

3.3.1. Stationary Energy

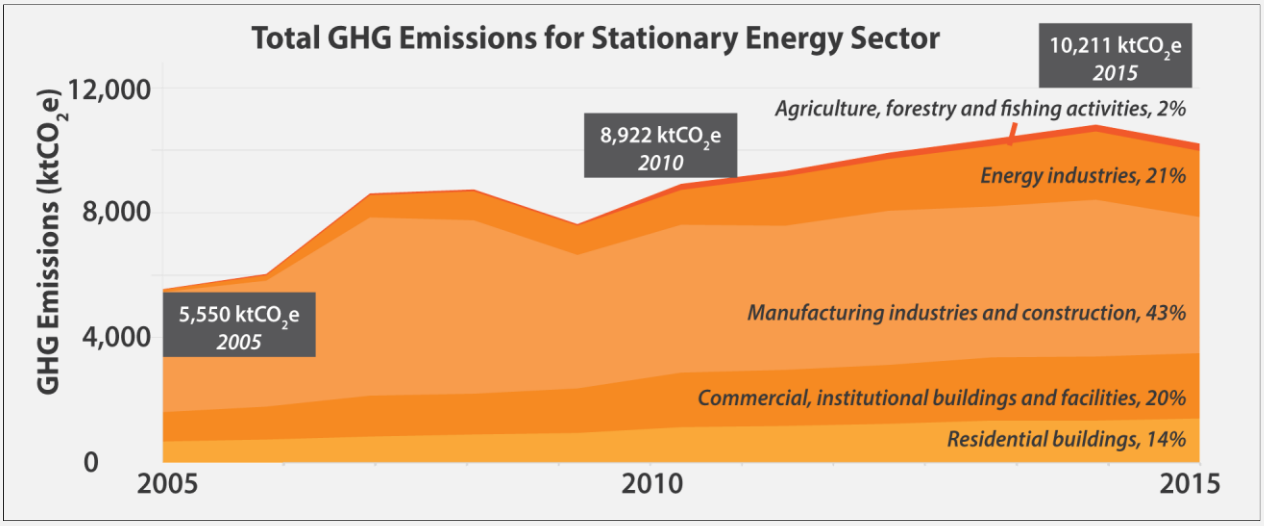


Figure 27: GHG emissions from stationary sub-sectors

Out of all the sub-sectors under Stationary Energy (refer to Figure 27), the **the manufacturing industries and constructions sub-sector accounted for highest GHG emissions in Iskandar Malaysia**. Manufacturing industries and construction of Iskandar Malaysia contributed about 43% of total Iskandar Malaysia GDP in 2015[25], a large portion of the industrial GDP is derived from electrical and electronics, chemicals and chemical products and food processing sub-sectors[26].

The second highest sub-sector is the energy industries, contributing 21% of the total stationary energy GHG emissions. These emissions are from all 6 power plants in Iskandar Malaysia, with a total capacity of 3,323MW. As mentioned in the previous chapter, all the power plants consume natural gas as fuel, except for Tanjung Bin IPP which consumes coal as its main fuel. Under the energy industries sub-sector, only auxiliary fuel use i.e. not used directly for energy generation were accounted in this inventory (BASIC reporting). The emissions for energy generation supplied to the grid were calculated separately and accounted for in the territorial total. **The emissions for energy generation supplied to the grid (GPC reference no. I.4.4) for the 6 power plants were calculated to be 12.59 million tCO_2e.**

Commercial, institutional buildings and facilities sub-sector contributed 20%, while residential buildings sub-sector contributed 14%. The agriculture, forestry and fishing activities sub-sector contributed 2%. Non-specified sources, fugitive emissions from mining, processing, storage and transportation of coal, and also fugitive emissions from oil and natural gas systems were not accounted in this inventory as they do not occur within the economic region.

3.3.2. Transportation

97.4 % of the total emissions from the transportation sector of Iskandar Malaysia is contributed by **on-road transportation** (Figure 28). The total fuel consumption of this sub-sector considering all fuel types – natural gas, petrol, diesel, fuel oil and also biodiesel were estimated to be 1,399 kilo tonnes of oil equivalent (ktoe). Among all the different fuel types, petrol consumption is the highest, followed by diesel. With reference to the GPC, emissions from biodiesel, biogenic origin materials shall be reported separately from the scopes and other gases. Therefore, emissions from

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[25] Projected data using data provided by Unit Perancang Ekonomi Negeri Johor (UPENJ) from 2007-2014
[26] Retrieved from http://iskandarmalaysia.com.my/promoted-sectors/

biodiesel consumption in Iskandar Malaysia were calculated and reported under column CO_2(b) at 0.04 million tCO_2e.

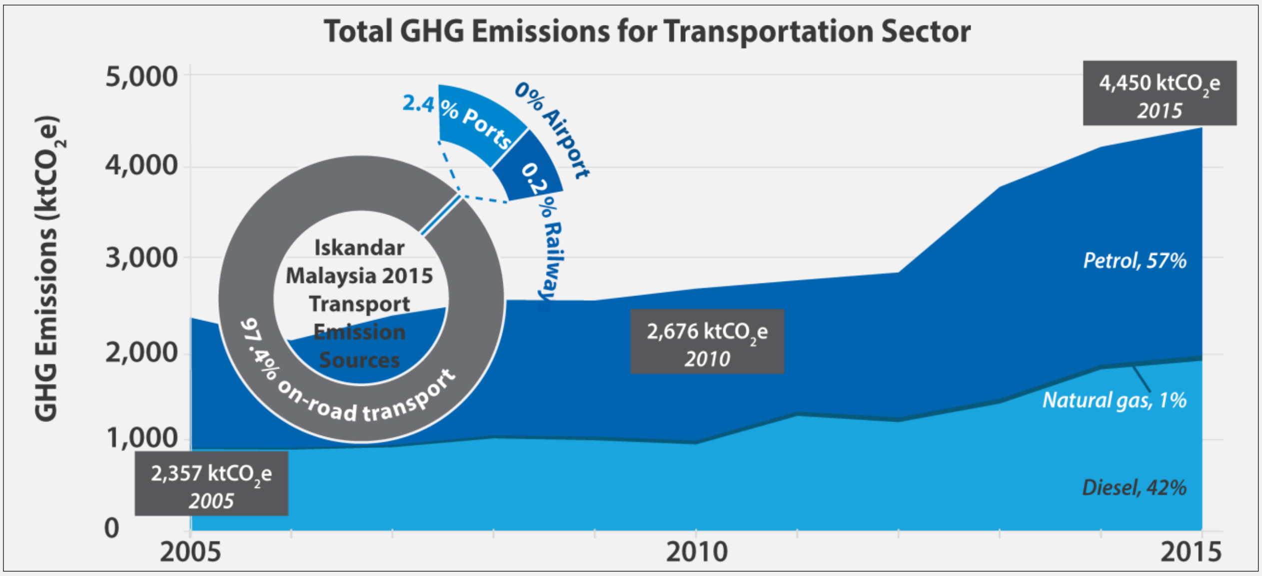


Figure 28: GHG emissions from transportation sub-sectors

Emissions from railway and off-road transportation sub-sectors were 0.2% and 2.4% respectively. Although emissions from these sub-sectors are negligible when compared to on-road transportation, emissions from these sub-sectors were still calculated and included in this inventory.

3.3.3. Waste

Solid waste disposal is the main contributor of emissions in the waste sector at 76% followed by wastewater treatment and discharge at 24%. Operating landfills are the main contributor of emissions in the waste sector at about 63%, followed by industrial wastewater (from POME and rubber mill) at 25%. Closed landfills and domestic wastewater contributed 8% and 4% respectively to the emissions in waste sector. Emissions from sludge is very minimal (Figure 29).

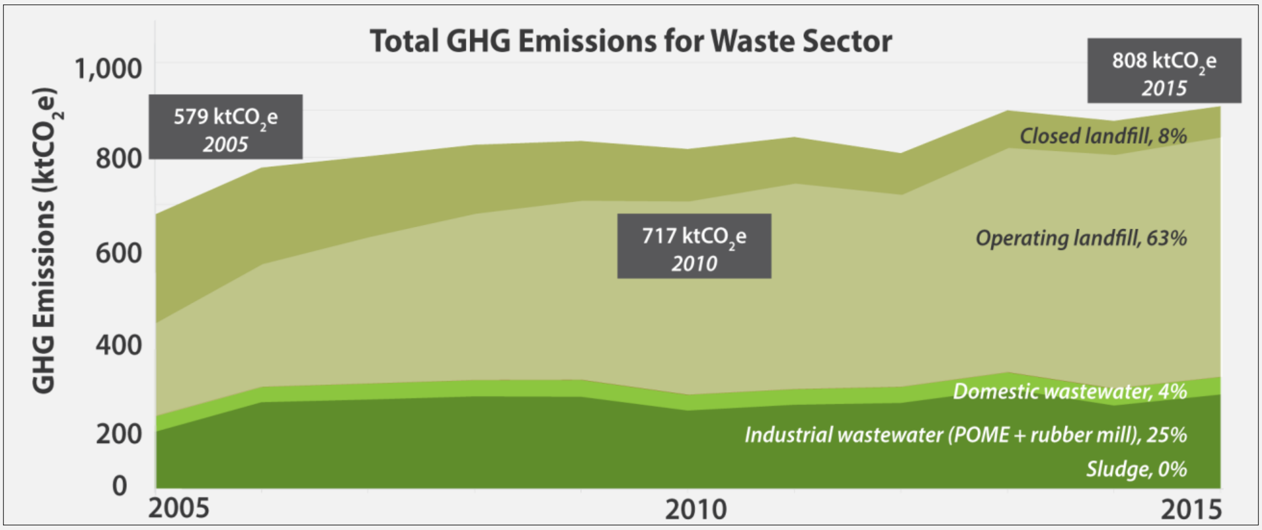


Figure 29: GHG emissions from waste sub-sectors

As mentioned in previous chapter, emissions from biomass shall be reported under AFOLU sector. Based on available data, the emissions from stockpile of biomass in oil palm estate such as EFB, OPT and OPF were calculated at 0.19 million tCO_2e which is about 23% of the emissions of waste sector.

Detailed 2015 Iskandar Malaysia GHG 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		142,105	11	0.23	142,484		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		1,269,737			1,269,737		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		192,805	17	0.74	193,474		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		1,899,120			1,899,120		M	H	Scaled down from secondary data based on population ratio
Manufacturing and construction									
Scope 1 Emissions from fuel combustion within the city boundary		1,754,847	73	11.41	1,759,907		M	L	Scaled down from secondary data based on industrial GDP
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		2,595,434			2,595,434		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		1,138,895	20	2.03	1,140,002		H	L	Primary data from power plants. Assumed auxiliary operations are 5% of the total grid-supplied energy consumption when data are not available
Scope 2 Emissions from grid-supplied energy consumed in power plant auxiliary operations within the city boundary		973,082			973,082		H	H	Primary data from power plants
Scope 1 Emissions from energy generation supplied to the grid		12,580,539	224	22.43	12,592,761		H	L	
Agriculture, forestry and fishing activities									
Scope 1 Emissions from fuel combustion within the city boundary		189,208	26	2.89	189,931		M	L	Scaled down from secondary data based on population ratio
Scope 2 Emissions from grid-supplied energy consumed within the city boundary		47,713			47,713		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		4,242,439	1,344	207.52	4,335,052	35,231	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	NE								Not estimated as there are only 2 units of pilot electrical vehicles available in Iskandar Malaysia
Railways									
Scope 1 Emissions from fuel combustion for railway transportation occurring within the city boundary		8,802	0	3.40	9,716		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		52,719	87	7.96	104,796		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 Scope 2 of 'Commercial and insitutional buildings and facilities' sub-sector
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			20,437		572,237		M	L	Primary data from authorities/operators and extrapolation made based on population and waste generation 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	NO								Not occurring in Iskandar Malaysia Economic Region
Scope 1 Emissions from solid waste generated outside the city boundary and disposed in landfills or open dumps within the city boundary	NO								Not occurring in Iskandar Malaysia Economic Region
Wastewater treatment and discharge									
Scope 1 Emissions from wastewater generated and treated within the city boundary			8,416	0.39	235,739		M	L	Primary data from operators and extrapolation made based on population and waste generation rate 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	NO								Not occurring in Iskandar Malaysia Economic Region
TOTAL	**ALL TERRITORIAL EMISSION**				**28,061,186**				
	ALL BASIC EMISSION				**15,468,425**				

Detailed 2015 Iskandar Malaysia Inventory by Scope

GHG Emissions Source (By Sector and Sub-sector)	Type of Scope (tCO_2e)		Total by city-induced reporting level (tCO_2e)
	Scope 1	Scope 2	BASIC
STATIONARY ENERGY			
Residential buildings	142,484	1,269,737	1,412,221
Commercial, institutional buildings & facilities	193,474	1,899,120	2,092,594
Manufacturing and construction	1,759,907	2,595,434	4,355,341
Energy industries	1,140,002	973,082	2,113,084
Energy industries	12,580,539		
Agriculture, forestry and fishing activities	189,931	47,713	237,644
TRANSPORTATION			
On-road transportation	4,334,052	NE	4,335,052
Railways	9,716	NO	9,716
Waterborne navigation	NE	NE	NE
Aviation	NE	NE	NE
Off-road transportation	104,796	IE	104,796
WASTE			
Solid waste disposal	572,237	NO	572,237
Solid waste disposal	NO		
Wastewater treatment and discharge	235,739	NO	234,739
Wastewater treatment and discharge	NO		
TOTAL	ALL TERRITORIAL EMISSION		**28,061,186**
	ALL BASIC EMISSION		**15,468,425**

Notation Keys:

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

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

● – Non-applicable emissions

Scope 3, IPPU and AFOLU sectors only applicable for BASIC+ reporting.

Data Quality Assessment

Data Quality	Activity Data (AD)	Emission Factor (EF)
High (H)	Detailed activity data	Specific emission factors
Medium (M)	Modeled activity data using robust assumptions	More general emission factors
Low (L)	Highly-modeled or uncertain activity data	Default emission factors

3.4. Iskandar Malaysia Emissions Intensity

3.4.1. Emission Intensity per GDP

The GHG emission intensity of Iskandar Malaysia for 2015 is reported at 0.27 $ktCO_2e$/RM million. The emission intensity was calculated using GDP based on 2005 constant price. This is consistent with the national GHG emissions reporting approach.

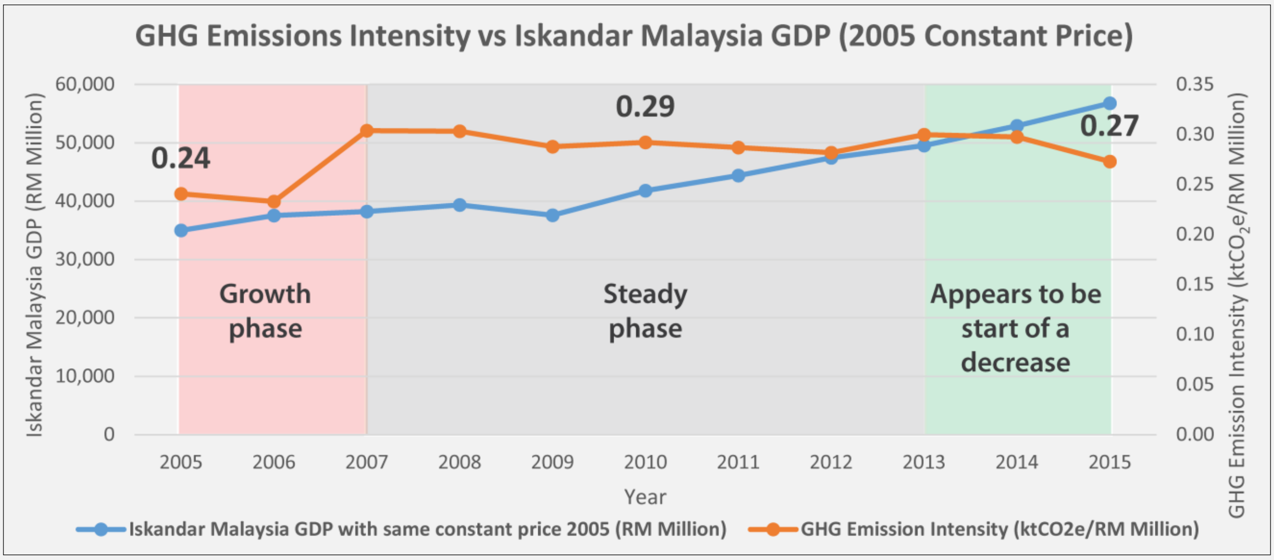


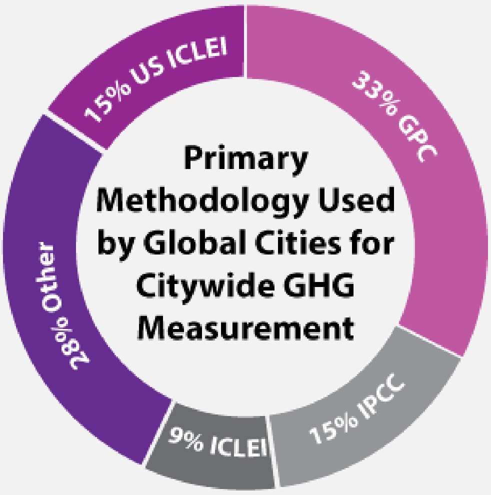
Figure 30: All BASIC emissions intensity vs Iskandar Malaysia GDP (at 2005 constant price)

Interestingly, the GHG intensity from 2005 to 2015 appears to progress through 3 phases:

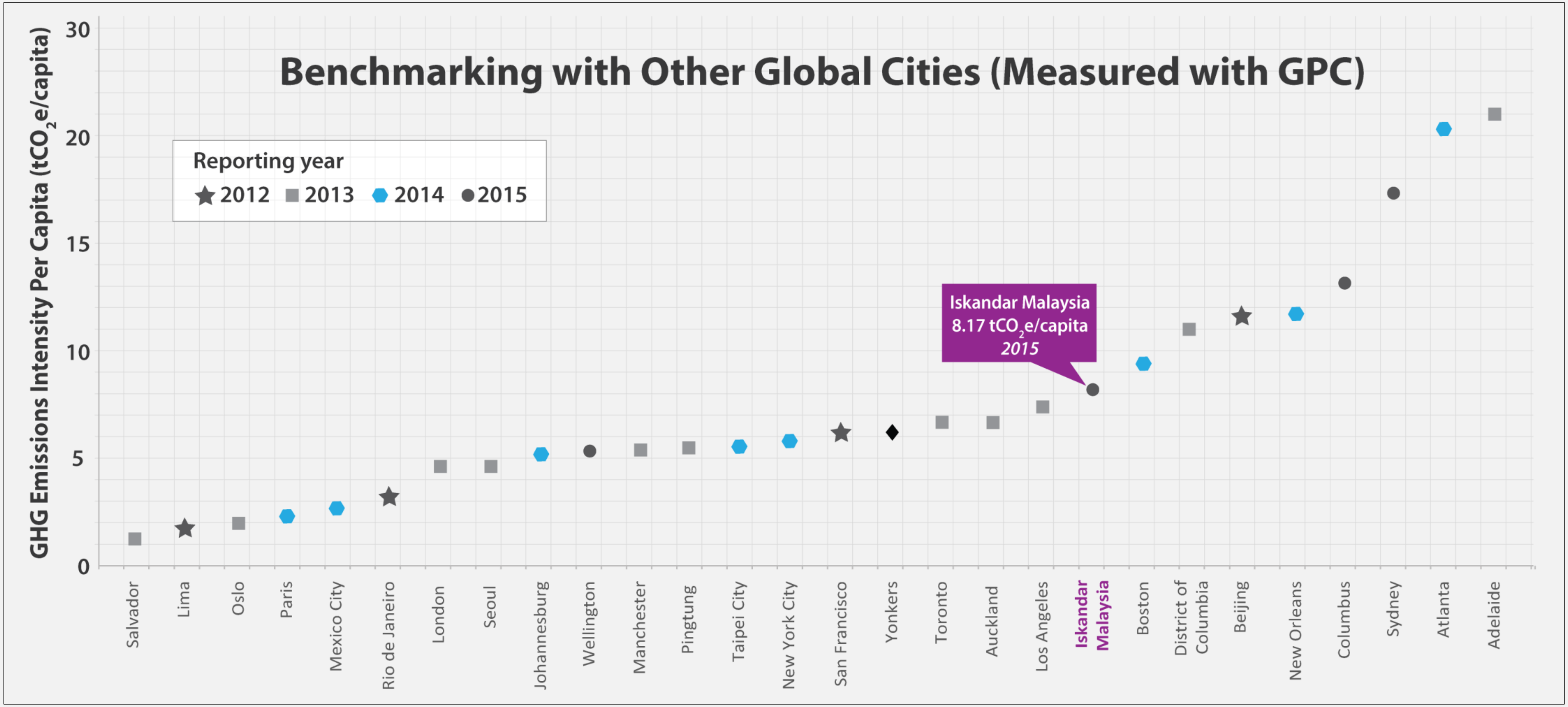
- 2005 – 2007 Growth phase
- 2008 - 2013 Steady phase
- 2014 - 2015 Appears to be start of a *decrease* (but not conclusive)

However, it should be noted that at this stage, it is too early to conclude that the GHG intensity of Iskandar Malaysia is on a decreasing trend for the coming years. This is because the economic region is still developing for which there will be uncertainties to consider.

3.4.2. Emission Intensity per Capita and Benchmarking



According to CDP (formerly known as Carbon Disclosure Project), 188 global cities publicly disclosed their annual city-wide emissions in year 2016. Among the 188 cities, 33% or 61 cities adopted GPC as their reporting methodology. A comparison of Iskandar Malaysia's emission intensity per capita was made between cities which have adopted GPC as their reporting methodology. These cities measured emissions between years 2013 to 2015. As illustrated in **Error! Reference source not found.**, GHG emissions per capita ranged from 1.27tCO_2e per capita (Salvador, Brazil with population of 2.9 million) to 21.00tCO_2e per capita (Adelaide, Australia with population of 0.49 million) whereas Iskandar Malaysia falls in the middle of the range on a global city-scale with emissions of 8.17tCO_2e per capita.


Benchmarking with Other Global Cities (Measured with GPC)
GHG Emissions Intensity Per Capita (tCO_2e/capita)
30
20
15
10
5
0
Reporting year
2012 2013 2014 2015
Iskandar Malaysia
8.17 tCO_2e/capita
2015
Salvador
Lima
Oslo
Paris
Mexico City
Rio de Janeiro
London
Seoul
Johannesburg
Wellington
Manchester
Pingtung
Taipei City
New York City
San Francisco
Yonkers
Toronto
Auckland
Los Angeles
Iskandar Malaysia
Boston
District of Columbia
Beijing
New Orleans
Columbus
Sydney
Atlanta
Adelaide

Source: CDP

Figure 31: Benchmarking with others global cities measured with GPC

In terms of GHG emissions intensity per GDP, Iskandar Malaysia is among the highest compared with other cities which have reported their emissions using GPC. It should be noted that Iskandar Malaysia is a developing city-region and the emissions intensity as such would be higher compared to these selected cities which are mostly developed cities.

Iskandar Malaysia had measured its GHG emissions based on GPC BASIC level reporting and with reference to 2006 IPCC Guidelines for its calculation methodologies. The other cities might have adopted BASIC+ level reporting with different calculation methodologies. Thus, the comparisons presented above should be treated as indicative only due to the lack of publicly available reports (at detailed reporting level) for other countries.

3.5. Emissions Reduction Initiatives in Iskandar Malaysia

Recognising the importance of sustainable development, several initiatives which aim to reduce emissions in stationary energy, transportation and waste sector have been implemented within Iskandar Malaysia by the federal government, which complement the LCS programmes led by IRDA.

3.5.1. Low Carbon Society

Among various LCS programmes implemented in Iskandar Malaysia, the highlights in year 2016 are **Johor Free Bus Service: Bas Muafakat Johor, Urban Farming Projects**, and **the Comprehensive Assessment System for Built Environment Efficiency (CASBEE).**

Johor Free Bus Service: Bas Muafakat Johor

As an initiative towards development of a LCS in Iskandar Malaysia, a free bus service - Bas Muafakat Johor, started its operation in April 2016. The free bus service provides free rides to the public to reduce traffic congestion along 15 routes across four districts in the economic region namely Johor Bahru, Johor Bahru Tengah, Pasir Gudang and Kulai. The public are encouraged to use the Bas Muafakat Johor service instead of driving their own motor vehicles thereby reducing the GHG emission. This service is provided by Johor State Government and handled by Perbadanan Pengangkutan Awam Johor (PAJ).

Figure 32: Free bus service - Bas Muafakat Johor[27]

Urban Farming Projects: Urban Farming Development Centre

The first project under the Iskandar Malaysia Urban Farming Development Centre (UFDC) at Jasa Apartments, Taman Mutiara Rini was launched in May 2016 by the Menteri Besar Johor, Dato' Khaled Nordin (Figure 33). The UFDC is built on a 0.6 hectare plot of land in the compounds of the apartment complex, using the social enterprise business model to run the project - 'Farm to Eat' and 'Farm to Sell'. The state government is promoting the urban farming facilities at 4 sites in Iskandar Malaysia namely Johor Bahru, Tebrau, Kulai and Pasir Gudang.

Figure 33: Dato' Khaled Nordin launched the first project under the Iskandar Malaysia UFDC at Jasa Apartments, Taman Mutiara Rini on 4 May 2016[28]

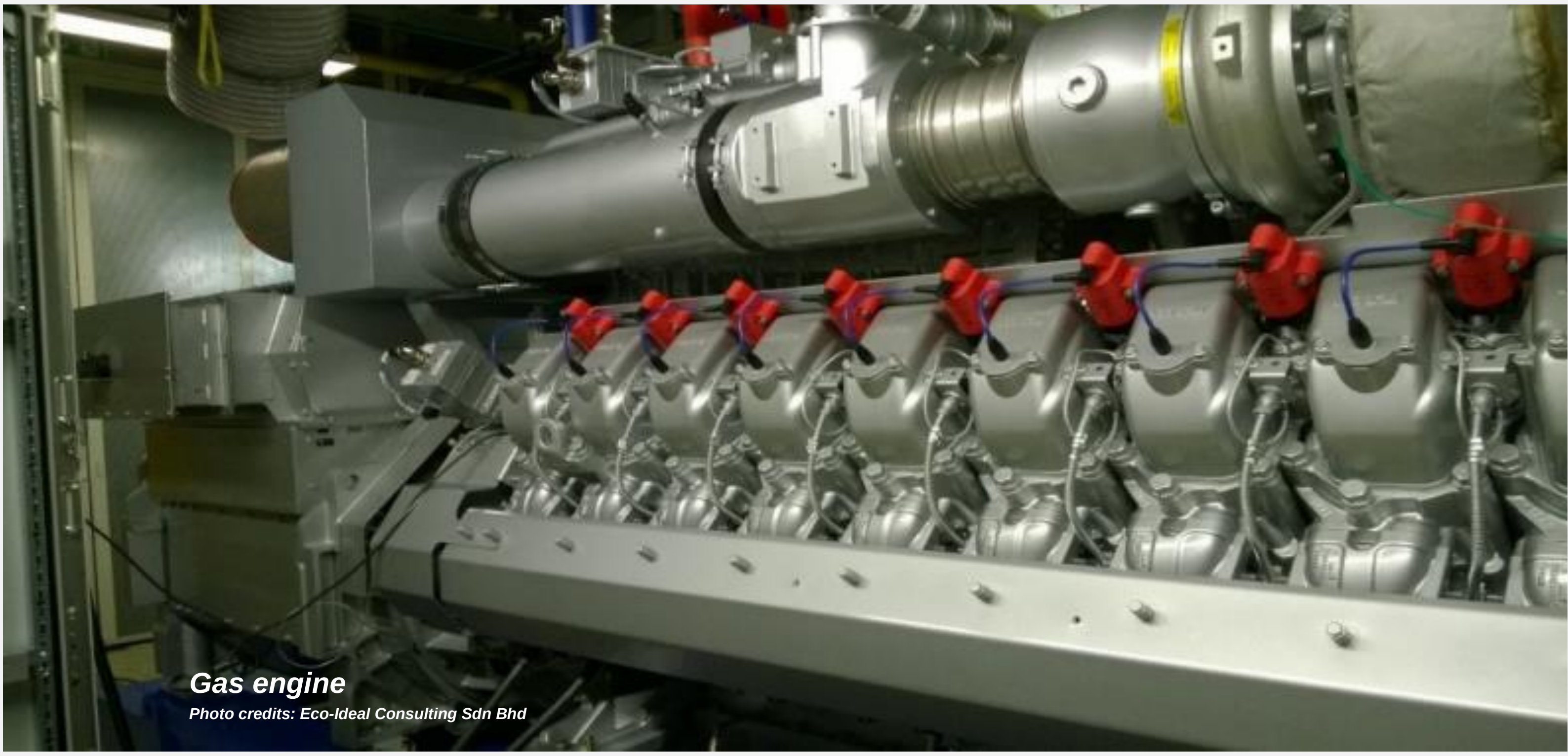
[27] Photo credit: https://causewaylink.com.my/muafakat-bus
[28] Photo credit: http://www.theiskandarian.com/web/states-first-urban-farming-programme/

Comprehensive Assessment System for Built Environment Efficiency (CASBEE)

Iskandar Malaysia continues its effort in making the economic region a low carbon green growth with the newly adopted CASBEE Iskandar manuals as assessment tools to encourage building owners and developers to "go-green". The pilot projects, which was conducted in collaboration with Japan institutions (the Institute for Building Environment and Energy Conservation (IBEC), Keio University and Hosei University), and Universiti Teknologi Malaysia (UTM) started in August 2015 and was completed in May 2016[29].

3.5.2. Stationary Energy Sector

Energy has always been and will always be a strong force that drives the economy of a country. The two energy-focused (2) initiatives in the economic region are Feed-in Tariff (FiT) and Industrial Energy Efficiency for Malaysian Manufacturing Sector (IEEMMS) projects.



Gas engine

Photo credits: Eco-Ideal Consulting Sdn Bhd

Renewable Energy/Energy Efficiency - Feed-in Tariff Project

In 2011, the FiT scheme was introduced in Malaysia with the aim of catalysing the generation of Renewable Energy (RE) and avoid the generation of millions of tonnes of CO_2 from the energy sector which relies mainly on the combustion of fossil fuel. The FiT scheme allows electricity produced from RE resources to be sold to power utilities (e.g. TNB) at a fixed premium price for a specific duration - the price and duration differs depending on the type of RE resource[30]. The RE resources which qualify to take part in the scheme include solar PV, biogas, biomass, small hydro and geothermal. The scheme is applicable for industries, businesses, institutions and households.

As of 2015, a total of 119 FiT projects in Iskandar Malaysia has been approved by the Sustainable Energy Development Authority (SEDA), a statutory body under the Ministry of Energy, Green Technology and Water (KeTTHA), which oversees the implementation of the FiT scheme (Table 3). **Since 2012, a total of 9.18 MW comprising 295 solar photovoltaic projects were**

[29] Source: http://iskandarmalaysia.com.my/iskandar-malaysia-rolls-initiatives-towards-smart-city-low-carbon-society/
[30] http://fit-seda-malaysia.com/

successfully installed and commissioned (Table 3)**. The total renewable energy generated from 2012 to 2015 was 23.27 MWh** (Table 4).

Table 3: Installed capacity of commissioned renewable energy plants in Iskandar Malaysia

INSTALLED CAPACITY OF COMMISSIONED RE PLANTS WITHIN ISKANDAR MALAYSIA (MW)						Number of Projects
Year	Biogas (BS)	Biomass (BM)	Small Hydro (SH)	Solar Photovoltaic (PV)	Geothermal (GEO)	
2012	-	-	-	2.72	-	23
2013	-	-	-	3.57	-	95
2014	-	-	-	1.87	-	88
2015	-	-	-	1.01	-	89
TOTAL	-	-	-	9.18	-	295

Table 4: Power generation of commissioned RE plants within Iskandar Malaysia

POWER GENERATION OF COMMISSIONED RE PLANTS WITHIN ISKANDAR MALAYSIA (KWH)					
Year	BS	BM	SH	PV	GEO
2012	-	-	-	33,745	-
2013	-	-	-	7,387,328	-
2014	-	-	-	8,045,858	-
2015	-	-	-	7,802,164	-
TOTAL	-	-	-	23,269,095	-

Table 5: Installed Capacity of Plants in Progress within Iskandar Malaysia

INSTALLED CAPACITY OF PLANTS IN PROGRESS WITHIN ISKANDAR MALAYSIA (MW)						Number of Projects	
Year	BS	BM	SH	PV	GEO	BG	PV
2012	-	-	-	-	-	-	-
2013	-	-	-	0.0755	-	-	2
2014	-	-	-	0.016	-	-	2
2015	2	-	-	0.831	-	1	15
2016	1.6			0.9805		1	100
TOTAL	3.6	-	-	1.903	-	2	119

Industrial Energy Efficiency for Malaysian Manufacturing Sector Project

The IEEMMS project aims to reduce the GHG emissions from the manufacturing sector in Malaysia by promoting energy-efficiency improvements through the implementation of energy management system and application of energy system optimisation in the sector. The project provides technical assistance to the manufacturing industries in developing and establishing of market-oriented policy instruments to support the sustainable progression of Malaysian manufacturing industries towards international best energy performance.

The project is funded by the Global Environment Facility (GEF) trust fund, implemented by United Nations Industrial Development Organization (UNIDO), and executed by Ministry of International Trade and Industry (MITI) and Small and Medium Enterprise Corporation Malaysia (SME Corp. Malaysia)(formerly also known as Small and Medium Industries Development Corporation (SMIDEC)) in partnership with KeTTHA, MNRE, ST, Standards and Industrial Research Institute of Malaysia (SIRIM Berhad), Federation of Malaysian Manufacturers (FMM), Malaysian Industrial Development Authority (MIDA), and Department of Standards Malaysia since year 2011.

A few manufacturing industries in Iskandar Malaysia had been selected as the pilot companies for the project. Among these industries, 6 manufacturing industries have been selected and published to showcase their success stories with others. Through the project, these **manufacturing industries managed to save total RM 5.8 million per year. 2.3 MWh of electricity (equivalent to RM 912,000) by Compressed Air Systems Optimisation (CASO), RM 1,731,500 by Steam Systems Optimisation (SSO), and 6.1 MWh of electricity (equivalent to RM 3,178,389).**

3.5.3. Transportation Sector

Iskandar Malaysia aims to be a “strong and sustainable metropolis of international standing” by 2025. To achieve this vision, Iskandar Malaysia requires world class and sustainable transportation system. By 2030, Iskandar Malaysia’s population is expected to double from 1.5 million in 2010 to about 3 million people. There will be massive changes to Iskandar Malaysia’s landscape in 15 years’ time as it develops, and so there is an urgent need for proper planning to ensure that the economic region is able to cope with the high demand of transportation needs in the near future.

The Transportation Blueprint 2010-2030 for Iskandar Malaysia had been prepared to plan for a world class and sustainable transportation system for the economic region. Under this Blueprint, the electric cars were introduced since 2015 and the construction of the Bus Rapid Transit (BRT) System is planned to start in 2017.

Iskandar Malaysia Bus Service

The Iskandar Malaysia Bus service began operation on 19 December 2009 with 34 buses that cover 16 routes throughout the Iskandar Malaysia region (Figure 34).

The Iskandar Malaysia Bus service had recorded a passenger rate of 70,000 in the first month of its operation, which is a huge success. In 2012, the Johor state government announced that another 20 new buses and 10 new routes would be added to serve the Iskandar Malaysia region[31]. A passenger rate of 405,000 was recorded in just 10 months of Iskandar Malaysia Bus service operation, and the number reached a million passengers after 15 months of operation[32]. This

[31] Source: http://www.nst.com.my/nation/general/20-more-buses-to-serve-iskandar-malaysia-1.147776#ixzz2yRufvNgU
[32] Source: http://ww1.utusan.com.my/utusan/info.asp?y=2010&dt=0926&pub=Utusan_Malaysia&sec=Johor&pg=wj_02.htm#ixzz4J5IZ6gUZ

means that there is an average of 3,100 passengers commuting using Iskandar Malaysia buses in a day[33]. The service received overwhelming positive feedback by the passengers, stating affordable ticket prices, punctuality of buses according to schedule, passenger safety, clean seats and customer services. The Iskandar Malaysia Bus service continues to contribute to Iskandar Malaysia's efforts in reducing GHG emissions and benefitting all levels of society especially those of the low-income group. On 1st February 2016, 5 of the routes were withdrawn due to low ridership although the remaining routes still proved very popular.

Figure 34: Iskandar Malaysia Bus[34]

Bus Rapid Transit

The Bus Rapid Transit (BRT) System is one of the public transportation projects under Trans-Iskandar to enhance public transportation system in Iskandar Malaysia. The system consists of 10 lines and about 250 stations and stops, which can cover 90% of the transportation needs in the economic region. Areas where commuting gridlocks frequently occur such as Skudai, Johor Jaya and Nusajaya will be linked with downtown Johor Bahru in the initial phase of BRT[35].

The BRT System aims to increase transport modal split to 50% public transport by 2030 and also to increase public transport ridership by providing reliable transit services. The planned BRT lines will have a total length of 320 kilometres to cover five flagship zones of Iskandar Malaysia. This includes 3 main lines – Johor Bahru to Skudai (21.05 kilometres), Johor Bahru to Pandan (9.57 kilometres) and Johor Bahru to Iskandar Puteri (Nusajaya) (13.93 kilometres)[36].

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[33] Source: http://ww1.utusan.com.my/utusan/info.asp?y=2011&dt=0423&pub=Utusan_Malaysia&sec=Johor&pg=wj_01.htm#ixzz4JYiZ8w6a
[34] Source: https://causewaylink.com.my/auxil/media/banner-iskandar.jpg
[35] Transportation Blueprint 2010 – 2030 for Iskandar Malaysia, Iskandar Regional Development Authority (IRDA)
[36] http://www.utusan.com.my/bisnes/korporat/projek-brt-iskandar-malaysia-bermula-2017-1.206762#sthash.yVK4D45t.dpuf

The project has already been approved on 30th March 2016 by the Federal Government with total cost estimated at about RM3 billion. Construction of this project will be in 3 phases, with the first phase scheduled to start in 2017 and to be completed by 2020[37].

Pedestrianisation and Road Pricing

Aside from public transportation, policies and plans for private transportation were also included in the Transportation Blueprint of Iskandar Malaysia. In 2014, a total of RM1.5 million has been allocated by the Federal Government to upgrade and provide cycling lanes and pedestrian pathways in Iskandar Malaysia[38]. The livelihood and liveability of the residential areas are improved through pedestrian-friendly suburban road layout, which allows greater pedestrian accessibility, connectivity and convenience[39].

According to Transport Blueprint 2010 – 2030 for Iskandar Malaysia, another plan for the future is to restrain traffic from entering the urban areas. Motorists who wish to enter the traffic restraint zones will have to pay a fee that will be continually adjusted to ensure those who choose to drive can run their errands stress-free. Greater enforcement and restrictions will be needed to ensure that motorcyclists do not invade the pedestrian spaces such that safety and access of pedestrians are not compromised.

3.5.4. Waste sector

Landfill gas utilisation project: Seelong Sanitary Landfill[40]

Seelong Sanitary landfill (SSL) is a sanitary landfill that was constructed by joint effort between the Johor State Government and Southern Waste Management (now known as SWM). The construction began on June 2003 for Cell 1 and other infrastructures. The first cell started landfill operation in January 2004.

SSL is operated as a central sanitary landfill to accommodate solid waste from three (3) Local Authorities in Johor namely MBJB, MPJBT and MPKu. SSL encompasses a land area of 275 acres situated at Seelong, Mukim Senai - Kulai about 30 km from the City of Johor Bahru.

The landfill has a design lifespan of 20 years which is capable of receiving waste of 15 million tonnes. The landfill will have a total of 13 waste disposal cells. The waste disposal cells will be implemented in stages as each cell is filled up.

For protection to the environment, composite liners will be installed at all cells with a leachate collection system to prevent ground water pollution. The advanced Disc Tube Reverse Osmosis (DTRO) technology used for its leachate treatment system is capable of meeting Standard B levels required by DoE for safe discharge. Daily operation involves proper waste covering with earth and applying of effective microorganism to prevent odour and expedite decomposition. SSL is also equipped with supporting facilities such as weighbridges linked to computerised information system to record, track and monitor the daily activities and users of the landfill.

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[37] http://www.themalaymailonline.com/malaysia/article/phase-1-of-brt-in-iskandar-malaysia-expected-to-be-ready-by-2020#sthash.9EwxUHZf.dpuf
[38]http://iskandarmalaysia.com.my/rm1-5-million-for-cycling-lanes-and-pedestrian-pathways-in-iskandar-malaysia/
[39] Transportation Blueprint 2010 – 2030 for Iskandar Malaysia, Iskandar Regional Development Authority (IRDA)
[40] Source: Landfill Gas CDM Projects by SWM, D.L Ho, Southern Waste Management Sdn Bhd, March 2006

SSL is the first sanitary landfill in Malaysia that has commissioned Clean Development Mechanism (CDM) project together with the Danish Government in an effort to reduce the direct emission of methane (CH_4) and mitigate the global greenhouse effect. SSL also has an education centre to facilitate research and study tours to increase public awareness on innovative waste management.

Seelong Sanitary Landfill

Photo credits: http://www.thestar.com.my/story/?file=/2010/11/2/nation/7345993&sec=nation

The CDM project involves landfill gas recovery system which extracts and transfers landfill gas (LFG) to an enclosed flare system and power generation system. The flare will burn the landfill gas through complete combustion down to carbon dioxide (CO_2) and water (H_2O) (concentration of methane (CH_4) in LFG normally range from 50~60%; carbon dioxide (CO_2) 35~40%; oxygen (O_2) <5%). The aim is to convert methane (CH_4) to carbon dioxide (CO_2) which has a significantly lower greenhouse effect.

SSL implemented an enclosed flare system for the combustion of landfill gas. **Since the commission of the CDM project in 2007 through 2012, SSL was credited by UNFCCC for mitigating 128,647tCO_2e**.

SSL is in the process of installing and commissioning a unit of LFG power generator which generates electricity and will be sold to national distribution licensee via national grid once successfully tested by authority, and commissioned for power generation. This will further improve the carbon footprint in a long run where it mitigates certain portion of reliance on fossil fuels as the source of electricity generation.

Photo credits: IRDA

4.0 CONCLUDING REMARKS AND WAY FORWARD

The GHG inventory 2015 for Iskandar Malaysia is the first regional/city level GHG reporting performed in Malaysia using an internationally recognised reporting standard (i.e. GPC). The report aims to provide a sound basis for assessing the GHG emissions of Iskandar Malaysia over the past 10 years and identification of the major GHG emission sources which should be the focus of mitigation efforts. Most importantly, through the work of preparing the GHG Inventory 2015, a monitoring and reporting framework for tracking the GHG emission performance for Iskandar Malaysia has been successfully developed.

As mentioned in previous chapters, Iskandar Malaysia falls in the middle of the range on a global city-scale with emissions of 8.17tCO_2e per capita compared with the other 61 cities that has reported their emissions based on GPC. This GHG Inventory would be an instrumental launching pad for future tracking and setting of emissions reduction target. The information on major emission sources within Iskandar Malaysia provides important data for development of strategic action plans with maximum impact on reduction of emissions. It is recommended that the GHG inventory is to be **updated on a yearly basis**.

Base Year for Tracing of Iskandar Malaysia Emissions

Table 6: Impact of different base year for tracking GHG emissions

	Base year 2005	Base year 2010
Iskandar Malaysia GHG emissions (ktCO_2e)	8,426	12,219
Iskandar Malaysia GDP at 2005 constant price (RM million)	35,000	41,813
Iskandar Malaysia GHG Intensity % growth of base year vs 2015 (ktCO_2e/RM million GDP)	+13%	-7%

The impact of selecting different base year for tracking GHG emissions is highly significant. GHG emissions in 2005 is significantly lower compared to the emissions in 2010. Consequently, when comparing the GHG intensity growth (from base year until 2015), using 2005 as a base year would mean a 13% *increase* while using 2010 as base year would mean 7% decrease.

The analysis shows that for future tracking of Iskandar Malaysia GHG emissions, selecting **2010 as the base year** would be more reasonable. The reasons are:

- Iskandar Malaysia was not officially in existence in 2005 and investment activities in the region were not yet in place.
- Iskandar Malaysia and the various economic activities within the region were more established from 2010.
- Importantly, various blueprints (RE, waste, transport) were only developed during the period around 2010 and relevant actions were implemented around 2010.

Tracking the emission intensity based on 2010 would make more sense to reflect the reduction level over time. Moreover, 2010 as base year will be consistent with the National Communication 2 (NC2) reporting year.

The Low Carbon Society Blueprint (3rd Edition) for Iskandar Malaysia has outlined a 58% reduction of GHG emission intensity and a 40% emission reduction with counter measures (CM) by 2025 using 2005 as a base year. For 2025, the total GHG emissions is estimated to be 18,900 $ktCO_2e$ while GDP is projected to be RM 141.1 billon. The emission intensity is 0.13 $ktCO_2e$/RM million.

Applying the same 58% reduction of GHG emission intensity but with 2010 as base year the emission intensity, the target emission intensity by year 2025 would be 0.12 $ktCO_2e$/RM million GDP (Figure 35). In 2015, the emission intensity of Iskandar Malaysia stands at 0.27 $ktCO_2e$/RM million GDP. To meet the 2025 emission intensity reduction target, it is estimated that an average annual GHG emission reduction rate of 7.7% is required from year 2015 onwards. In comparison, the GHG emission intensity reduction achieved by Iskandar Malaysia over a period of 5 years (2010-2015) is only 7%, with an annual average reduction rate of 1.42% in GHG emissions intensity.

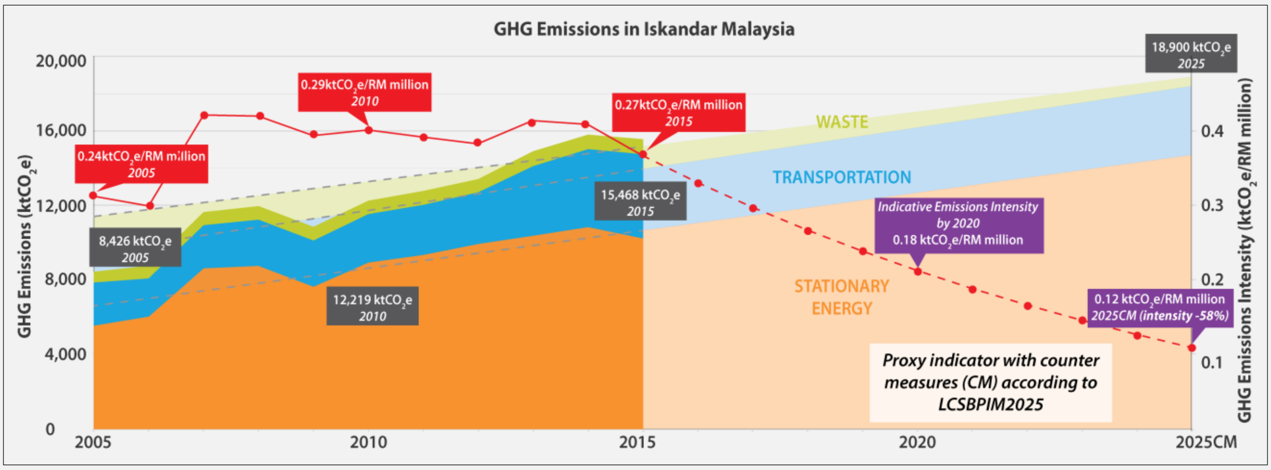


Figure 35:Towards achieving GHG emissions reductions target

No city inventory is perfect. All cities/regions would have gaps in their data and have to make estimations for parts of their emissions inventories. This inventory has been compiled using the best available data and methodologies, however there remains potential for improvement. Subsequent inventories should seek to build on the work done here, and improve the accuracy, reliability, and coverage of data.

Going forward, IRDA shall seek to address the 3 broad areas set out below in its effort to improve its inventory. It identifies some priority areas and some recommended actions.

Develop	• Sector specific emisson targets • Review emission reduction action plan • Set up a GHG Inventory unit in IRDA
Improve	• Data availability specific to Iskandar Malaysia • Expand reporting coverage and scope
Report	• Iskandar Malaysia GHG Inventory for tracking of emissions • Benchmark against similar city/ region

4.1. Develop

All sectors will need to contribute to the emissions reduction targets according to their technological and economic potential. Action in all sectors responsible for Iskandar Malaysia's emissions will be needed. However, due to differences in each sector, the amount of reductions achievable is also expected to be different. Therefore, emission targets shall be sector-specific taking into account the conditions and circumstances of each sector while still setting ambitious but achievable mitigation goals.

The Environment Division of IRDA shall conduct reviews of the emissions reduction action plan to assess progress towards the environmental goals and commitments, and revise the action plan when necessary. It will also be necessary to involve relevant agencies in all stages of the task and continuously check on the data for compilation, review, and verification purposes towards achieving Iskandar Malaysia’s GHG emissions reduction target. New businesses and industries will be encouraged to achieve low (zero emissions as long-term goal) carbon standards based on international best practices. To encourage such endeavour, Iskandar Malaysia will look into both “carrot and stick” approaches; whereby economic instrument such as tax incentives can be offered to pioneering companies and penalties imposed on those who failed to meet the required standards.

4.2. Improve

The GPC stipulates a regular and continual update to a city’s inventory. This means that according to the GPC reporting standard, it is necessary to update the Iskandar Malaysia GHG inventory on a regular basis when relevant new and improved data are available. When improved data have become available, IRDA will review and update its methods and data sources for calculating GHG emissions for affected sectors within Iskandar Malaysia.

It may therefore be necessary to expand the reporting coverage and scope. The main strategic focus is to drive efficiency improvements in the GHG emission accounting and reporting, and to address broader issues across the economic region to meet the GHG emission reduction target.

Moving forward, IRDA will need to proactively address the data gaps identified during the 2015 inventory, including collecting real time and local specific data (with long term integration to the Iskandar Malaysia Urban Observatory initiative)) where appropriate and practical. Engagement of local authorities and relevant agencies to provide region-specific data will be continued in parallel.

GPC BASIC+

The BASIC+ reporting level covers the emission sources in BASIC (scope 1 and scope 2 emissions from stationary energy and transport and scope 1 and scope 3 emissions from waste) as well as the following sources:

- Industrial Processes and Product Use (IPPU)
- Agricultural, Forestry and Land Use (AFOLU)
- Transboundary transportation

The GPC recommends for cities to aim for BASIC+ reporting where these emission sources are relevant. It is noted that one of the main economic activities in Iskandar Malaysia is industry and manufacturing with plans to further develop the industrial sector. The contribution of the industrial sector to the economic region's GDP in 2015 is RM 20.3 billion which is about 36%. The contribution of AFOLU to GHG emissions is also likely to be non-trivial. Incidentally, the emission sources covered in the BASIC+ level is also aligned with IPCC requirements for national reporting.

The 2015 GHG inventory being the inaugural emissions reporting for Iskandar Malaysia using GPC, the BASIC reporting level was selected instead of the more challenging BASIC+ level. With the experience gained and capabilities developed in preparing the Iskandar Malaysia 2015 GHG Inventory, IRDA should aim for BASIC+ for future emissions reporting as the BASIC+ reporting level would provide a more comprehensive understanding of GHG emissions in Iskandar Malaysia. With better data, it would enable a better understanding of GHG emissions and progress of mitigation efforts. More importantly, a better understanding would be fundamental to the decision-making process for policy-makers and authorities.

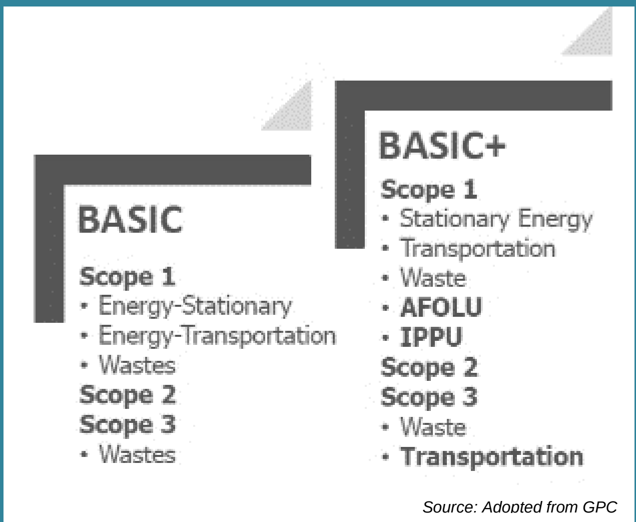


Figure 36: BASIC and BASIC+ reporting level

4.3. Report

Iskandar Malaysia GHG Inventory 2015 – this report contains transparent and detailed information on the GHG inventory for tracking GHG emissions that occur within the boundary of Iskandar Malaysia. This comprehensive inventory allows Iskandar Malaysia to evaluate its progress towards meeting the set emissions reduction target. The GPC recommends that cities update their inventory on an annual basis, as it provides frequent and timely progress on overall GHG emissions tracking.

Benchmarking is a process of measuring performance using specific indicators that are comparable across different entities – in this case, city/region. Benchmarking against similar city/region should be carried out with some caution. This is due to the different methodologies applied from city/region to city/region. For example, one city/region may include emissions from railways from all train stations servicing the city/region while another may not. Iskandar Malaysia's benchmarking studies will allow IRDA to identify aspects in which improvement can be made, facilitate comparisons between other similar city/region, and assist monitoring the performance of Iskandar Malaysia over time.

All these policy interventions will be monitored and tracked through future GHG inventory updating and the impacts and effectiveness of various measures can be evaluated and analysed.

DEFAULT VALUES AND EMISSION FACTORS

General

1. Population Data (Million)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Malaysia	26.05	26.55	27.06	27.57	28.08	28.59	28.96	29.34	29.71	30.10	30.49
Peninsular Malaysia	20.8	21.2	21.6	22.0	22.4	22.8	23.1	23.4	23.7	24.0	24.3
Johor	3.07	3.13	3.19	3.25	3.31	3.36	3.40	3.44	3.48	3.52	3.55
Iskandar Malaysia	1.34	1.34	1.44	1.50	1.56	1.62	1.69	1.74	1.81	1.87	1.89

Source:
Malaysia, Peninsular Malaysia, Johor
2005 - 2010: EPU, http://www.epu.gov.my/sites/default/files/1.2.1.pdf
2011 - 2015: EPU, http://www.epu.gov.my/sites/default/files/1.2.2.pdf

Iskandar Malaysia
2005, 2007 - 2014: UPENJ

2. GDP (RM Million)

Year	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Total GDP											
Peninsular Malaysia	451,313	476,897	506,808	532,608	522,237	564,954	595,218	632,369	663,455	549,088	576,542
Johor	50,058	52,539	54,685	56,990	55,268	63,922	68,098	72,501	75,921	80,857	84,608
Iskandar Malaysia	35,000	37,535	38,208	39,336	37,600	41,813	44,398	47,434	49,540	52,938	56,772
Industrial GDP											
Peninsular Malaysia	223,188	233,019	238,887	239,301	221,984	241,340	248,309	262,322	271,342	245,554	257,831
Johor	27,225	28,336	28,640	28,850	26,974	33,614	35,291	37,367	38,891	41,679	43,602
Iskandar Malaysia	14,672	15,456	18,225	17,717	15,924	18,889	19,666	21,051	21,588	23,428	20,273

Source:
Peninsular Malaysia, Johor
2005 - 2009: EPU,
http://www.epu.gov.my/documents/10124/05e3168d-a43d-4026-9817-53ab0e894d87
http://www.epu.gov.my/en/economic-statistics/national-accounts
2010 - 2014: EPU,
http://www.epu.gov.my/documents/10124/e0daf6f7-960a-464d-b13c-759694e01a91
http://www.epu.gov.my/en/economic-statistics/national-accounts

Johor
2015: Laporan Ekonomi Negeri Johor 2014/2015, UPENJ

Iskandar Malaysia
2005, 2006 – 2016: UPENJ

Note:
1. 2015 data are projected using the growth rate of 5% (Source: DoS Portal)
2. GDP for Peninsular Malaysia including Supra State (Supra State covers production activities that are beyond the centre of predominant economic interest for any state)
3. 2015 data for Johor are projected using the growth rate of 5% (Source: DoS Portal)
4. GDP are adjusted to 2005 constant price to ensure consistency in data, with assumption of discount rate 3%

Default Values

1. Net Calorific Valye (NCV)

Type of Fuel	Net Calorific Value (NCV) (TJ/Gg)
Natural Gas	48.0
Petrol	44.0
Diesel	43.0
Fuel Oil	40.4
LPG	47.3
Kerosene	43.8
Coal & Coke	28.2
Refinery Gas	49.5
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:

Net Calorific Value (NCV) - Table 1.2, Page 1.18 - 1.19, 2006 IPCC Guidelines for National Greenhouse Gas Inventories Chapter 1, Volume 2: Energy Net Calorific Value (NCV) of Refinery Gas - Page 88, Malaysia Energy Statistics Handbook 2015

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. Degradable organic carbon in disposal year (DOC)

Type of Waste	Percentage (%)
Wood and wood products	43
Paper and cardboard	40
Food waste	15
Textiles	24
Garden, yard and park waste	20
Nappies	24

Source:

2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 2, Table 2.4, Page 2.14

4. Fraction of DOC which Decomposes (DOC_f) = 0.5

Source:

2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Page 3.13

5. Fraction of CH_4 (F)

Source	
in generated landfill gas[a]	0.5
in biogas[b]	0.6

Source:

[a] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Table 3.2, Page 3.15

[b] UNFCCC CDM, Tools for Project and leakage emissions from anaerobic digesters (Version 01.0.0)

6. Density of CH_4 = 0.00067 t/m^3

Source:

UNFCCC CDM, Tools for Project and leakage emissions from anaerobic digesters (Version 01.0.0)

7. Oxidation Factor (OX)

Lanfill level	
Managed, unmanaged and uncategorized SWDS	0
Managed covered with CH_4 oxidizing material	0.1

Source:

[a] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Table 3.2, Page 3.15

8. Methane Generation Rate (k)

Type of Waste	MSW[a]	Biomass (EFB, OPT, OPF)[b]
Paper/ Textiles	0.07	-
Wood	0.035	-
Garden/ Park	0.17	0.1
Food Waste	0.4	-

Source:

[a] 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Table 3.3, Default value for Tropical (MAT > 20° C), Moist and Wet (MAP ⩾ 1000 mm), Page 3.17

[b] 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Table 3.3, the lower value from the range provided for the Boreal and Temperate Climate Zone, Page 3.17

9. BOD Correction Factor

Industrial BOD Discharged in Sewers	
Uncontrolled	1

Source:

2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 6, Page 6.14

10. Default Maximum CH_4 Producing Capacity (B_O) for Domestic Wastewater

Domestic Wastewater: 0.6 kg CH_4/kg BOD

Source:

2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Table 6.2, Page 6.12

11. Methane Correction Factors (MCF)

Municipal Solid Waste - Lanfill level[a]	
Managed – anaerobic	1.0
Unmanaged – deep (>5 m waste) and /or high water table	0.8
Biomass Waste (EFB, OTP and OPF)[b]	
Stockpile	0.36
Domestic Wastewater – Treatement type[c]	
Centralized, aerobic treatment plant	0.0
Anaerobic reactor	0.8
Anaerobic shallow lagoon	0.2
Domestic Sludge– Treatement type[d]	
Sludge Drying Bed	0.2
Sludge Lagoon	0.8
Industrial Wastewater – Treatement type[e]	
Anaerobic deep lagoon	0.2

Source:

[a] 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Table 3.1, Page 3.14

[b] According to AMS III E, paragraph 34, due to the high uncertainty in the estimation of methane emissions from stockpiles, the MCF value of 0.36 to be applied in the calculation

[c] 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Table 6.3, Page 6.13

[d] 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Table 6.3, Page 6.13

[e] 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Table 6.8, Page 6.21

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

Type of Fuel	CO_2 (kg/TJ)	CH_4 (kg/TJ)	N_2O (kg/TJ)
LPG	63,100	5.0	0.1
Kerosene	71,900	10.0	0.6
Coal & Coke	94,600	300.0	1.5
Commercial / Institutional			
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
Coal & Coke	96,100	10.0	1.5
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
Refinery Gas	57,600	1.0	0.1
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:

Emission Factor - Table 2.2 - 2.5, Page 2.16 - 2.23, 2006 IPCC Guidelines for National GHG Inventories, Chapter 2, Volume 2: Stationary Combustion

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 GHG Inventories, Volume 2, Chapter 1, Page 1.23 - 1.24, Table 1.4
2. 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 3, Page 3.16, Table 3.2.1
3. 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 3, Page 3.21, Table 3.2.2
4. 2006 IPCC Guidelines for National GHG Inventories, Volume 2, Chapter 3, Page 3.50, Table 3.5.*2*

3. Grid

Year	Grid Emission Factor (tCO_2e/MWh)
2005	0.614
2006	0.661
2007	0.684
2008	0.672
2009	0.683
2010	0.760
2011	0.747
2012	0.741
2013	0.742
2014	0.694
2015	0.694

Assumption:

2015 grid emission factor is the same as 2014 grid emission factor

Source:

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

APPENDIX 1: FGD WORKSHOP

A Focus Group Discussion (FGD) on GHG Inventory preparation in Iskandar Malaysia 2015 was successfully held on 13 Oct 2016 at Hotel Jen, Puteri Harbour. Some 50 representatives from both government and private sectors attended the event.

The aim of this FGD was to share and discuss with key stakeholders on the draft results and obtained inputs and feedback. Besides the discussion, Dr. Fong Wee Kean of WRI also shared the global perspective of city/region GHG accounting and reporting at the event.

Discussion output of the FGD as below:

DATA	INPUT
General	
Population	• No objection on the data sources used for the calculation.
GDP	• No objection on the adjustment made, adjusted the constant price to same constant year.
Emissions factor/ GWP	• Iskandar Malaysia inventory 2015 using AR5. • International inventory using AR4 GWP, no decision from UNFCCC to use AR5. • Grid emission factor for 2014 is lower than previous years as coal power plant(s) is not accounted. Thus best to use the average grid emission. ***Decision:*** • Iskandar Malaysia inventory 2015 will uses AR5 for its reporting and calculate another set of data using AR4 so its comparable with national inventory. • Grid emission factor 2015 will use the average grid emission factor 2012-2014.

DATA	INPUT
Stationary Energy	
Natural gas consumption	• To get new version of NEB 2005 & 2006 from ST. • Data custodian: ST
Petroleum products consumption	• Oil & Gas industries (above threshold) only requested to submit their sustainability reports to Bursa Malaysia • Oil & Gas industries provided national level by sector to ST but not to specific region/city. ***Decision:*** • Using scale down approach for 2015 inventory. • Further discussion with ST on setting up regional specific data collection system
Electricity consumption	***Decision:*** • ST in principle agreed to provide electricity consumption for 2015 based on Iskandar Malaysia region provided Iskandar Malaysia boundary provided. Further discussion with ST is needed.
Waste	
Solid waste	• MPOB suggested to get biomass data (use of biomass and type of treatment from individual plants due to the data confidentiality as the MPOB was unable to disclose the data) • National level only accounted EFB used in composting. Composting of EFB is considered as emissions from agriculture sector as it is not handled in the mills. • Clinical waste is under scope 3 thus it is not included in this report. ***Decision:*** • Biomass from POM will be excluded from industrial waste sector but accounted under AFULO.

Wastewater	• NC3 has added 2 additional industrial sectors
	    o Refinery
	    o Pulp & paper
	• DoE Johor has some information on industrial sector
	Decision:
	• Request from DOE HQ

Programme

Date : 13 October 2016 (Thursday)

Time : 8:30am – 2:00pm

Venue : Hotel Jen, Puteri Habour, Johor Bahru

Time	Programme
8.30 – 9.00 AM	Registration and Welcoming Refreshment
9.00 – 9.10 AM	Welcoming Remarks by Head of Environment Division, IRDA - Mr. Boyd Dionysius Joeman
9.10 – 9.30AM	City/Region GHG Accounting and Reporting – A Global Perspective - Dr. Fong Wee Kean, World Resources Institute
9.30 – 9.50 AM	Draft GHG Emission Report for Iskandar Malaysia Region 2015, Eco-Ideal Consulting Sdn. Bhd. (Consultant) - Engr. Soon Hun Yang (Team leader)
9.50 – 12.00 PM	Focus Group Discussions
12.00 – 12.30 PM	Summary of Discussion Results and Way Forward
12.30 – 2.00 PM	Lunch and End of Event

Attendance List

Name	Organisation
Government Agency	
1. Faridah Binti Ahmad	Badan Kawal Selia Air Johor
2. Amy Charlene Wong	Jabatan Alam Sekitar (JAS)
3. Janizan bin Abu Kassim	JAS Johor
4. Sharifah Zakiah Syed Sahab	JAS Johor
5. Hazereen Binti Mohammad	JAS Johor
6. Azlina MD Dom	Jabatan Pertanian Negeri Johor
7. Dato' Yap Kok Seng	Kementerian Sumber Asli dan Alam Sekitar
8. Dr. Gary W. Theseira	Kementerian Sumber Asli dan Alam Sekitar
9. Paul Wong Kok Kiong	KeTTHA
10. Mohd Dzahari Bin Ahmad Rafik	Malaysian Palm Oil Board
11. Mohd Faizal Bin hassan	MBJB
12. Mohd Anariza B Mohd Noor	MBJB
13. Yeoh Yuan Xiang	MOA
14. Hazlan Abdul Aziz	MOT
15. Mohamad Zul Feka Bin Kamri	MPJBT
16. Mohd Qayyum Sunawan	MPJBT
17. Adib Reeza Osman	MPKU
18. Hussein Bin Bakar	MPKU
19. Muhd Yusof Abd Wahab	MPPG
20. Muhammad Razif B. Ramlan	MPPG
21. Ainee Khatijah Binti Zainudin	Perbadanan Pengangkutan Awam Johor
22. Hafizah Binti Sharif	Perbadanan Pengangkutan Awam Johor
23. Aimi Hazwanie Nordin	Suruhanjaya Tenaga
24. Norazlina Binti Bahari	SWCorp.
Private	
25. Zulkifli Hamzah	Gas Malaysia Berhad
26. Izzat Bin Mohd Adnan	Kilang Kelapa Sawit Masai, Keck Seng (M) Sdn. Bhd.
27. Mohd Fazizi Ishak	KTMB
28. Kan See Mun	Petron Malaysia Refining & Marketing Bhd.
29. Shamsir Shamsudin	SAJ Holdings SB
30. Azlin Selamat	SAJ Holdings SB
31. Mohd Zin Othman	SAJ Holdings SB
32. Hasrul Mohamad	Senai Airport Terminal Services Sdn Bhd

Name	Organisation
33. Hooi E-Wen	SWM Environment Sdn. Bhd.
34. Mohammad Amiruddin Kamaluddin	Tanjung Bin Power
35. Danial Delane Bin Abdullah	Tanjung Pelepas Port Sdn. Bhd.
36. Norliah Sakib	Tanjung Pelepas Port Sdn. Bhd.
37. Shahrul Izam Abas	Tg Langsat Port
38. Wan Azman B. Wan Ismail	YTL Power Services Sdn. Bhd.
39. Yusri Husin	YTL Power Services Sdn. Bhd.
Project Team	
40. Chang Siaw Yen	Eco-Ideal Consulting Sdn. Bhd.
41. Chen Saw Ling	Eco-Ideal Consulting Sdn. Bhd.
42. Chua Ming Yin	Eco-Ideal Consulting Sdn. Bhd.
43. Muhammad Uzaier Fitri Abdul Aziz	Eco-Ideal Consulting Sdn. Bhd.
44. Nurul Hidayah Binti Zulkipli	Eco-Ideal Consulting Sdn. Bhd.
45. Soon Hun Yang	Eco-Ideal Consulting Sdn. Bhd.
46. Tan Ching Tiong	Eco-Ideal Consulting Sdn. Bhd.
47. Boyd Dionysius Joeman	IRDA
48. Choo Hui Hong	IRDA
49. Sharifah Shahidah Syed Ahmad	IRDA
50. Prof. Dr. Ho Chin Siong	UTM-LCARC
51. Chau Loon Wai	UTM-LCARC
52. Mlysha Nurshyla Abdul Rahim	UTM-LCARC
53. Nadzirah Jausus	UTM-LCARC
54. Dr. Fong Wee Kean	World Resources Institute

APPENDIX 2: CALCULATION REMARKS

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I	**Stationary Energy**			
I.1	**Residential Buildings**			
I.1.1	1	✓	Emissions from fuel combustion	1. Fuel consumption data and fuel types used for Peninsular Malaysia were extracted from NEB 2005 – 2014. Consumptions of 2015 were projected using annual growth rate of fuel consumption from NEB 2014, page 70-71, table 26. 2. Fuel consumption for Iskandar Malaysia were accounted by scaling down consumption for Peninsular Malaysia to consumption for Iskandar Malaysia by using population ratio. 3. Population Peninsular Malaysia 2005 – 2014 were obtained from EPU. Population data for 2015 were projected based on average yearly growth rate for Peninsular Malaysia population from 2005 – 2014. 4. Iskandar Malaysia population data from 2005 – 2014 were obtained from UPENJ and 2015 was projected based on population growth rate of Johor, obtained from EPU. 5. Fuel consumptions by sectors in Peninsular Malaysia were estimated using the formula: $\frac{Consumption\ of\ product\ in\ Peninsular\ Malaysia\ ('000\ barrels)}{Consumption\ of\ product\ in\ Malaysia\ ('000\ barrels)}\ x\ Consumption\ of\ product\ for\ all\ sectors\ in\ Malaysia\ (ktoe)\ x\ \frac{Consumption\ of\ products\ for\ the\ particular\ sector\ in\ Malaysia\ (ktoe)}{Consumption\ of\ product\ for\ all\ sectors\ in\ Malaysia\ (ktoe)}$ 6. Emission factors for all fuels were obtained from 2006 IPCC Guidelines for National GHG Inventories, page 2.22 – 2.23, Table 2.5. 7. NCV for all fuels were obtained from 2006 IPCC Guidelines for National GHG Inventories, page 1.18-1.19, Table 1.2. 8. Assumptions of fuel's 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 9. GWP is obtained from IPCC AR5, GHG Protocol.

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				10. GHG Emission is calculated by the formula: $\frac{Fuel\ consumption\ x\ Emission\ factor\ of\ the\ fuel\ (CO_2, CH_4\ and\ N_2O)\ x\ NCV\ of\ the\ fuel}{1000}\ x\ GWP$ 11. Total GHG Emission is: $CO_2\ emission + CH_4\ emissions + N_2O\ emissions$
I.1.2	2	✓	Grid-supplied energy consumed	1. Grid-supplied energy consumed data were obtained from ST for the whole Johor State. 2. Consumptions were scaled down using population data of Iskandar Malaysia. 3. Iskandar Malaysia population data from 2005 – 2014 were obtained from UPENJ and 2015 was projected based on the Johor's population growth rate from 2014 to 2015. 4. Peninsular Malaysia's grid emission factors (2005 – 2014) were obtained from MGTC. 2015 emission factor was assumed to be the same as 2014. 5. Grid GHG emissions were calculated using the formula: $Grid\ consumption\ x\ Grid\ emission\ factor$
I.1.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted for BASIC reporting
I.2	**Commercial and Institutional Buildings and Facilities**			
I.2.1	1	✓	Emissions from fuel combustion	Same as I.1 Residential Buildings
I.2.2	2	✓	Grid-supplied energy consumed	Same as I.1 Residential Buildings
I.2.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted for BASIC reporting

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.3	**Manufacturing Industries and Construction**			
I.3.1	1	✓	Emissions from fuel combustion	1. Fuel consumption data and fuel types used for Peninsular Malaysia were extracted from NEB 2005 – 2014. Data for 2015 were projected using annual growth rate of fuel consumption from NEB 2014, page 70-71, table 26. 2. Scale down consumption by using industrial GDP (Manufacturing GDP + Construction GDP) 3. Industrial GDP by economic activities of Peninsular Malaysia, Johor and Iskandar Malaysia were obtained from EPU Malaysia and UPENJ. Johor GDP by state and kind of economic activity were obtained from *Laporan Ekonomi Negeri Johor 2014/2015*, UPENJ. 4. GDP for Peninsular Malaysia includes Supra State, which covers production activities that are beyond the centre of predominant economic interest for any state. 5. Peninsular Malaysia's GDP from 2014 – 2015 and Iskandar Malaysia's GDP from 2013 – 2015 were adjusted to constant price 2005 to ensure consistency in data, with assumption of discount rate 3% using the formula below: $\frac{Actual\ Iskandar\ Malaysia\ GDP}{(1 + Discount\ Rate)^{number\ of\ year\ discounted}}$ 6. 2015 GDP was projected using the growth rate of 5% obtained from DoS portal. 7. Iskandar Malaysia Industrial GDP for 2005 and 2015 were calculated using: $\frac{Iskandar\ Malaysia\ GDP}{Johor\ GDP}\ x\ (Manufacturing\ GDP\ of\ Johor + Construction\ GDP\ of\ Johor)$ 8. Fuel consumptions for Iskandar Malaysia were scaled down using Iskandar Malaysia Industrial GDP with the formula: $Consumption\ for\ Peninsular\ Malaysia\ x\ \frac{Iskandar\ Malaysia\ Industrial\ GDP}{Peninsular\ Malaysia\ Industrial\ GDP}$

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.3.2	2	✓	Grid-supplied energy consumed	1. Grid-supplied energy consumed data were obtained from ST for the whole Johor State. 2. Scale down consumption by using Industrial GDP (Manufacturing GDP + Construction GDP) 3. Industrial GDP by economic activities of Johor and IM were obtained from EPU Malaysia and UPENJ. 4. According to the data given for 2013 and 2014 by UPENJ, there is no agriculture and mining & quarrying activities in Iskandar Malaysia region that contributes to the Iskandar Malaysia GDP. Therefore, Iskandar Malaysia industrial GDP will only include manufacturing and construction activities. 9. Iskandar Malaysia Industrial GDP for 2005-2012 and 2015 were estimated using: $\frac{Iskandar\ Malaysia\ GDP}{Johor\ GDP}\ x\ (Manufacturing\ GDP\ of\ Johor + Construction\ GDP\ of\ Johor)$ 5. Peninsular Malaysia's grid emission factors (2005 – 2014) were obtained from MGTC. 2015 emissions factor was assumed to be the same as 2014. 6. Grid GHG emissions were calculated using the formula: $Grid\ consumption\ x\ Grid\ emission\ factor$
I.3.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted for BASIC reporting
I.4	**Energy Industries**			
I.4.1	1	✓	Emissions from energy used in power plant auxiliary operations	1. Actual auxiliary consumption data were obtained from YTL Pasir Gudang Power Station, Lotte Chemical Titan Pasir Gudang Power Station and Lotte Chemical Titan Tanjung Langsat Power Station. 2. According to Tanjung Bin Power Sdn. Bhd., auxiliary energy consumption is about 5% of total fuel being consumed for facility's gross energy generation (MW_G). Therefore, the auxiliary consumptions of Sultan Iskandar Power Station in Pasir Gudang, Tanjung Bin Independent Power Plant and Perstima Pasir Gudang Independent Power Plant were assumed to be 5% of total fuel consumption for the energy generation supplied to the grid.

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.4.2	2	✓	Grid-supplied energy consumed	1. Actual electricity consumption for auxiliary operations of power plants were obtained from each power stations respectively. 2. Sultan Iskandar Power Station in Pasir Gudang is excluded from calculation due to data unavailability. Peninsular Malaysia's grid emission factors (2005 – 2014) were obtained from MGTC. 2015 emissions factor was assumed to be the same as 2014. 7. Grid GHG emissions were calculated using the formula: $Grid\ consumption\ x\ Grid\ emission\ factor$
I.4.3	3	×	Transmission and distribution losses from grid-supplied energy	Not accounted for BASIC reporting
I.4.4	1	✓	Emission from energy generation supplied to the grid	1. Actual fuel consumption data were obtained from each power stations respectively. 2. Data for Sultan Iskandar Power Station in Pasir Gudang (2005-2010) were backcasted using the average annual growth rate of final energy consumption from 1990 – 2014 according to NEB 2014, page 70-71, table 26. 3. Data for Tanjung Bin Independent Power Plant (2015) were projected using average growth rate for fuel oil consumption. 4. Data for Lotte Chemical Titan Malaysia (2011 – 2012) were backcasted using the average annual growth rate of final energy consumption from 1990 – 2014 according to NEB 2014, page 70-71, table 26.
I.5	**Agriculture, Forestry and Fishing Activities**			
I.5.1	1	✓	Emissions from fuel combustion	Same as I.1 Residential Buildings
I.5.2	2	✓	Grid-supplied energy consumed	Same as I.1 Residential Buildings
I.5.3	3	×	Transmission and distribution losses from grid-supply energy	Not accounted for BASIC reporting

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.6	**Non-Specified Sources**			
I.6.1	1	✓	Emissions from fuel combustion	NO
I.6.2	2	✓	Grid-supplied energy consumed	NO
I.6.3	3	×	Emissions from transmission and distribution losses from grid-supply energy	NO
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
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

<table>
<tr><th>GPC Ref.</th><th colspan="2">Scope</th><th>Activities</th><th>Remarks (i.e. Data Input/ Assumptions/ Notation Key)</th></tr>
<tr><td>I</td><td colspan="4">Transportation</td></tr>
<tr><td>I.1</td><td colspan="4">On-road Transportation</td></tr>
<tr><td>I.1.1</td><td>1</td><td>✓</td><td>Emissions from fuel combustion</td><td>1. Population of Malaysia 2005 - 2015 is obtained from EPU.
2. Population of Iskandar Malaysia 2005 – 2014 is obtained from UPENJ and 2015 is projected based on the population growth of Johor.
3. Fuel sales for transportation sector in Malaysia is obtained from NEB 2005 – 2014. Data for 2015 is projected using the average of the average annual growth rate of fuel consumption from NEB 2014, page 70-71, table 26.
4. Fuel sales in Iskandar Malaysia is estimated by using:
$$Fuel\ sales\ in\ Malaysia\ x\ \frac{Population\ in\ Iskandar\ Malaysia}{Population\ in\ Malaysia}$$
5. Emission factors for all fuels are obtained from 2006 IPCC Guidelines for National GHG Inventories, page 2.22 – 2.23, Table 2.5
6. NCV for all fuels are obtained from 2006 IPCC Guidelines for National GHG Inventories, page 1.18-1.19, Table 1.2
7. Assumption for fuel’s emission factors and NCV for:
a. Petrol is assumed to be motor gasoline
b. Fuel oil is assumed to be residual fuel oil
8. GWP is obtained from IPCC AR5, GHG Protocol
9. GHG Emission for transport is calculated using:
$$\frac{Fuel\ sale\ x\ NCV\ of\ each\ fuel\ types\ x\ Emission\ factor\ of\ each\ fuel\ types\ (CO_2, CH_4\ and\ N_2O)}{1000}$$
12. Total GHG Emission is:
$$CO_2\ emission\ +\ CH_4\ emissions\ +\ N_2O\ emissions$$</td></tr>
<tr><td>I.1.2</td><td>2</td><td>✓</td><td>Grid-supplied energy consumed</td><td>NE as there are only 2 units of pilot electrical vehicles available in Iskandar Malaysia</td></tr>
</table>

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.1.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted for BASIC reporting
I.2	**Railway**			
I.2.1	1	✓	Emissions from fuel combustion	1. No. of trip (cargo and intercity train), diesel consumption and train distance (2011 - 2015) were obtained from KTMB. For 2005 – 2010 data, the no. of trips was estimated using the percentage growth of no. of trips from 2011 – 2015, assuming that diesel consumption and train distance are the same as 2011 – 2015 data. 2. The trip distance is from Layang-Layang to Johor Bahru, including Pasir Gudang and Port of Tanjung Pelepas. 3. Emission factor of diesel is obtained from 2006 IPCC Guidelines for National GHG Inventories, page 3.43, table 3.4.1 4. Density of diesel oil is obtained from GHG Protocol Calculation Tool "GHG emissions from stationary combustion" developed by WRI (2008), version 4.0 5. NCV of diesel oil is obtained from 2006 IPCC Guidelines for National GHG Inventories, page 1.18, table 1.2 6. GWP is obtained from IPCC AR5, GHG Protocol
I.2.2	2	✓	Grid-supplied energy consumed	NO as the railway transportation in Iskandar Malaysia consume diesel as fuel only
I.2.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting
I.3	**Waterborne Navigation**			
I.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
I.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

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.3.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting
I.4	**Aviation**			
I.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
I.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
I.4.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting
I.5	**Off-road Transportation**			
I.5.1	1	✓	Emissions from fuel combustion	1. Actual diesel consumption amount was obtained from Johor Port, Tanjung Pelepas Port and Senai Airport for their off-road transportation. 2. Emission factor of diesel is obtained from 2006 IPCC Guidelines for National GHG Inventories, page 3.43, table 3.4.1 3. Density of diesel oil is obtained from GHG Protocol Calculation Tool “GHG emissions from stationary combustion” developed by WRI (2008), version 4.0 4. NCV of diesel oil is obtained from 2006 IPCC Guidelines for National GHG Inventories, page 1.18, table 1.2 5. GWP is obtained from IPCC AR5, GHG Protocol
I.5.2	2	✓	Grid-supplied energy consumed	IE under Scope 2 of ‘Commercial and institutional buildings and facilities’ sub-sector in Stationary Energy sector.

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
I.5.3	3	×	Transboundary journeys occurring outside the city, and T&D losses from grid-supplied energy use	Not accounted in BASIC reporting.
II	**Waste**			
II.1	**Solid Waste Disposal**			
II.1.1	1	✓	Emissions from solid waste generated in the city and disposed in landfills/open dumps within the city	1. Waste composition data for Tapak Pelupusan (TP) Seelong and amount of waste received in TP Seelong and TP Pekan Nanas (2010 – 2014) were obtained from SWCorp. 2. Amount of waste received in MD Pontian and MP Pasir Gudang were obtained from MDP and MPPG respectively. 3. Municipal waste discarded rate for Peninsular Malaysia in 2012 was obtained from the Survey on Solid Waste Composition, Characteristics & Existing Practice of Solid Waste Recycling in Malaysia. 4. Growth rate for the municipal waste discarded rate is assumed to increase 2% every 3 years. 5. 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 ratio: $$\frac{Amount\ of\ waste\ discarded\ to\ respective\ landfill}{Total\ amount\ of\ waste\ discarded\ to\ all\ landfills}\ x\ Amount\ of\ waste\ estimated\ using\ population\ and\ waste\ discarded\ rate$$ 6. List of landfills operating and closed in Johor was obtained from DoE GIS data. 7. At where the data of other operating landfills were not available, data were obtained by estimating using formulas. a. The total annual waste discarded to landfill were estimated using the formula: $$Population\ in\ Iskandar\ Malaysia\ x\ Waste\ generation\ rate\ (kg/capita/day)$$ b. The amount of waste received in respective landfill were estimated using ratio calculated. $$Ratio\ = \frac{Amount\ of\ waste\ sent\ to\ respective\ landfill}{Total\ amount\ of\ waste\ sent\ to\ all\ landfills\ per\ day}$$ 8. All the solid waste was assumed to be discarded at landfills. 9. Waste composition at all landfills was assumed to be the same as TP Seelong.

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				10. Historical waste volumes were estimated based on population data and average waste generation rate per capita. a. Amount of waste disposed to TP Pekan Nenas (1988 – 2009) = Total population in MDP x disposal rate (kg/cap/day) calculated from actual waste received in 2010 – 2013 from SWM Environment Sdn Bhd. b. Amount of waste disposed to TP Seelong (2005 – 2009) = (Total population in MNJN + MPJBT + MPKu) x disposal rate (kg/cap/day) calculated from actual waste received in 2010 – 2013 from SWM Environment Sdn Bhd. 11. The emissions from waste disposal model the actual emissions generated in each reporting year. This includes emissions from both operating and closed landfills. 12. GHG emissions was calculated based on Tier 2 First Order Decay (FOD) method from IPCC 2006, Volume 5, Chapter 3. 13. Zero delay where average decomposition started at the beginning of month 7 was assumed. 14. Default values for Degradable Organic Carbon (DOC) in disposal year 2006, sourced from IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 2, Page 2.14, Table 2.4. 15. Default value of the fraction of Degradable Organic Carbon which decomposes (DOC_f), sourced from 2006 IPCC Guidelines for GHG Inventories, Volume 5, Chapter 3, Page 3.13 16. Default values of Methane Correction Factors (MCF) sourced from 2006 IPCC Guidelines for GHG Inventories, Volume 5, Chapter 3, Page 3.14, Table 3.1 17. Default value of CH_4 in generated landfill gas (F), sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 3, Page 3.15 18. Default values of oxidation factor (OX), sourced from 2006 IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5, Chapter 3, Page 3.15, Table 3.2 19. Default values of methane generation rate (k), sourced from 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) 20. GWP is obtained from IPCC Fifth AR5, GHG Protocol
II.1.2	3	✓	Emissions from solid waste generated in the city but disposed in landfills/open dumps outside the city	NO

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
II.1.3	1	✓	Emissions from waste generated outside the city and disposed in landfills/open dumps within the city	NO
II.2	**Biological Treatment of Waste**			
II.2.1	1	✓	Emissions from solid waste generated in the city that is treated biologically in the city	NO
II.2.2	3	✓	Emissions from solid waste generated in the city that is treated biologically outside the city	NO
II.2.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	NO
III.3	**Incineration and Open Burning**			
II.3.1	1	✓	Emissions from waste generated and treated within the city	NO
II.3.2	3	✓	Emissions from waste generated within but treated outside the city	NO

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
II.3.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	NO
II.4	**Wastewater Treatment and Discharge**			
II.4.1	1	✓	Emissions from wastewater generated and treated within the city	<u>Municipal Wastewater</u> 1. Emissions from municipal wastewater were estimated based on the total volume of wastewater treated by each 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 26% of population under MDP is within Iskandar Malaysia Region (calculated using the total area of MDP boundary with the Iskandar Malaysia boundary that falls under MDP). 5. GHG emissions were calculated from year 2004 to 2015. 6. 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 7. To calculate N_2O emissions: a. Nitrogen in effluent were estimated 8. Emission factor and emissions of indirect N_2O emissions from wastewater were estimated. Data of wastewater volumes and treatment methods were provided by IWK for MPKu, MPJBT and MDP. Where data of wastewater volumes were unavailable, they were extrapolated from wastewater volumes of other Local Authorities according to population ratio. 9. Default value of correction factor for industrial BOD discharged in sewers – uncollected, sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.14. 10. Default maximum CH_4 producing capacity for domestic wastewater, sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2.

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				11. Default values for Methane Correction Factor (MCF) for domestic wastewater, sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.13, Table 6.3 <u>Industrial Wastewater</u> 12. Emissions from industrial wastewater treatment were estimated based on industrial production data and wastewater outflows treated by each treatment plant. 13. 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. 14. 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[41] 15. Default value for density of CH_4, Fraction of CH_4 in the biogas, sourced from Tools for Project and Leakage Emissions from Anaerobic Digesters (Version 01.0.0). 16. Default Maximum CH_4 producing capacity (B_o) for industrial wastewater sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.12, Table 6.2. 17. Methane Correction Factor (MCF) for industrial wastewater – anaerobic deep lagoon sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.21, Table 6.8 18. The COD for wastewater from rubber processing was assumed to be 8,750mg/L[42] <u>Municipal Wastewater and Industrial Wastewater</u> 19. 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) 20. Formula used in calculation for CH_4 is as follow:

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

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				$CH_4\ emissions\ = \sum i\ [(TOW_i - S_i)EF_i - R_i]^{10^{-3}}$ 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

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				21. Formula used in calculation for N_2O emissions is as follow: $N_2O\ emissions = [(P\ x\ Protein\ x\ F_{NPR}\ x\ F_{NON-CON}\ x\ F_{IND-COM}) - N_{SLUDGE}]\ x\ EF_{EFFLUENT}\ x \left(\frac{44}{28}\right)^{10^{-3}}$ 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 22. GWP is obtained from IPCC AR5, GHG Protocol Municipal Sludge 23. Emissions from municipal sludge treatment were estimated based on the total volume of sludge treated by each treatment plant. 24. Three different types of sludge treatment processes were accounted in this inventory: Sludge Drying Bed (DB), Sludge Lagoon (SL) and Sludge Reception Facility (SRF). 25. Emission factors for each treatment methods were sourced from IPCC 2006. 26. Total volume of sludge by treatment methods within Johor were obtained from IWK. Where data was unavailable, sludge volumes were extrapolated from the wastewater volume from other Local Authorities according to population ratio. 27. Default values for MCF for domestic sludge, sourced from 2006 IPCC Guidelines for National GHG Inventories, Volume 5, Chapter 6, Page 6.13, Table 6.3 28. The fraction of population in income group in inventory year for each STP, U = 1. 29. The degree of utilisation of treatment/discharge pathway or system for each income group fraction in inventory year for each STP, T = 1

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
				30. 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. 31. According to DEU (2006), 0.04kg of BOD is removed as sludge from a person a day.
II.4.2	3	✓	Emissions from wastewater generated within but treated outside the city	NO
II.4.3	1	✓	Emissions from waste generated outside the city boundary but treated within the city	NO
V	**Industrial Processes and Product Uses (IPPU)**			
V.1	1	×	Emissions from industrial processes occurring in the city boundary	Not accounted in BASIC reporting
V.2	1	×	Emissions from product use occurring within the city boundary	Not accounted in BASIC reporting
V	**Agriculture, Forestry and Other Land Use (AFOLU)**			
V.1	1	×	Emissions from livestock	Not accounted in BASIC reporting
V.2	1	×	Emissions from land	Not accounted in BASIC reporting
V.3	1	×	Emissions from aggregate sources and non-CO2 emission sources on land	Not accounted in BASIC reporting

GPC Ref.	Scope		Activities	Remarks (i.e. Data Input/ Assumptions/ Notation Key)
VI	**Other Scope 3**			
VI.1	1	×	Other Scope 3	Not accounted in BASIC reporting

APPENDIX 3: PROJECT IMPLEMENTATION

Project Team

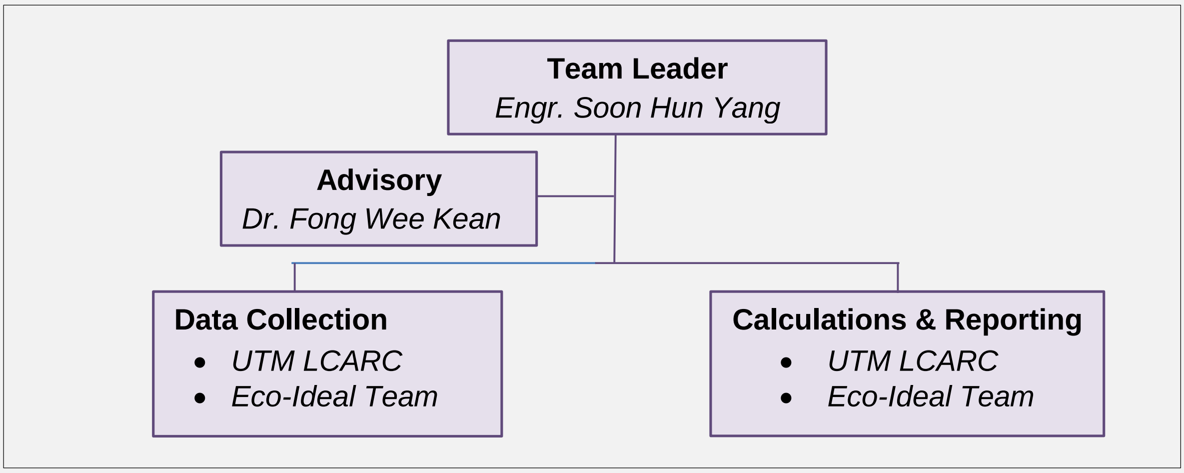
A project team which comprised of a consortium of multi-disciplinary experts with relevant international and local experiences was set up during the inception phase. The team consisted of planners, engineers as well as environmental scientists who had direct carbon management experiences.

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.

UTM LCARC team, represented by Professor Dr. Ho Chin Siong will assist in data collection required according to GPC standard and stakeholder engagement process.

The project team organisation and the role is illustrated below:



Organisation	Key Roles & Responsibilities
Eco-Ideal	• 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 UTM LCARC) and report to IRDA • Data collection in cooperation with UTM LCARC – focus on data available within headquarters (HQ) level, e.g. Putrajaya • Data review and analysis • Justification of exclusions • Prepare City Level Report based on GPC for Iskandar Malaysia Economic Region for year 2015

Organisation	Key Roles & Responsibilities
Dr. Fong Wee Kean	• Advisor role – advise on compliance with GPC • QA on compliance with GPC • Attend key meetings and discussions
UTM LCARC	• Based on GPC's data requirement, compile and provide data from LCS (both year 2005 & 2010) • Provide inputs and advise on local data availability • Follow-up and collect data source available locally within Iskandar Malaysia/Johor • Conduct primary data collection locally to fulfil data gaps where required • Contribute to reporting where relevant • Attend key meetings and discussions

Data Collection and Stakeholders Engagement

A stakeholder consultation workshop with relevant players was held on 17 April 2016 at the outset to assess the readiness of data and information required for the reporting using GPC. A GPC Preliminary Data Collection Form was developed and discussed during the workshop. The workshop was attended by more than 20 representatives from ST, UPENJ, Local Authorities within Iskandar Malaysia region, Putrajaya Corporation (Perbandaran Putrajaya, PPJ), DOS Johor, DOE Johor, Johor Water Regulating Body (Badan Kawalselia Air Johor, BAKAJ), SWM Environment Sdn Bhd, WRI, UTM-LCARC, IRDA and Eco-Ideal Consulting Sdn. Bhd.. Dr. Fong briefed the meeting on GPC and preliminary discussion on data availability and data custodian was discussed during the workshop. Official data collection letters were issued and circulated to all stakeholders/ data suppliers.

A number of discussions with UTM-LCARC team on the data collection and a total of 5 progress meetings were conducted throughout the project. Besides, a meeting with IRDA top management also has been conducted to brief them on the outcome of the project and to gain their supports for future inventories.

- Monthly Progress Meeting No.1: 11 May 2016
- Monthly Progress Meeting No.2: 20 June 2016
- Monthly Progress Meeting No.3: 2 August 2016
- Monthly Progress Meeting No.4: 8 September 2016
- Pre-FGD meeting: 4 October 2016
- FGD workshop: 13 October 2016
- IRDA Top Management Meeting: 19 December 2016

Meetings with MNRE and ST were also conducted on 23 June 2016 to discuss on the data harmonisation effort with national level GHG inventory, consistencies of data used and disaggregated data required from ST.

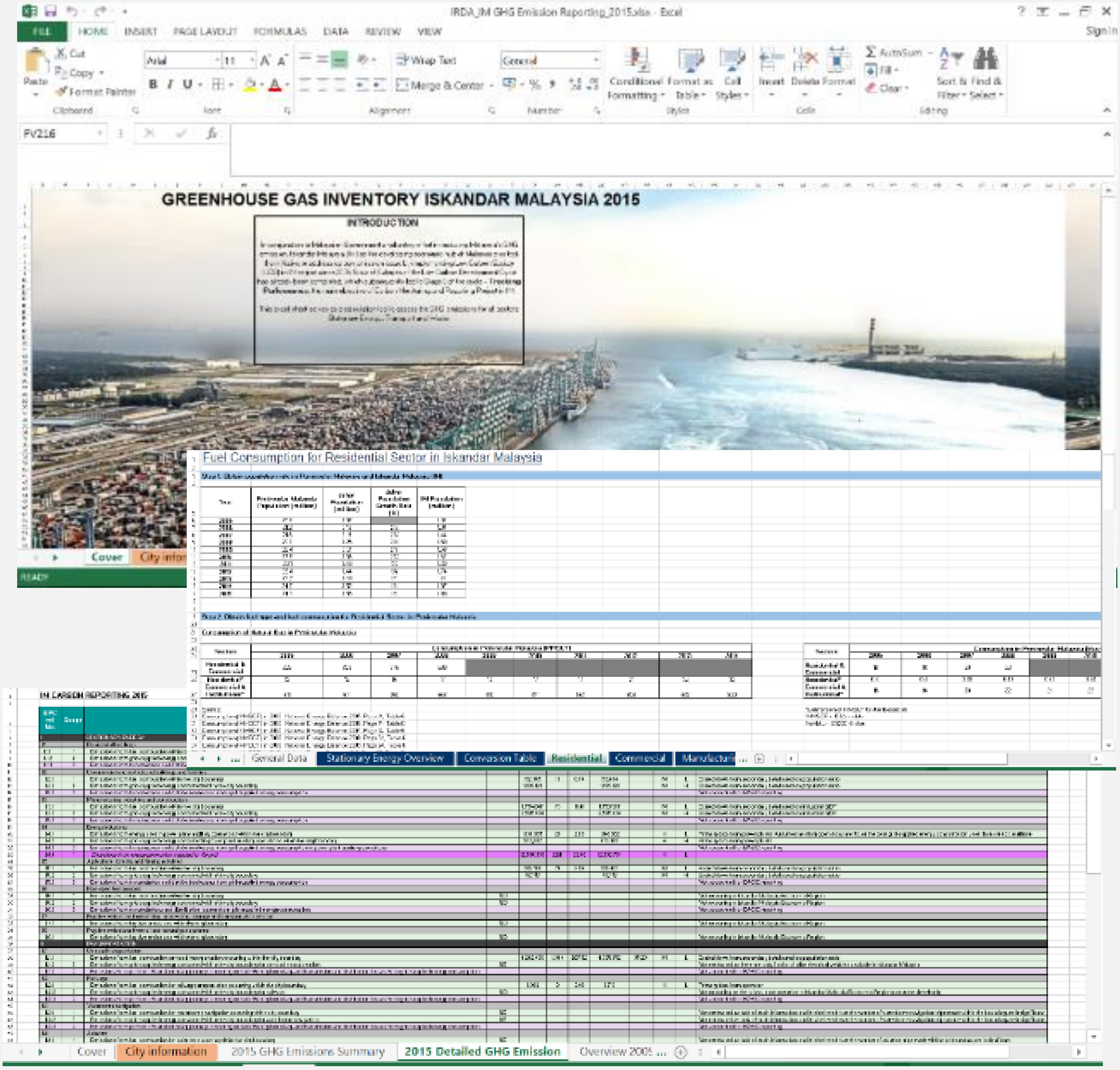
The 3 main issues with the data collection were identified as below:

- Disaggregation of data by sub-sectors and geographical coverage
- Gaps between data used in LCC and collected from the agencies
- Confidentiality of sensitive business information (i.e. fuel sales)

Calculation Sheet

A user-friendly digital template based on Microsoft Excel has been developed and will be handed-over to IRDA for continuous updating.

Screen shots of the said template:



Project Timeline

ACTIVITY	PERIODS (week)																		
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	
	30 Jun - 6 Jul	7 - 13 Jul	14 - 20 Jul	21 - 27 Jul	28 Jul - 3	4 - 10 Aug	11 - 17 Aug	18 - 24 Aug	25 - 31 Aug	1 - 7 Sep	8 - 14 Sep	15 - 21 Sep	22 - 28 Sep	29 Sep - 5	6 - 12 Oct	13 - 19 Oct	20 - 26 Oct	27 Oct - 3	Dec
Issuance of LOA																			
Kick-off meeting																			
1st stakeholder meeting																			
Progress meetings		X			X	X								X				X	
Data collection	X	X	X	X	X	X	X	X	X		X	X	X	X					
Survey					X	X	X	X	X				X	X					
Data analysis and calculation	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X				
FGDs and stakeholder engagement	X	X	X	X	X	X	X	X	X							X			
Submission of inception report		X																	
Submission of interim report					X														
Submission of draft executive summary															X				
Submission of final executive summary																		X	
Submission of final report																			X

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ISKANDAR
REGIONAL
DEVELOPMENT
AUTHORITY

ISKANDAR MALAYSIA GREENHOUSE GAS INVENTORY 2015

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