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THANE Smart City Ltd.

WHERE PEACE MEETS PROSPERITY

Thane City, India

Greenhouse Gas Emission Inventory Report 2017-18

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ICLEI Local Governments for Sustainability

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Contributing Team from ICLEI South Asia:
Tejas Shinde, Nikhil Kulkarni, Ankit Makvana, Nikhil Kolsepatil, Soumya Chaturvedula

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Contact:
ICLEI South Asia
C-3, Lower Ground Floor, Green Park Extension
New Delhi - 110016, India
iclei-southasia@iclei.org
http://southasia.iclei.org/

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1.1 Thane City Profile

The city of Thane is one of Maharashtra state's major cities and the district headquarters. The National Census, 2011 pegged the population of the city at about 1.82 million persons. Thane is included in the Mumbai Metropolitan Region and is one of the 18 urban centers therein. Being the first urban center on the periphery of Mumbai city, the city occupies a unique position in the region and has experienced rapid demographic growth. However owing to large industrial development and its proximity to the metropolis of Mumbai, Thane city has exhibited marked improvement in generating increased revenues and utilized these for economic growth, improved services and expanded infrastructure. The geographical jurisdiction of the Thane city spreads over an area of 128.23 sq. km. The city is located at the mean sea level on the northern part of the Konkan region. The city is also known as Lake City because of its 35 lakes.

1.2 Demography

The Thane Municipal Corporation (TMC) was established on 1st October, 1982. As per Census of India, 2011, the population of Thane was 1,841,488 persons in 2011; of which male and female population stands at 975,399 and 866,089 persons respectively.

The city has reported an average annual growth rate of 4.42% in its population from year 2001 to 2011.

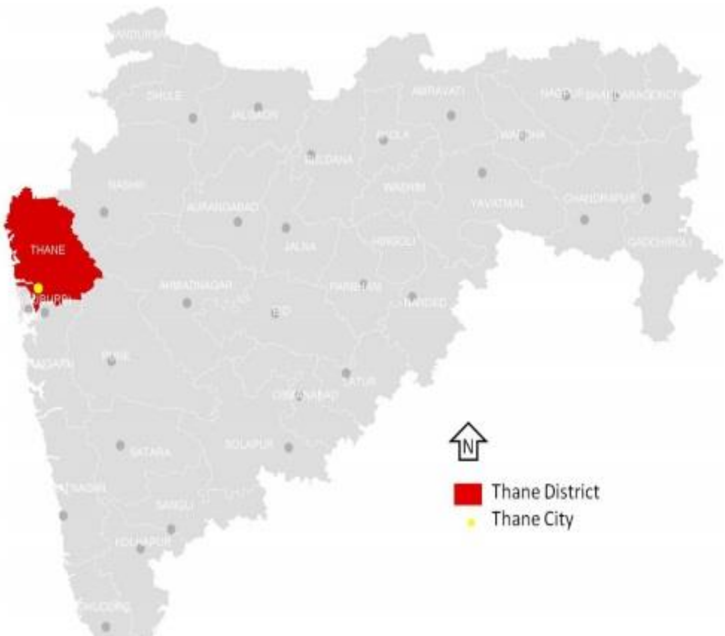

Figure 1: Indicative Location of Thane in Maharashtra State

1.3 Climate

Thane has a tropical monsoon climate that borders on a tropical wet and dry climate. Overall climate is equable with high rainfall days and very days of extreme temperatures. Thane temperature varies from 22^{o} C to 36^{o} C. In winter, the temperature is between 12^{o}C to 20^{o} C while summer temperature varies ranges from 36^{o} C to 41^{o} C. Out of total rainfall, 80% rainfall is usually received from June to October. The average annual rainfall is 2000-2500 mm and humidity ranges from 61 to 86%, making it a city with a predominantly humid weather. The driest days are in the winter months (October – January) while the wettest days are experienced in July.

1.4 Economic Activities

Thane has witnessed substantial growth and increasing demand in the commercial and realty sectors due to its proximity to Mumbai. Due to this increasing demand, commercial and consumer-oriented services e.g. malls, shopping complexes, commercial hubs, hospitality services are increasing rapidly in the city. Thane district is the second largest contributor to Maharashtra state's economy (13.1%) after Mumbai (22.1%), with its adjoining Thane-Belapur-Kalyan areas emerging as a major industrial belt. Thane district's gross district domestic product stood at INR 1794.8 billion (USD 26.9 billion) in 2012-2013, increasing by over 3 times from a value of INR 540.52 billion (USD 8.1 billion) in 2004-2005. Thane is an emerging destination for the IT/ITES sector and associated residential and retail developments including large commercial spaces and malls.

The employable population in Thane depends largely on the huge employment market in Mumbai. Industrial development in Thane has slowed down in recent times due to increased operational costs in the fast-developing urban setup of the city and industries are moving out of the city towards the newly developing industrial belt of Bhiwandi-Kalyan-Badlapur, located at a distance of 15-20 km from the city.

Economic growth in the last couple of decades has been driven by many IT industries being established in the city, and spatial and development policies pursued by the State Government of Maharashtra have also contributed to economic development. The IT/ITES sector is growing rapidly in Thane, with the city being the preferred location to set up IT industries, after the cities of Pune and Mumbai.

The city then onwards has emerged as a center of political power. The city boundary is limited by Sanjay Gandhi National Park on the east and the Thane creek on the west. Hence, the density of city is somewhat increasing.

1.5 Thane City Local Government

TMC was established on 1st October, 1982. Thane Municipal Corporation has undertaken many developmental projects and schemes since 1982 for a balanced development of the city. Thane city is spread across 128 sq. km. of area and is divided into 9 general wards for the purpose of maintenance of several services being provided by the municipal corporation. The municipal corporation maintains various services like street lighting, water supply, sewerage treatment plant, waste management etc. in the city. The corporation has administrative wing and political wing to take decisions on new developments and implementing urban development projects in the city.

Besides this, the corporation also has municipal markets, municipal gardens, boating centers, preprimary schools, primary schools, secondary schools, special schools, municipal colleges, administrative training center, nursing college, municipal hospital, health centers, and fire brigade stations etc. which are maintained by the municipal corporation through its staff in the relevant departments in the city.

The total length of the road network in Thane is about 283km out of which 216.81km are major roads and 66.19km are internal roads. The major Eastern Express Highway connecting Mumbai to rest of Maharashtra attracts heavy inflow of traffic to city. Thane City's vicinity to Mumbai has made it a preferred residential hub for the service industry. Recent years have seen an aggressive real estate development. Given this rapid development, Thane city is focusing on a number of projects addressing basic civic services.

Thane city has been selected as a Smart City under the Government of India's Smart City Mission. Under its Smart City Plan, Thane is implementing smart projects that make use of various innovative technological solutions. The key focus of the Smart City initiative in Thane is to provide a healthy, sustainable and energy efficient environment for city dwellers. Some of the Smart City projects being undertaken are

- Retrofitting 30,000 streetlights with LED Streetlights
- Implementing Integrated Command and Control Centre linked with Disaster Early Warning System
- Development of new suburban train station
- Development of Station Area Traffic Improvement Scheme on Thane East side.
- Implementing public bike-sharing initiative
- Procurement of electric buses
- Installation of Solar PV system up to 10 MW over municipal buildings

2 Baseline Assessment of Thane City

2.1 Greenhouse Gas Inventory:

Thane city's baseline inventory has been prepared based on energy consumption and municipal operation data for the period 2013-14 to 2017-18. The Greenhouse Gas (GHG) inventory has been prepared following the guidelines and protocols.

Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC) created by a collaborative effort between World Resources Institute, C40 Cities Climate Leadership Group, and ICLEI – Local Governments for Sustainability. In particular, it complies with the BASIC level reporting which covers Scope 1 and Scope 2 emissions from stationary energy and transportation, as well as Scope 1 and Scope 3 emissions from waste (Refer Appendix).

The GHG emissions inventory consists of two analyses, one for the emissions within the community determined by the geographical boundaries of the city's municipal jurisdiction and the other for urban services provided by the TMC.

Community-level inventory is a useful tool to establish baseline status of GHG emissions and in developing mitigation actions for the entire city community. It includes emissions from community activities that occur within the municipal government's jurisdiction. This includes emissions due to activities such as residential buildings, commercial/institutional facilities, industrial units and processes, agriculture, forestry and land-use, and mobile transportation units.

Local Government inventory includes emissions from all local operations that the municipal corporation owns or controls. The various sectors considered for this inventory include local government buildings, facilities such as street lighting and traffic lighting, water, waste and sewage facilities, and municipal vehicle fleet. Based on the inventory data for the baseline year, the municipal government can develop innovative approaches to provide sustainable urban services and can demonstrate leadership in pursuing emission mitigation efforts that illustrate the possibilities of different mitigation actions to the community.

A city's GHG inventory is not just simply the sum of GHG emissions from its community-level activities and from the operations carried out by the local government body to provide basic urban services. Usually, a major part of the emissions due to local government operations is a subset of the community level emissions. Often the community inventory data already accounts for the data pertaining to municipal government operations and so due care should be taken to avoid double accounting of emissions.

For example, the electricity consumption in municipal facilities for water supply, sewage treatment, and street lighting may already be accounted in the community-wide electricity consumption data based on relevant customer/end-user categories as prescribed under the electricity distribution and tariff arrangements. Adding the electricity consumption data from such facilities, obtained from the respective departments within the local government, to the community-wide data again will result in double accounting of the emissions and such overlaps have to be prevented by careful handling of data.

However, it is necessary to acknowledge that analyzing community-weigh emissions presents its own challenges as the natural flow of energy and materials is typically most accurate at the national level. Reducing the spatial area of analysis, from national to sub-national and local levels result in a less accurate reflection of the material and energy flows. Therefore, a community level GHG emission accounting means that a combination of national and local area information is required in order to model the emissions. This report identifies the main energy carriers and the intensive GHG emitting sectors that contribute to the local carbon footprint and air pollution within the geographical boundary of Thane Municipal Corporation.

2.1.1 Methodology for GHG emission inventory

The GHGs considered in the GHG emission inventory are carbon dioxide (CO_2), methane (CH_4) and nitrogen oxide (N_2O), gases which account for nearly 99% of global GHG emissions.

The GHG inventory has been reported in terms of emissions of each individual GHG and the total carbon dioxide equivalent (CO_2e) emission. To arrive at the CO_2e, the global warming potential (GWP) of each gas for a 100-year timeline is factored. The GWP gives the climate change impact, in terms of the warming effect on the atmosphere, for each GHG with reference to CO_2. The GWP values based on the IPCC's Fourth Assessment Report are presented in the Table below.

Table 1: 100 Year GWPs of GHGs with respect to CO2

Gas	Lifetime (years)	GWP for 100 years
CH_4	12	25
N_2O	114	298

Emissions Factors

For estimating the GHG emissions from the various activities or sources in a region, it is not feasible to carry out a direct physical measurement of GHGs emitted. The common methodology for estimating GHG emissions is by using the principle of emission factor and the relevant activity data to estimate the emissions.

$$GHG_A = EF_A \times D_A$$

where, GHG_A = GHG emissions resulting from activity A
EF_A = emission factor for activity A
D_A = data for activity A

The emission factor for a particular activity is dependent on the energy use and the direct emissions of GHGs resulting from the activity. As the emission factors are dependent on the energy use and the direct GHG emissions, they tend to vary over locations or even for different technologies. For example, the emission factor per kWh of electricity used would vary over countries or regions due to the varying energy mix, characteristics of fuel used and the efficiency of electricity generation. The emission factor per km travelled would vary depending on the fuel characteristics, the engine characteristics for the vehicle, the driving and traffic patterns prevalent. For accurately estimating a GHG inventory, it is thus important to use the emission factor best suited to the location.

For the present study, relevant emission factors as available in HEAT+ tool have been used to arrive at GHG emissions from activities in the region. HEAT+ contains numerous country specific emission factors and energy densities for a wide range of fuels, combustion technologies and waste types. HEAT+ uses these values to calculate the GHG emissions resulting from electricity usage, fuel consumption and waste decomposition.

2.1.2 Harmonized Emission Analysis Tool plus (HEAT+)

ICLEI's Harmonized Emission Analysis Tool *plus* (Heat+) is an online emissions accounting software package that helps local governments to account for GHG emissions and develop a comprehensive energy and carbon inventory of their respective cities. The tool helps them in making informed climate action decisions and was utilized to assist with the accounting of Thane's level of GHG emissions during the 5-year period of the inventory. The Heat+ tool incorporates the latest technical findings (IPCC, 2006) and is based on the International Local Government GHG Emissions Analysis Protocol (IEAP).It also incorporates the new international reporting requirements and standards outlined in the Global Protocol for Community-Scale Greenhouse Gas Emissions (GPC).

HEAT+ is now GPC compliant. However, the government module is retained from the differentiation that was brought in with IEAP.

The Harmonized Emissions Analysis Tool (HEAT+) is a specialized online application designed to help local governments:

1. Create emissions inventory of GHGs as well as air pollutants such as nitrogen oxides, sulphur oxides, carbon monoxide, volatile organic compounds, and particulate matter;
2. Forecast growth of these emissions for a future year;
3. Evaluate policies and measures to reduce emissions of these pollutants; and
4. Prepare action plans to reduce emissions.

While ICLEI designed HEAT+ as a GHG planning tool for its local government members to use while undertaking the five-mile stone process of the Cities for Climate Protection (CCP) Campaign, this tool has been substantially updated to support cities in the implementation of ICLEI's latest Climate Action methodology, the Green Climate Cities. Decision makers from other levels of governments as well as from the private sector and non-governmental organizations will also find the tool useful. With an easy to navigate interface, numerous built-in reports, extensive Intergovernmental Panel on Climate Change (IPCC) and country-specific emissions coefficient data sets, HEAT+ provides an unparalleled software environment for everything right from preparing city specific GHG inventories to evaluating the benefits of individual policies and measures for developing comprehensive action plans.

2.1.3 Data Sources and Collection

The baseline year for GHG inventory is considered as financial year 2017-18. The data is collected for last 5 years up to 2013-14 from the baseline year. A full inventory includes GHG emissions from energy, waste, forestry and land use change. However, due to limited resources and data constraints, the direct emissions from agriculture, land-use change and forestry sectors were not included.

ICLEI South Asia and TMC staff members engaged through meetings and letters with a number of municipal, local and sub-national stakeholders to source the relevant energy consumption data focusing on the large carbon emitters within the municipal area. Supply and demand-side data were therefore collected and analyzed. The various sources of energy & other relevant data used in the report are elaborated in Table 2 below:

Table 2: Sources of the data used for GHG emission estimation

Fuel Type	Sector	Source of Data
Electricity	Residential	Maharashtra State Electricity Distribution Company Limited (MSEDCL)
	Commercial/Institutional	MSEDCL
	Manufacturing Industry and Construction	MSEDCL
	Municipal Buildings	Electrical department, TMC
	Water works department – Water treatment plant and pumping stations	Electrical Department, TMC
	Drainage department – drainage pumping stations and sewage treatment plants	Electrical Department, TMC
	Street lights	Electrical Department, TMC
Diesel	Community Transport	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Manufacturing Industry and Construction	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Municipal Vehicles	Workshop Department TMC
Petrol	Community Transport	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Manufacturing Industry and Construction	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Municipal Vehicles	Workshop Department TMC
LPG	Residential	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Commercial/Institutional	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
	Auto LPG – Transportation	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
Kerosene	Residential	District Supply Office, Thane District
PNG	Residential	Mahanagar Gas Limited
	Commercial	Mahanagar Gas Limited
	Industrial	Mahanagar Gas Limited
CNG	Residential	Mahanagar Gas Limited
	Commercial	Mahanagar Gas Limited
	Industrial	Mahanagar Gas Limited
Furnace Oil	Manufacturing Industry and Construction	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
Light Diesel Oil	Manufacturing Industry and Construction	HPCL- Mumbai, IOCL- Mumbai, BPCL-Mumbai
Transport Sector		Regional Transport Office (RTO) –Thane
Solid Waste Management		Solid Waste Management Department, TMC

Municipal Water Supply	Water Supply Department, TMC
Municipal Wastewater treatment	Sewerage Management Department, TMC
Municipal Street Lighting	Electrical Department- TMC

2.1.4 Economy-wide Trend of Energy Consumption and GHG Emissions

Economy-wide analysis of the data collected for GHG emissions inventory led to determining the average growth or decline in energy consumption and GHG emissions from different sectors, classified based on their activities within the boundaries of the city under study. Table 3 presents the energy consumption by different sectors of Thane city between the years 2013-14 and 2017-18. Thane's total energy consumption stood at 13,063,502.86 Gigajoule (GJ) during the baseline year 2017-18.

Table 3: Sector-wise trend of Energy Consumption in Thane

Sector	Annual Energy Consumption in Giga Joule (GJ)				
	2013-14	**2014-15**	**2015-16**	**2016-17**	**2017-18**
Residential Buildings	5,277,116.68	5,502,298.64	5,631,291.41	5,716,663.92	6,146,579.29
Commercial and Institutional buildings/facilities	1,309,671.18	1,338,626.64	1,465,347.50 0	1,570,059.21	1,694,386.23
Manufacturing Industries and Construction	1,274,047.87	1,242,117.38	1,288,298.56	1,234,373.42	1,205,759.10
Agriculture, forestry and fishing activities	-	-	-	-	-
Transport	2,827,348.03	3,197,426.4	3,489,401.9	3,860,651.0	4,016,778.2
Total	**10,688,183.76**	**11,280,469.05**	**11,874,339.36**	**12,381,747.58**	**13,063,502.8**

Note: No energy consumption is observed in the GPC sector - Agriculture, forestry and fishing activities and hence it is not included in the table

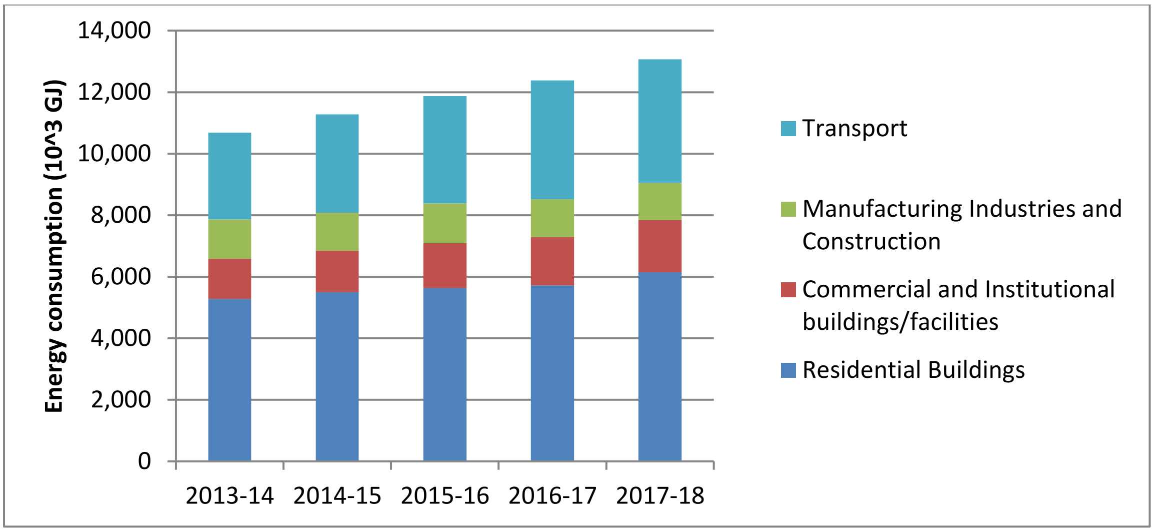

Figure 2: Trend of Energy Consumption in Thane from 2013-14 to 2017-18

From Figure 2 above it is evident that energy consumption in city is gradually increasing every year at an average annual growth rate (AAGR) of 4.5%. The highest growth rate is witnessed in the Transportation sector, with energy use rising at an AAGR of 8.4%, followed by the Commercial and Institutional sector (AAGR of 6.0%) and the Residential sector (AAGR of 3.3%).

The overall GHG emissions from various sectors across the city's community has been estimated based on the data collected and is presented in Table 4 below. The total GHG emission for Thane city in the year 2017-18 stands at 2.29 million tonnes of CO_2equivalent (tCO_2e), translating to per capita emission of 1.02 tCO_2e.

Table 4: Sector-wise trend of GHG Emissions in Thane

Sector	Annual GHG emissions (tonnes of CO2e)				
	2013-14	2014-15	2015-16	2016-17	2017-18
Residential Buildings	852,457.6	902,210.8	942,040.9	931,586.4	989,819.6
Commercial and Institutional buildings/facilities	262,678.9	266,247.8	277,968.3	293,019.7	325,851.3
Manufacturing Industries and Construction	279,105.4	264,099.0	270,763.9	255,593.9	250,144.7
Transport	234,302.9	261,160.4	283,159.0	312,256.9	326,057.3
Waste	358,144.9	367,175.8	380,152.8	385,650.9	399,420.9
Total	**1,986,689.8**	**2,060,893.8**	**2,154,084.9**	**2,178,107.8**	**2,291,293.7**

Note: No energy consumption and thereby GHG emission is observed in the GPC sector - Agriculture, forestry and fishing activities and hence it is not included in the table

Gas-wise emissions (CO_2, CH_4 and N_2O) along with notation keys for sectors and sources not considered in the inventory for the base year are available in a summary table in section 3 of this report.

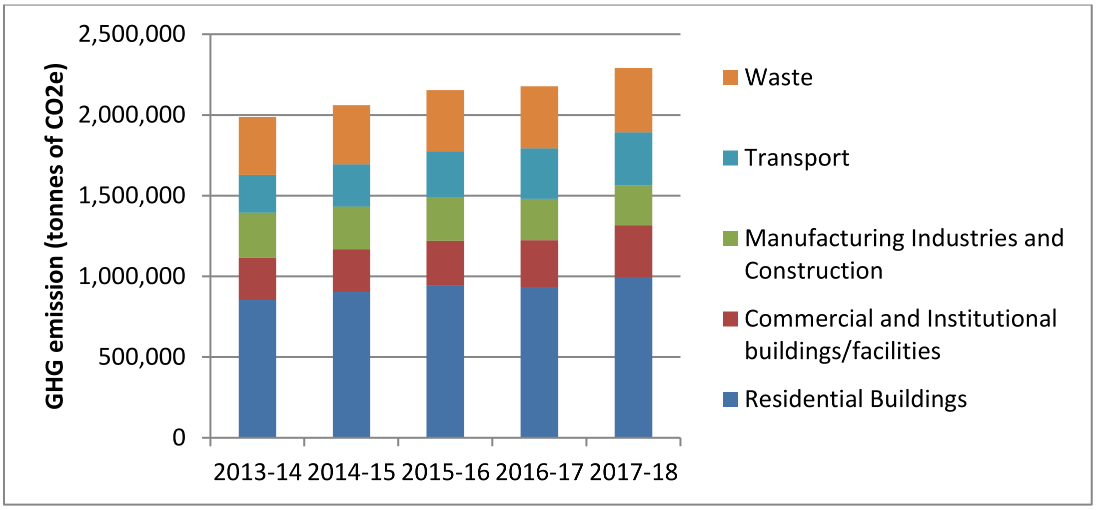

Figure 3 : Trend of GHG Emissions in Thane from 2013-14 to 2017-18

It is evident from Figure 3 above that the GHG emissions from city are on a linear rise with an AAGR of 3.1% from 2013-14 to 2017-18. The Transport sector showed the highest growth rate for GHG emissions, with an AAGR of 7.8%. GHG emissions from Waste and Commercial/Institutional sectors grew at AAGR of 2.3% and 4.8% respectively while the Residential sector registered an AAGR of 3.2%.

It is also noticed that the emissions from the Industrial sector are seeing a decline because most of the industries have either moved out of the city due to higher operational expenses or are switching to cleaner fuels such as piped natural gas. The operation of these industries varies with market demand, hence a variation is observed in their electricity and PNG demand. It was observed that very few (one to two) industries still require furnace oil to meet their energy demand.

2.1.5 Baseline Energy Consumption and Emissions

The baseline year is considered as a historical point for comparison of past and current available data. This anchor point helps in tracking the energy and emission reduction targets set forth by the action plans. The baseline year for Thane's GHG inventory is considered to be 2017-18 given that it is the latest year wherein requisite information was documented and available across all sectors. To align with the general accounting principle adopted by the local government and data sources, emissions are accounted on a financial year basis. Data has been collected for last five years to understand the trend of energy consumption and GHG emissions.

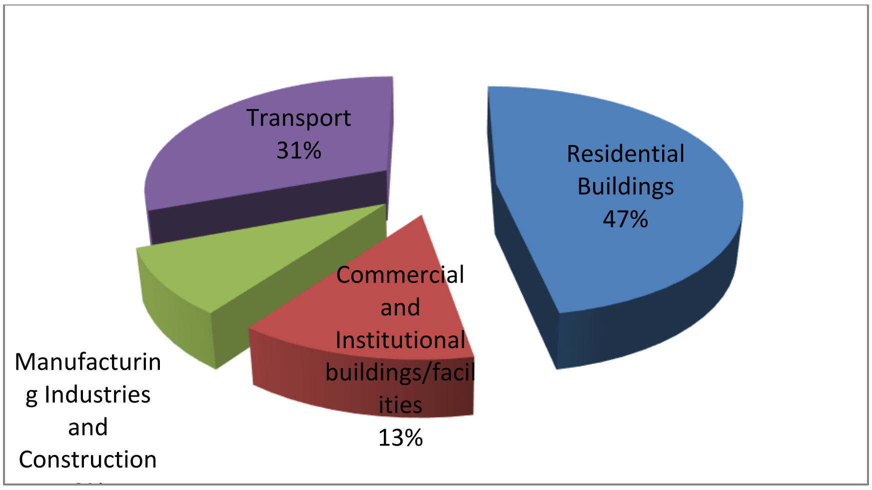

Figure 4: Sector-wise Energy Consumption in Thane in Baseline Year 2017-18

The Residential sector is observed to be the largest consumer of energy in Thane accounting for nearly half of the city's energy consumption in 2017-18, followed by Transportation sector with a share of 31%. Commercial and Institutional sector consumes 13% of the city's total energy while the Manufacturing Industries and Construction sector consumes the least i.e. 9%.

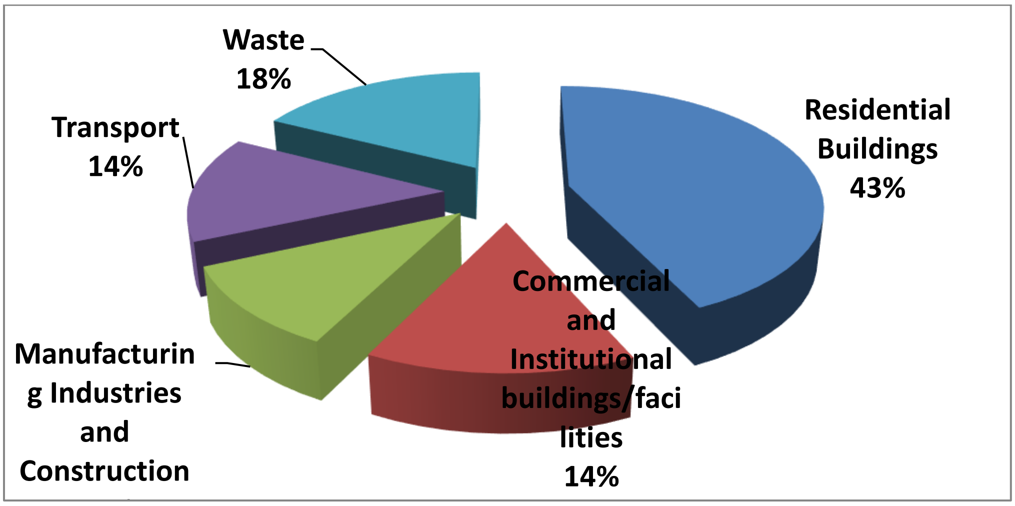

Figure 5: Sector-wise GHG Emission in Thane City in Baseline Year 2017-18

Thane, aptly known as the dormitory city of Mumbai, has a considerable residential population which contributed to 43% of the city's GHG emission in 2017-18 as seen in Figure 5, mirroring the Residential sector's share in the city's energy consumption. GHG emissions from the Waste sector, including from solid waste and wastewater, accounted for about 18% of Thane's city-wide emissions while the Commercial/Institutional sector contributed to 14% of emissions. Industrial and Transport sectors contribute 11% and 14% respectively to the total GHG emissions.

2.1.6 Supply Side Energy Consumption and Emissions

Primary and secondary energy sources that cater to energy demand of end-use sectors are referred to as supply-side sources. These include liquid, solid and gaseous fuels, electricity and any renewable energy sources. Demand side refers to energy end users i.e. sectors like residential, commercial, industrial etc. within an urban jurisdiction. Grid indirect electricity is unarguably the highest contributor of energy as well as GHG emissions in Thane. While other liquid and gaseous fuels cater to a considerable extent of the city's energy demand as evident from the Figure 6 below.

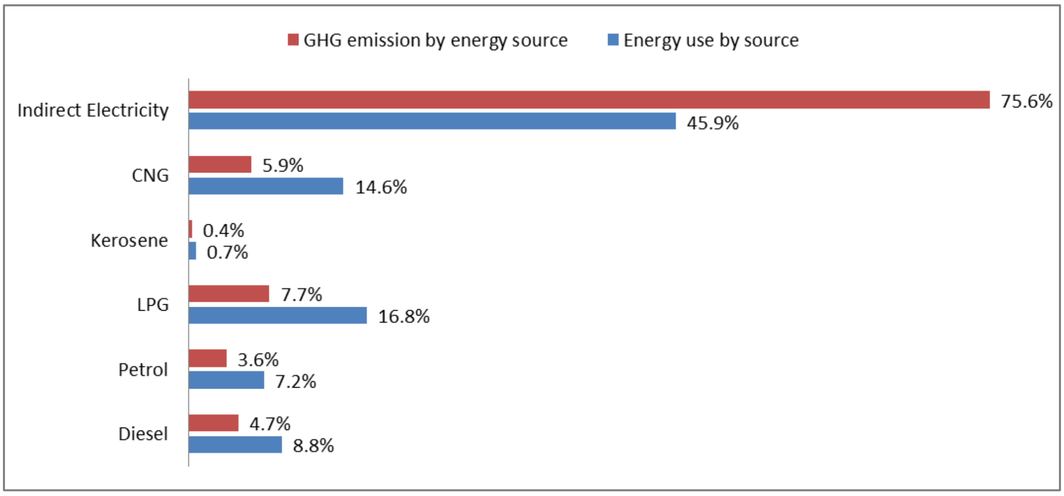

Figure 6: Share of Energy Use and GHG Emission by Energy Sources, 2017-18

Electricity contributes 45.9% of energy consumption in Thane while results in 75.6% of GHG emissions. Liquefied petroleum gas (LPG) contributes to 16.8% of energy use and CNG accounts for 14.6%. Petrol, diesel and LPG are key energy sources used in the city's transport.

2.1.7 Energy Indirect Emissions from Grid Electricity at Community Level

2.1.7.1 Sector-wise Grid Electricity Consumption in Thane City:

At the community level, electricity is considered to be most convenient and readily available source of energy. Electricity is extensively used in residential, commercial, industrial sectors. An increasing is seen in the electricity consumption across different sectors over the years in Figure 7 below. The total electricity consumption grew from 1,509.28 million kWh in 2013-14 to 1,677.01 million kWh in 2017-18. However, the reduction in demand in year 2016-17 is considerable and against the perceived trend. While a slight reduction in electricity consumption is observed in 2016-17, it is primarily due to a drive by the power distribution company to cut off illegal/faulty and defunct power connections across all different consumer categories. Electricity consumption in the industrial sector has shown a decreasing trend as many industries are moving out of city.

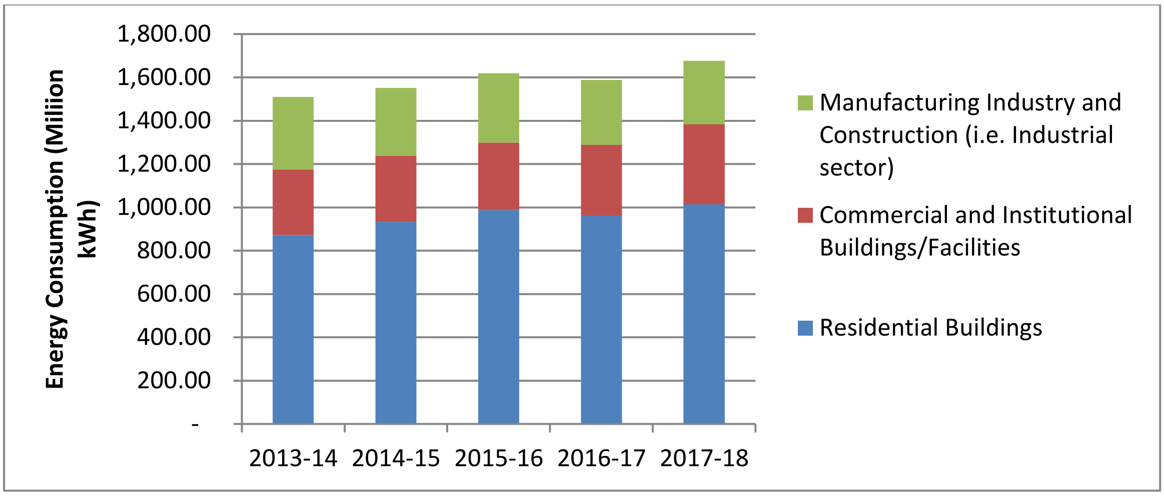

Figure 7: Trend of Sector-wise Grid Electricity Consumption

GHG emissions resulting from electricity consumption across different sectors from 2013-14 to 2017-18 are depicted in Figure 8. Emissions exhibit a similar trend as that of energy consumption.

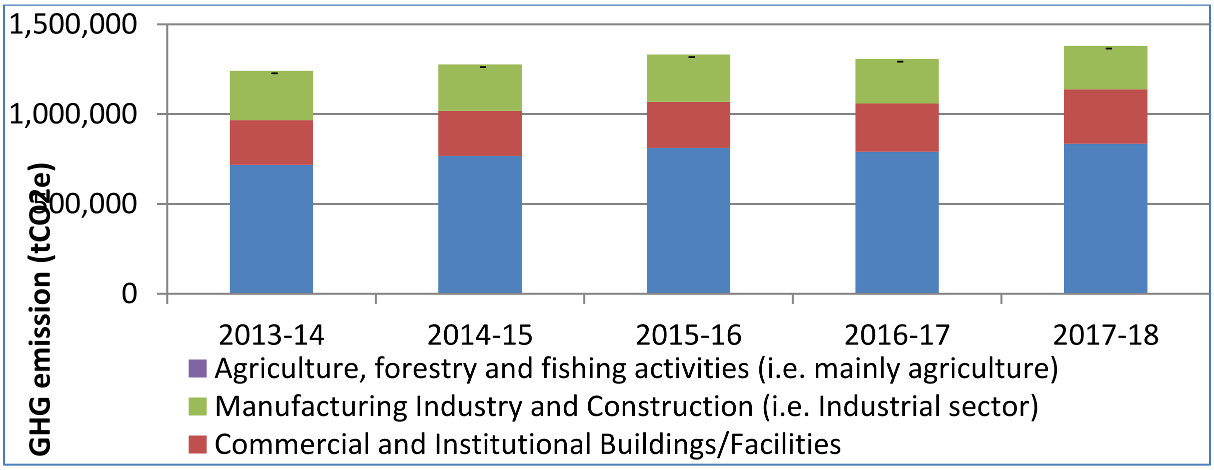

Figure 8: Trend of GHG Emissions from Grid Electricity Consumption

2.1.8 Direct Emission from Stationary Combustion at Community Level

Direct emission from stationary combustion refers to the emissions from the intentional oxidation of fuels within a stationary apparatus that is designed for producing heat or mechanical work in a process (e.g. burning of kerosene and LPG for residential use, furnace oil for industries). It does not include fuel used for transportation. The quantity of direct GHG emission for stationary combustion depends on the volume and type of fuels used across sectors such as residential, commercial/institutional and industrial. It is estimated by multiplying the fuel consumption by the GHG emission factor for the specific fuel.

2.1.8.1 Residential Buildings

LPG, piped natural gas (PNG), and kerosene are the fuels used in Thane's households. While most residential end-users are now opting for PNG supply due to its availability and affordability, a considerable number of residents in the city are still using LPG. Kerosene is used by low income dwellers who cannot afford LPG. Recent government norms and regulations are discouraging kerosene use.

PNG is supplied by a single government institution, the Mahanagar Gas Limited (MGL). LPG is supplied as domestic and non-domestic cylinders by oil marketing companies (OMCs). In Figure 9, LPG and PNG consumption has risen in the city with new users and connections sought in bulk for new residential buildings while kerosene consumption is declining.

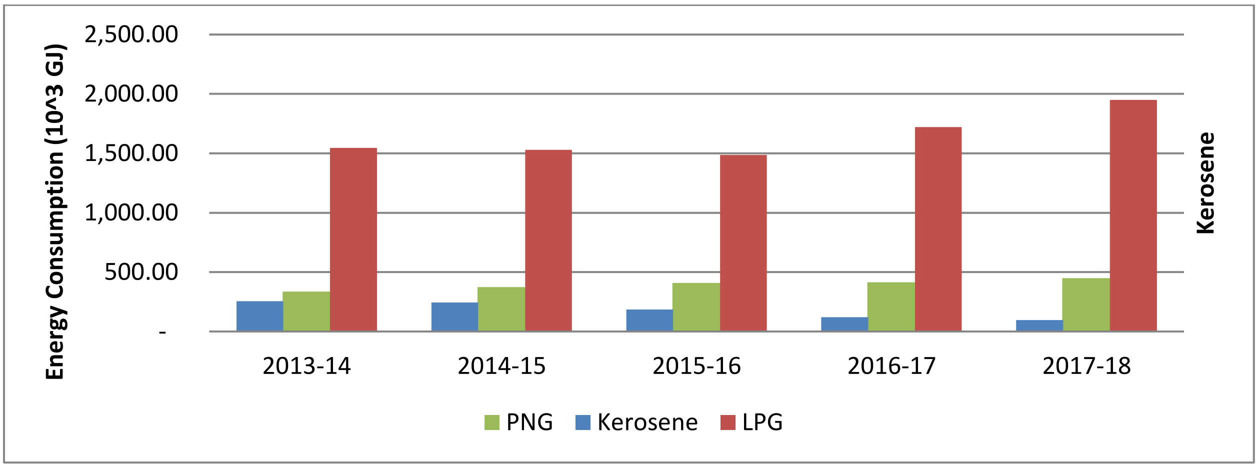

Figure 9: Trend of Energy Consumption for Residential Sector

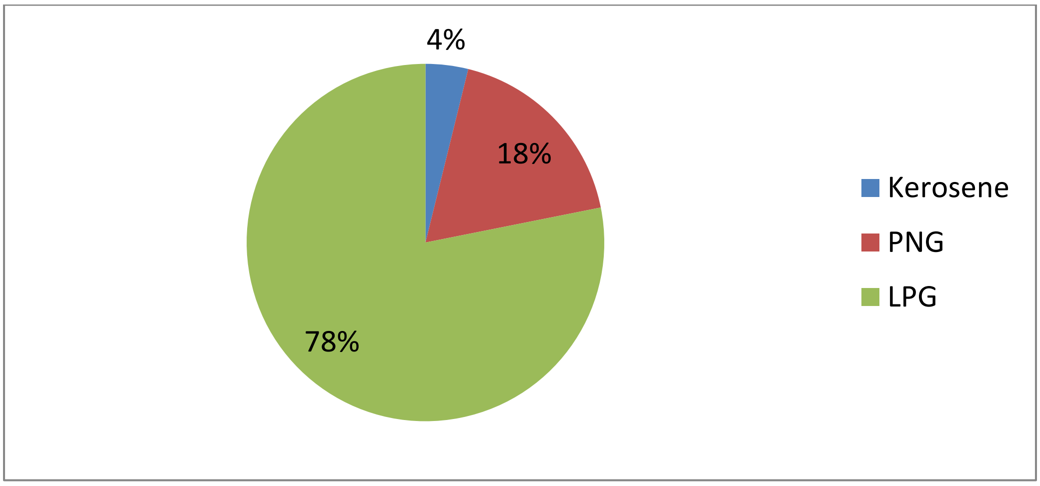

Figure 10: Share of GHG emissions from Stationary Fuel Consumption in Residential Sector

LPG results in 78% of the residential stationary GHG emissions followed by PNG (18%) and kerosene (4%). With increase in its piped network, PNG has emerged as convenient and cleaner fuel to cater to energy demand, primarily for cooking in households. However, LPG is the dominant fuel used in residences and contributes to nearly four-fifth of stationary GHG emissions therein.

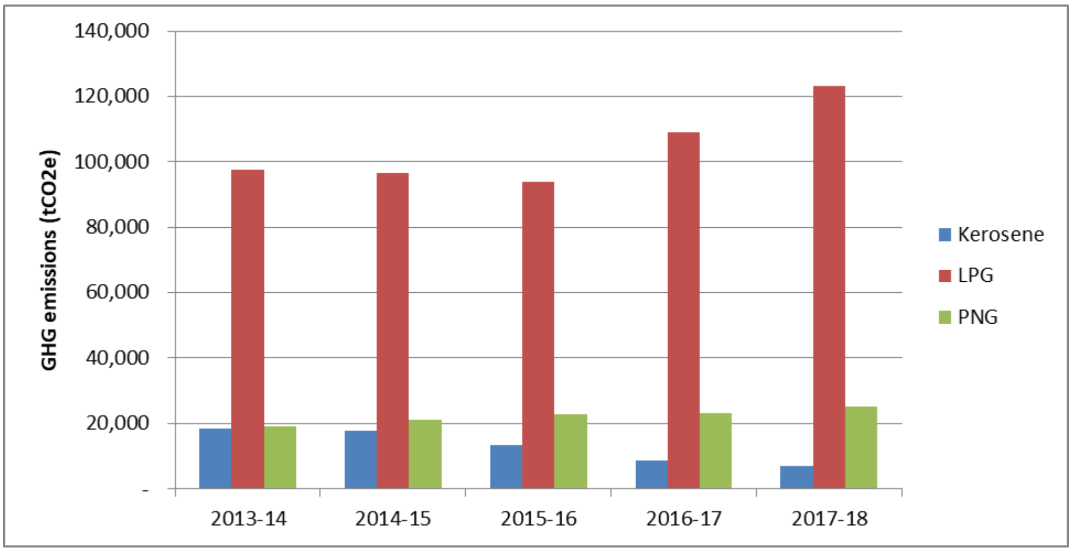

Figure 11: Trend of GHG Emissions from Stationary Fuel Consumption in Residential Sector

2.1.8.2 Commercial and Institutional Building/Facilities

LPG and PNG are the main fuels used in Thane's commercial and institutional buildings such as hotels, malls, restaurants, educational institutions, and office buildings. During the year 2017-18, LPG consumption in commercial sector stood at 5,487.5 metric tonnes (MT) while PNG consumption stood at 3,187,357 standard cubic meters (SCM).

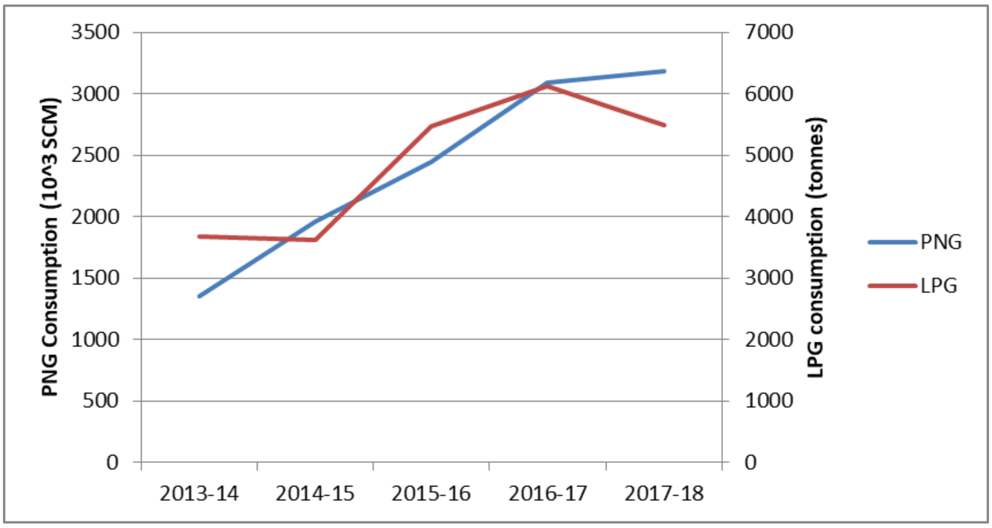

Figure 12: Trend of PNG and LPG Consumption in Commercial/Institutional Sector

It is to be noted that the commercial LPG consumption shows a decline in demand in year 2017-18. The LPG data is accounted by fuel supply companies under two categories (i.e. domestic and non-domestic sales), hence the data for commercial sector consumption comprises of commercial as well as industrial consumption. LPG consumption trend in Figure 12 also reflects industrial output based on market demand. PNG consumption has witnessed a rising trend and its commercial viability has improved over the years. GHG emissions from LPG consumption are higher in the Commercial/Institutional sector, given the higher number of LPG users as compared to that of PNG as well as inclusion of industrial sector consumption in accounting of LPG sales.

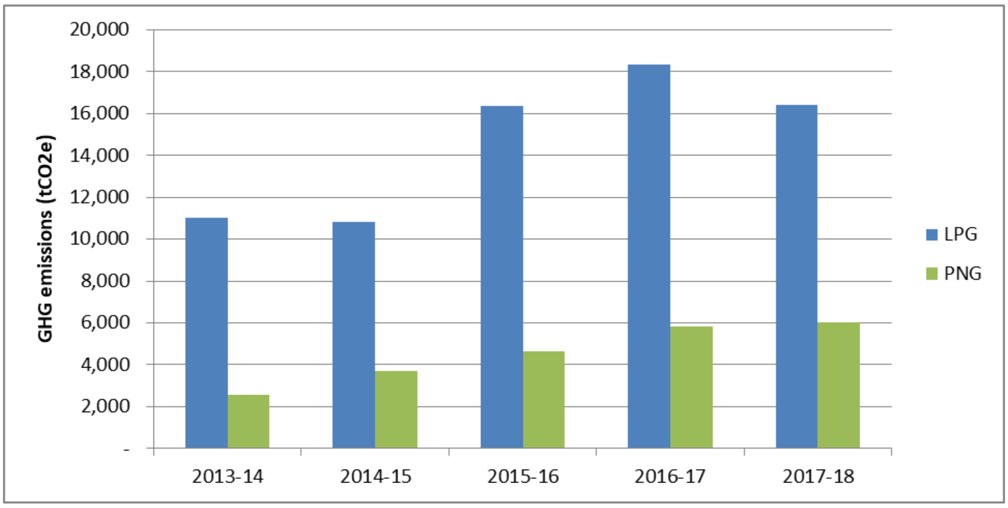

Figure 13: Trend of GHG Emission in Commercial/Institutional Sector

2.1.8.3 Manufacturing Industries and Construction Sector

In Thane, most of industries are using PNG fuel to cater to their stationary energy demand.

During data collection, oil marketing companies have indicated that there are only one to two industries in the city which use fuel oil and furnace oil as fuel. The furnace oil consumption data in these industries is not available since the demand is intermittent. Furthermore, LPG consumption is accounted under the Commercial sector since disaggregated records of LPG sales figures for the industrial sector are not available. Data providers have also noted LPG consumption is not as significant in the industrial sector. Trend of PNG consumption, as seen in Figure 14, depicts that its consumption has increased from 2013-14 to 2017-18. The increase in consumption has slowed down since 2015-16 and decreased in 2017-18, due to variation in industrial market demand and relocation of industries to other areas outside the city.

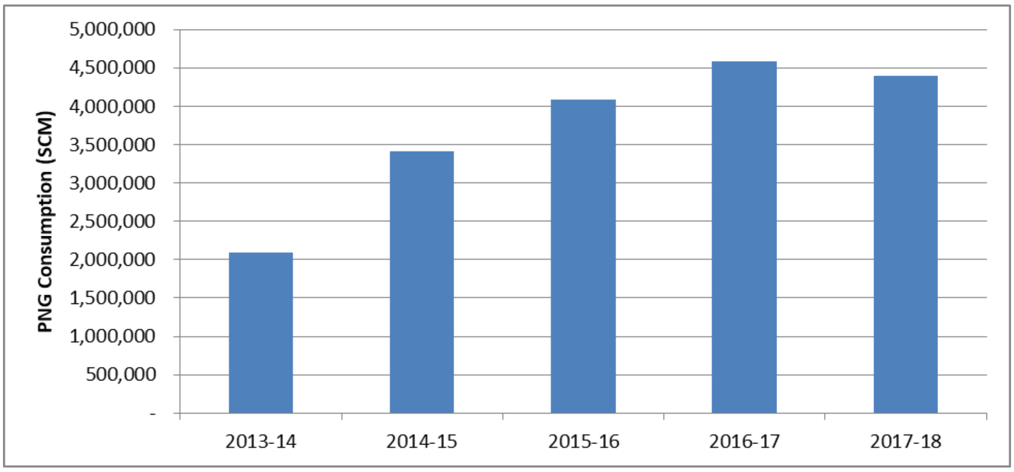

Figure 14: Trend of PNG Consumption in Industrial Sector

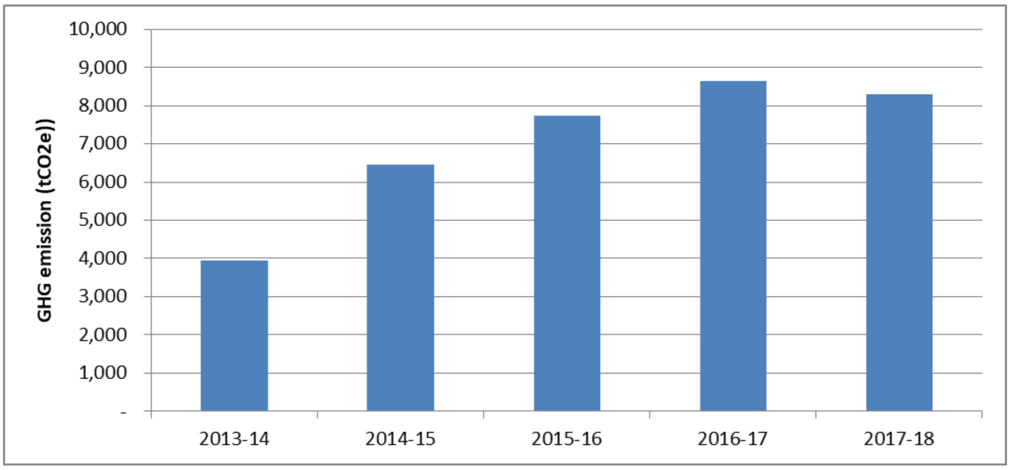

Figure 15: Trend of GHG emissions from PNG Consumption in Industrial Sector

2.1.9 Direct Emission from Transport at the Community Level

Petrol, Diesel and CNG are the three main fuels used in on-road transport in the city. As seen in Figure 16, consumption of all three fuels shows a rising trend, driven by Thane's rising vehicle population and demographic growth.

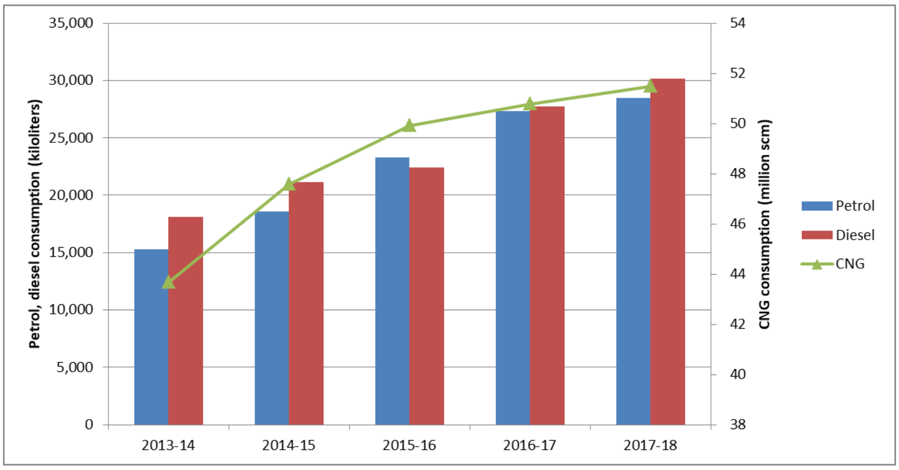

Figure 16: Trend of Fuel Consumption in Transport Sector

Transport sector contributed to GHG emissions of 326,041.79 tCO_2e in 2017-18 in Thane including rail emissions from both sub-urban and long distance trains. Use of

CNG, which is relatively cleaner compared to diesel and petrol, has increased in the city. This is reflected in the higher share of transport related GHG emissions from CNG (33%), compared with that of petrol (20%), diesel (26%) and railways (21%). The sub-urban railways within Thane uses electricity as an energy source where as long distance trains uses mix of electricity and diesel.

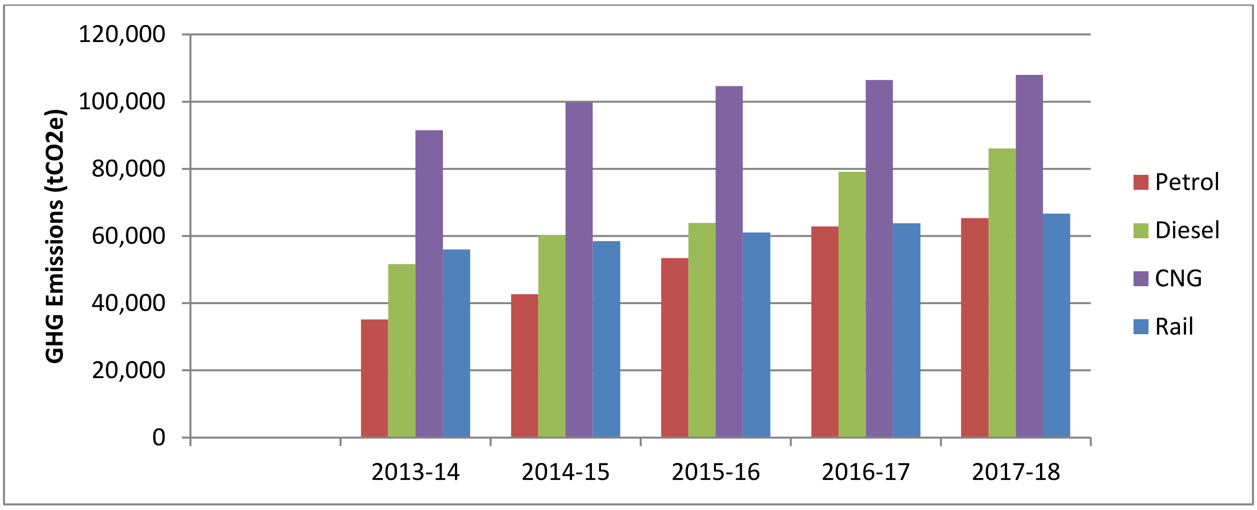

Figure 17: Trend of GHG Emissions from Fuel Consumption in Transport Sector

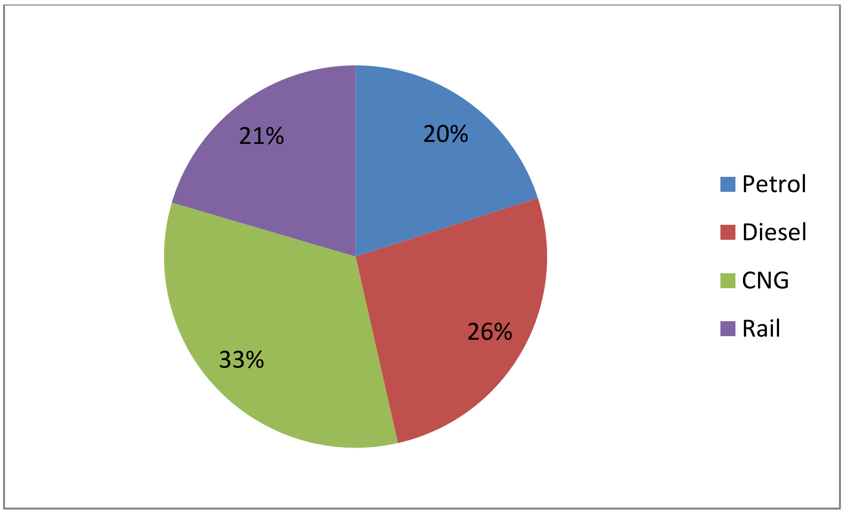

Figure 18: Share of GHG Emissions in Transportation Sector, 2017-18

2.1.10 Direct Emission from Waste at the Community Level

2.1.10.1 Solid Waste

Municipal solid waste (MSW) consists of biodegradable organic matter, partially degradable matter and non-degradable materials. GHG emissions from anaerobic decomposition of bio-degradable matter present in the municipal solid waste, from treatment facilities and methane (CH_4) emissions from solid waste disposal sites are major sources of GHG emissions in the waste sector. The direct GHG emissions from solid waste can be estimated based on parameters such as the solid waste generation, its composition, type of technology used for treatment and management of the landfill site.

In order to estimate the GHG emissions from solid waste management as per the 2006 IPCC Guidelines and GPC, the condition of landfill has been considered as wet for Thane city. The city receives an annual rainfall between 2500 to 4500 mm which is more than the 1000 mm, a consideration for wet landfill as per IPCC guidelines. Further for emission estimation, given that the city's disposal site is not a scientific landfill, the type of disposal site applicable is unmanaged disposal site, with a depth greater than 5m.

With rising population, the solid waste generation in city is rising considerably. Thane generated about 950 TPD of municipal solid waste in year 2017-18. In order to manage the waste, TMC is undertaking initiatives such as installation of bio-methanation plant, waste to energy plant, which has led to increased processing of MSW. TMC also has operational plants/facilities that generate bio-CNG from animal carcass. Presently, the waste is being dumped at disposal site located at Diaghar. TMC is looking at new options for scientific disposal of MSW with improvements in waste management practices.

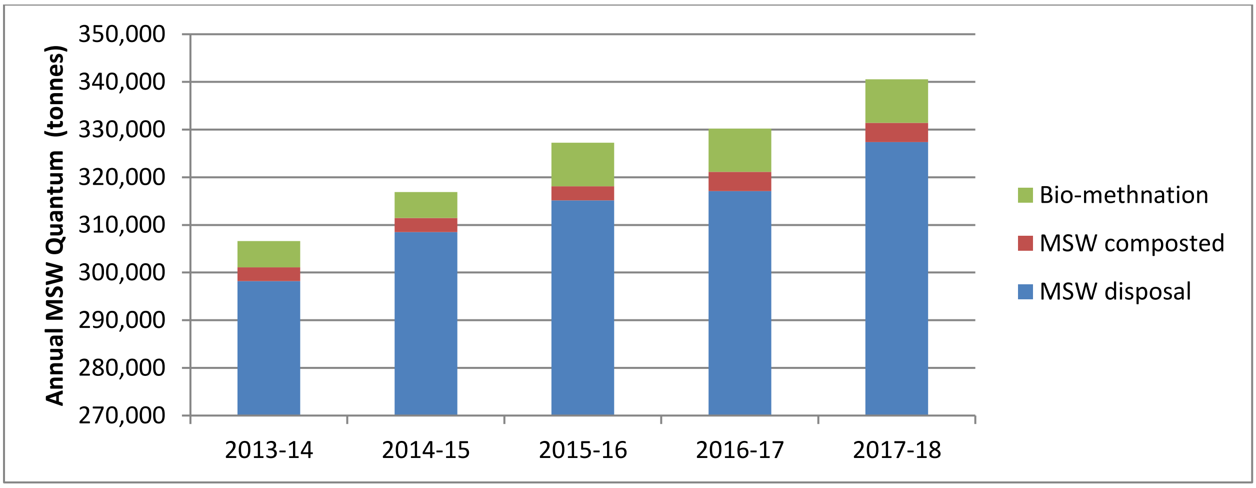

Figure 19: Trend of Annual Municipal Solid Waste Processing and Disposal

The total GHG emissions from solid waste management in Thane in 2017-18 amount to 331,263tCO_2e. MSW disposal is the major source with emissions of 330,392 tCO_2e in 2017-18. Emissions from composting of MSW stood at 689 tCO_2e and from treatment of MSW in waste to energy facilities amounted to 183 in the base year. Augmenting waste processing capacity further can help reduce MSW disposal related emissions.

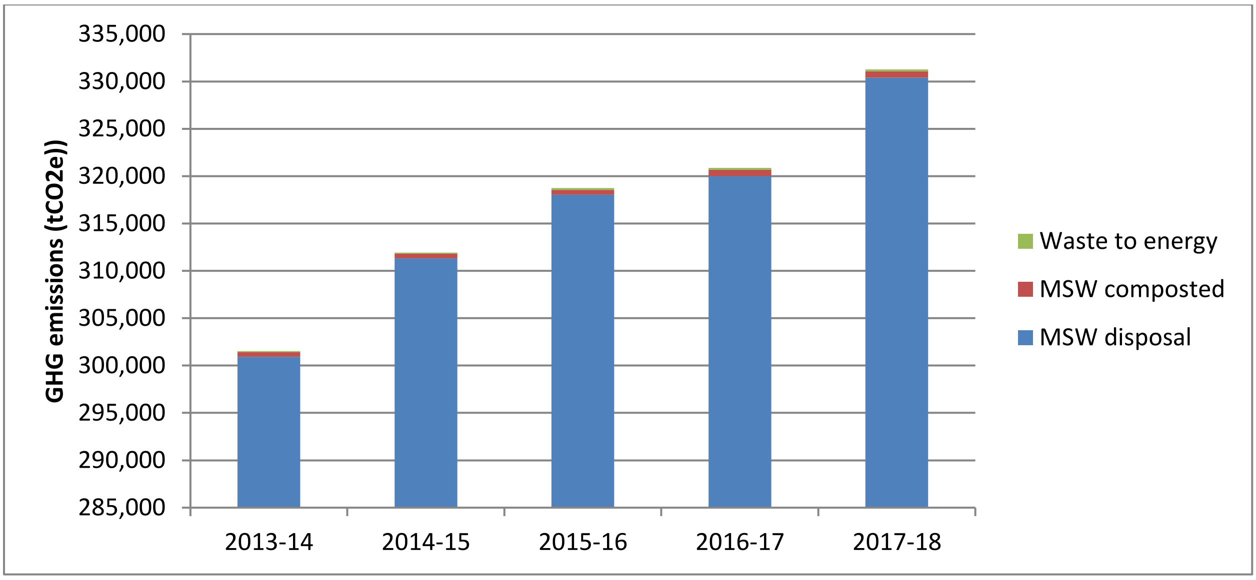

Figure 20: Trend of GHG Emissions from Solid Waste

2.1.10.2 Domestic Waste Water Management and Associated Emissions:

Wastewater from domestic sources generates CH_4 emission on its treatment (on site, sewered to a centralized treatment plant or disposed of untreated into nearby areas or via an outfall) or disposal anaerobically. The extent of CH_4 emission from wastewater depends primarily on the quantity of degradable organic material in the wastewater, the volume of wastewater generated and the type of treatment system. As per 2006 IPCC Guidelines, CH_4 emissions are impacted by the type of treatment system or wastewater discharge pathway being used (such as sewers, septic tanks, latrines, centralized treatment plants, and direct discharge to sea, lake or river) and its corresponding methane generation potential, and the proportion of the resident population that uses these different wastewater treatment/discharge pathways or systems.

The total wastewater generated in Thane city is estimated to be 345 MLD in 2017-18. The city currently has two wastewater treatment facilities and few private STPs with actual treatment of about 82 MLD. About 46% of the city's households were connected to sewer network in 2017-18. About 38% population used septic tanks for wastewater discharge and 0.65% of the population used pit latrines in the base year. Based on the data received from TMC's Sewerage Management department, the Biochemical oxygen demand (BOD) value of the city's wastewater is about 100 g/L.

GHG emissions associated with wastewater discharge and treatment in Thane are estimated to be 68,158 tCO_2e in 2017-18. With a significant portion of the population dependent on septic tanks, these are the largest source of wastewater emissions, given their high CH4 generation potential. Emissions from septic tanks have reduced due to increased sewer network coverage and thereby reduced dependency on septic tanks. GHG emissions from wastewater that is neither collected through the sewer network nor treated due to inadequacy of treatment capacity are also significant in the city.

Table 5: GHG Emissions from Waste Water Treatment in Thane

Treatment/ discharge pathway or system	2013-14	2014-15	2015-16	2016-17	2017-18
Sewer (collected and aerobic treatment, not well managed)	1,885	5,051	7,576	7,576	7,744
Sewer (collected and not treated)	-	1,065	9,505	10,332	11,979
Others/ None (Sea Lake or river discharge without treatment) -	6,525	4,099	1,836	1,680	1,529
Septic system - Uncollected	22,817	20,345	16,901	18,661	19,411
Latrine - Uncollected	106	92	74	75	76
Domestic wastewater N_2O emissions	25,272	24,580	25,523	26,469	27,418
Total	56,605.90	55,232.16	61,414.95	64,792.64	68,157.96

2.2 Emissions from Municipal Operations and Facilities:

2.2.1 Sector-wise Energy Consumption and GHG Emissions from Municipal Buildings and Facilities:

TMC is responsible for provision of civic infrastructure services such as water supply, sanitation, street lighting and solid waste management while also undertaking key roles in administration and monitoring of these services. Energy is consumed for these purposes and leads to direct and indirect GHG emission. Water supply and water treatment plants (WTPs), sewage treatment plants (STPs) and street lighting facilities consume electricity for their day-to-day operation. Likewise, electricity is required to power municipal buildings and facilities such as offices, hospitals, auditoriums, gardens etc. Fuel is also consumed by the vehicle fleet of the municipal government.

Table 6: Break-up of Energy Consumption in Municipal Buildings and Facilities

Emission Source	Service/Facility	2013-14	2014-15	2015-16	2016-17	2017-18
Buildings	Administrative, Healthcare and Community Buildings	207,218	207,218	214,847	194,233	318,479
Facilities	**Waste Water Treatment**	10,109	10,109	8,968	7,513	6,415
	Water Supply	140,904	140,900	136,400	132,196	151,258
	Street Lighting	91,660	91,660	88,124	85,932	77,461
	Crematorium	-	26,486	35,589	31,641	62,216
Transport	Municipal vehicles	225,411	259,278	293,144	334,444	360,308
Total		675,302	735,651	777,072	785,959	976,138

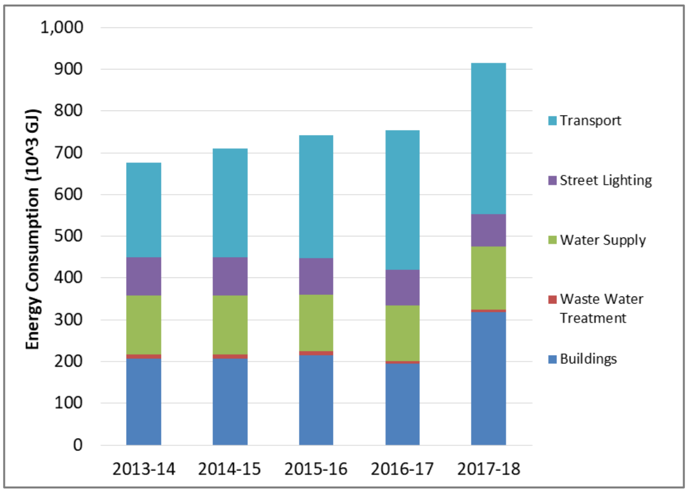

Figure 21: Trend of Energy Consumption in Municipal Buildings and Facilities

Energy consumption in TMC's operations and facilities grew at AAGR of 8.9% from 2013-14 to 2017-18. Energy consumption has risen due to the addition of new buildings and facilities. A declining trend is observed in energy consumption in TMC owned buildings until 2016-17, owing to measures for energy conservation resulting from renewable energy and energy efficiency interventions undertaken therein. The municipal vehicle fleet is the largest energy consumer, accounting for 36.9% of TMC's total energy use, followed by buildings (share of 32.6%). Water supply and street lighting contribute to 15.5% and 6.4% of energy consumption respectively.

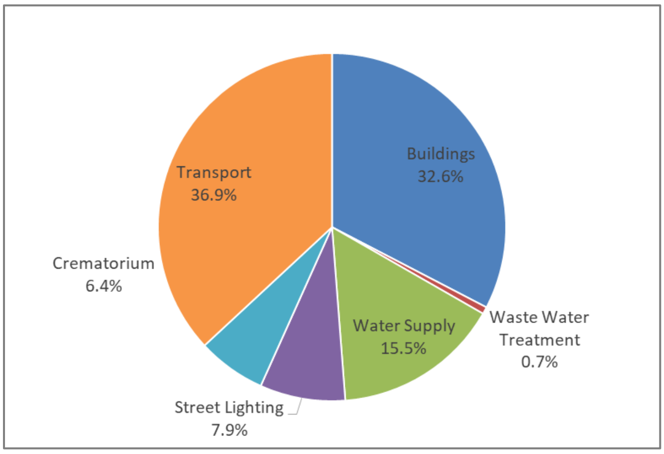

Figure 22: Break-up of Energy Consumption in Municipal Buildings and Facilities in 2017-18

The total GHG emissions from municipal buildings, facilities and transport for the year 2017-18 are estimated to be 151,909 tCO_2e. Emissions resulting from municipal operations have increased at an AAGR of 5% from 2013-14 to 2017-18. Municipal buildings contributed to 47.8% of total municipal emissions in 2017-18, followed by water supply facilities (22.8%), transport (16.7%) and streetlights (11.7%).

Table 7: Break-up of GHG Emissions from Municipal Operations

Emission Source	Service/Facility	2013-14	2014-15	2015-16	2016-17	2017-18
Buildings	Administrative, Healthcare and Community Buildings	47,310	47,310	49,043	44,301	72,646
Facilities	Waste Water Treatment	2,310	2,310	2,050	1,717	1,466
	Water Supply	32,204	32,203	31,174	30,213	34,570
	Street Lighting	20,949	20,949	20,141	19,640	17,704
	Crematorium	-	109	118	106	96
Transport	Municipal vehicles	16,284	18,579	20,875	23,756	25,426
	Total	**119,057**	**121,460**	**123,400**	**119,734**	**151,909**

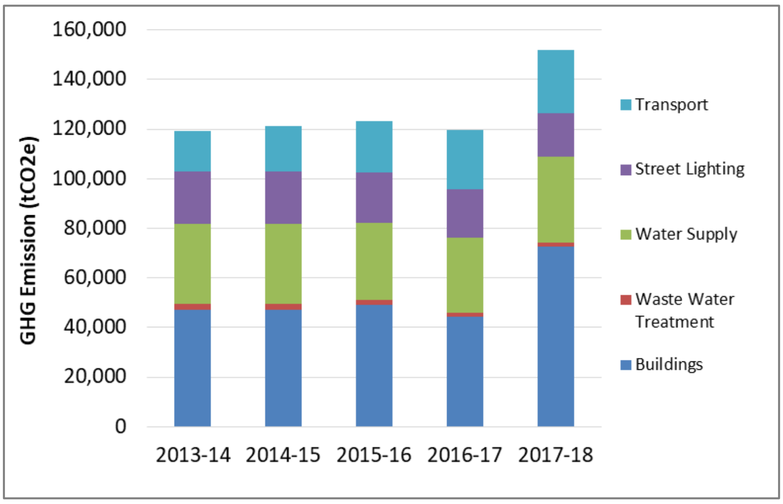

Figure 23: Trend of GHG Emissions from Municipal Buildings and Facilities

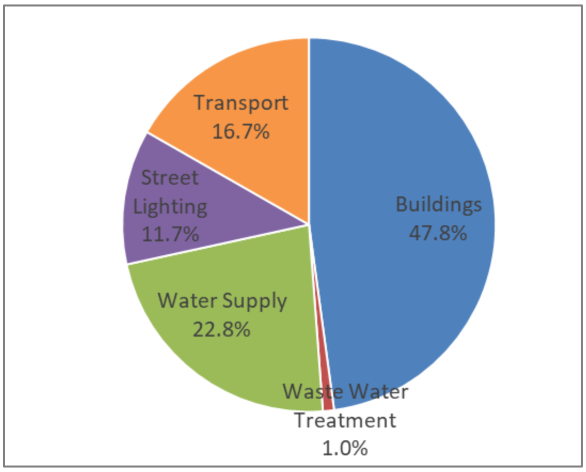

Figure 24: Breakup of GHG Emissions in Municipal Buildings and Facilities in 2017-18

2.2.1.1 Electricity Consumption by Municipal Buildings and Facilities:

TMC consumes grid electricity for its municipal operations and facilities. The key consumers of electricity include administrative buildings (including crematoria), water treatment and supply facilities, wastewater treatment facilities, and streetlights. Municipal buildings are a key consumer of grid electricity in TMC operations, having a major share over the years, followed by water supply and treatment facilities. In 2017-18, buildings accounted for 57% of TMC's total electricity consumption, with water supply contributing to 27% of electricity demand. A reduction is observed in street light energy consumption and GHG emissions since TMC has implemented a city-wide LED streetlight retrofitting project.

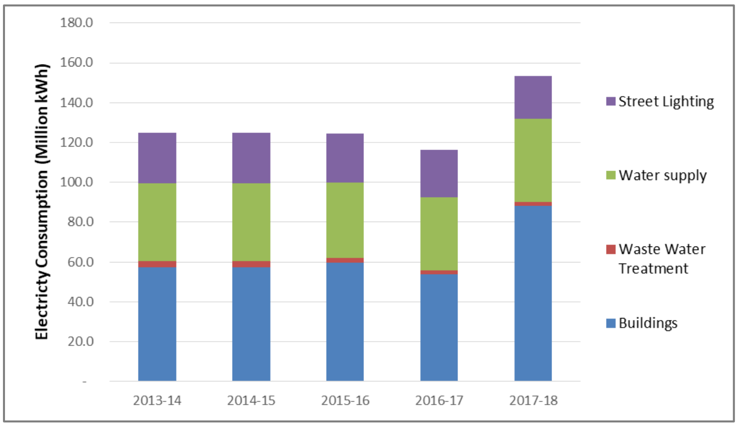

Figure 25: Trend of Electricity Consumption in Municipal Buildings and Facilities

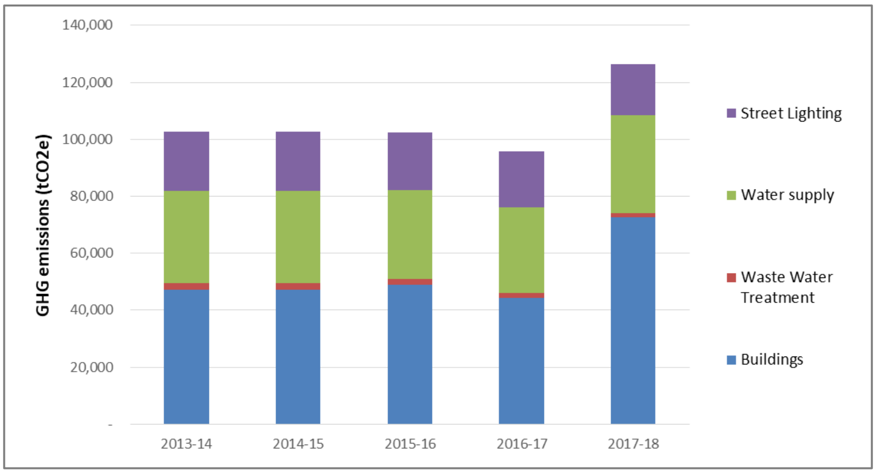

Figure 26: GHG Emissions from Electricity Consumption in Municipal Buildings and Facilities

2.2.1.2 Fuel Consumption and GHG emissions by Municipal Vehicles:

TMC has its own fleet of vehicles used for municipal services as well as a dedicated public transport system in Thane. The vehicles consume petrol, diesel and CNG which is procured from retail pumps. The public bus transport service gets its own dedicated bulk supply from oil marketing companies at their bus depots. The energy consumed by these TMC owned vehicles is represented in Figure 27.

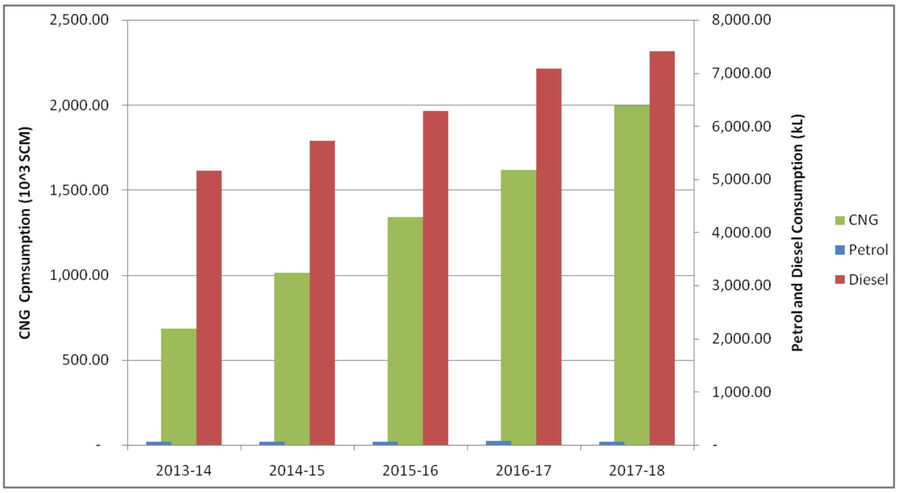

Figure 27: Trend of Energy Consumption by Municipal Vehicles

In year 2017-18, diesel fuel is largest source of emissions in the municipal fleet emission, accounting for 83% of GHG emissions. CNG contributes to 16% of the total emissions from municipal transport. Petrol is consumed in passenger vehicles used by TMC staff for local work related travel.

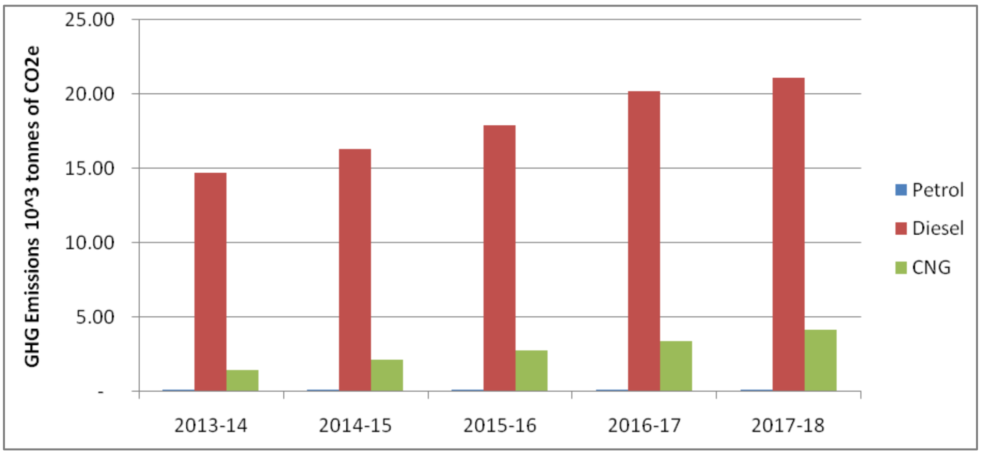

Figure 28: Trend of GHG Emissions from Municipal Vehicles

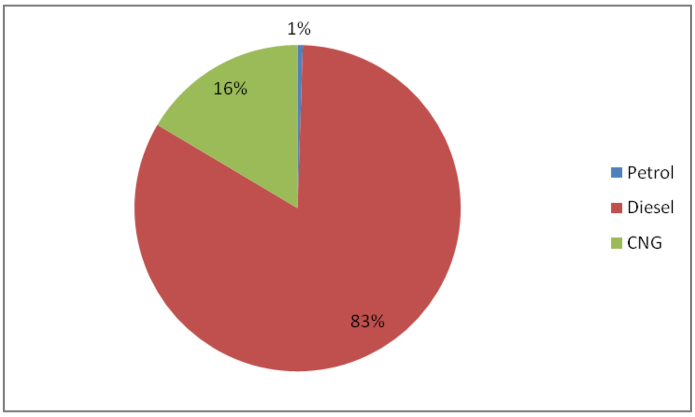

Figure 29: Share of GHG emissions by Fuels in Municipal Vehicles

2.3 Sustainability Indicators for Thane City

.

Table 8: Key Sustainability Indicators for Thane City

Sustainability Indicator	Unit of Measure	Thane (2017 -18)
Energy consumption per capita	GJ/capita	5.83
GHG emission per capita	tCO_2e/capita	1.02
Energy consumption per household	GJ/HH	27.46
GHG emission per household	tCO_2e/HH	4.82
Energy consumption per unit area	GJ/sq. km	101,875.56
GHG emission per unit area	tCO_2e/sq. km	17,868.6

3 GHG emissions inventory summary reporting output

City Information		Data Source
Official name of local government	Thane Municipal Corporation	N/A
Country	India	N/A
Region	South Asia	N/A
Inventory year (specify months covered)	April 2017 to March 2018	N/A
Description of boundary and map	City boundary representing jurisdiction of Thane Municipal Corporation (local government)	
Resident population	1,841,488	Population statistics for 2011 from National Census of India, 2011

Inventory Setup	
GWP (IPCC AR version used)	Fourth Assessment Report, 2007
Types of emissions factors (IPCC or LCA)	IPCC

Emission Sources and Emissions

Sector	Sub-Sector	*Direct (fuel combustion) or Indirect (grid energy) or Other (in separate rows)*	Total tCO_2e or Notation Key	ETS or non-ETS (in separate rows)	Type of Energy	Activity data			Emissions (CO_2 Gas)			Emissions (CH4 Gas)			Emissions (N20 Gas)			Notation keys (if no data to report)	
						Amount	Unit	Data source	Amount	Unit	Method	Amount	Unit	Method	Amount	Unit	Method	Notation key	Explanation
Stationary Energy	Residential	Indirect	834,514	-	Electricity	1,014.26	Million kWh	Electricity supplier	831,690.43	tonnes of CO_2e	Location-based using consumption and national grid emission factor	202.85	tonnes of CO_2e	Location-based using consumption and national grid emission factor	2,621.19	tonnes of CO_2e	Location-based using consumption and national grid emission factor		
		Direct	6,926	-	Kerosene	2,685.00	kiloliters	Public fuel distribution office	6,901.98	tonnes of CO_2e	Fuel consumption	7.20	tonnes of CO_2e	Fuel consumption	17.16	tonnes of CO_2e	Fuel consumption		
		Direct	123,141	-	LPG	41,213.00	tonnes	Fuel/Oil supply companies	123,033.75	tonnes of CO_2e	Fuel consumption	48.75	tonnes of CO_2e	Fuel consumption	58.10	tonnes of CO_2e	Fuel consumption		
		Direct	25,238		PNG	13,376,181.00	cubic metre	Piped gas supplier	25,213.57	tonnes of CO_2e	Fuel consumption	11.24	tonnes of CO_2e	Fuel consumption	13.39	tonnes of CO_2e	Fuel consumption		
	Commercial	Indirect	303,441	-	Electricity	368.80	Million kWh	Electricity supplier	302,414.36	tonnes of CO_2e	Location-based using consumption and national grid emission factor	73.76	tonnes of CO_2e	Location-based using consumption and national grid emission factor	953.10	tonnes of CO_2e	Location-based using consumption and national grid emission factor		
		Direct	16,396	-	LPG	5,487.50	tonnes	Fuel/Oil supply companies	16,381.91	tonnes of CO_2e	Fuel consumption	6.49	tonnes of CO_2e	Fuel consumption	7.74	tonnes of CO_2e	Fuel consumption		
		Direct	6,014		PNG	3,187,357.00	cubic metre	Piped gas supplier	6,008.04	tonnes of CO_2e	Fuel consumption	2.68	tonnes of CO_2e	Fuel consumption	3.19	tonnes of CO_2e	Fuel consumption		
	Institutional	Indirect	IE	-														IE	Included under Commercial sector as no disaggregated data for this sub-sector
		Direct	IE	-														IE	Included under Commercial sector as no disaggregated data for this sub-sector
	Industry	Indirect	241,860	-	Electricity	293.95	Million kWh	Electricity supplier	241,041.90	tonnes of CO_2e	Location-based using consumption and national grid emission factor	58.79	tonnes of CO_2e	Location-based using consumption and national grid emission factor	759.68	tonnes of CO_2e	Location-based using consumption and national grid emission factor		
		Direct	8,284	-	PNG	4,390,665.00	cubic metre	Piped gas supplier	8,276.23	tonnes of CO_2e	Fuel consumption	3.69	tonnes of CO_2e	Fuel consumption	4.40	tonnes of CO_2e	Fuel consumption		
	Agriculture	Indirect	NO	-	-	0.00	-	Electricity supplier	-	-	-	-	-	-	-	-	-	NO	Agriculture activity is not taking place within the city limits. No electricity consumption occuring within city limits as per data from electricity supplier

Emission Sources and Emissions																			
						Activity data			**Emissions (CO_2 Gas)**			**Emissions (CH4 Gas)**			**Emissions (N20 Gas)**			**Notation keys (if no data to report)**	
Sector	**Sub-Sector**	***Direct (fuel combustion) or Indirect (grid energy) or Other (in separate rows)***	**Total tCO_2e or Notation Key**	**ETS or non-ETS (in separate rows)**	**Type of Energy**	**Amount**	**Unit**	**Data source**	**Amount**	**Unit**	**Method**	**Amount**	**Unit**	**Method**	**Amount**	**Unit**	**Method**	**Notation key**	**Explanation**
		Direct	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	Agriculture activity is not taking place within city limits and no corresponding fuel use.
	Fugitive	Direct	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	Activities such as coal and oil extraction & processing leading to fugitive emissions are not occuring within the city limits
Transportation	On-road	Indirect	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No electric transport within the city, hence no significant indirect emissions.
		Direct	65,378	-	Petrol	28,458.00	kiloliters	Fuel/Oil supply companies	65,139.76	tonnes of CO_2e	Fuel Sales method	70.50	tonnes of CO_2e	Fuel Sales method	168.07	tonnes of CO_2e	Fuel Sales method		
		Direct	86,096	-	Diesel	30,193.52	kiloliters	Fuel/Oil supply companies	85,801.98	tonnes of CO_2e	Fuel Sales method	86.84	tonnes of CO_2e	Fuel Sales method	207.04	tonnes of CO_2e	Fuel Sales method		
		Direct	107,947	-	CNG	51,494,443.22	cubic metre	Fuel/Oil supply companies	107,649.67	tonnes of CO_2e	Fuel Sales method	239.86	tonnes of CO_2e	Fuel Sales method	57.18	tonnes of CO_2e	Fuel Sales method		
	Rail	Indirect	58,930	-	Electricity	3,938,467,239.17	passenger-km	Comprehensive Mobility Plan for Thane City, Draft Final Report September 2018; Indian Railways statistics	58,930.13	tonnes of CO_2e	Passenger-km basis	-		Passenger-km basis	-		Passenger-km basis		
		Direct	7,706	-	Fuel (Diesel)	1,149,407,981.57	passenger-km	Comprehensive Mobility Plan for Thane City, Draft Final Report September 2018; Indian Railways statistics	7,706.26	tonnes of CO_2e	Passenger-km basis	-		Passenger-km basis	-		Passenger-km basis		
	Waterborne	Indirect	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No water transport within the city
		Direct	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No water transport within the city
	Aviation	Indirect	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No Airport within the city limits
		Direct	NO	-		-	-	-	-	-	-	-	-	-	-	-	-	NO	No Airport within the city limits
	Off-road	Indirect	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	Electricity consumption for off-road transport is not taking place as these are using conventional fuel engines
		Direct	IE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	IE	Emissions are included in On-road transport, due to unavailability of reliable disaggregated fuel consumption data for off-road vehicles.
Waste	Solid waste disposal	Direct	330,392	N/A	N/A	327,391	tonnes of waste	Solid Waste Department, Thane Municipal Corporation	0.00	tonnes of CO_2e	Methane Commitment method	330,391.77	tonnes of CO_2e	Methane Commitment method	-	tonnes of CO_2e	Methane Commitment method		
	Biological treatment	Direct	689	N/A	N/A	4,015.00	tonnes of waste	Solid Waste Department, Thane Municipal Corporation	0.00	tonnes of CO_2e	Amount of waste composted	401.50	tonnes of CO_2e	Amount of waste composted	287.15	tonnes of CO_2e	Amount of waste composted		
	Biological	Direct	183	N/A	N/A	9,125.00	tonnes of	Solid Waste	0.00	tonnes of	Amount of waste	182.50	tonnes of	Amount of	-	tonnes of	Amount of		

Emission Sources and Emissions

Sector	Sub-Sector	*Direct (fuel combustion) or Indirect (grid energy) or Other (in separate rows)*	Total tCO_2e or Notation Key	ETS or non-ETS (in separate rows)	Type of Energy	Activity data			Emissions (CO_2 Gas)			Emissions (CH4 Gas)			Emissions (N20 Gas)			Notation keys (if no data to report)	
						Amount	Unit	Data source	Amount	Unit	Method	Amount	Unit	Method	Amount	Unit	Method	Notation key	Explanation
	treatment						waste	Department, Thane Municipal Corporation		CO_2e	undergoing biomethanation		CO_2e	waste undergoing biomethanatio n		CO_2e	waste undergoing biomethanatio n		
	Incineration and open burning	Direct	NO	N/A	N/A	-	-		-	-	-	-	-	-	-	-	-	NO	
	Wastewater	Direct	68,158	N/A	N/A	13,987.73	tonnes of organics	Sewage Management Department, Thane Municipal Corporation	0.00	tonnes of CO_2e	Organic content based and population-based approach	40,739.50	tonnes of CO_2e	Organic content based and population-based approach	27,418.98	tonnes of CO_2e	Organic content based and population-based approach		
IPPU	Industrial process	Direct	NE	N/A	N/A													NE	Not estimated due to absence of data
	Product use	Direct	NE	N/A	N/A													NE	Not estimated due to absence of data
AFOLU	Livestock	Direct	NE	N/A	N/A													NE	Not estimated due to absence of data
	Land use	Direct	NE	N/A	N/A													NE	Not estimated due to absence of data
	Other AFOLU	Direct	NE	N/A	N/A													NE	Not estimated due to absence of data

Energy Generation

Sector	Inside or outside city boundary (in separate rows)	Total $t_{CO_2}e$	ETS or non-ETS (in separate rows)	Type of Energy	Activity data			Emissions ($_{CO_2}$ Gas)			Emissions (CH4 Gas)			Emissions (N20 Gas)			Notation keys (if no data to report)	
					Amount	Unit	Data source	Amount	Unit	Data source	Amount	Unit	Data source	Amount	Unit	Data source	Notation key	Explanation
Electricity-only generation	Inside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No power generating facilities within the city boundary
	Outside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No power generating facilities within the city boundary
CHP generation	Inside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No grid supplied CHP within city limits
	Outside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No grid supplied CHP within city limits
Heat/cold generation	Inside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No heating or cooling networks exists
	Outside city boundary	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NO	No heating or cooling networks exists
Local renewable energy generation	N/A	NE	-	-	-	-	-	-	-	-	-	-	-	-	-	-	NE	Reliable information on activity data not available

Emission Credits

Category	Sold or purchased	Total tC2Oe or Notation Key	Allocation to sector	Sub- category	Date of sale/ purchase	Activity data			Emissions ($_{CO_2}$ Gas)			Emissions (CH4 Gas)			Emissions (N20 Gas)		
						Amount	Unit	Data source	Amount	Unit	Data source	Amount	Unit	Data source	Amount	Unit	Data source
Offset credits generated in the city	*Sold*	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Credits purchased from outside	*Purchased*	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Purchase of certified green electricity	*Purchased*	NO	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Appendix

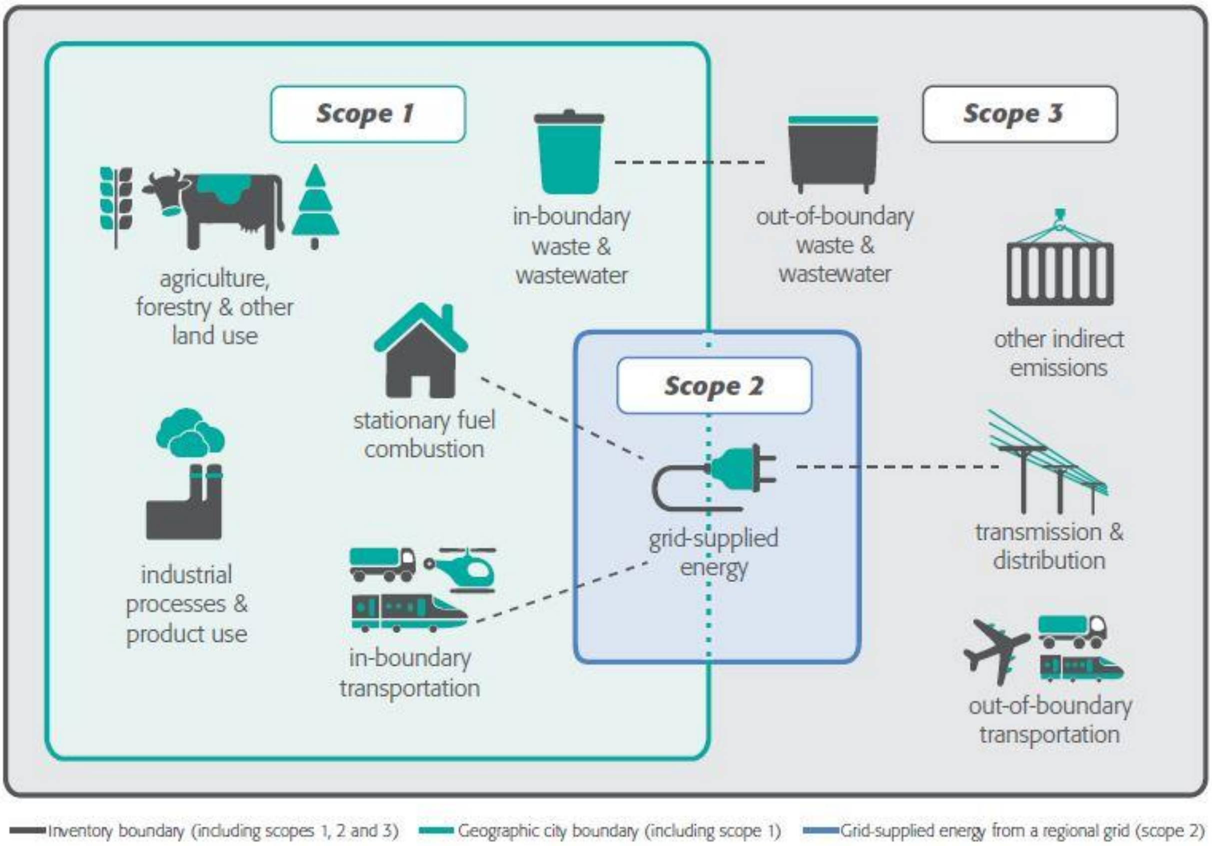

Figure 30: Sources of GHG Emission at the City-level as per GPC