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Climate Resilient City Action Plan - Coimbatore

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1. BACKGROUND

1.1 Introduction

It is projected that over 60% of the world's population will be based in cities by the year 2030[1]. As per a report by the Global Commission on Economy and Climate[2], Indian urban centers will house over 600 million of the country's population by this time. Due to high concentrations of people, infrastructure and resources, cities through the anthropogenic activities release the most Green House Gases (GHGs) and the most adverse impacts of climate change will also likely be in these areas according to the World Bank[3]. In this context, it is of the utmost urgency that a city is able to increase climate resilience to avoid these impacts.

Climate resilience is defined as the capacity for a socio-ecological system to: (1) absorb stresses and maintain function in the face of external stresses imposed upon it by climate change and (2) adapt, reorganize, and evolve into more desirable configurations that improve sustainability of the system, leaving it better prepared for future climate change impacts (Folke, 2006). Therefore, planning for urban resilience should take into consideration the activities that release GHGs and propose actions that not only help to reduce the sources of emissions but also help the city to adapt to the challenges of climate change, such as sea level rise, temperature changes, precipitation changes or extreme events.

1.2 Methodology

The Climate Resilient City Action Plan (CRCAP) for Coimbatore has been developed using the Climate Resilient Cities Methodology. This Methodology is tailor made for Local Governments (LGs), providing **step by step guidance for the development of a Climate Resilient City Action Plan** that addresses both, climate change adaptation and climate change mitigation. This process is based on the premise that **climate resilience refers to both climate change mitigation and adaptation, and linkages therein**.

The process equips LGs to estimate the GHG intensity of city activities, assess the climate risks of various systems in the city in the context of urbanization and vulnerability, identify actions to address existing and forecasted climate fragility and develop an implementation and monitoring plan, which will not only help the city to adapt to existing and impending climate change impacts, but will also steer the city's focus to climate change mitigation measures as well.

This process builds on ICLEI's Cities for Climate Protection (CCP) Campaign, ICLEI's flagship mitigation program, the GreenClimateCities (GCC) program and ICLEI's adaptation tool-kit, the ICLEI Asian Cities Climate Change Resilience Network (ACCCRN) Process or IAP toolkit.

[1] United Nations (UN), 2014. World Urbanization Prospects, the 2014 revision. UN Department of Economic and Social Affairs, Population Division.

[2] The New Climate Economy, 2014. Chapter 2: Engines of National and Global Growth. Better Growth, Better Climate- Charting and new path for low-carbon growth and a safer climate. http://2014.newclimateeconomy.report/

[3] World Bank, Climate Resilient Cities: A primer on reducing vulnerabilities to climate change impacts and strengthening disaster risk management in East Asian cities, 2008: Washington D.C

1.2.1 Overview of Climate Resilient Cities Methodology

The Climate Resilient Cities Methodology is a 9-step process in 3 phases: ***Analyze, Act and Accelerate*** - each unfolding into three steps - outlining how **climate fragility** can be assessed and **climate resilient options (to achieve low emissions development and climate adaptive development)** can be identified and integrated into urban development policies, plans and processes. It consists of a wide **range of tools and guidance notes** to support local governments to deliver effective local climate action. The figure below shows the various tools used in the Methodology.

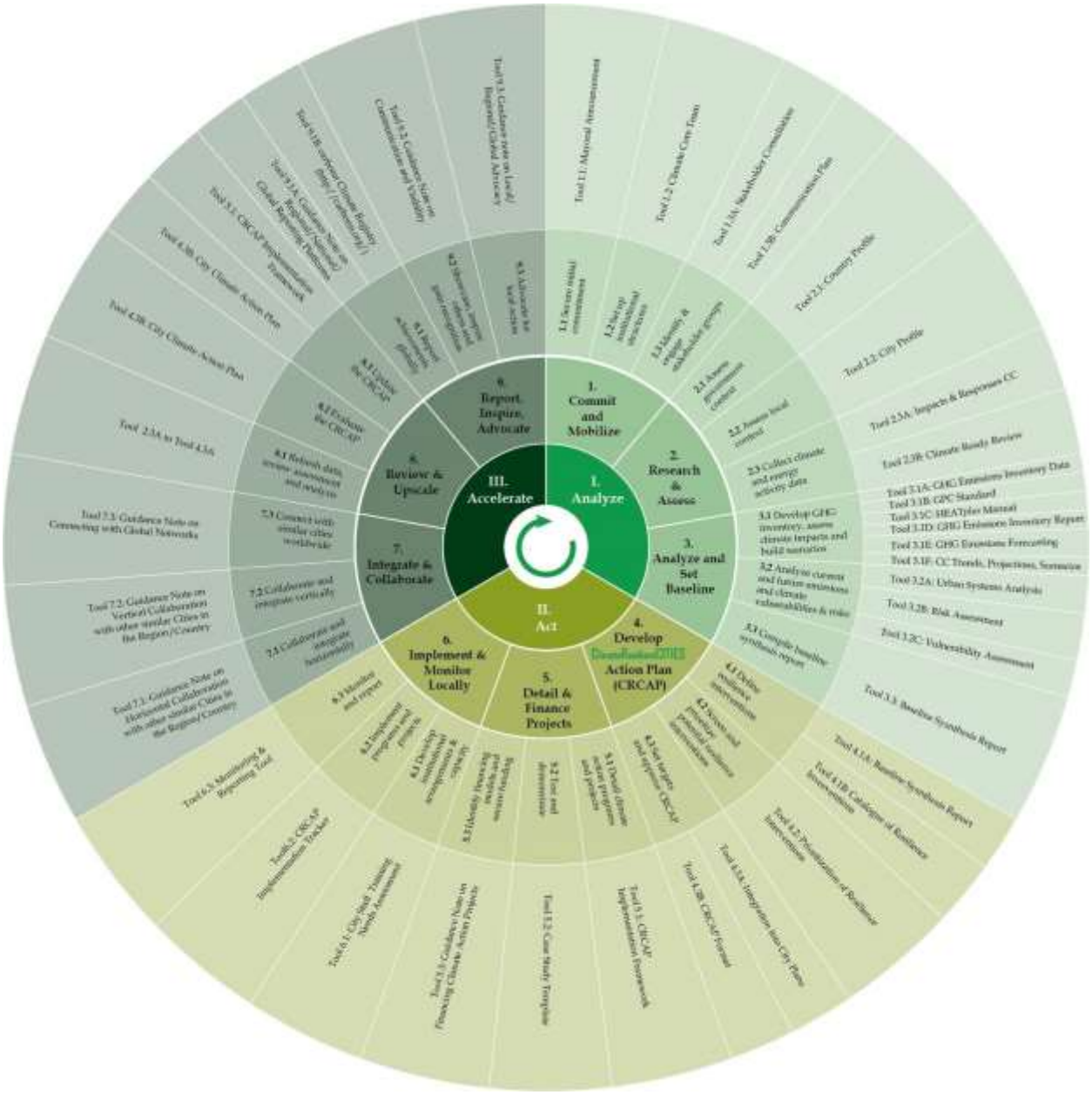

Figure 1: Climate Resilient Cities Methodology

1.2.2 Climate Resilient City Action Plan in Coimbatore

The Climate Resilient City Action Plan (CRCAP) process in Coimbatore was initiated by the Coimbatore City Municipal Corporation (CCMC) under the CapaCITIES Project supported by Swiss Agency for Cooperation and Development and was facilitated by ICLEI South Asia.

ICLEI South Asia assisted CCMC to collect baseline data to develop a profile for the city, giving details of socio-economic scenarios, service delivery status, emissions and general governance systems in the city.

The process involved the updation of an existing GHG emission inventory of CCMC using the HEAT+ tool. The inventory was used to identify possible mitigation measures that can be undertaken in the city to reduce the GHG emissions from the city. This was accompanied by Shared Learning Dialogues (SLDs) where city level stakeholder group and the Core Team from CCMC came together to determine the fragile urban systems in the city. Primary climate studies conducted by IIT Madras as well as secondary studies on climate trends and projections helped to identify possible climate risks to the city and their possible impacts on and risks to the fragile systems. The vulnerability assessment helped to identify the areas and populations within the city who are impacted by these climate risks. Finally, a second shared learning dialogue helped to identify resilience interventions for each fragile system and prioritise them to form an action plan for the city.

The city of Coimbatore identified a Core Team (Annexure 1) and a Stakeholder Group (Annexure 2) to carry out these activities. The Core Team consisted of officials from the local government who deal with various urban systems that are looked after by CCMC. The Stakeholder Group consisted of individuals from different parastatal bodies in the city, as well as NGOs, institutions and local community based members. The Core Team and the Stakeholder Group actively participated in the SLDs to develop the CRCAP.

2. CITY PROFILE

2.1 Introduction

Coimbatore is the second largest city in Tamil Nadu, with a population of more than10 lakhs covering an area of 257 sq. km. The city is situated on the banks of the river Noyyal surrounded by the Western Ghats. It is one of the fastest growing cities in India and is a major hub for textiles, industries, commerce, education, information technology, healthcare, and manufacturing. There are a number of cotton production and textile industries located in and around the city, giving it the name of 'Manchester of South India'.

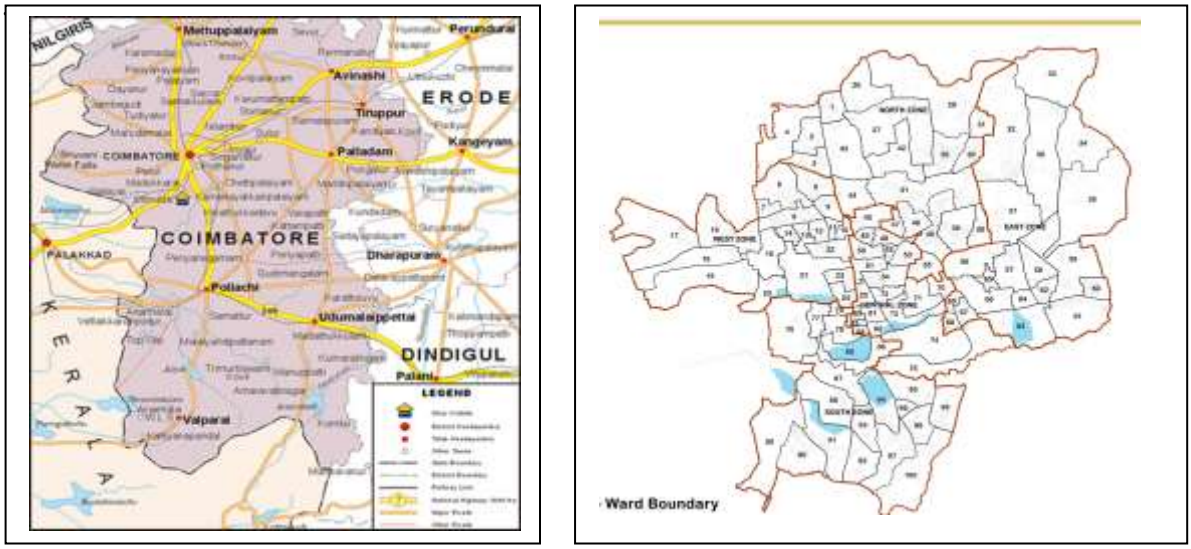

Figure 2: Map of Coimbatore

2.2 Location and Linkages

Coimbatore is located at a distance of 500 kms from Chennai in south west direction. Coimbatore serves as an entry and exit point to Kerala and the popular tourist hill station of Ooty. It is well connected with major cities and towns of India by highways, railways and airways. There are seven major arterial roads in the city that connect various parts of the State and three National Highways passing through the city. Broad gauge trains connect Coimbatore to all parts of India and Tamil Nadu. Coimbatore is the second largest income generating station in Southern Railway after Chennai. Coimbatore North Junction is another important railway junction in the city apart from Coimbatore Junction and Podanur Junction. In addition, the Nilgiri Mountain Railway that goes up to the hill station at Ooty has its lower terminus at Mettupalayam, a town very close to Coimbatore. The city has an airport at Peelamedu 11km from the main city. The Coimbatore airport caters to domestic flights to all the major Indian cities and international flights to Sharjah and Singapore.

2.3 Demography

The population of the Coimbatore Corporation is 10.50 lakhs as per the 2011 census. The population and growth rate of the Coimbatore Corporation are given below.

Table 1: Population Growth Rate (Source: CDP and City Wide Concept Plan, Coimbatore)

YEAR	Actual Population	Decadal Growth (%)	Density / per Sq.Km
1971	622,462	7.30	--
1981	700,923	12.60	6,667
1991	806,321	15.04	7,727
2001	930,882	15.45	8,815
2011	1,050,721	12.87	4,088

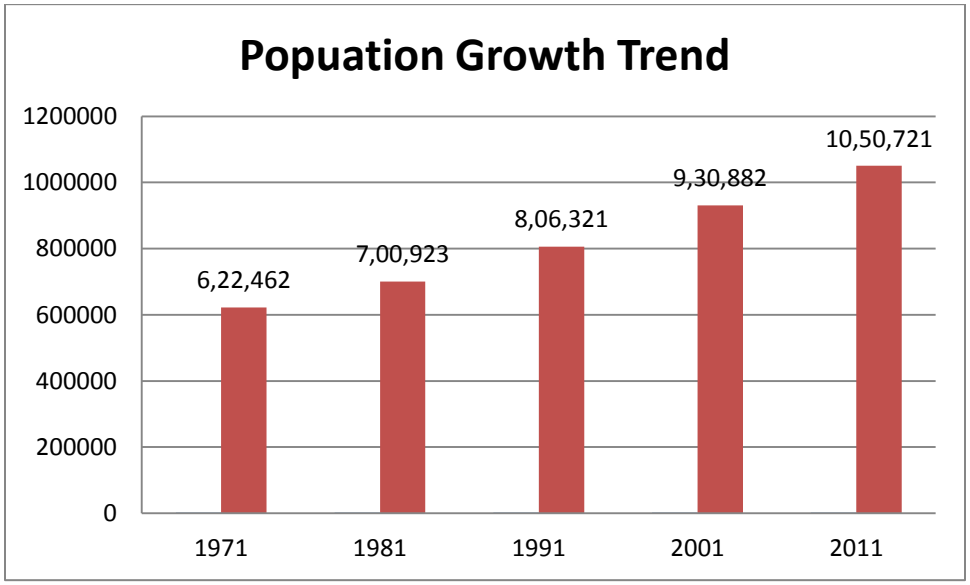

Figure 3: Population Growth Trend

Although the population of the city has jumped up from close to 9 lakhs in 2001 to more than 10 lakhs in 2011 and the population density of the city has decreased from 8815 persons per sq.km in 2001 to 4088 persons per sq.km in 2011 due to the expansion of Corporation city limits as can be seen in the table above.

Gender Ratio: Sex ratio of Coimbatore city is 997 females per 1000 males and the child sex ratio is 953 girls per 1000 boys as per Census 2011. The sex ratio of Coimbatore city is much higher than the national average of 940 females per 1000 males.

Literacy Ratio: Average literacy rate of Coimbatore city is 91% of which male literacy is 95% and female literacy is 88% as per the Census 2011. In terms of literacy, Coimbatore is placed among the top ranking cities of the country. Social awareness levels are high and community organisations are active in the city, as are the self help groups.

Population Projection: As per the City Development Plan for Coimbatore, the population is expected to be 18.98 lakhs in 2021 and 26.14 lakhs in 2041. This will definitely lead to greater stress on natural resources and urban services provided by the CCMC if the city does not take into consideration the population factor while planning their future projects related to service delivery. The population growth

will also increase energy demand and this may well impact the GHG emissions from the city both from the residential and from the transport sector.

Table 2: Projected Population (Source: CDP Coimbatore)

Year	Census Population	Projected Population
1961	580,138	--
1971	622,462	--
1981	700,923	--
1991	806,321	--
2001	930,882	--
2011	1,050,721	--
2021	--	1,898,525
2031	--	2,228,084
2041	--	2,614,850
2051	--	3,068,755
2061	--	3,601,451

2.4 Climate

Climate: Coimbatore has a warm and humid climate. The summer months from March to May are hot and humid, with maximum temperatures of around 38°C or more. Temperature starts dipping from the month of August onwards up to the end of the winter season, though minimum winter temperatures remain above 18°C. Humidity is relatively high in the mornings and rises in the winter period. Humidity is relatively high in the afternoons during the summer months.

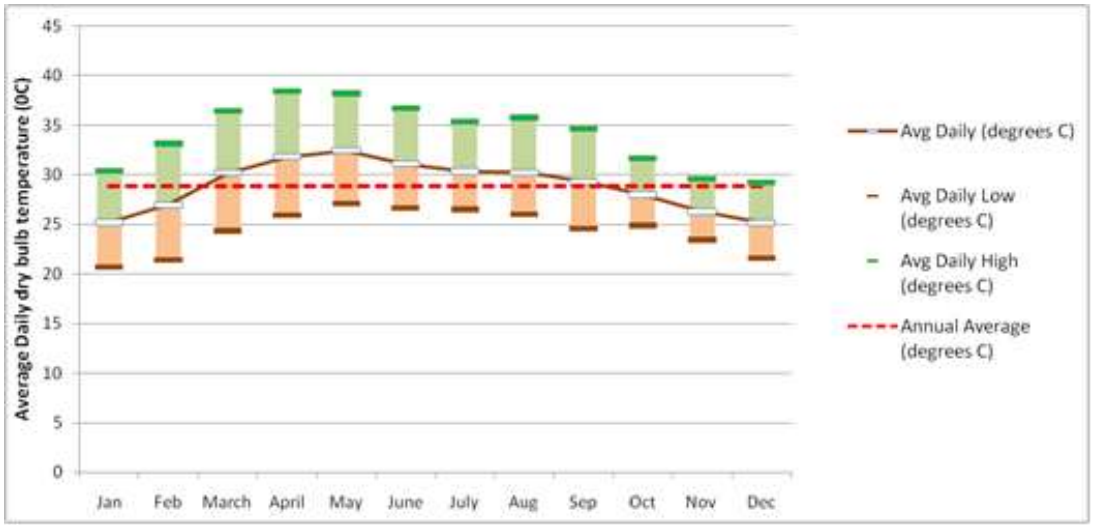

Figure 4: Month wise average daily temperature variation with respect to annual average temperature for Coimbatore city (1982-2006) (Source: ASHRAE, 2009)

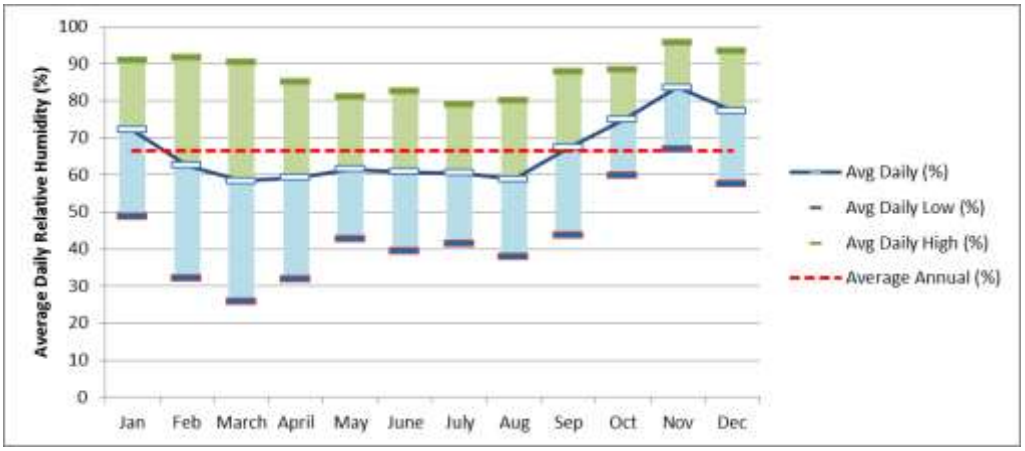

Figure 5: Month wise average daily relative humidity variation with respect to annual average relative humidity for Coimbatore city (1982-2006) (Source: ASHRAE, 2009)

Rainfall: Due to the presence of the mountain pass, major parts of the region benefit from the South-West monsoon in the months from June to August. After a warm, humid September, the regular monsoon starts from October lasting till early November. These monsoons are brought about by the retreating North-Eastern monsoon. The average annual rainfall is around 700 mm with the North East and the South West monsoons.

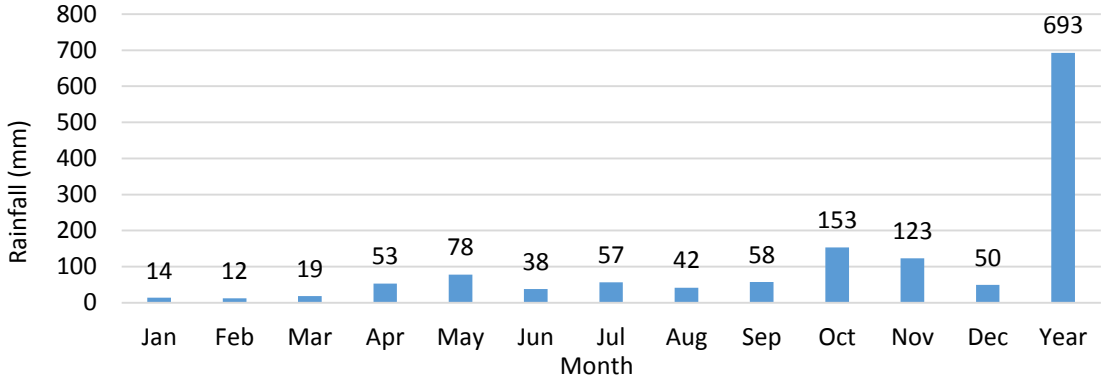

Figure 6: Average Rainfall (Source: CDP, Coimbatore)

2.5 Economic Activities

Economic base**:** The city's primary industries are engineering and textiles with more than 30,000 small, medium and large industries located in and around the city. Coimbatore is famous for the manufacture of motor pump sets and various engineering products such as textile machinery, automobile spares, motors, electronics, steel and aluminium foundries. The rich fertile soil and tropical climate is excellent for the growth of paddy, cotton, tea, oil seeds and tobacco.

Coimbatore is called the "Manchester of South India" due to its extensive textile industry, fed by the surrounding cotton fields. The region also houses the country's largest amount of hosiery and poultry industries.

Coimbatore houses a large number of small and medium textile mills. It also has central textile research institutes like the Central Institute for Cotton Research (CICR) - Southern Regional station and the Sardar Vallabhai Patel International School of Textiles and Management. The South Indian Textiles Research Association (SITRA) is also based in Coimbatore.

The city has two special economic zones (SEZ), the Coimbatore Hi-Tech Infrastructure SEZ and the Coimbatore TIDEL Park. Coimbatore is the second largest producer of software in the state, next to Chennai. TIDEL Park and other Information Technology parks in the city has aided in the growth of IT and business process outsourcing industries. With good cost-effective telecom connectivity and a large number of qualified software engineers, Coimbatore is more than equipped to meet IT and IT-enabled service requirements.

Coimbatore has a large and a diversified manufacturing sector facilitated by the presence of research institutes like Tamil Nadu Agricultural University, South India Textile Research Association (SITRA) and large number of engineering colleges producing about 1 lakh engineers. The city is also recognized for educational institutions and Coimbatore Agricultural University is famous as one of the best agricultural colleges in South Asia.

Coimbatore has more than 700 wet grinder manufacturers. The term "Coimbatore Wet Grinder" was given a Geographical indication for wet grinders manufactured in Coimbatore. Coimbatore is also home to a common facility for the manufacturers of wet grinders. Coimbatore is also famous for the manufacture of motor pump sets and various engineering products includes textile machinery, automobile spares, motors, electronics, steel and aluminium foundries. The motor and pump industry supplies two third of India's requirements.

Coimbatore is one of the major gold jewellery manufacturing hubs in India renowned for making cast jewellery and machine made jewellery is also a major diamond cutting centre in South India. Owing to the presence of a large number of jewellery manufacturers and the strong engineering base, the city is home to a number of companies manufacturing jewellery making machinery.

These medium and small scale industries result in emissions and effluents that impact the air and water conditions. A large number of small scale industries release their effluents directly into the open drains and nalahs that lead to one of the several lakes within the city, resulting in pollution of the water bodies. These also impact the ground water since these lakes help recharge the ground water in Coimbatore. The industries also have a large demand on energy and are major emitters of GHG, thus playing an important role in causing climate change while also retaining a lot of potential to take action on the same.

2.6 Local Government Body

The city of Coimbatore was constituted as Municipality in the year 1866 and was subsequently constituted as a City Municipal Corporation from 1981. The entire city of 257.04.sq.km has been divided into five zones consisting of 20 wards each.

The Corporation consists of two Wings i.e., the Administrative and the Political.

Political Wing: An elected council wing comprising of a directly elected Mayor and ward councilors represents the elected wing. There are 100 wards and one elected councilor from each ward. The entire city has been divided into five zones and each zone comprising of 20 elected members and headed by the Chairman of the council.

Administrative Wing: The Commissioner heads the administrative wing. All the department heads assist the Commissioner in administrative activities. The functions of the administrative wing are all executive functions with the administrative head, establishment matters such as appointment, transfers, pay and allowances, etc., correspondence with Government and other departments, public relations, redressal of public grievances, legal matters, sanctioning of estimates and approval of contracts, payments, urban service delivery and others.

The functions of various departments, under the Administrative wing are,

Engineering Department: This department is headed by the City Engineer. It is primarily responsible for the proper management and execution of works besides planning, preparation and implementation of all developmental works of the Corporation like water supply, drainage, sewerage, storm water drains, roads, street lights, etc.

Public Health Department: The department is headed by City Health Officer and assisted by the Assistant Health Officer, Health Inspectors and Sanitary Inspectors. This department is responsible for SWM primary collection, malaria control, family planning, mother and child health care, birth and death registration etc. The Health Inspectors and Sanitary Inspectors, is responsible for monitoring and supervising the work of sanitary laborers in the wards.

Town Planning Department: Town Planning Section is headed by Town Planning Officer (TPO) and the Auto DCR Cell in Main Office assisting in town planning matters. The major function of this department is issue of building license, preparation and implementation of development plans and eviction of encroachments, urban planning and building regulation.

General Administration Department: The department is headed by the Assistant Commissioner (Personnel). This department is responsible for establishment, other essential matters relating to office, officers, staff and their welfare like preparation of staff pay bills, maintenance of registers for advances, GPF, pension, PF's etc.

Revenue and Accounts Department: The department is headed by the Assistant Commissioner (Accounts and Revenue). This department maintains two separate accounts, General Fund and Water Supply / Drainage Fund.

General Fund Accounts department monitors and supervises the work relating to finance, budget and accounts of the Corporation relating to all the areas except water supply and drainage. Monitoring income and expenditure for Revenue and capital fund Accounts and Elementary education fund Accounts as per budgetary provisions also fall under this department. Other responsibilities include scrutinizing of pay bills and disbursing salaries to employees, payment for all works and supply bills, payment of all terminal benefits to the retired Corporation employees and finalization of annual accounts relating to revenue and capital fund, elementary education fund. Water Supply and Drainage Accounts section is headed by the Accounts Officer (Water Supply). This section monitors and supervises the work relating to finance, budget and accounts of the water supply and drainage works of the Corporation.

Currently, there is no elected political body in the municipal corporation. The Municipal Commissioner is also serving as the Special Officer for the municipal corporation. He is responsible for ratifying and endorsing all plans for the city. The Core Team for creation of the CRCAP for Coimbatore consisted of members from the Engineering, Public Health and Town Planning Departments. Members from these departments are also part of the Stakeholder Group of the city of Coimbatore.

2.7 Major Urban Systems

2.7.1 Water supply

The source of water supply for Coimbatore Corporation is from Siruvani River, Bhavani River & Aliyar River and protected water supply to Coimbatore Corporation is provided through five water supply schemes.

Table 3: Details of Existing Schemes (Source: TWIC Water Supply Study Report, CCMC)

Schemes	Erstwhile Corporation area in MLD	Added area in MLD	Total Qty in MLD
Siruvani	87.00	7.20	94.2
Pillur I	35.72	22.13	57.85
Pillur II	87.35		87.35
Kurichi Kuniamuthur Scheme		7.30	7.3
Kavundampalaym and Vadavalli scheme		11.00	11.00
Total	**210.07**	**47.63**	**257.7**

The Head works of Siruvani and Pillur I water supply schemes are operated and maintained by Tamil Nadu Water Supply and Drainage Board and the Pillur Water Supply Scheme II, Head works and MSR are maintained by the Coimbatore Corporation. The bulk water is supplied from these schemes to two Master Service Reservoirs (MSRs) maintained by Coimbatore Corporation. From these two Master Service Reservoirs, water is being distributed through elevated service reservoirs and distribution network pipelines. The MSR at Ramakrishnapuram is fed by the gravity main under Pillur Scheme I and the MSR at Bharathi Park is fed by the gravity main of Siruvani Scheme. The added areas of the CCMC are being fed by the Kurichi Kuniamuthur Scheme and the Kavundampalayam and Vadavalli Scheme, though the major amount of water is coming from the Pillur I scheme.

There are about 3 lakhs house service connections for supply of drinking water under Siruvani and Pillur I & II scheme in the city by providing with metered house service connections.

Table 4: Service Standards for Delivery of Essential Services (Source: Coimbatore Corporation)

Proposed Indicator	SLB fixed by GoI	Service level provided 2015-16	Service Level to be provided 2016-17
Coverage of Water Supply Connections	100%	44%	50%
Per Capita Supply of Water	135 lpcd	102 lpcd	115 lpcd
Extent of metering of water connections	100%	26%	30%
Extent of non-revenue water (NRW)	20%	56%	46%
Continuity of Water Supply	24 hours	Once in 4 days / 4 Hrs.	Once in 3 days / 4 Hrs.

Quality of Water Supplied	100%	75%	80%
Efficiency in redressal of customer complaints	80%	65%	70%
Cost recovery in water supply services	100%	60%	70%
Efficiency in collection of water supply-related charges	90%	60%	75%

At the time of collection of the data, the coverage of water supply connections was poor, particularly in the newly added areas and non revenue water loss was quite high. There is a shortage of water in the city and supply is only for 4 hours in 3 to 4 days. Residents generally store water in tanks when supply comes and use it when supply is off.

Proposals and ongoing initiatives:

24x7 Water Supply Scheme: The Coimbatore Corporation has prepared DPR for Upgradation of the existing water supply and distribution system in the city of Coimbatore into 24x7 water supply systems. The project is approved under the JNNURM Scheme of MoUD. The estimated project cost is 556.57 crores.

Now, the Coimbatore Corporation has floated tender and invited applications from the eligible applicants for the Implementation of 24x7 Water Supply System for the City of Coimbatore.

The Project will be implemented through public-private partnership (PPP) model on Build, Transfer and Operate (BTO) basis in two stages i.e., construction under the engineering, procurement and construction stage and the operation and maintenance of the Project under the O&M stage. A part of the capital expenditure required for the project will be incurred from the grants from CCMC, Government of India, Government of Tamil Nadu as per the provisions of the JNNURM scheme and the Tamil Nadu Infrastructure Development Board.

Water Supply System to the Extended Areas: CCMC has prepared a DPR for augmentation of sourcing and treatment and extension of water distribution in added areas. The Govt. of Tamilnadu has received approval from the Government of India for Implementation of Water Supply Improvement Scheme under Atal Mission for Rejuvenation and Urban Transformation (AMRUT).

The estimated cost of the project is around Rs. 1,672.00 crores. The work is under implementation now and all the project components will be completed in phased manner from 2017 to 2020.

2.7.2 Sewerage

Partial Underground System: CCMC has Underground Sewerage System (UGS) partially in the erstwhile corporation area while the remaining areas in the erstwhile corporation and recently added areas are covered by open drains. The existing sewerage system in Coimbatore covers an area of 23.10 Sq.Km and sewer lines were laid to a length of 162 Km and service connections were provided to 24,380 households. The area covered by this underground sewerage system is divided in three zones. Zone I commissioned in 1954 sewer line covers approx. 7.5 sq.km, while the balance 15.6 Sq.Km of area is covered by zones II and III and commissioned in 1998.

Treatment facility: The CCMC has 3 Sewage Treatment Plants (STPs) which are located at Ukkadam, Ondipudur and Nanjundapuram.

The sewage of zone I and II is brought to Ukkadam STP. The treatment facility at Ukkadam broadly consists of screen chamber, grit chamber, settling tank, sludge digestion tank and sludge drying bed.

Ondipudur treatment plant has a capacity of 60 MLD. The Nanjudapuram treatment plant was under court stay order for a long time due to a dispute regarding the land. Recently the court has cleared the plant for operation and it will be functional soon.

Access to Toilets: An estimated 7.5% of the households are without any outlet or toilets and there is discharge of sewage to water bodies and storm water drains in several places. Individual sanitary facilities like septic tanks cater to the populace not served by the underground drainage system. It is estimated that close to 20% of the households do not have safe disposal facility (septic tank or sewerage network). 313 public conveniences cater to population uncovered by either of the above systems, which is inadequate to meet the norms.

Table 5: Service Standards for Delivery of Essential Services (Source: Coimbatore Corporation)

Proposed Indicator	Service level Benchmark fixed by GoI	Service level provided 2015-16	Service Level to be provided 2016-17	Comments
Coverage of toilets	100%	80%	92%	Swachh Bharat Mission scheme is being implemented that will help to achieve 100% coverage.
Coverage of Sewage network services	100%	55%	65%	-
Collection efficiency of the sewage network	100%	25%	40%	-
Adequacy of sewage treatment capacity	100%	50%	80%	-
Quality of sewage treatment	100%	70%	80%	-
Extent of reuse and recycling of sewage	20%	-	10%	-
Efficiency in redressal of customer complaints	80%	60%	70%	-
Extent of cost recovery in sewage management	100%	-	50%	Proposal for by-law approval, submitted to DMA.
Efficiency in collection of sewage charges	100%	19.43%	77%	-

At the time of collection of information, sewerage network coverage was low, but work was ongoing to improve coverage and also encourage household level connection to the sewer lines. Treatment capacity is inadequate in the city and there was no reuse or recycling of sewage. Sewage charges are non-existent

and linked to general property taxes, and therefore capital for improvement, operation and maintenance is not available with the city.

Ongoing Sewerage expansion and other proposals: The ongoing sewerage project covers an area of 87 sq.km, sewer lines of 582 km and 103506 connections with an estimated cost of 377 crores.

In addition, a DPR for uncovered and newly added areas at an estimated cost of Rs. 1631 crore has already been prepared and this project will be implemented in the period between 2017 to 2020.

2.7.3 Solid Waste Management

Waste generation and primary collection: Coimbatore generates an estimated 890 Tonnes per day of which it manages to collect close to 855 tonnes. The primary collection is handled completely by CCMC either through its own employees or through contract labour.

PPP project for Transfer stations, Secondary Transportation, Processing and Landfill: A private agency through a PPP contract manages the activities starting with the construction and management of transfer stations till the landfill stage. In all, CCMC has four transfer stations at Peela medu, Sathy Road, Ukkadam and Ondipudur. Three of the four transfer stations are operational. Hook Loaders are used for secondary transportation from transfer station to the compost yard / landfill site at Vellalore. The private agency has been engaged by the CCMC under JnNURM scheme to transport the waste from the transfer stations to the disposal site.

The disposal site at Vellalore has been operational with an extent of 604 acres. Under the JnNURM scheme, the compost plant and sanitary landfill facility has been installed under PPP mode.

Vermi-composting and Biomethanatation: Recently, CCMC has initiated vermi-composting in which over 100 TPD of waste is being handled and processed. Further another 1.5 Ton bio-methanation plant for processing organic waste has been implemented and is used to light up streetlights in the adjoining areas.

Table 6: Service Standards for Delivery of Essential Services (Source: Coimbatore Corporation)

Proposed Indicator	Service level Benchmark fixed by GoI	Service level provided 2015-16	Service Level to be provided 2016-17	Comments
Household level coverage of solid waste management services	100%	60%	70%	After purchase of New Tipper we can cover all the houses.
Efficiency of collection of Municipal solid waste	100%	80%	90%	-
Extent of segregation of Municipal solid waste	100%	80%	90%	-
Extent of Municipal solid waste recovered	80%	70%	75%	-
Extent of scientific disposal of Municipal solid waste	100%	50%	60%	-
Efficiency in redressal of customer complaints	80%	60%	65%	-

Proposed Indicator	Service level Benchmark fixed by GoI	Service level provided 2015-16	Service Level to be provided 2016-17	Comments
Extent of cost recovery in SWM Services	100%	15%	25%	-
Efficiency in collection of SWM Charges	90%	60%	70%	-

At the time of collection of information, there was a relatively good system of collection of waste and transfer to the disposal site. However, in spite of having a scientific landfill, mixed waste was being dumped in the landfill and around it, due to operational and managerial conflicts. There is poor cost recovery system for solid waste management services which affects the planning of better services.

Proposed initiatives: The Coimbatore Corporation is desirous of setting up of 100 TPD capacity processing and recycling facility for Construction and Demolition Waste in Coimbatore City through Public Private Partnership (PPP) Mode covering the following components.

- Collection and transportation of construction and demolition waste
- Setting up of 100 TPD capacity processing and recycling facility for Construction and Demolition Waste in the assigned site near Ukkadam
- Processing of construction and demolition waste using mechanized process into useful products / materials and their sale into the market
- Transfer of rejects to the designated site

Tender has been finalized and work order has been issued to the contractor to initiate the setting up of 100 TPD capacity processing and recycling facility

2.7.4 Water ways and drains

Located on the banks of the Noyyal river, Coimbatore's drainage system comprises of a network of natural and man-made drains and water bodies that ultimately discharge surface run-off into Noyyal River. Numerous channels and tanks constitute the major storm water drainage system for CCMC. With a general slope of the city from North to south, the storm water drainage system in CMC comprises primary, secondary and tertiary drains. Primary drain is the Noyyal River. Secondary drains include the natural channels/ canals with a discharge capacity of up to 5 cum/ sec. Tertiary drains are the roadside, built-up open or covered drains and the unlined kutcha type drains.

The CCMC maintains storm water drains of total length 1780.10 Km within its jurisdiction. The existing roadside storm water drains are linked with drainage channels, which convey storm water runoff from the respective catchment areas to Noyyal River and also act as the ultimate disposal points.

Under JNNURM, the Corporation had started the first phase of the Storm Water Drainage (SWD) project in 2008. The first phase of the project covered portions of the city area (60 wards) and involved constructing drains for 737 km at a cost of Rs. 180 crore. The Government of India had financed the project in part. The State Government had contributed 20 per cent of the cost and the Corporation spent the rest 30 per cent.

Table 7: Service Standards for Delivery of Essential Services (Source: Coimbatore Corporation)

Proposed Indicator	Service level Benchmark fixed by GoI	Service level provided by CCMC 2015-16	Service Level to be provided by CCMC 2016-17	Comments
Coverage of storm water drainage network	100%	52 %	75 %	After Construction of new drainages we will achieve 100% service level
Incidence of water logging / flooding	0	20	15	

Proposals: Construction of Storm Water Drains in added areas under Atal Mission for Rejuvenation and Urban Transformation (AMRUT) has been proposed at an estimated cost of Rs. 1,076.00 crores and will be implemented before 2020.

2.7.5 Transportation

The city is well connected to the rest of the state region by rail, road and air. It is a major junction on the Madras-Palakkad Broad Gauge section and NH 47 runs through the center of the city. Coimbatore International airport at Peelamedu (8 km from the city) links it with all major cities of the country and few international destinations in the Middle East and South East Asian countries. There is also an air-force base at Sulur (12 km). The Coimbatore city has six major arterial roads and three National Highways, NH – 47 (Kanyakumari – Salem), NH – 67 (Coimbatore – Nagapattinam) and NH – 209 (Bengaluru – Dindigul) passing through the city. A by–pass highway completed in 1998 has helped in eliminating part of the commercial vehicle traffic in the city.

The Tamil Nadu State Transport Corporation (TNSTC) and the private bus operators operate Town bus services in most parts of the City and villages in the District; buses also connect to all towns in Tamil Nadu, North Kerala, South Karnataka and Tirupati. As per the City Mobility Plan (CMP) of 2014, the number of mofussil routes operated by the TNSTC Coimbatore division is 119 with 446 numbers of buses. Number of town buses held in the Coimbatore city is 688 which are operated by TNSTC. Of these, 631 buses are on road. Average daily ridership of TNSTC buses in Coimbatore is 6.61 lakhs. In addition to TNSTC buses there are 300 more private buses operating in Coimbatore.

There are currently six bus terminals operate under CCMC. These terminals are the Town Bus Stand, Ukkadam Bus Stand, Singanallur Bus Stand, Mettupalayam Bus Stand, Thiruvallur Bus Stand and the Central Bus Stand at Gandhipuram. The three intercity bus terminals are located along three arterials.

In Coimbatore City, intermediate public transport (IPT) is mostly serviced by autorickshaws and taxis. In addition to that some mini buses are also operated there. There are 8541 autorickshaws, 434 taxis and 106 mini buses being operated by private operators. The average trip length of auto rickshaws is around 5 Kms and for call taxis is around 10 Kms. They provide last mile connectivity for passengers travelling long distances by buses. Average daily passengers travelled by the IPT services in Coimbatore are 1.2 lakhs.

Broad gauge trains connect to all parts of India and a meter gauge line connects the city to Dindigul. Town bus services ply to most parts of city and villages in the district; buses also connect to all towns in Tamil Nadu, North Kerala, South Karnataka and Tirupathi. The number of mofussil routes operated by Coimbatore division is about 120 with more than 500 buses. The number of town buses in the city is around 800 in 228 different routes. Private vehicle usage is very high within the city, particularly for two wheelers.

The CMP for Coimbatore includes strategies for better public transport and mass transit systems, improved non motorised transport, integrated inter modal transport among other infrastructural developments. A large number of these strategies can support urban resilience, by helping to reduce GHG emissions as well as improving health and safety of the citizens.

2.7.6 Housing Stock & Demand

Almost 25 to 28 percent additions to the housing stock are estimated to be made informally without obtaining necessary permissions and sanctions. On one side, a lot of financial agencies and government schemes offer incentives and encourage the development of housing sector where as on the other side the regulation mechanism creates hurdle to the development due to its complexity. It may be observed that 33% of the total land area of LPA is reserved for residential purposes. 80% of these residential lands have already been developed fully. According to the census of 2001, the average household size is 4.14. The Coimbatore City Corporation has reported that there are about 5 lakhs assessed residential properties and it is estimated that there can be about 50,000 households that are outside the assessment framework. It is observed that nearly about 2,000 dwelling units are added annually to the housing stock in the city. It has been estimated that nearly half of these dwelling units are being constructed beyond the framework of any regulation. A fairly large unregulated housing stock also means a loss of opportunity for the CCMC to address residential energy demand.

2.7.7 Electricity and Energy

Electricity Consumption

Tamil Nadu Electricity Board (TNEB) is the distribution utility supplying electricity to Coimbatore. The electricity consumption for Coimbatore has been growing rapidly at an annual growth rate of 15.72%, with a total consumption of 2,313.91 Million kWh in the year 2015-16.

Table 8: Year-wise Total Electricity Consumption for Coimbatore City (Source: TNEB, Coimbatore)

Consumer	Electricity Consumption (Million kWh)					
	2011-12	2012-13	2013-14	2014-15	2015-16	Annual Growth Rate
Domestic/Residential	430.17	581.95	627.25	671.69	710.75	13.38%
Commercial	183.33	247.5	272.61	303.5	323.83	15.28%
Industries (Tiny & LT)	184.96	210.28	244.63	307.25	331.86	15.74%
Hight Tension (HT)	456.74	676.17	775.47	848.4	881.14	17.85%
Govt. & Pvt. Institutions	27.257	40.66	43.61	46.25	49.36	16.00%

Bulk Supply, Public Worship & Temporary Supply	6.61	9.24	11.8	15.06	14.78	22.28%
Municipal Services	1.29	1.71	1.93	2.02	2.19	14.15%
Total	**1290.357**	**1767.51**	**1977.3**	**2194.17**	**2313.91**	**15.72%**

Coimbatore is an industrial city known for its textiles, engineering and software industries, and the industrial sector accounts for over half of the city's electricity consumption. The residential sector is also a significant end-use consumer accounting for 31% of the total electricity consumption, followed by the commercial consumers having a share of 14% as seen below in the graph.

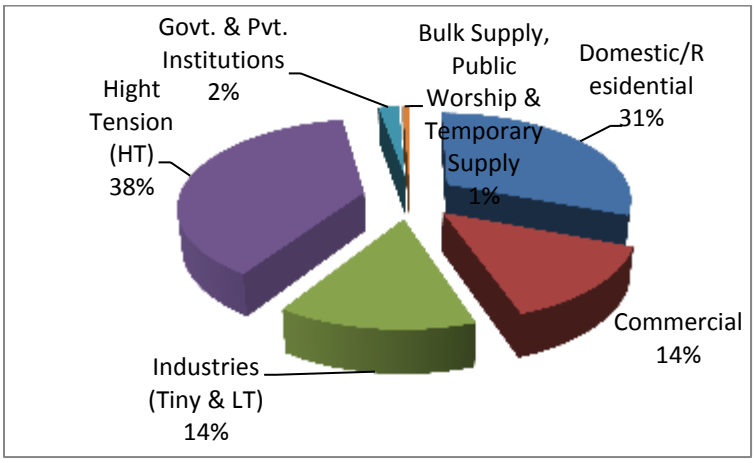

Figure 7: Share of Electricity Consumption by End-Use Consumers for Coimbatore City (2015-16)

Monthly energy consumption is useful in understanding minimum and peak consumption in city and the seasonal variations therein. The monthly power consumption indicates that energy consumption is increasing from June to December, with the highest electricity consumption of 204.01 Million kWh taking place in the month of November, a rise of about 11% compared to the electricity consumption in March. Months of June, July, August, September, October, November and December have very similar levels of consumption. Seasonal load is high as compared to base load from June to December and the city has a seasonal load ratio of 16%.

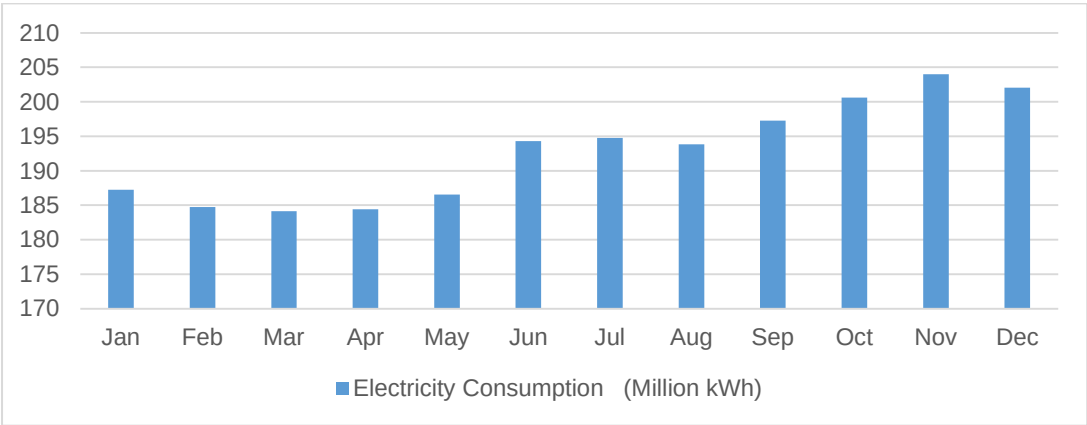

Figure 8: Month-wise Electricity Consumption for Coimbatore City (2015) (Source: Data from TNEB - Metro – Combatore)

2.8 Sustainability Journey of the city

Coimbatore has been actively involved in initiatives on low emission development, climate resilience building and sustainable energy such as the Urban Climate project [4], Local Renewables Model Communities Network project[5], the Solar Cities Programme in the recent past. Adoption of the Energy Conservation Building Code (ECBC), specifying minimum energy performance requirements and applicable for commercial buildings with an electrical connected load of 100 kW or more, is mandatory across the state of Tamil Nadu since 2012[6]. While activities have been undertaken to assess capacities and identify gaps and needs for effective enforcement of the ECBC at the local government level in Coimbatore, the city has not been enforcing the ECBC[7].

Coimbatore was a participant in the Promoting Low Emission Urban Development Strategies in Emerging Economy Countries (Urban-LEDS) programme[8]. Under this project, the baseline energy and GHG emissions assessment for the city indicated that residential buildings and the commercial/institutional sector contribute to 20% of Coimbatore's total GHG emission, and the industrial sector has a share of 29%.

Coimbatore city has been selected under the Solar Cities Programme and has prepared its Solar Master Plan which targets a total energy reduction of 10% in its energy consumption, translating to savings of 589.51 Million kWh by the year 2016, with 335.80 Million kWh from renewable energy installation and 253.71 Million kWh from energy efficiency measures. To promote renewable energy and energy efficiency, the Coimbatore Municipal Corporation has taken the lead and implemented a number of renewable energy and energy efficiency projects in its buildings and facilities in the past 2 years, with about 600 kW of solar PV installed across its offices, schools, bus stations, maternity centres, canteens and sewage treatment plants and water pumping stations. The Coimbatore Corporation is also proposing to export the excess energy generated from its solar PV installations via net metering.

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[4] The Urban Climate Project was executed by ICLEI in partnership with the National Institute of Urban Affairs (NIUA) and funded by United States Department of State (USDoS) under their Asia Pacific Partnership (APP) Programme. The Urban Climate Project has implemented during 2008-11. UCP project assisted the city to implement infrastructure projects through technical and to some extent financial support for pilot interventions by including cleaner and efficient technologies and also to model GHG deflections to showcase benefits. CCMC implemented four interventions viz, Energy Efficiency in own building (JnNURM Cell), Bore Wells Pilot Energy Audit & implementation of energy efficiency recommendations, Wind-Solar Hybrid and Energy Efficient Lighting in Coimbatore's New Bus Terminal, resulting in annual energy savings of about 166,000 kWh and GHG emission reduction of 5,900 tCO_2e.

[5] The Local Renewables Model Communities Network project has been implemented in Coimbatore city with funding through the Deutsche Gesellschaft für Technische Zusammenarbeit (GTZ) GmbH. This international project, implemented from 2005-2010, provided support to strengthen participating local government in promoting sustainable energy and to become model city in their national and regional contexts.

[6] In the state budget for the year 2012-13, it was announced that the Government of Tamil Nadu would initiate action to implement the Energy Conservation Building Code (ECBC) in commercial buildings and certain categories of major building complexes based on their energy consumption.

[7] Coimbatore was one of three cities in Tamil Nadu (Chennai and Madurai), involved in a ECBC capacity building and training needs assessment for Tamil Nadu study undertaken in 2012 by ICLEI South Asia in partnership with the Centre for Human Settlements (CHS) and Anna University.

[8] The objective of the Urban-LEDS project, an international programme implemented by the UN-Habitat and ICLEI in select cities from emerging economy countries of Brazil, India, Indonesia and South Africa, is to enhance the transition to low emission urban development by integrating low-carbon strategies into the local development planning process. In India, two Model Cities – Thane and Rajkot are engaged in this programme along with six Satellite Cities.

Energy efficiency being the need of the hour, CCMC had initiated various energy efficiency measures such as ESCo model for street lights, conversion of electrical light fittings into energy efficient LED fittings in its administrative buildings, bus stands, zonal offices, ward offices, division offices. Conventional lights are being replaced by energy efficient LED street lights in phased manner.

Table 9: Solar Power Plant Installation Details (Source: Engineering Section, CCMC)

Location	Capacity Installed (Kwp)	Approx. Energy Savings (Kwh)	Utility Savings Rs.
Amma Canteens	8	25920	208656
Administrative Buildings	87.5	382576	3079731
Water Treatment Plants & STP's	350	150675	1135445
Urban Health Center's	45	165690	1333805
Corporation Higher Sec. Schools	112.5	513920	4137043
Total	**603**	**1238781**	**9894680**

"Sunya – Towards Zero Waste"

The CCMC had undertaken a Decentralised MSW Resource Management Project on a pilot basis in the year 2012 under the project named "SUNYA-Towards Zero Waste in South Asia" funded by the European Union in Ward 23 in the West zone. The Sunya project suggested an approach based on *zero-waste* as an efficient model, which includes reduction, reuse, recycling solutions, information and educational campaigns, based on a strategic interaction of regional/local government and other stakeholders.

The outcome of the project is as follows:

- Door-to-Door collection of segregated wastes from all the 2000 households and 750 commercial establishments in the ward has been ensured cent per cent.
- Motivated and productive workforce with a dignified and safe working environment among the sanitary workers.
- All the 89 Nos. of waste collection bins/containers that were placed along the roadsides have been totally removed, thereby making the ward sans bins.
- The bio-degradable wastes collected in the households in ward 23 are converted into city compost in the composting facility specially established for this purpose within the ward itself. The compost so produced has been given back to the residents in the ward which has in effect boosted their morale in effective source segregation.
- A dedicated system for collection of garden waste have been initiated once a week on every Wednesday.

The situation after implementation of the initiative is as follows:

- Source segregation in all the waste generation and collection points is ensured
- Coverage of complete Door-to-door collection is ensured.
- Open littering is not witnessed even after removal of roadside bins/containers.
- Dedicated collection and transportation of wet organic wastes from the households on a daily basis is ensured and sent for processing plant.
- Dedicated collection and transportation of dry wastes from the households and the commercial establishments on a daily basis is ensured and the collected wastes are sent to the recycling firm that CCMC has tied up with.

Outcomes of the project

- Since source segregation in all the waste generation and collection points is ensured, the job of the sanitary workers has become easier.
- Since the required and appropriate maintenance-free implements such as hand carts and protective safety gears are provided to the sanitary workers have in turn boosted their morale in effective source segregation and collection.
- Since there is a permanent facility for processing of the wet organic wastes collected mixing of wastes is completely avoided.
- Since there is an incentive mechanism to the sanitary workers in place through sale of dry recyclables have in turn boosted their morale in effective source segregation and collection.
- Continuous monitoring of the waste generated and collected is in place.

Bio-mechanization and Vermi-composting in Vellalore:

A Municipal Solid Waste Management Complex comprising a Vermi-composting facility, Windrow Composting, 2 Nos of Bio-methanation plants (Each of capacity 1.5 MT) and a Model organic farming has been established at Vellalore site. As of now, the CCMC handles about 100 MT of wet organic wastes at the Vermi-compost plant and the Bio-methanation plants. A total of about 3.5 MT of Vermi-compost and City Compost is produced at the plant. A tri-party agreement between the CCMC, the Private Operator of the Vermi Compost Plant and Madras Fertilisers Limited will be signed shortly for sale of Compost through MFL. The biogas produced in the biomethanation plant is converted into electrical power and is utilised to illuminate street lights within the Vellalore waste processing facility.

Biogas crematorium at Nanjundapuram:

The Coimbatore Corporation had installed a Gasifier Crematorium at Nanjundapuram area in the year 2010 in which the burners were be powered by biomass gasifier. Previously, in the place of biomass gasifier, only Liquefied Petroleum Gas (LPG) was used for cremation purposes. The Coimbatore Corporation used 4 commercial LPG cylinders, incurring an expenditure of Rs.4,180/- per day, using 120 cylinders per month. About 120 bodies were cremated in a month. In order to bring down the cost towards the expenditure on LPG cylinders, the Coimbatore Corporation during the year 2015 initiated an innovative project by installing a 100 m^3 capacity kitchen waste based biogas plant at the above mentioned Gasifier Crematorium Premises at Nanjundapuram. The kitchen wastes of quantity 1500 Kgs collected per day in the form of organic vegetable wastes, stale cooked/uncooked food wastes from the hotels and restaurants besides the households in and around the Nanjundapuram areas are collected and processed at this plant. About 100 m^3 of methane gas is produced at the plant per day. The bio-gas produced through anaerobic digestion of kitchen wastes is burned to generate Clean Renewable Energy.

The methane gas produced in the plant is charged into the crematorium's burner as fuel along with the regular LPG cylinders. Before installation of the Biogas plant at the Crematorium about 120 Commercial LPG cylinders (each cylinder weighing 19 Kgs) per month were used for cremation purpose. After installation of the Biogas plant, the usage of LPG cylinders has been reduced to 60 cylinders per month at the rate of 2 cylinders per day thereby reducing the cost to Rs.2,090/- per day. The plant is free from malodour and the water released from the plant is let out into the existing Underground Sewerage System.

Biogas Plant in Amma Canteen (Community Canteen)

Amma Unavagam (meaning "Mother Restaurant" in Tamil) is a food subsidization program run by the Government of Tamil Nadu aimed at helping the very poor sections of the society. At the

Saravanampatty Amma Canteen, idlis for breakfast and sambar rice and curd rice for lunch are prepared every day. For a day's cooking around 21 Kgs of Commercial Liquefied Petroleum Gas (LPG) (each cylinder weighing 19 kgs) is required and costs nearly Rs.1,650/- per day and Rs.41,250/- per month. To cut cost on the LPG cylinders, the CCMC initiated an innovative project by installing a 25 m^3 Capacity Kitchen waste based cum sewage water Hu-methane Biogas gas Plant at Amma Unavagam Premises at Saravanampatti in Ward No.31 of the North Zone. The Kitchen wastes of quantity 500 Kgs collected in the form of organic vegetable wastes, stale cooked/uncooked food wastes, etc., from the hotels and restaurants including the sewage water collected in and around the Saravanapatti areas are processed in this plant. The Bio-gas produced through anaerobic digestion of Kitchen wastes and the sewage water is burned to generate Clean Renewable Energy.The methane gas produced at the plant is 25 m^3 per day. After installation of the Biogas cum Hu-methane gas plant, the usage of LPG cylinders has been reduced to only 2 Nos per month.

Major projects

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

The aim of the mission is to provide basic services (e.g. water supply, sewerage, urban transport) to households and build amenities in cities which will improve the quality of life for all, especially the poor and the disadvantaged. Under this programme, Government of India has selected 500 AMRUT Cities in the Country based on the urban population of the State/ UT. In which 27 Cities / Towns, have been selected in Tami Nadu viz., 12 City Municipal Corporations, 14 Municipalities and 1 Town Panchayats and Coimbatore City Municipal Corporation is one of them.

The Mission will focus on the following thrust areas,

- Water supply,
- Sewerage facilities and septage management,
- Storm water drains to reduce flooding,
- Pedestrian, non-motorized and public transport facilities, parking spaces, and
- Enhancing amenity value of cities by creating and upgrading green spaces, parks and recreation centers, especially for children.

The various infrastructure improvement projects have been proposed in the Coimbatore Corporation are given below with starting / completing year, with estimated cost and service level benchmarking of the proposed services.

Table 10: Water Supply Scheme (Source: Engineering Section, CCMC)

Project Name	Year in which to be implemented	Year in which proposed to be completed	Estimated cost (in Crore)
Improvement to water supply scheme-Added Area-(Kurichi, Kuniamuthur)	2015	2017	150.20
Improvement to water supply scheme-Added Area-(Saravanampatti, Vellakinar, Tudiyalur, Chinnavedampatti)	2016	2018	198.80
Improvement to water supply scheme-Added Area-(Kalappati, Vilankurichi)	2017	2019	103.00
AMR- Metering	2015	2020	305.00
Raw water Transmission Tunnel at Kattan Hills	2017	2018	150.00
Source Augmentation	2017	2020	765.00
Total			**1,672.00**

Table 11: Sewerage and Septage Management (Source: Engineering Section, CCMC)

Project Name	Year in which to be implemented	Year in which proposed to be completed	Estimated cost (in Crore)
Providing sewerage scheme (UGSS) facilities to newly added areas	2016	2020	1,556.00
For infrastructure facility for reuse of treated water	2018	2020	75.00
Total			**1,631.00**

Table 12: Storm Water Drains(Source: Engineering Section, CCMC)

Project Name	Year in which to be implemented	Year in which proposed to be completed	Estimated cost (in Crore)
Construction of Storm Water Drains-added areas	2016	2020	1,076.00
Total			**1,076.00**

Table 13: Urban Transport (Source: Engineering Section, CCMC)

Project Name	Year in which to be implemented	Year in which proposed to be completed	Estimated cost (in Crore)
Pedestrian Walkway and Cycle Track	2015	2020	376.00
Foot Over Bridge	2015	2020	27.00
NMT Parking at New Bus Stand at Vellalore	2018	2020	250.00
Around Bund Cycle Track	2015	2020	86.00
Multi-level Car Parking-Big Bazaar Street-(MLCP)	2016	2020	109.00
Total			**848.00**

Table 14: Other Projects (Source: Engineering Section, CCMC)

Project Name	Year in which to be implemented	Year in which proposed to be completed	Estimated cost in Crore
Amrut children Park	2015	2020	40.00
Green Park around Bund	2015	2020	90.00
Total			**130.00**
Grand Total			**5,357.00**

Table 15: Summary of the Finance Share Sector Wise (Source: Engineering Section, CCMC)

Sector Wise	GOI 33.33%	State 20%	ULB 46.67%	Total
Water Supply Schemes	557.33	334.00	780.67	1,672.00
Sewerage and Septage	543.67	326.00	761.33	1,631.00
Storm Water Drains	358.67	215.00	502.33	1,076.00
Urban Transport	282.67	170.00	395.33	848.00
Other Projects	43.33	26.00	60.67	130.00
Total	**1,742.34**	**1,045.00**	**2,439.66**	**5,357.00**

An assessment of the projects proposed under the AMRUT scheme, shows that a large number of these projects have a potential for building urban resilience in Coimbatore. For instance, improved water supply, better sewerage network, storm water drains, particularly to the added and previously unserved or under-served areas, can have major beneficial impacts on the health of the population. Improved public and non motorised transport can reduce air pollution as well as have beneficial impacts on GHG emissions and public health. Development of green areas can reduce heat island effects that are particularly relevant for Coimbatore which has a relatively hot climate all year round.

Smart City

The Smart Cities Mission is a Centrally Sponsored Program of Government of India (GoI) under the Ministry of Urban Development (MOUD). Under this Mission, GoI envisaged support 100 cities with an outlay of Rs. 50,000 Crores with a matching grant from State Governments/Urban Local Bodies. Its duration will be five years from 2015-16 to 2019-20. There are twelve cities have been shortlisted in Tamil Nadu under the Smart Cities Mission. Coimbatore is one of the cities selected from Tamil Nadu.

Under the smart city implementation, the following projects have been proposed. The total project cost of Smart City Proposal is Rs.1570.00 Crores Out of this, Rs.1427.00 Cr. pertains to Area Based Development and Rs.143.00 Crores is for pan city proposal.

Table 16: Smart City Proposals

Projects	Amount in Crores
Area Development Plan	
Lake Restoration: De-silting, De-weeding, Bund strengthening, Drains, Treatment and allied facilities	189.00
Lake-front Development: Landscaped Cycling / walking tracks, Watch Towers, Viewing Galleries, Solar/LED Lighting, Boating / Water sports, Nature parks, Medicinal gardens	66.00
Re-configuring Arterial Roads with Footpath/ Cycle Tracks, Bike sharing, Landscaping, Drains/ducting, NMT bridges, Parking, Road surfacing, Signages, Bus shelters, 80 ft Road formation connecting Singanallur lake	271.00
Other Roads - Footpaths, Landscaping, Drains/ducting, Parking, Road surfacing and Signages	352.00
Rainwater Harvesting	11.00
Septage management	15.00

Projects	Amount in Crores
Solid Waste Management	23.00
Access to Toilets	4.00
Housing for All and Social Infrastructure	233.00
Energy	78.00
a. Project Development	62.00
b. Contingencies & Escalation	125.00
SUB TOTAL (i)	1427.00
PAN - CITY SOLUTION	
CCTV Surveillance and allied systems	84.00
LED Street lighting	59.00
SUB TOTAL (ii)	143.00
TOTAL (i) + (ii)	**1570.00**

A large number of the smart city project proposals of lake restoration and development, rain water harvesting, SWM and housing can have beneficial impacts on urban resilience that will be explored in later sections in detail. LED street lighting has substantial benefits of GHG emission reduction and reduction in energy consumption.

2 MW Power Plant

The city municipal corporation has proposed the setting up of a solar power plant at its old dumpyard in Kavundampalayam with a capacity to 2 MW of solar power under smart city mission, which could be fed into the power grid of TANGEDCO. The tender will be invited soon from the approved solar city consultants of Ministry of New and Renewable Energy, Govt. of India, for "Preparation of The Detailed Project Report for 2 MW RE plant at Kavudampalayam Old Compost Yard as per the guidelines of Ministry of New & Renewable Energy, New Delhi & Tamilnadu Electricity Regulatory Commission".

3. BASELINE ASSESSMENT OF GHG EMISSIONS

3.1 GHG Emissions Inventory

GHG emission inventory for year 2011 to 2015 was prepared under CapaCITIES project for Coimbatore. The emissions inventory comprises of two parallel analyses, one for the local government operations and one for all the emissions within the community determined by the geographical boundaries of the Municipality's jurisdiction.

Community-level inventories include emissions from community activities within the local government's jurisdiction. This includes emissions from sources and/or activities from stationary units (residential, commercial/institutional facilities, industrial, agricultural), mobile transportation units, waste, industrial processes and product use, and agriculture, forestry and land-use. A community-wide inventory is a useful planning tool in developing mitigation actions for the entire community.

Local Government operations inventories include emissions from all of the operations that a local government owns or controls. Sectors included in a local government operations inventory include local government buildings, facilities such as street lighting and traffic lighting, water, waste and sewage facilities, municipal vehicle fleet. Based on the baseline inventory, the local government can demonstrate leadership by pursuing mitigation efforts that illustrate the possibilities of mitigation actions to the community.

The majority of emissions from local government operations are usually a subset of the community emissions. The GHG inventory of a city is not simply the sum of GHG emissions from its community and those from local government operations. Many a times, the community inventory data already accounts for data pertaining to local municipal operations and due care should be taken to avoid double counting by adding such data to the community inventory again.

For example, community-wide electricity consumption data may already include electricity consumption in municipal facilities for water supply, sewage treatment and street lighting under relevant customer/end-user categories as prescribed under the electricity distribution and tariff arrangements. Adding electricity consumption data in such facilities, obtained from the respective departments within the local government, to the community-wide data again will result in double counting.

It must however be acknowledged that analysing community-scale 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 an analysis, from national to sub-national level results in a lower level of accuracy in reflecting the energy flows. Therefore, analysing GHG emissions at a local community level 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 are situated within the municipal boundary of Coimbatore and are therefore contributing to the Municipality's carbon footprint, as well as to the local air pollution.

3.2 Harmonized Emission Analysis Tool Plus (HEAT+)

In an effort to develop a comprehensive energy and carbon inventory, understand the city activities, measure the emissions, and provide options of mitigation measures best suited for the local government's development plans, an ICLEI emissions accounting software package was used to assist with the analysis. Harmonized Emission Analysis Tool Plus (HEAT+) 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 the tool used for GHG emissions. **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 on-line 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 TM (CCPTM) Campaign, this tool has been substantially updated to support cities in the implementation of ICLEI's latest Green Climate Cities Program. 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.

3.2.1 Data Sources and Collection

The baseline year for this study was the financial year of 2015-16 (i.e. April 2015-March 2016**)**. A full GHG inventory includes emissions from energy, waste, agriculture, 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 due to limited data availability.

A full GHG inventory includes emissions from energy, waste, agriculture, forestry and land-use change, the direct emissions from agriculture, land-use change and forestry sectors have not been included in the analysis as it is not happening with in city boundary.

ICLEI South Asia and Coimbatore Municipal Corporation are 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 was therefore collected and analysed.

Supply-side refers to the classification of both primary and secondary energy types that are distributed to the demand-side for use; these include liquid and solid fuels, electricity and renewables. Demand-side energy refers to the energy end user, i.e. the sectors like residential, commercial, industrial users of energy within and urban jurisdiction. The various sources of relevant data used in the report are elaborated in Table-17.

Table 17: Energy Data Sources

Fuel Type	Sector	Source of Data
Electricity	Residential	The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), TNEB
	Commercial/Institutional	The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), TNEB
	Manufacturing Industry and Construction	The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), TNEB
	Municipal Buildings	The Tamil Nadu Generation and Distribution Corporation Limited (TANGEDCO), TNEB and Corporation Budget Book (2015-16)
	Water treatment plant and pumping stations	JnNURM Section, Coimbatore Corporation and Corporation Budget Book (2015-16)
	drainage pumping stations and sewage treatment plants	JnNURM Section, Coimbatore Corporation and Corporation Budget Book (2015-16)
	Street lights	Engineering Department, Coimbatore Corporation
	Solid waste management – waste transfer stations / compost plants	SWM department, Coimbatore Corporation and UPL – compost plant operator
Diesel	Community Transport	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Manufacturing Industry and Construction	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Municipal Vehicles	SWM Department of Coimbatore Corporation & Corporation Budget Book (2015-16)
	DG sets at water pumping stations and water treatment plants	JnNURM Department of Coimbatore Corporation & Corporation Budget Book (2015-16)
	DG sets at drainage pumping stations and Sewage treatment plants	SWM Department of Coimbatore Corporation & Corporation Budget Book (2015-16)
Petrol	Community Transport	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Manufacturing Industry and Construction	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Municipal Vehicles	SWM Department of Coimbatore Corporation & Corporation Budget Book (2015-16)
LPG	Residential	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Commercial/Institutional	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
	Auto LPG – Transportation	Oil companies, Coimbatore – IOCL, HPCL, BPCL & Reliance
Kerosene	Residential	District Supply Office (DSO), Collector Office, Coimbatore
Transport Sector		Regional Transport Offices (RTO) of South, North & Central, Coimbatore
Solid Waste Management		SWM Department & Corporation Budget Book (2015-16)

Fuel Type	Sector	Source of Data
Municipal Water Supply		Engineering & JnNURM Departments & Corporation Budget Book (2015-16)
Municipal STP		JnNURM Department & Corporation Budget Book (2015-16)
Municipal Street Lighting		Engineering Department & Corporation Budget Book (2015-16)
Municipal Vehicle Fleet		SWM Department & Corporation Budget Book (2015-16)

3.2.2 Summary of Trends in Energy Consumption and GHG Emission Baseline

Overall economy wide energy consumption trend has been shown in Figure 9. Trend of energy consumption is linearly increasing by 0.81% from 2012-13 to 2015-16; there is a 8% reduction in the energy consumption in the transport sector, while stationary energy use (buildings - residential, commercial & industrial) increases by more than 40%. Trend of GHG Emissions (Figure 10) also shows an increase of 7.32% in the year 2016, from 2012-13 to 2015-16. Emissions from stationary energy use (more than 30%) and waste disposal (~22%) largely contribute to this increase.

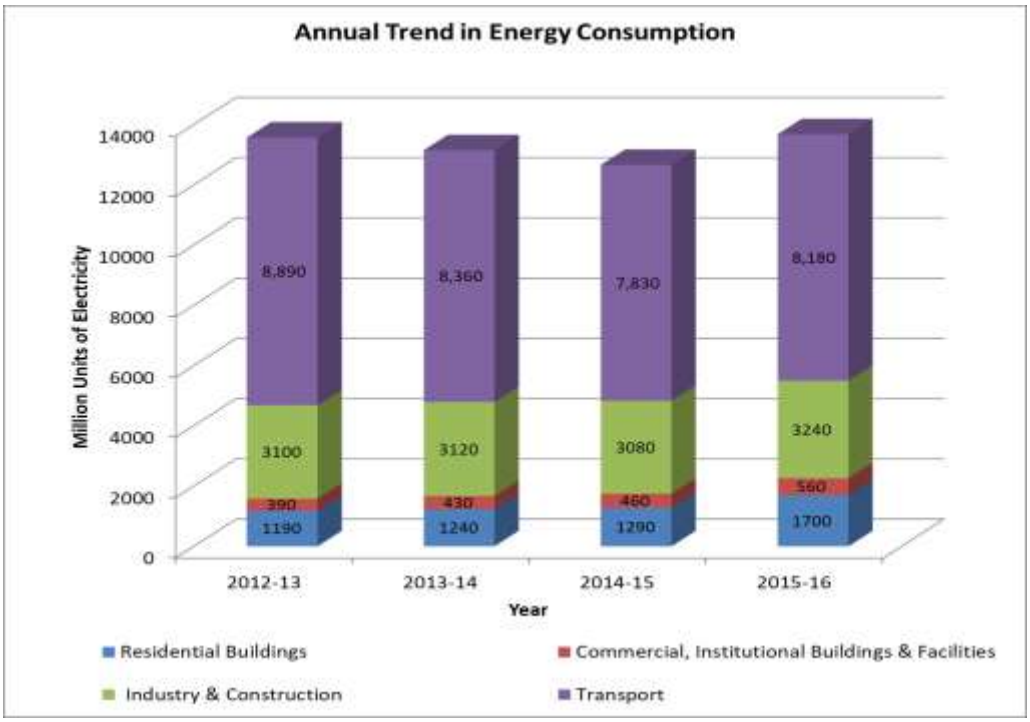


Figure 9: Annual Trend in Energy Consumption (2013 – 2016)

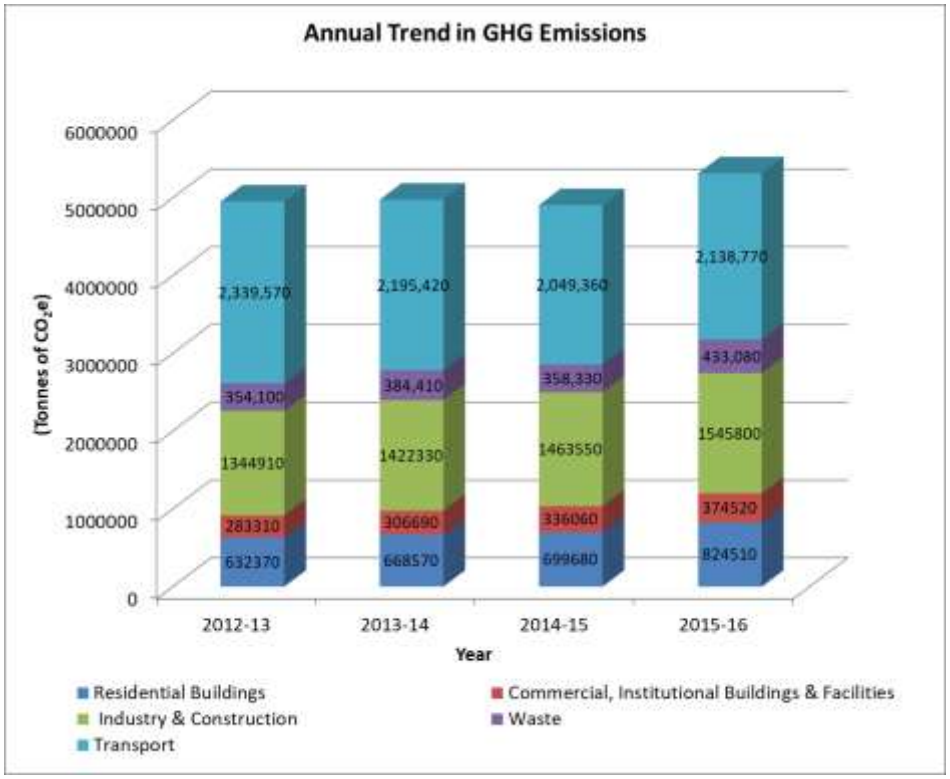


Figure 10: Annual Trend in GHG Emissions (2012-13 to 2015-16)

3.2.3 Energy Consumption and GHG Emission Baseline

2015-2016 is considered as the baseline for the Climate Resilient City Action Plan in Coimbatore. Figure 11 gives a summary of the energy baseline in 2015-16. On-road Transportation is the largest consumer of energy in Coimbatore, accounting for approximately 43% of the energy use. This is followed by energy use in manufacturing industry and construction sector which accounts for approximately 31% of the energy consumption. The residential sector and commercial / institutional sectors are contributing 16.66% and 7.57% respectively. The municipal facilities contribute to 1.31% of the total energy consumption.

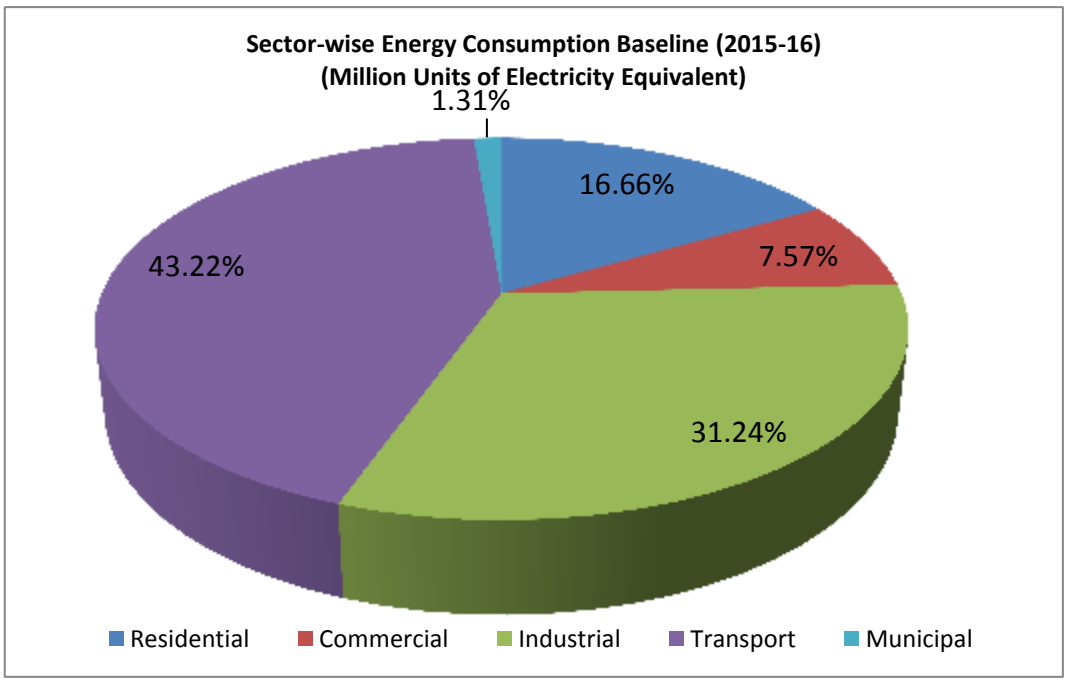


Figure 11 Share of Energy Consumption by Sector in Coimbatore, 2015-16

In line with the trends of energy demand, the major contributors to GHG emission is on-road transportation sector, followed by manufacturing industry and construction and residential sectors (see Figure 12). The on-road transportation sector energy use contributes to approximately 40% of the total GHG emission while manufacturing industry and construction sector accounts for approximately 29% of the emission. Percentage share of the residential, waste sector and commercial/institutional sector are 15%, 8%, and 7% respectively.

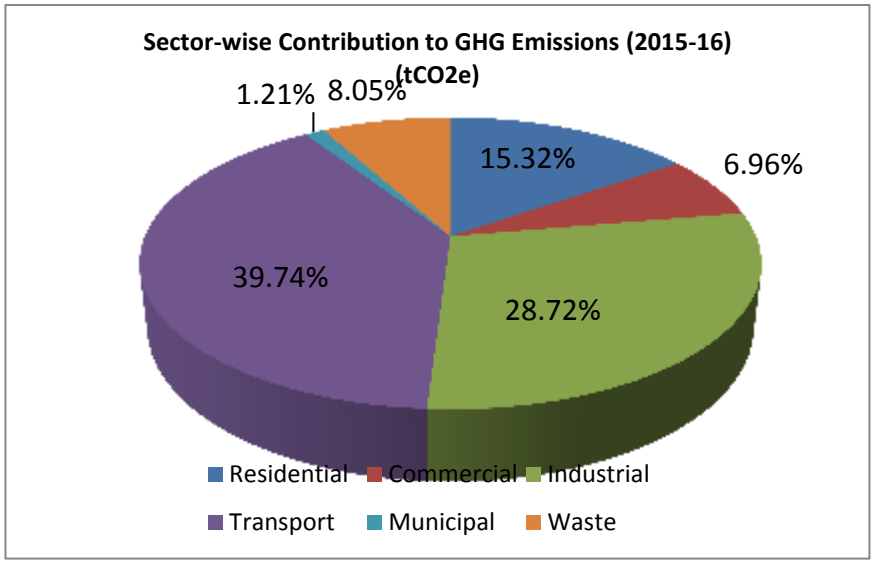


Figure 12: Share of GHG Emission by Sector in Coimbatore, 2015-16

The key sustainability indicators for Coimbatore city for the year 2015-16 have been provided in the Table 18. These indicators can enable comparison with the other Indian cities as well as cities around the globe. However, such comparison should be done with due caution since results may vary across cities, even amongst those located in the same country, on account of the differing local context (in terms of socio-economic conditions and drivers), data availability and data management practices followed in the cities, and the overall methodology adopted for developing GHG inventory.

Table 18: Key Sustainability Indicators for Coimbatore City

Sustainability Indicator	Unit of Measure	Coimbatore (2015-16)
Energy consumption per capita	GJ/capita	22.97
GHG emission per capita	tCO_2e/capita	2.44
Energy consumption per household	GJ/HH	114.87
GHG emission per household	tCO_2e/HH	12.20
Energy consumption per unit area	GJ/sq. km	192,276.35
GHG emission per unit area	tCO_2e/sq. km	20,415.34

3.2.4 Supply Side Energy and Emissions

Supply-side refers to the classification of both primary and secondary energy types that are distributed to the demand-side sectors for use; these include liquid, solid and gaseous fuels, electricity and renewables.

Grid electricity is the dominant energy type, typically associated with consumption in residential, commercial/institutional and industrial sectors. Petroleum products are the second dominant fuel type consumed, typically used for community transportation in the city as well as in the industrial sector

Diesel and related energy use is the predominant in Coimbatore and makes up 40.46% of the energy mix. being used prominently in all sectors (See Figure - 8) and followed by petrol, electricity, LPG and kerosene. In terms of GHG emissions, electricity emission contributes nearly 40% and followed by diesel, petrol, LPG in Coimbatore.

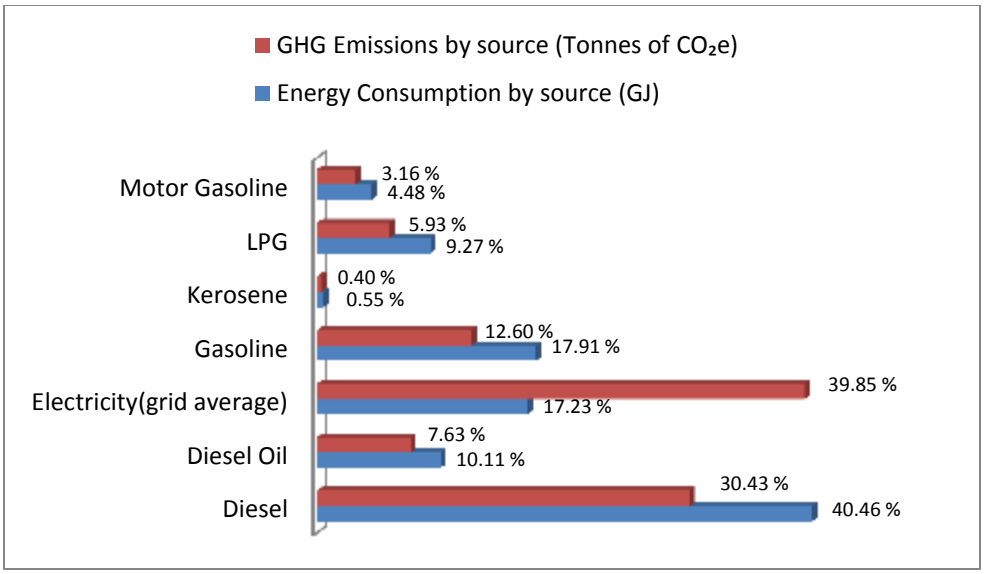


Figure 13: Share of Energy Consumption and GHG Emission by Energy Source

3.2.5 Energy Indirect Emissions from Grid Electricity at the Community Level

The pattern of grid electricity from manufacturing industry and construction is significantly increasing in the last four years followed by residential and commercial (see Figure 11).

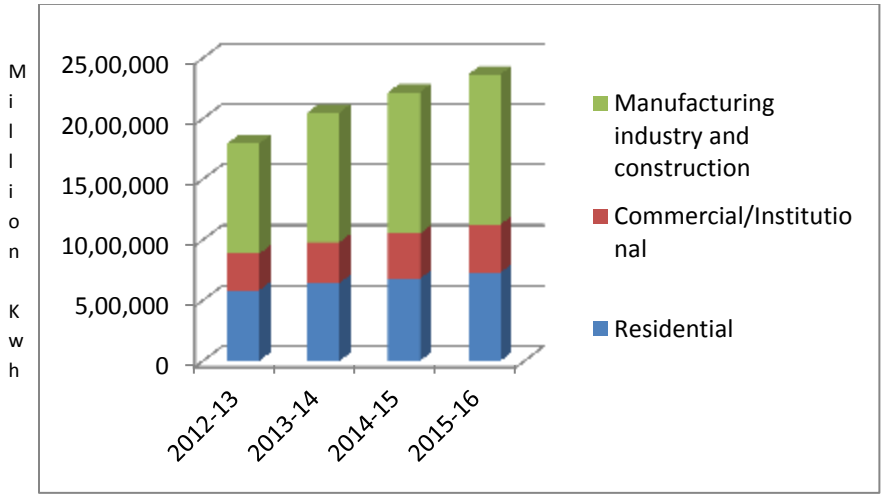


Figure 14: Trend of Electricity Consumption by Sectors

The Manufacturing Industry and Construction sector is the largest end user of electricity accounting for almost half of the city-wide consumption. This is followed by residential and the Commercial/Institutional Sectors, which consume 31% and 17% respectively. (See Figure 12)

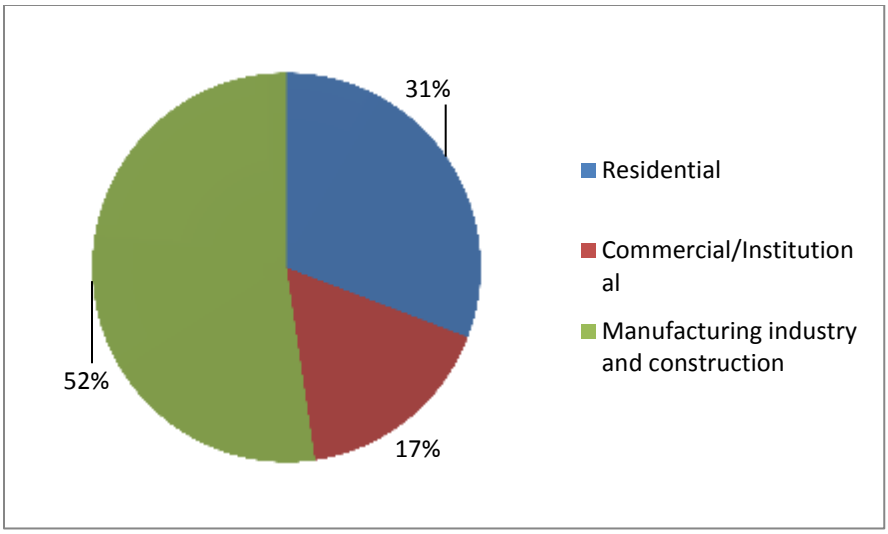


Figure 15: Share of Electricity Consumption by sector in 2015-16

GHG Emissions from Electricity Consumption

The total GHG emission from electricity generated in the year 2015-16 in Coimbatore was 1,946,336 tCO2e. Since the GHG emission is derived by multiplying the applicable single emission factor with the electricity consumption values, the sectoral shares of GHG emission are the same as those for consumption of electricity. The Manufacturing Industry and Construction sector is the largest contributor, emitting 1,019,039 tCO2e. Followed by the residential and commercial / institutional sectors emits 599,994 tCO2e and 327,303 tCO2e respectively.

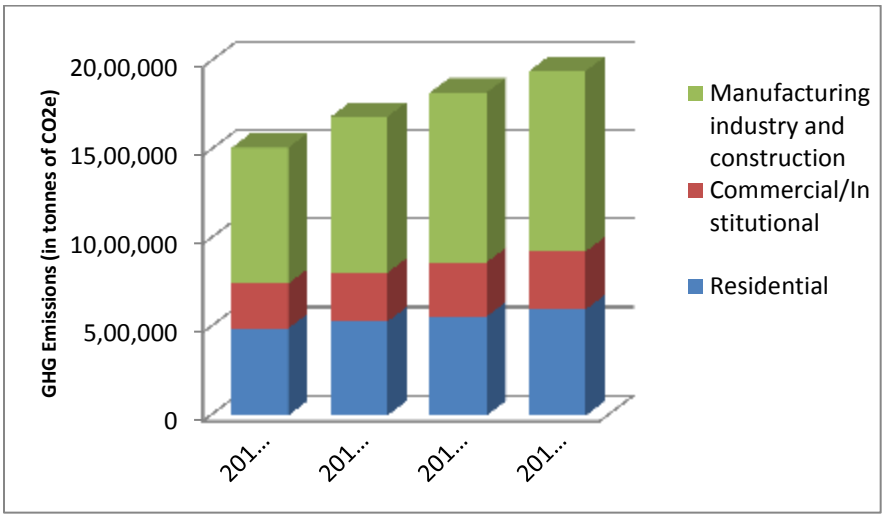


Figure 16: Sector-wise trend of GHG Emission from Electricity Consumption

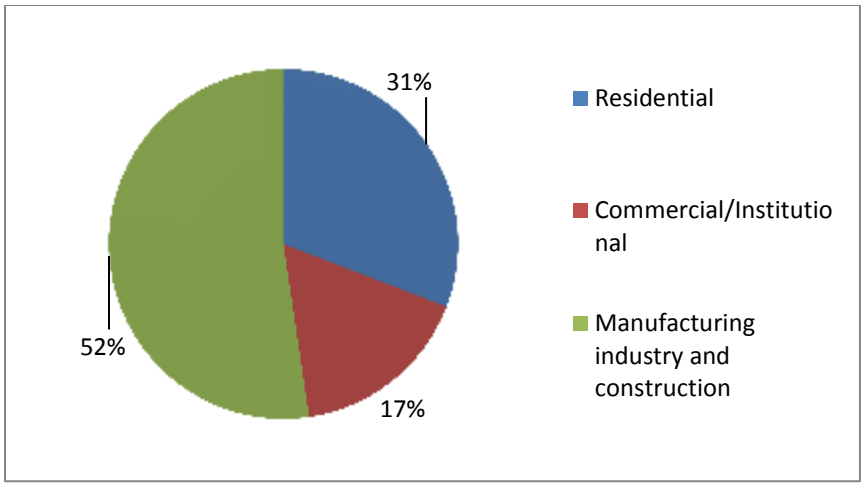


Figure 17: Share of GHG emission by sector from electricity in 2015-16

3.2.6 Direct Emission from Stationary Combustion at the Community Level

Stationary combustion refers to the fuel use for all purposes other than transportation (e.g. burning of kerosene and LPG for residential use, furnace oil used for industrial purposes). The direct GHG emissions are driven by the volume and type of fuels used for stationary combustion across sectors such as residential, commercial/institutional and industrial. The direct emissions are estimated by multiplying the fuel consumption by the specific GHG emission factor for the fuel.

Residential Buildings Sector:

The fuels used to meet cooking and heating requirements in the Residential Buildings sector in the city are kerosene and LPG. The LPG is retailed by the oil companies through the distributors within the Coimbatore. Subsidized kerosene is distributed through the Public Distribution System (PDS) and plays an important role in meeting energy demands, particularly for low income households. Trend of LPG consumption is increasing while kerosene consumption is decreasing (see figure 15 and 16).

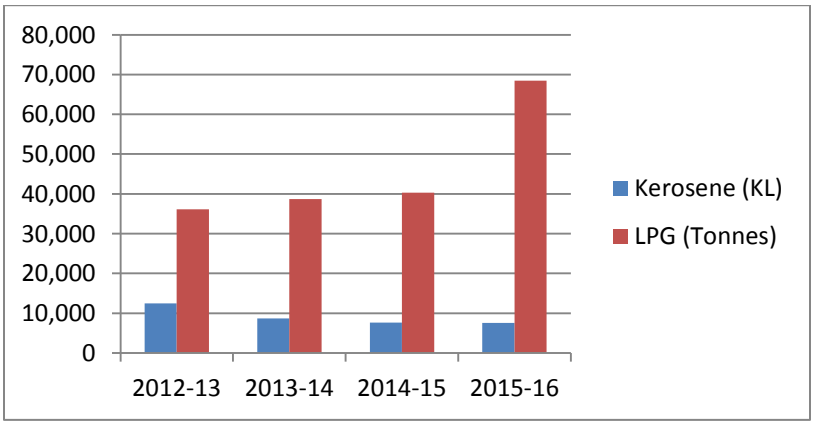


Figure 18: Trend of Fuel (Kerosene, LPG and PNG) Consumption by Residential Buildings Sector

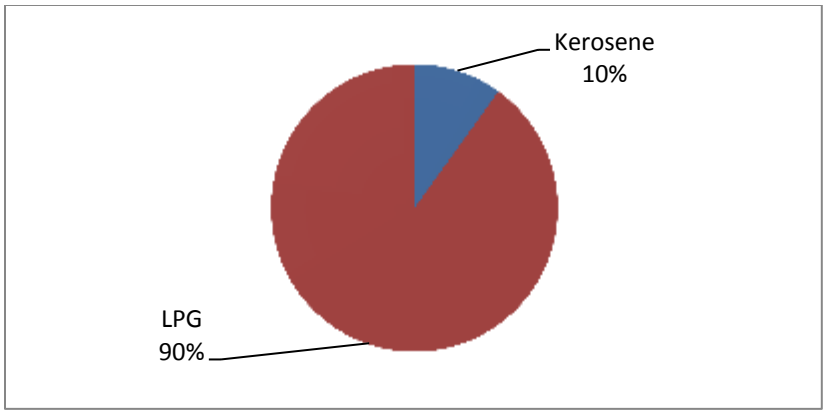


Figure 19: Share of Stationary Energy Use by Fuel in the Residential Buildings Sector, 2015-16

GHG Emissions from Stationary Fuel-use in Residential Buildings Sector: In the last four years, there has been a marginal decrease in the kerosene emissions generated from stationary fuel use in Coimbatore. The CO2 emissions from stationary fuel use fell from 32339.25 tCO2 in 2012-13 to 19578 tCO2 in 2015-16. The LPG emission increased from 108076.12 tCO2 in 2012-13 to 204939 tCO2 in 2015-16. This trend has been demonstrated in Figure-22.

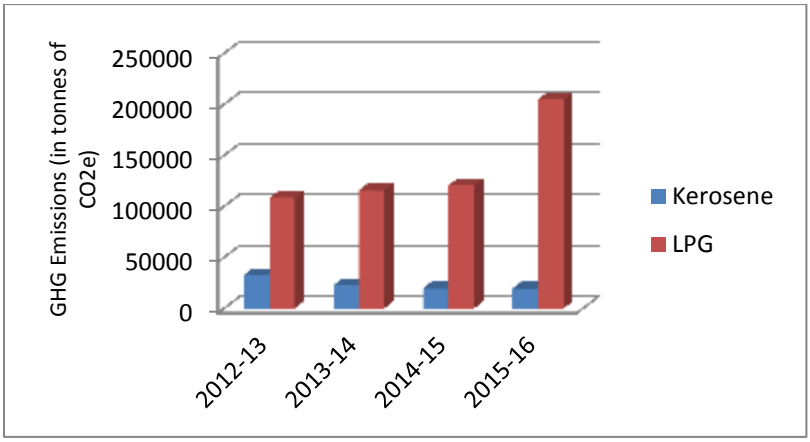


Figure 20: Trend of GHG emissions by Stationary Fuel in the Residential Buildings Sector

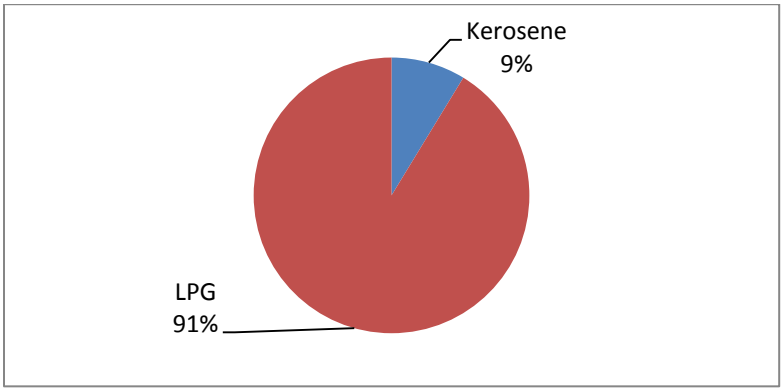


Figure 21: Share of GHG emissions by Stationary Fuel in the Residential Buildings Sector, 2015-16

Commercial and Institutional Buildings/Facilities Sector

The primary fuels used by commercial end users in Coimbatore such as hotels, shops, malls, educational institutes, private office buildings etc. liquefied petroleum gas (LPG), combusted mainly to meet energy requirements for cooking and water heating purposes. Bharat Gas, Hindustan Gas and Indane are the companies supplying LPG to commercial/institutional and residential sectors, through a network of dealers.

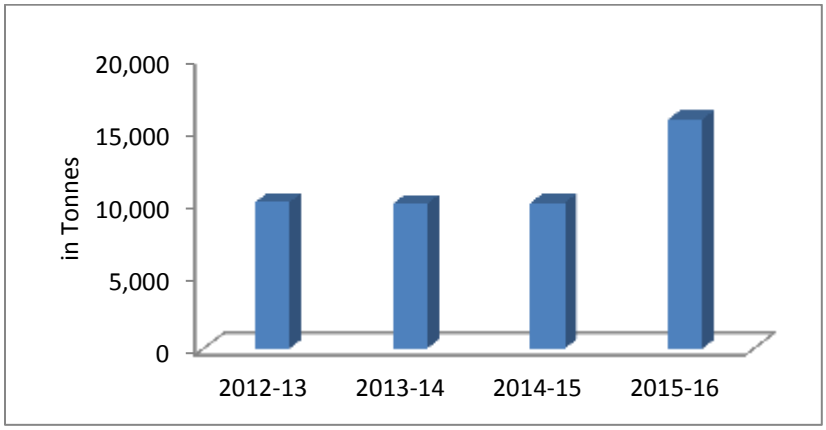


Figure 22: Trend of LPG fuel Consumption in the Commercial/Institutional Sector

GHG Emissions from Stationary Fuel-use in Commercial/Institutional Sector: There has been an increase in the level of emissions generated from stationary LPG fuel use in Commercial/Institutional sector. The CO2 emissions from stationary LPG fuel use increased from 30150.83 tCO2 in 2012-13 to 47212 tCO2 in 2015-16. This trend has been demonstrated in Figure-20.

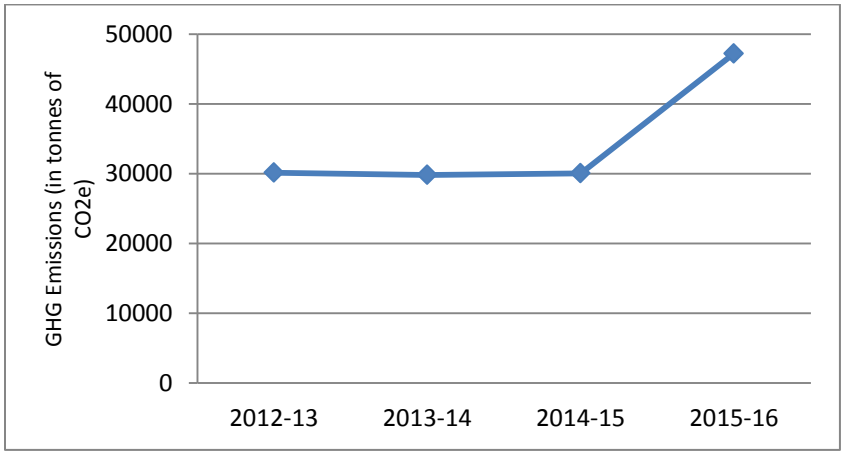


Figure 23: Trend of GHG emissions from Commercial/Institutional Sector

Manufacturing Industries and Construction Sector

Coimbatore is the second most important city in the state of Tamil Nadu after Chennai. It is one of the fastest growing cities in India and is a major hub for textiles, industries, commerce, education, information technology, healthcare, and manufacturing. There are a number of cotton production

and textile industries located in and around the city, giving it the name of 'Manchester of South India'.

The major fuels consumed to meet industrial energy demand in the city are petrol and diesel. The petrol and diesel are supplied through the various dealers located in and around the city.

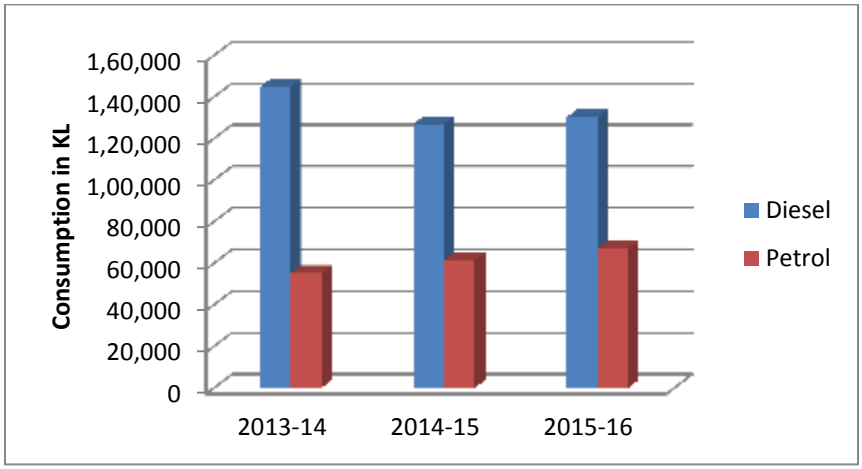


Figure 24: Trend of Fuel Consumption in Manufacturing Industries and Construction Sector

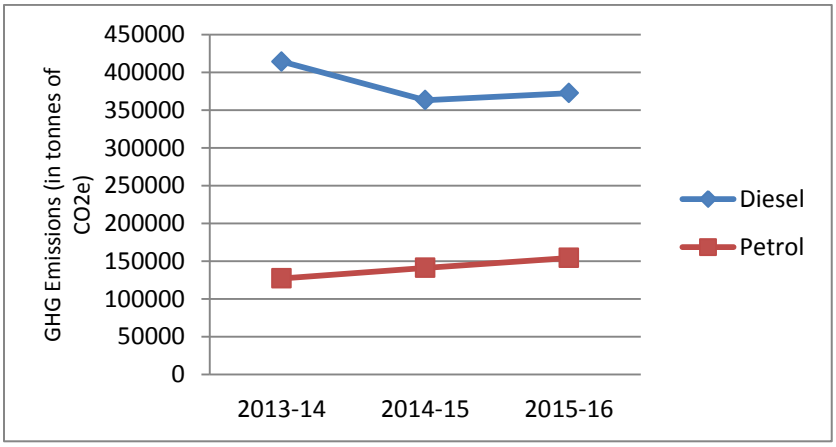


Figure 25: Trend of GHG Emission from Stationary Fuel Use in Manufacturing Industry and Construction Sector

3.2.7 On-road Transportation

The major fuels used for transportation are diesel, petrol and LPG. Bharat Petroleum Corporation Limited (BPCL), Hindustan Petroleum Corporation Limited (HPCL) and Indian Oil Corporation Limited (IOCL) are the oil companies retailing the petrol, diesel and LPG fuels across petrol pumps and gas stations in the city.

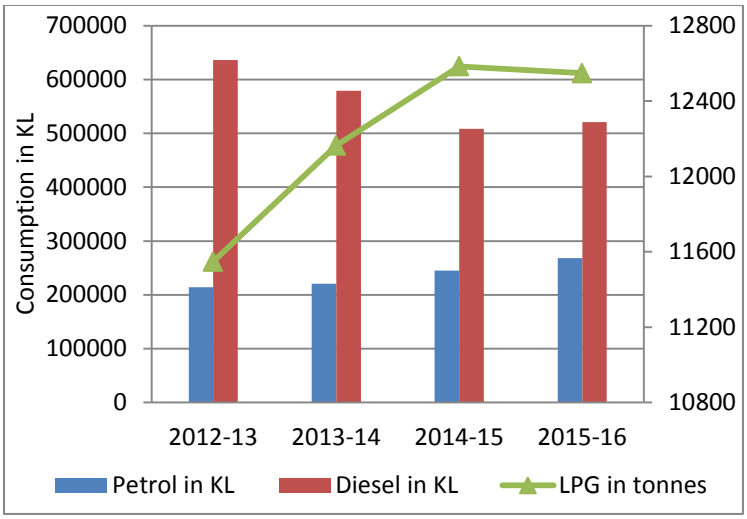


Figure 26: Trend of Fuel Consumption for Road Transportation

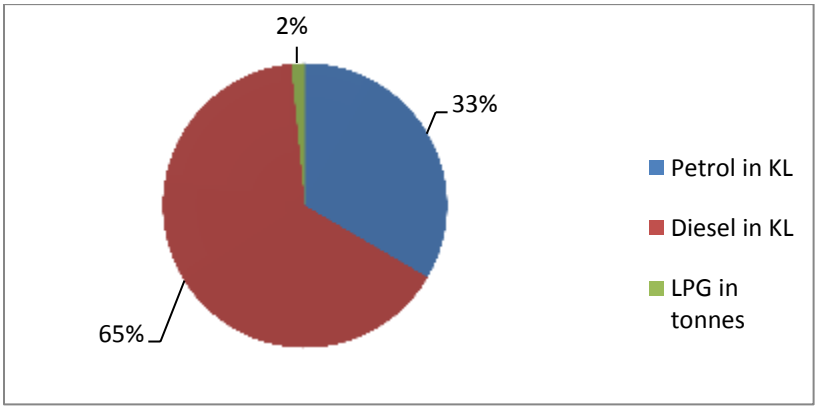


Figure 27: Share of stationary Energy Use by fuel in the road transportation, 2015-16

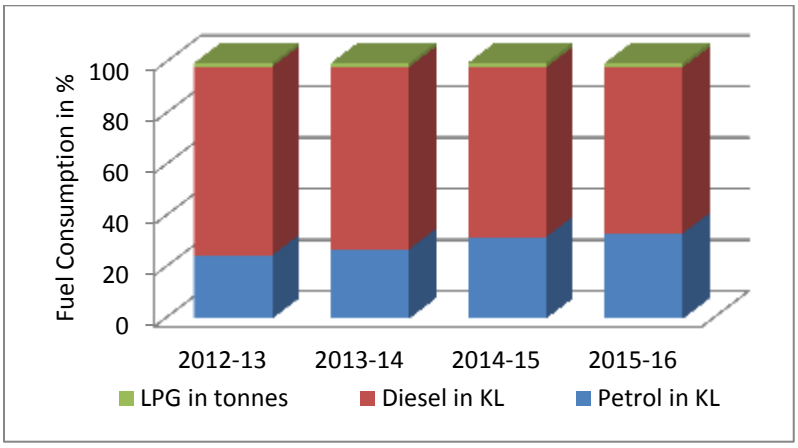


Figure 28: Share of Energy Use by Type of Fuel in the Transport Sector

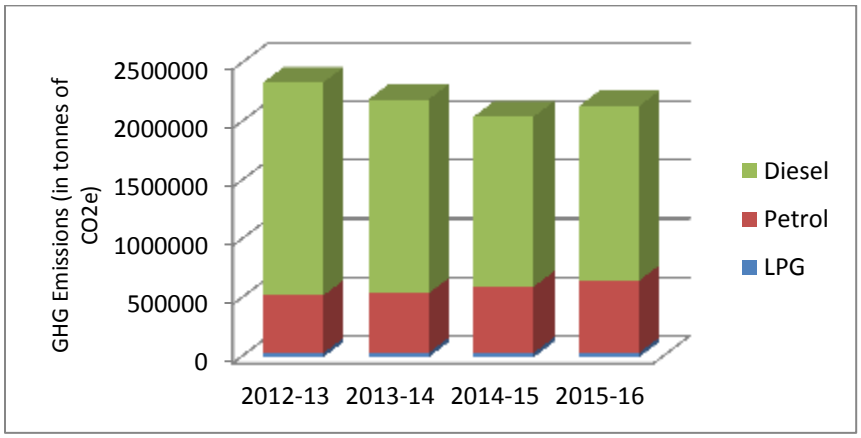


Figure 29: Trend of GHG emissions from On-road Mobile Sources

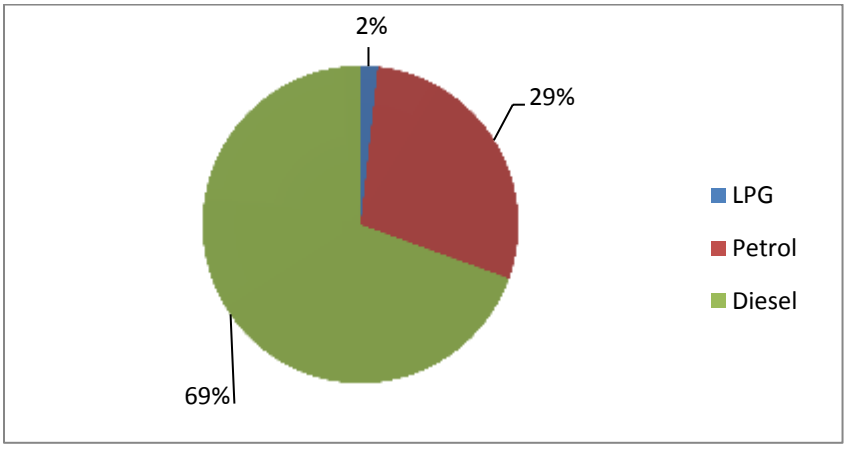


Figure 30: Share of GHG emissions from On-road Mobile Sources, 2015-16

3.2.8 Solid Waste Treatment and Disposal at the community level

Municipal solid waste (MSW) generally includes degradable matter (such as paper, textiles, food waste, straw and yard waste), partially degradable matter (such as wood, disposable napkins, sludge) and non-degradable materials (such as leather, plastics, rubbers, metals, glass, ash from fuel burning like coal, briquettes or woods, dust and electronic waste)[9]. Anaerobic decomposition of bio-degradable matter present in MSW generates GHG emission. CH_4 emissions from solid waste disposal sites are the largest source of GHG emission in the Waste Sector10. The direct GHG emissions from solid waste can be estimated based on parameters such as the solid waste generation, its composition and management of the landfill site.

[9]Jha, A.K. et al., Greenhouse gas emissions from municipal solid waste management in Indian mega-cities: A case study of Chennai landfill sites, Chemosphere (2007)

[10] IPCC Guidelines for National Greenhouse Gas Inventories, Volume 5: Waste. Prepared by the National Greenhouse Gas Inventories Programme. Available online at http://www.ipcc-nggip.iges.or.jp/public/2006gl/index.html

The total daily solid waste generation in Coimbatore city for the year 2015-16 is approximately 855 metric tonnes per day. So far as the waste characterization is concerned, it is highly composed of food waste (52%) followed by mixed bulky plastic & metals (7.60%), cloths (7.40%) and mixed plastic & paper waste (6.30%). Part of the solid waste goes for composting and the rest of it goes for open dumping.

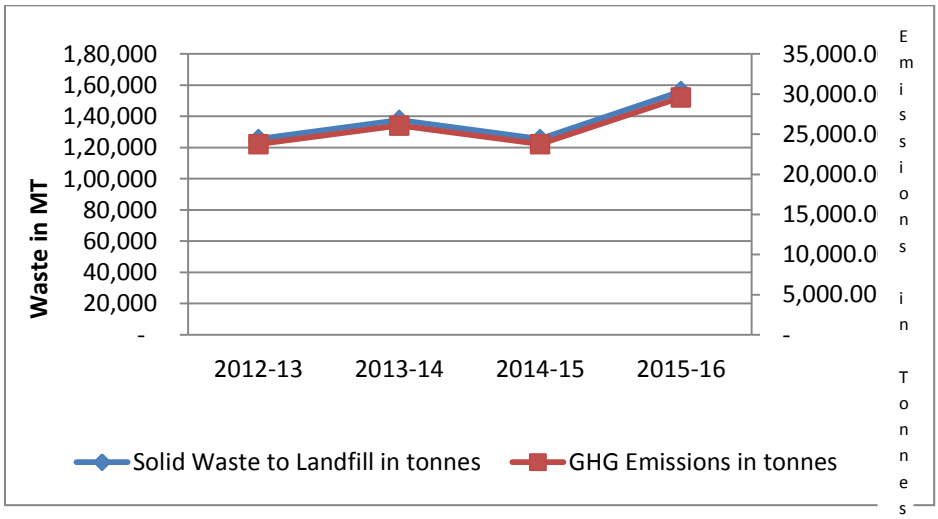


Figure 31: Trend of Generation and Processing of Solid Waste

3.2.9 Waste Water Emissions at city level

Besides solid waste, waste water has also been considered for the purpose of accounting emissions in the waste sector. The following table gives an understanding of the amount of waste water generated in the city over the years.

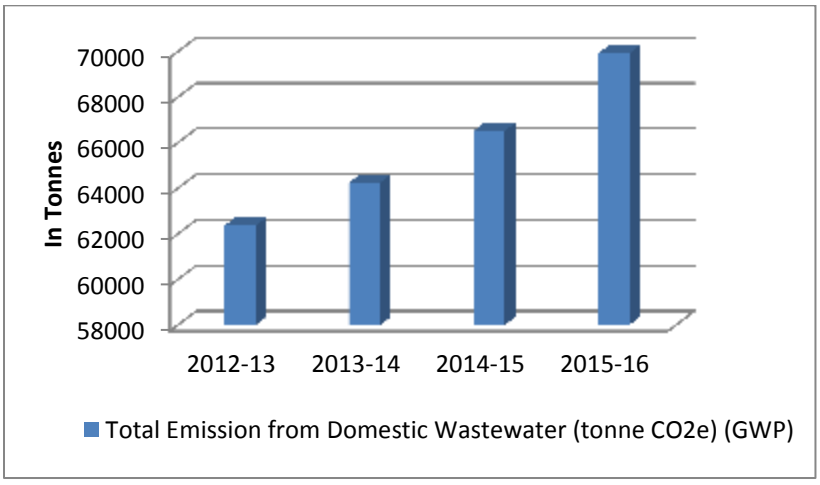


Figure 32: Trend of Waste Water Emissions at city level

3.2.10 Emissions from Municipal Operations and Facilities

Energy Indirect emission from Municipal Facilities and Buildings

Coimbatore has consumed a total of 60.00 million kWh in its municipal facilities and buildings in 2015-16. Street light facilities consume highest electricity, which is 46.37 million kWh followed by water / waste water 9.16 million kWh and building sector consuming 4.47 million kWh.

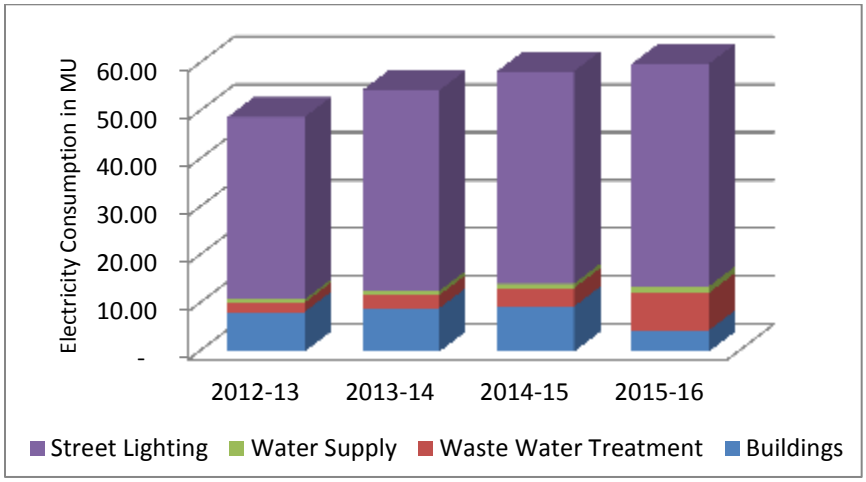


Figure 33: Trend of Electricity Consumption in Municipal Buildings and Facilities

Street light accounts for 77% of the total municipal electricity consumption. This is followed by waste water treatment plants, municipal buildings and water supply, which consume 13%, 8% and 2% respectively. (See Figure 31)

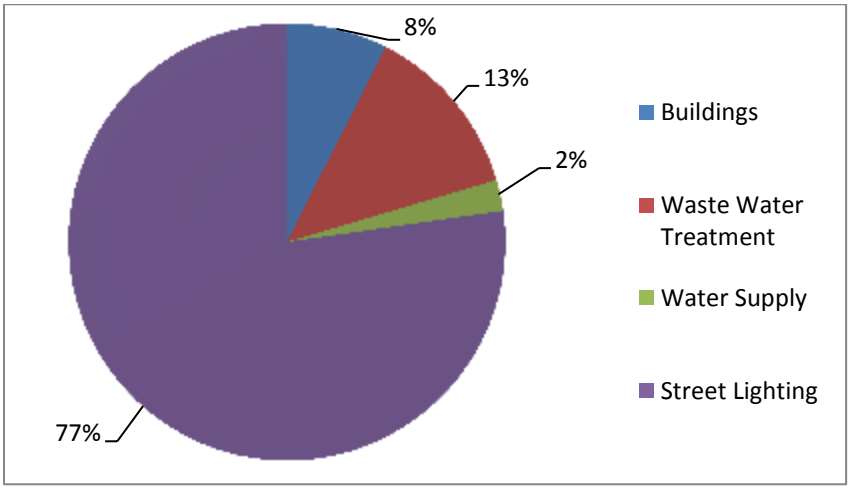


Figure 34: Share of Electricity Consumption in Municipal Buildings and Facilities, 2015-16

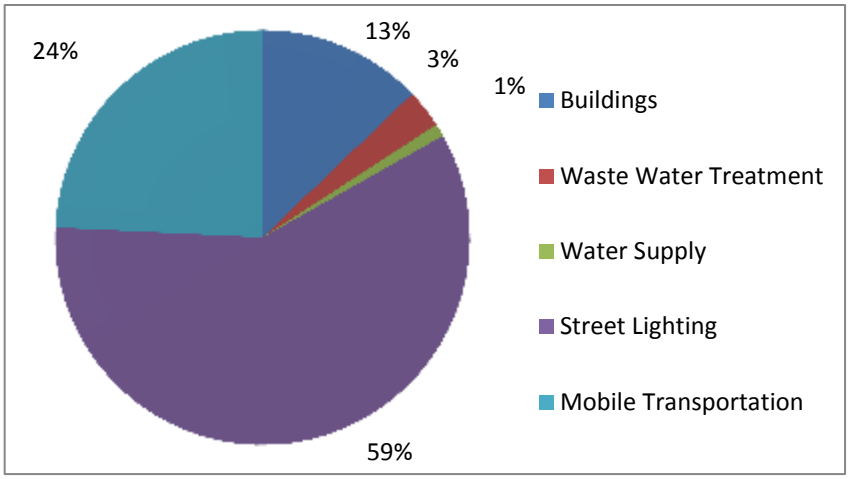


Figure 35: Share of stationary fuel use in Municipal Buildings and Facilities, 2015-16

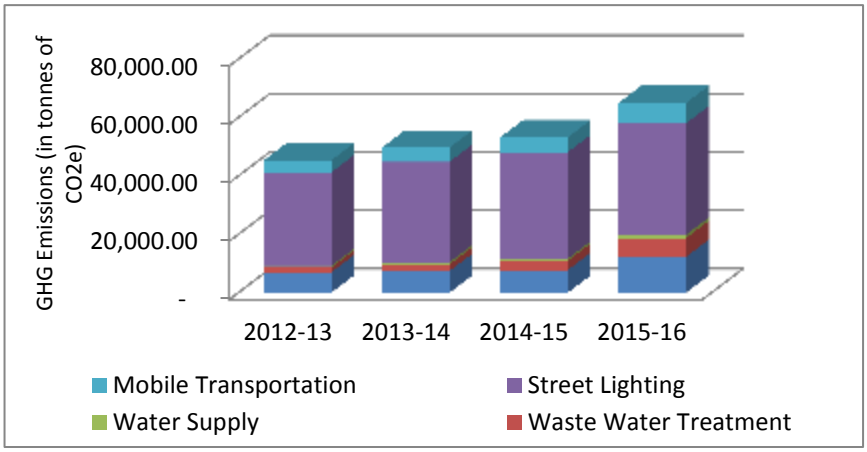


Figure 36: Trend of GHG emission from Municipal Building and facilities

3.3 Energy and GHG Emissions Projections

Climate Resilient Cities Action Plan is prepared for 5 years, with a long term vision for 20-30 years that is determined by the local authority. Energy consumption and GHG emissions are projected by using Tool 3.1E: GHG Emissions Forecasting for medium term (yearly from 2016-17 to 2025-26) and long term scenario (every 5 years from 2026-27 to 2049-50) (SeeFigure 38).

Stationary fuel and electricity consumptions have been projected by using Geometric mean of past four years for community sectors. Energy consumption from utility services/ facilities (i.e. water supply, drainage and solid waste management) has been projected based on population growth (by taking average of population projection by arithmetical increase method, geometrical increase method and incremental increase method) and future planning of Rajkot Municipal Corporation (See Figure 37). Based on a forecast of the energy consumption, the corresponding GHG emissions are calculated using the HEAT+ software (See Figure 38).

37: Projected medium and long term Energy Consumption Scenario

Sectors	Energy Source/Activity	Baseline Activity Data		Projected Energy Use (Medium Term Scenario)			Projected Energy Use (Long Term Scenario)		
		Unit	2015-16	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
Residential Buildings	Electricity	MU	728.95	1056.28	1225.22	1530.60	2217.92	4657.04	9778.55
	Kerosene	kL	7571	3132.15	2200.48	1295.78	536.07	91.75	15.70
	LPG	tonnes	68481	198942.14	304782.11	577940.98	1678959.37	14169469.27	119582321.31
Commercial and Institutional Buildings	Electricity	MU	351.95	574.02	698.08	936.21	1526.93	4061.72	10804.43
	LPG	tonnes	15776	33311.99	44920.23	70340.30	148527.83	662239.58	2952721.11
Facilities	Electricity	MU		0.00	0.00	0.00	0.00	0.00	0.00
	Diesel	KL		0.00	0.00	0.00	0.00	0.00	0.00
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	MU	1238.06	2067.44	2538.10	3452.42	5765.19	16076.63	44830.79
	Petrol	KL	66986	97516.33	113322.12	141961.54	206663.61	437976.34	928190.87

Sectors	Energy Source/Activity	Baseline Activity Data		Projected Energy Use (Medium Term Scenario)			Projected Energy Use (Long Term Scenario)		
		Unit	2015-16	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
	Diesel	kL	130320	93468.59	81832.82	67037.88	48081.15	24733.41	12723.11
Waste	Solid Waste to Landfill	tonnes							
	Solid Waste to RDF	tonnes							
	Solid waste to Compost	tonnes	156138						
Mobility (Transportation)	Auto - LPG	tonnes	12548	14412.44	15233.61	16553.91	19013.57	25083.59	33091.45
	Petrol	kL	267943	390061.45	453282.84	567836.96	826635.92	1751844.33	3712587.96
	Diesel	kL	521282	373878.17	327335.46	268155.98	192329.04	98937.20	50894.91

38 : Projected medium and long term GHG emission Scenario

Sectors	Energy Source/Activity	Baseline GHG Emission (tonnes of CO2e) (using HEAT+)				Projected GHG emission (Medium Term scenario)		
		2015-16	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
Residential Buildings	Electricity	6,69,747	9,36,014.66	10,85,714.43	18,24,865.93	26,44,316.04	55,52,366.81	-
	Kerosene	16,409	6,788.52	4,769.26	1,386.17	573.46	98.15	-
	LPG	2,53,662	7,36,906.25	11,28,950.54	50,24,516.71	145,96,575.99	1231,86,860.95	-
Commercial and Institutional Buildings	Electricity	3,31,106	5,20,837.19	6,33,403.29	12,56,332.09	20,49,039.21	54,50,569.72	-
	LPG	54,824	1,15,764.49	1,56,105.01	4,44,489.95	9,38,567.68	41,84,782.48	-
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	11,70,244	18,84,762.10	23,13,837.25	47,43,509.25	79,21,189.90	220,88,782.16	-
	Petrol	1,65,835	2,41,417.83	2,80,547.67	4,74,610.47	6,90,924.57	14,64,256.90	-
	Diesel	3,47,588	2,49,298	2,18,263	1,37,056	98,300	50,566	-
Waste	Solid Waste to	-					7,58,694.85	9,45,138.00

Sectors	Energy Source/Activity	Baseline GHG Emission (tonnes of CO2e) (using HEAT+)				Projected GHG emission (Medium Term scenario)		
		2015-16	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
	Landfill							
	Solid Waste to energy		-4,29,786.60	-4,46,073.03	-4,75,286.86	-5,23,976.53	-6,50,642.78	-8,10,533.01
	Solid Waste to Compost	4,70,617	-	-	-	-	-	-
Mobile (Transportation)	LPG	499	22,394.92	23,670.90	28,737.11	33,007.00	43,544.38	-
	Petrol	1,55,865	9,65,660.50	11,22,175.32	18,98,399.37	27,63,619.20	58,56,787.14	-
	Diesel	2,54,811	9,97,204.16	8,73,065.91	5,48,235.75	3,93,210.16	2,02,273.73	-
	CNG	1,20,687	-	-	-	-	-	-
Total		40,11,893.41	62,47,262.2	73,94,430.0	159,06,851.7	316,05,346.3	1681,88,940.8	1,34,605.0

4. CLIMATE SCENARIO IN THE CITY

The Coimbatore city experiences moderate, salubrious climate due to its proximity to thickly forested mountain ranges and the cool breeze blowing through the Palghat gap which makes the consistently hot temperature pleasant. The average maximum and minimum temperatures recorded in the city are 35°C and 20°C respectively. Highest temperature ever recorded is 41°C and lowest is 12°C. The city in general experiences scanty rainfall since it falls in the rain shadow region of the Western Ghats. The total average annual rainfall is 614 - 647 mm. Coimbatore receives both North Eastern Monsoon and South Western Monsoon.

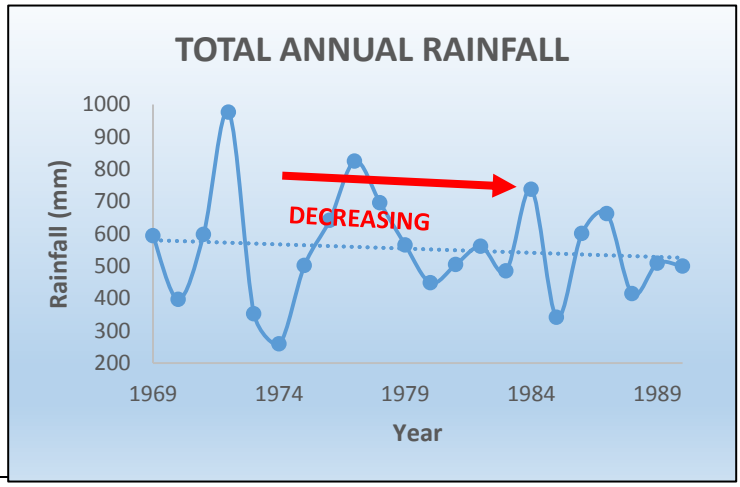
4.1 Past Trend

Tamil Nadu State Action Plan for Climate Change (TNSAPCC) indicates that annual rainfall has increased by 8.5% to 4.4% in the Cauvery basin and north of Cauvery basin in Tamil Nadu respectively in last 100 years. But river basins that are south of the Cauvery basin (Coimbatore lies in South of Cauvery basin) has experienced decrease in annual rainfall by 9.8%[11].

Coimbatore city is classified as iso-hyperthermic (steady very hot temperatures). Balasubramanian et al (1994) based on their analysis of the prevailing temperature in Coimbatore from 1962 to 1992 found that there was decadal variability in maximum and minimum temperature and this was on the rise up to 0.1 to 2.7°C.

TNSAPCC report also stated that onset of southwest monsoon over Tamil Nadu has advanced by one day over 20 years from 1901-2011. It shows decrease of number of rainy days over the state. However, there has been significant increase in the heavy precipitation events.

As part of the CapaCITIES project, IIT Madras conducted a trend analysis of climate data collected from Coimbatore Guage Stations. The annual rainfall trend shows a significant downward trend from the years 1970 to 1995. The annual maximum temperature and the annual minimum temperature show an increasing and decreasing trend over the same period. Thus the overall effect will be a wide range of temperature variability.



[11] Source: Tamil Nadu State Action Plan for Climate Change: http://www.moef.gov.in/sites/default/files/Tamilnadu%20Final%20report.pdf

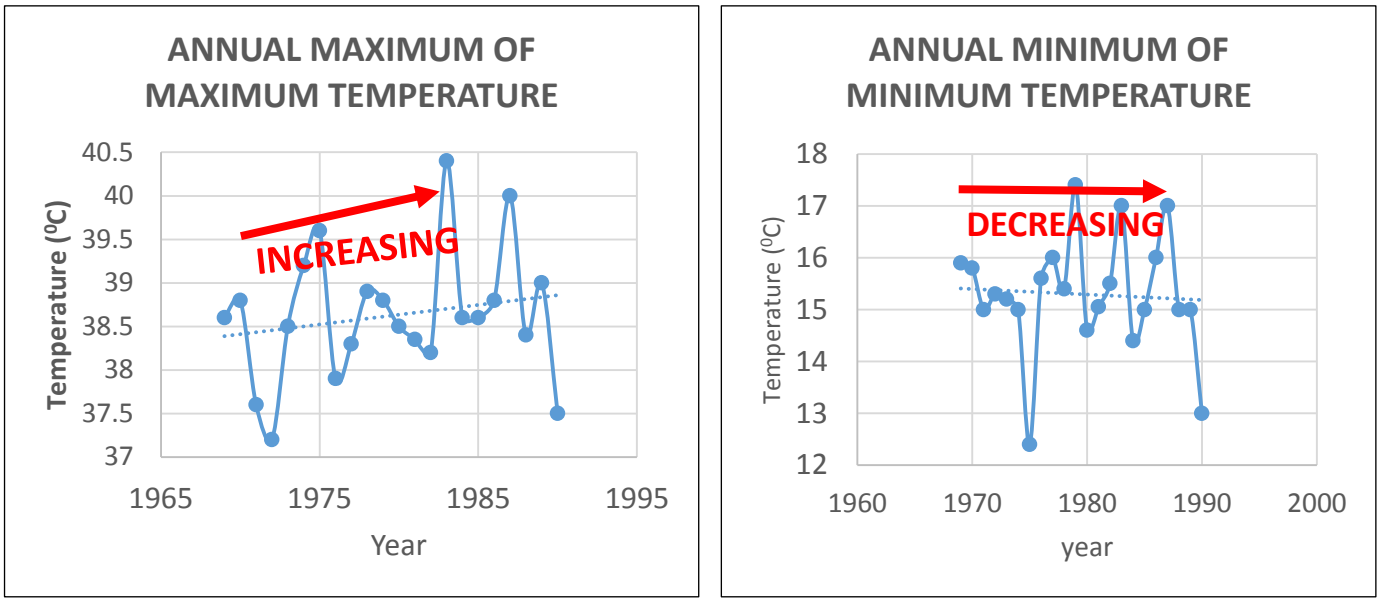


Figure 39: Trends of Rainfall and Temperature (IIT Madras, 2017)

4.2 Future Projection

The IIT Madras study used the daily observed data from 1984 for projections for RCP 2.6, 4.5, 6.0 and 8.5.

Table 19: Details of the RCP Models

RCP	Global warming increase (°C)		Definition
	2046-2065	2081-2100	
RCP2.6	1.0 (0.4 to 1.6)	1.0 (0.3 to 1.7)	Radiative forcing first increases to 3.1 W/m2 and then return to 2.6 W/m2 by 2100
RCP4.5	1.4 (0.9 to 2.0)	1.8 (1.1 to 2.6)	Total radiative forcing is stabilized before 2100 for reducing greenhouse gas emissions
RCP6.0	1.3 (0.8 to 1.8)	2.2 (1.4 to 3.1)	Total radiative forcing is stabilized after 2100 without overshoot for reducing greenhouse gas emissions.
RCP8.5	2.0 (1.4 to 2.6)	3.7 (2.6 to 4.8)	Increasing greenhouse gas emissions leading to high greenhouse gas concentration levels.

4.2.1 Rainfall Projections

A report (District Wise Climate Change Information for the State of Tamil Nadu) published by the Environmental Information System (ENVIS) Tamil Nadu, Government of Tamil Nadu, indicates an

increase of 0.1%, 4.0% and 11.0% rainfall (as shown in figure) over the Coimbatore district for the period of 2010-2040, 2040-2070 and 2070-2100 with reference to the baseline year 1970-2000[12].

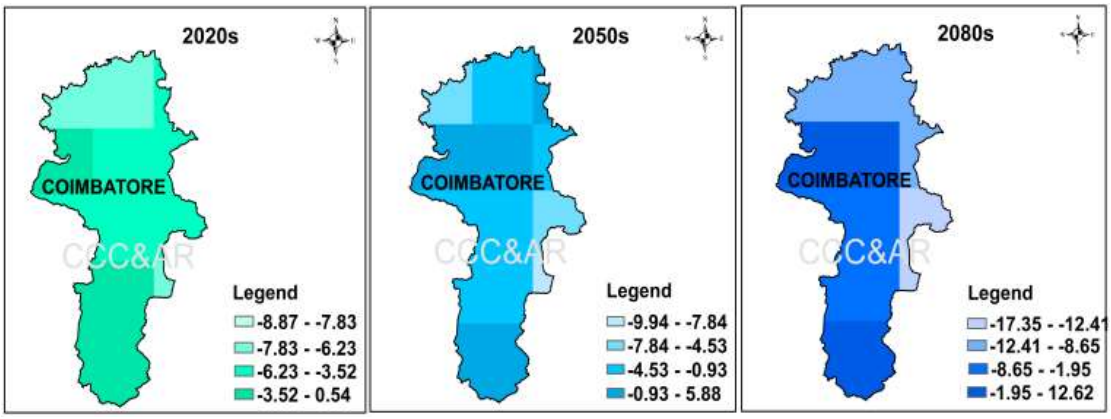


Figure 40: Percentage change in annual rainfall of Coimbatore District for the period 2020s, 2050s and 2080s

TNSAPCC reports slight decrease of annual rainfall (50 mm) over Tamil Nadu by the end of the century with reference to baseline years 1970- 2000. However, district wise projections (as shown in figure) indicate an increase of annual rainfall over Coimbatore district.

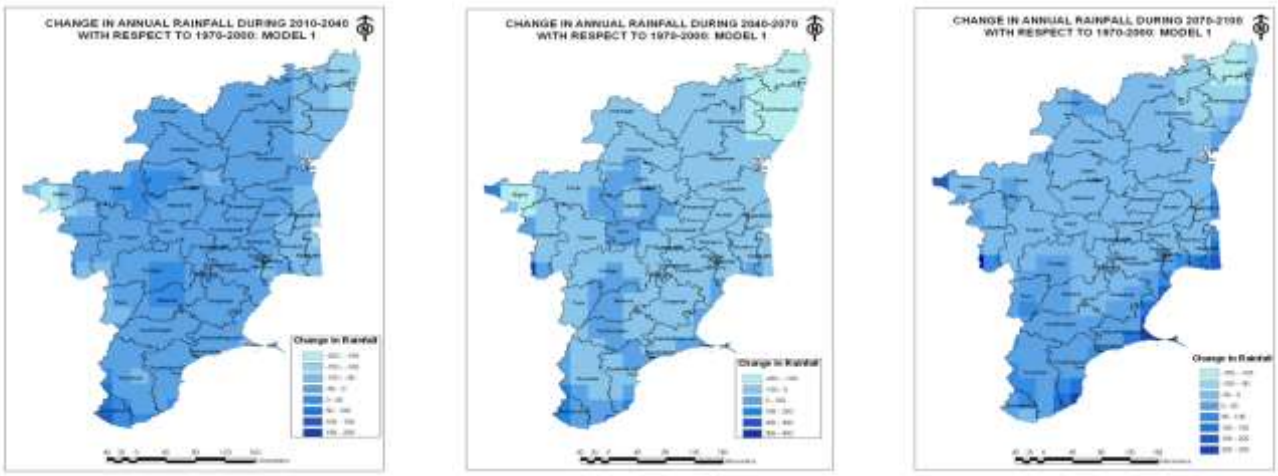


Figure 41: Change in annual rainfall (mm) projections for 2010-2040, 2040-2070 and 2070-2100 with reference to baseline (1970-2000)[13]

12 Source; District Wise Climate Change Information for the State of Tamil Nadu http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/17_COIMBATORE_RAINFALL.pdf

13 Source: Tamil Nadu State Action Plan for Climate Change: http://www.moef.gov.in/sites/default/files/Tamilnadu%20Final%20report.pdf

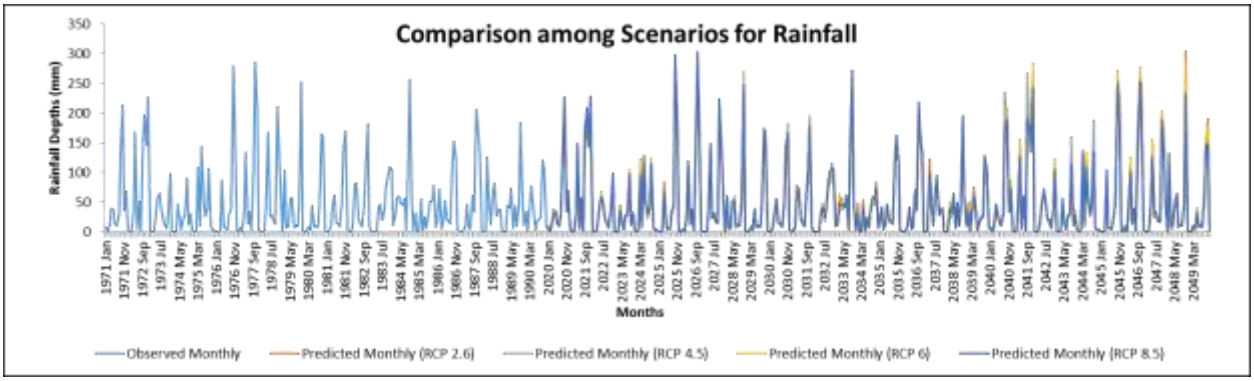


Figure 42: Comparison Scenarios for Rainfall

An analysis of the different RCPs conducted by IIT Madras shows that RCP 2.6 shows that the average annual rainfall will increase 1.5% in the next 30 years, RCP 4.5 shows that the average annual rainfall will decrease 4.5% in the next 30 years, while RCP 6 and RCP 8.5 has very less effect on overall annual rainfall i.e. it may shows a change of -0.5% and +0.5% respectively.

IIT Madras has also analysed the IDF (Intensity, Density and Frequency) Curves for the four RCP scenarios for different return periods of rainfall (2 years, 10 years and 100 years). This shows that as the duration of rainfall decreases, the intensity of rainfall is increasing in each RCP scenario as shown in figure below.

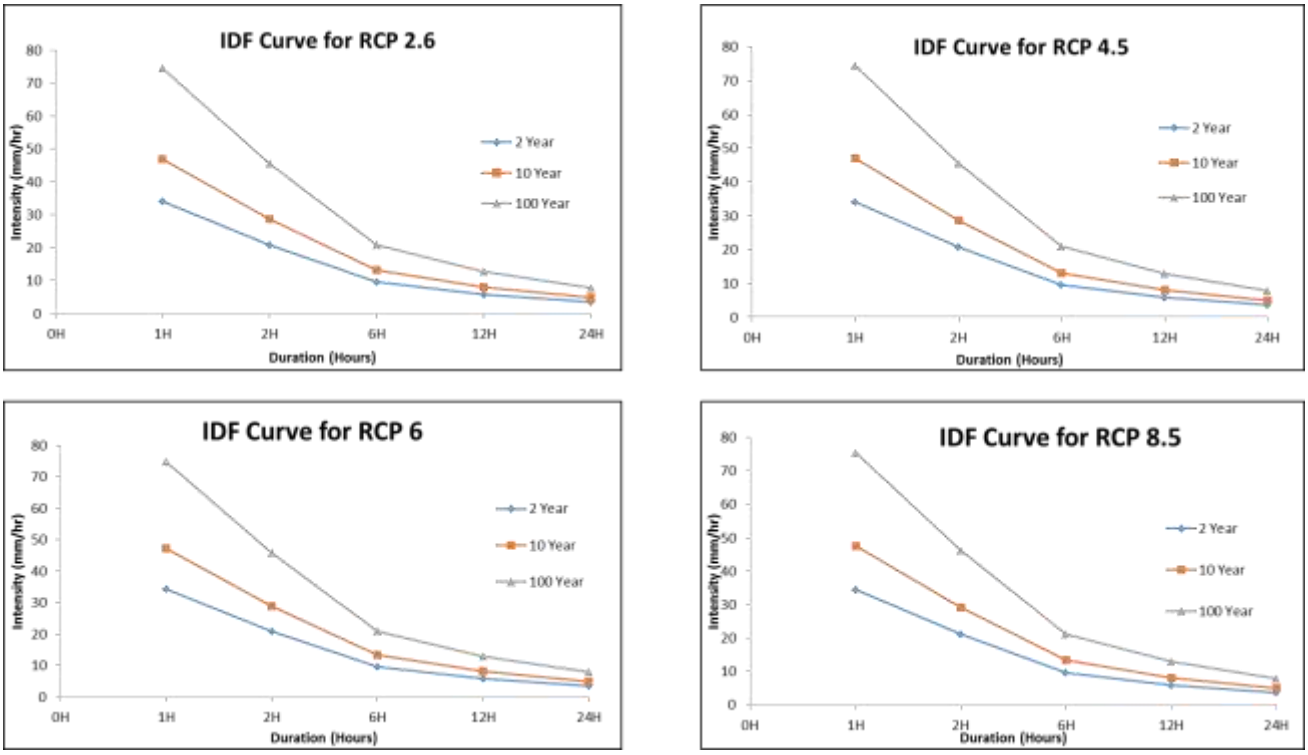


Figure 43: IDF curves of Rainfall for Different RCPs

While the former studies consider a much larger region, the latter considers only the city area, and therefore is likely to be more appropriate for use at the local level. The rainfall will have negligible increase overall, but short duration high intensity rainfall will increase in frequency.

4.2.2 Temperature Projections

ENVIS Tamil Nadu report indicates an increase of temperature 1.1°C, 2.3°C and 3.4°C (for the period of 2010-2040, 2040-2070 and 2070-2100 with respect of reference to the baseline (1970-2000). The average change of maximum and minimum temperature for Coimbatore district is expected to increase by 3.3°C and 3.4°C (As shown in Figure 3 and 4) respectively by the end of the century[14].

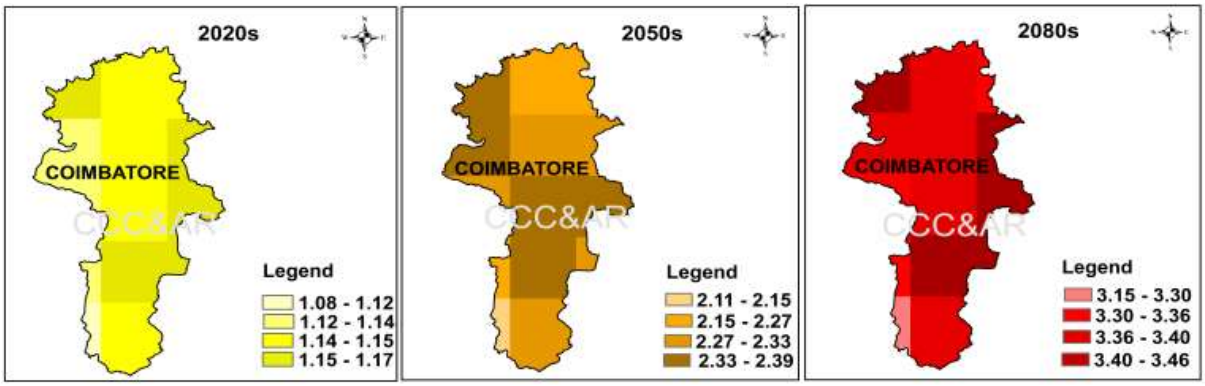


Figure 44: Changes in Max. Temperature for 2020s, 2050s & 2080s

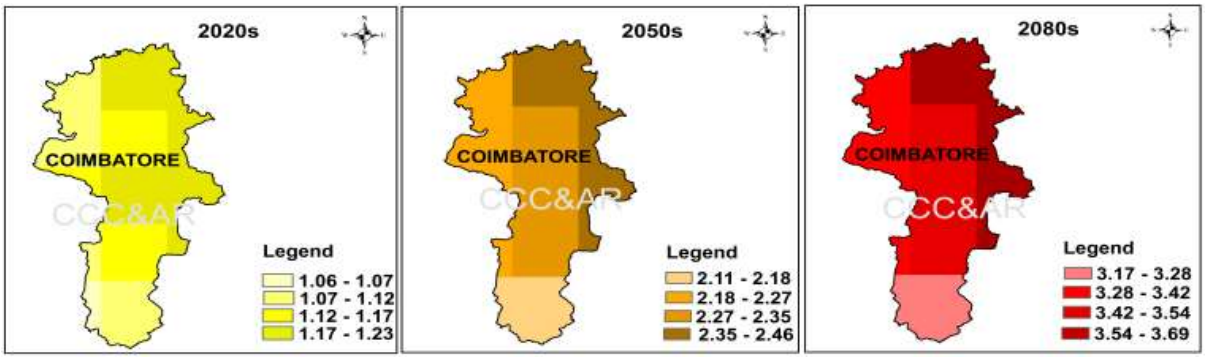


Figure 45: Changes in Min. Temperature for 2020s, 2050s & 2080s

TNSAPCC also indicates a general maximum temperature increase of about 3.4°C over the North western districts of Nilgiris, Coimbatore, Tiruppur and western parts of Dindigul district at the end of the century.

Table 20: Temperature Changes

District Name	Change in Minimum and Maximum Temperature in °C			
Coimbatore		2010-2040	2040-2070	2070-2100
	T Max	1.3	1.9	3.1

[14] Source: District Wise Climate Change Information for the State of Tamil Nadu
http://www.tnenvis.nic.in/WriteReadData/UserFiles/file/17_COIMBATORE_TEMPERATURE%20.pdf

	T Min	**1.2**	**2.3**	**3.3**

The study by IIT Madras considers the projections of maximum and minimum temperature under different RCP scenarios for the city of Coimbatore. This study also indicates an increase in temperature for both minimum and maximum temperatures of Coimbatore by 2050. This can be seen from the figures below for maximum and minimum temperatures for different RCP scenarios.

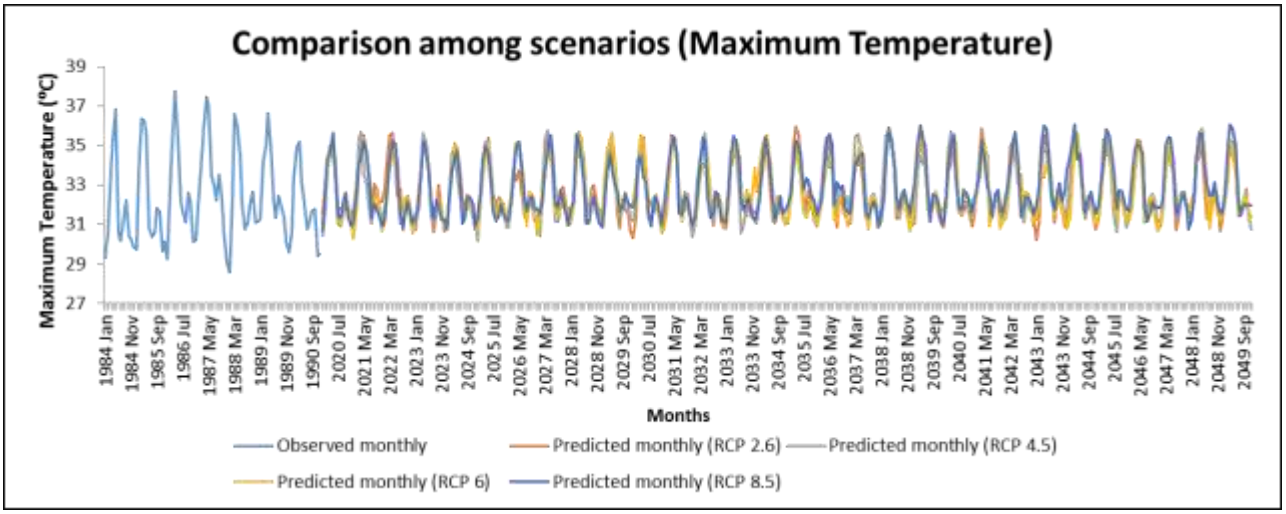


Figure 46: Comparison of Scenarios for Maximum Temperature

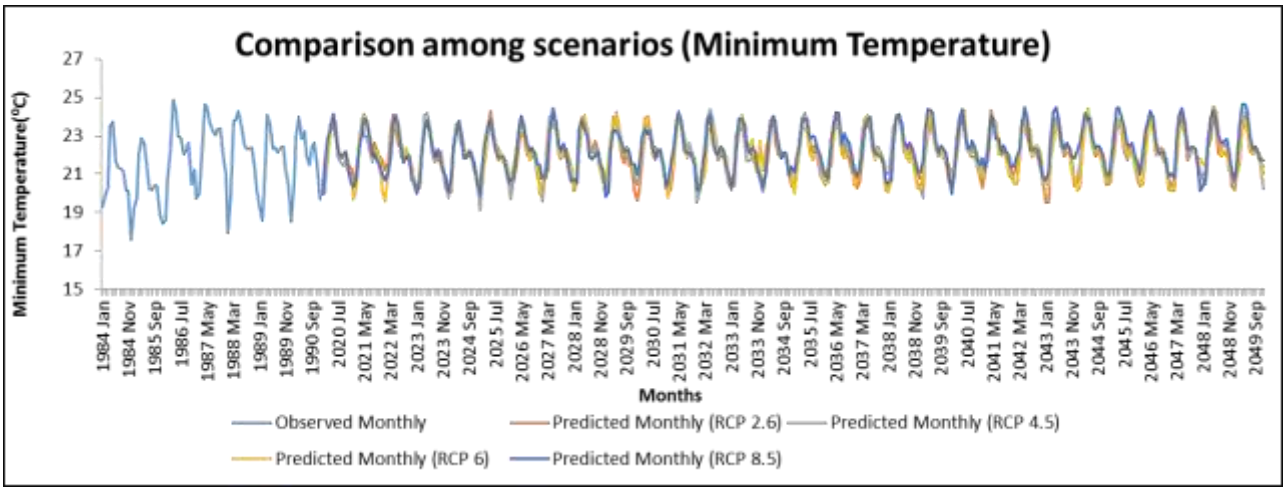


Figure 47: Comparison of Scenarios for Minimum Temperature

All three studies show a distinct increase in the maximum and minimum temperatures. So it can be estimated that both regionally and locally, temperatures are expected to rise in future.

A compilation of the different climate scenario assessment statements are provided in the table below. Studies of the ENVIS report of Tamil Nadu, the Tamil Nadu State Action Plan on Climate Change and the study by IIT Madras has been summarized in the table. For temperatures, all three studies show an increase in the projections, but for rainfall, the first two studies show an increase in rainfall, but the last

one by IIT Madras shows a negligible increase in rainfall with high chances of short duration high intensity rainfall. As mentioned earlier, this is possibly due to the region which is under the study.

Table 21: Climate Scenario Statements

Changing Climate Conditions	Assessments	Climate Scenario Summary Statements
Precipitation change	***ENVIS Tamil Nadu, District level report (District Wise Climate Change Information for the State of Tamil Nadu)***	The annual rainfall for Coimbatore district may increase by **11.0%** by the end of the century as per the emission scenario of A1B.
	Tamil Nadu State Action plan for Climate Change District level information)	TNSAPCC reports slight decrease of annual rainfall (50 mm) over Tamil Nadu by the end of the century with reference to baseline years 1970- 2000. However, district wise projections (as shown in figure) indicate an increase of annual rainfall over Coimbatore district.
	Study by IIT Madras	The study shows that the annual rainfall for Coimbatore has an increasing trend between 1.5% to 6% under different RCP scenarios up to the year of 2050.
Temperature change	***ENVIS Tamil Nadu, District level report (District Wise Climate Change Information for the State of Tamil Nadu)***	The average change of maximum and minimum temperature for the Coimbatore district are expected to increase by 3.3°C and 3.4°C respectively by the end of the century.
	Tamil Nadu State Action plan for Climate Change (District level information)	TNSAPCC also indicates increase in Tmax and Tmin.
	Study by IIT Madras	For all RCP scenarios, the study shows an increase in annual minimum and maximum temperatures up to the year 2050.

Through a series of stakeholders consultation and focused group discussions with the civil society, Government departments, research based institutions and in light of local climate studies conducted by IIT Madras, it has been agreed by the Core Team and Stakeholders Group that the City of Coimbatore faces the following two climate risks:

Climate Risk 1: ***Increased Temperature*** – Both maximum and minimum temperatures of the city show an increasing trend and are projected to increase up to the year 2050.

Climate Risk 2: ***Slight increase in precipitation but increased frequency and intensity of rain*** – Rainfall shows an increasing trend between 0.5% and 1.5% under different RCP scenarios, up to the year 2050.

5. URBAN SYSTEMS ANALYSIS

5.1 Climate Impact Assessment of Urban Systems

Climate impact assessment of urban systems helps to assess their fragilities with respect to the climate impacts identified earlier. In Coimbatore, the major urban systems that have been identified as fragile and that have been assessed include:

A. Water

B. Land Use Planning

C. Solid Waste Management

D. Sewerage and Drainage

E. Transportation

The risks associated with the fragilities of these systems were calculated through a risk assessment exercise conducted by the Stakeholder Group and Core Team during an SLD. The Urban Systems Analysis is attached in Annexure 3 and the Risk Assessment is attached in Annexure 4.

5.2 Water supply

The water supply system in Coimbatore is managed by the CCMC and the Public Works Department (PWD) of Tamil Nadu. Water scarcity is a major issue in Coimbatore, caused by indiscriminate use, lack of conservation efforts, encroachment of water bodies. There is no management of NRW. Intergrated water management with neighbouring areas and states at the catchment level are needed (inter and intra state coordination for catchment area management). This increases the fragility of the system.

There is a lack of adequate water storage facilities. Policy changes required for protection of water sources and regulation of water use. Although several water bodies are present in the city, pollution and encroachment and loss of connectivity of the lakes are resulting in constriction of water resources in the city.

Fragility Statement:
Coimbatore faces severe water shortage due to indiscriminate use, lack of conservation efforts, encroachment of water bodies, poor management of NRW as well as poor regulatory policies for water use.

Climate Fragility Statement:
With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table. Absence of adequate water will impact GDP, economy (industry and agriculture) and health.

5.3 Sewerage

Sewerage is managed by the CCMC. At present, there is incomplete connection with sewer lines. A large part of the residential properties have septic tanks for in situ treatment of waste water. A major part of the

black water is also released into open drains that lead to the local lakes within the city, causing pollution and algal blooms.

There is incomplete treatment of sewage. Policy level changes need to be made for reuse of water from ROs, industrial waste water, etc.

Fragility Statement:
There is inadequate collection and treatment of sewage and policy regulations for reuse of sewerage and waste water (RO waste water) is lacking.

Climate Fragility Statement:
Increased temperatures will impact the treatment mechanism. High intensity rainfall in short duration will lead to overflow of sewage lines, dilution of waste water, thereby impacting the efficiency of waste water treatment.

5.4 Land use planning (including green spaces)

Unplanned developmental changes have led to loss of greenery and water body encroachment, impacting micro-climate in the city. Land use planning should include open spaces and space for municipal utilities such as waste facilities or water treatment plants. The major issues faced by the city include:

- Encroachment of lakes
- Cutting of trees
- Green area reduction

Policy changes are required in the city to ensure incorporation of minimum open spaces in land use.

Both Town Planning Department and Local Planning Authority (LPA) are responsible for the management of this system.

Fragility Statement:
City requires a land use plan that provides space for open areas and space for municipal utilities, and that needs to be followed so that there is minimum loss of greenery and water body encroachment, that can impact the micro-climate in the city.

Climate Fragility Statement:
With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.

5.5 Solid Waste Management

The CCMC is responsible for municipal waste management. Centralised management of waste is conducted. Decentralised management options are lacking and needs to be developed for better management. Segregation of waste is not done at household level to a full extent. Secondary segregation is important. Garbage is dumped in the dumpyards leading to odour and hygiene issues.

Policy level changes and enforcement mechanisms need to be strengthened. Awareness generation among community for behavioral change is required. Facilities for disposal of waste including hazardous waste, e-waste, C&D waste, and slaughter house waste is lacking. Extended producer responsibility needs to be designed. Decentralised systems need to be designed.

Fragility Statement:
The exisitng system of centralised waste management does not include facilities for proper segregation of waste, and for treatment of hazardous waste, e-waste, C&D waste, and animal waste, and lacks decentralised systems and policy level support regarding household segregation, extended producer responsbility, etc.

Climate Fragility Statement:
Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.

5.6 Transport

Public bus services are provided by the Tamil Nadu State Transport Corporation. At present, the traffic situation in Coimbatore is getting more and more congested due to increasing private vehicle usage. Two wheelers are very prevalent. Public transport options are limited.

Fragility Statement:
Increased private vehicle usage due to lack of public transport mechanisms is leading to increased emissions.

Climate Fragility Statement:
Increased temperatures will lead to use of more private vehicles indirectly, which will increase the heat and emissions.

5.7 Risk Assessment

The climate fragility statements are prioritized through a participatory assessment, during an SLD, based on the degree of risk that each expected climate impact poses for the identified fragile systems.

The risk score for each climate fragility statement is defined as a combination of the likelihood of an event to occur and the consequences faced if the event occurred. The process followed for risk scoring is detailed in **Annexure 4**. The following table shows the risk status of the five climate fragility statements.

Table 22: Risk Assessment of Climate Fragility Statements

Urban Systems	Climate fragility statement	Risk Score	Risk Status
Water	With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table.	20	Extreme
	Absence of adequate water will impact GDP, economy (industry and agriculture) and health.	20	Extreme
Land use planning (including green spaces)	With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.	16	High
Sewerage Management	Increased temperatures will impact the treatment mechanism.	1	Low

Urban Systems	Climate fragility statement	Risk Score	Risk Status
	High intensity rainfall in short duration will lead to overflow of sewage lines, dilution of waste water, thereby impacting the efficiency of waste water treatment.	25	Extreme
Solid Waste Management	Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.	12	High
Transportation	Increased temperatures will lead to more vehicles indirectly, which will increase the heat and emissions.	12	High

Based on this risk assessment all five fragile urban systems Water and Sewerage Management, Land Use planning, Solid Waste Management, and Transportation show extreme and high risk which require urgent attention.

5.8 Vulnerability Assessment

5.8.1 Overview

The vulnerability assessment helps to assess the city in terms of the geographical location, demography, infrastructure, socio economic condition, ecological condition and the impacts of climate change on these. The Intergovernmental Panel on Climate Change (IPCC, 2007) defines vulnerability as a function of three parameters of the character, magnitude, and rate of climate variation to which a system is exposed, its sensitivity, and its adaptive capacity.

Vulnerability assessment consists of identification of vulnerable areas and actors for all the prioritized fragile urban systems and analysis of their adaptive capacities. The following elements are considered:

1) **Identification of Vulnerable Places**: Highly vulnerable areas in context of identified fragile urban system of the city were identified and mapped to arrive at vulnerable hotspots affected by maximum number of fragile urban systems.
2) **Identification of Vulnerable actors and their adaptive capacity:** In each of the vulnerable areas, the actors that play a critical role towards building urban resilience were identified and assessed in terms of their **capacity** to organize and respond to threat or disruption, access to **resources** necessary for response (manpower, technology, funds) and access to **information** necessary to develop effective plans and actions and to improve responses to disruptions. These determine the adaptive capacity/resilience of the identified actors for a particular fragile system.

The sections below identify the vulnerable areas, vulnerable actors and adaptive capacity of the fragile urban systems using the Climate Fragility Statements developed and in consultation with the stakeholder group.

5.8.2 Identification of vulnerable areas of Fragile Urban Systems

Water:

The vulnerable areas in Coimbatore for water as per the broad consensus in the SLD were identified as follows:

Climate Fragility Statements	Area/ward
With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table. Absence of adequate water will impact GDP, economy (industry and agriculture) and health.	80, 81, 82, 83, 85, 86, 72, 74, 78, 54, 59, 60, 61, 63, 89, 94, 95, 96, 97, 98, 100, 16, 15, 14, 20, 21, 23, 24, 25, 39, 38, 41, 30, 31, 32, 33, 36, 28, 50, 51

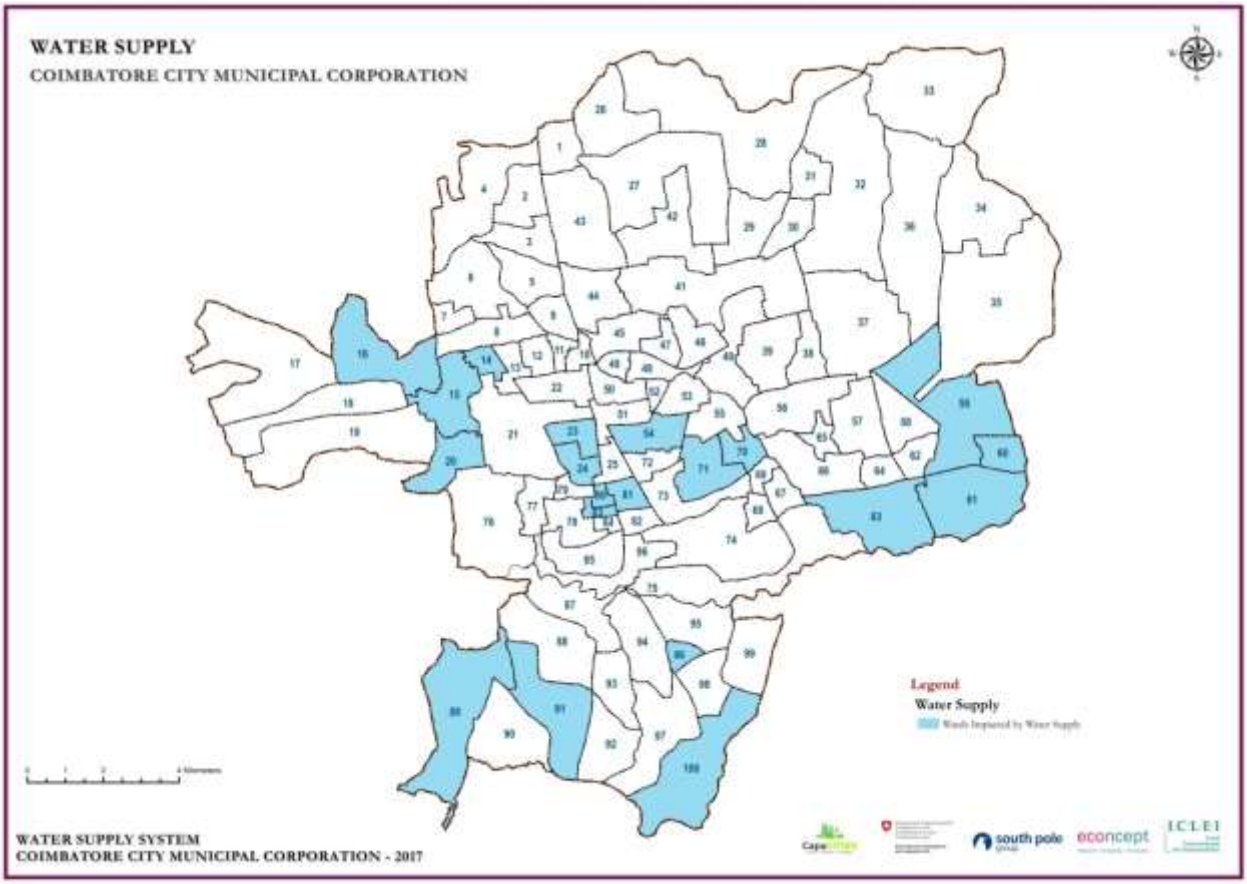


Figure 48: Wards most vulnerable to climate risks in the context of Water in Coimbatore

Sewerage Management

The vulnerable areas in Coimbatore for sewerage management as per the broad consensus in the SLD were identified as follows:

Climate Fragility Statements	Area/ward
Increased temperatures will impact the treatment mechanism. High intensity rainfall in short duration will lead to overflow of sewage lines, dilution of waste water, thereby impacting the efficiency of waste water treatment.	ABD area of smart city, drains and canals connecting the lakes , newly added areas - 1, 2, 3, 4, 5, 6, 7, 8, 9, 15, 16, 18, 19, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 89, 90, 91, 92, 97, 100, 74

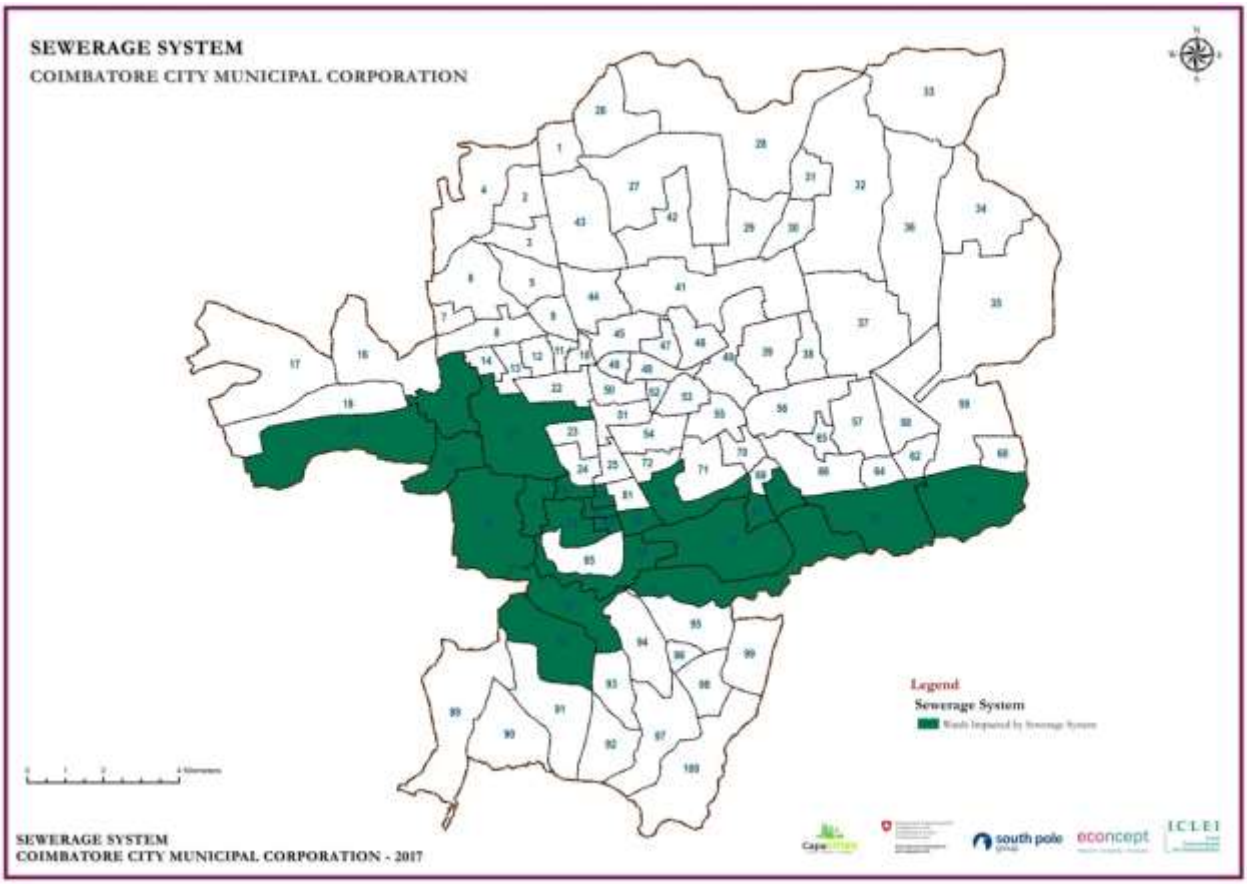


Figure 49: Wards most vulnerable to climate risks in the context of Sewerage Management in Coimbatore

Land Use Planning

The vulnerable areas in Coimbatore for land use planning as per the broad consensus in the SLD were identified as follows:

Climate Fragility Statements	Area/ward
With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production	4, 2, 3, 1, 16, 17, 18, 19, 20, 21, 26, 28, 61, 62, 63, 64, 73, 80, 81, 82, 83, 84, 91, 97, 98, 99, 100, central zone near the water bodies- see sewerage map

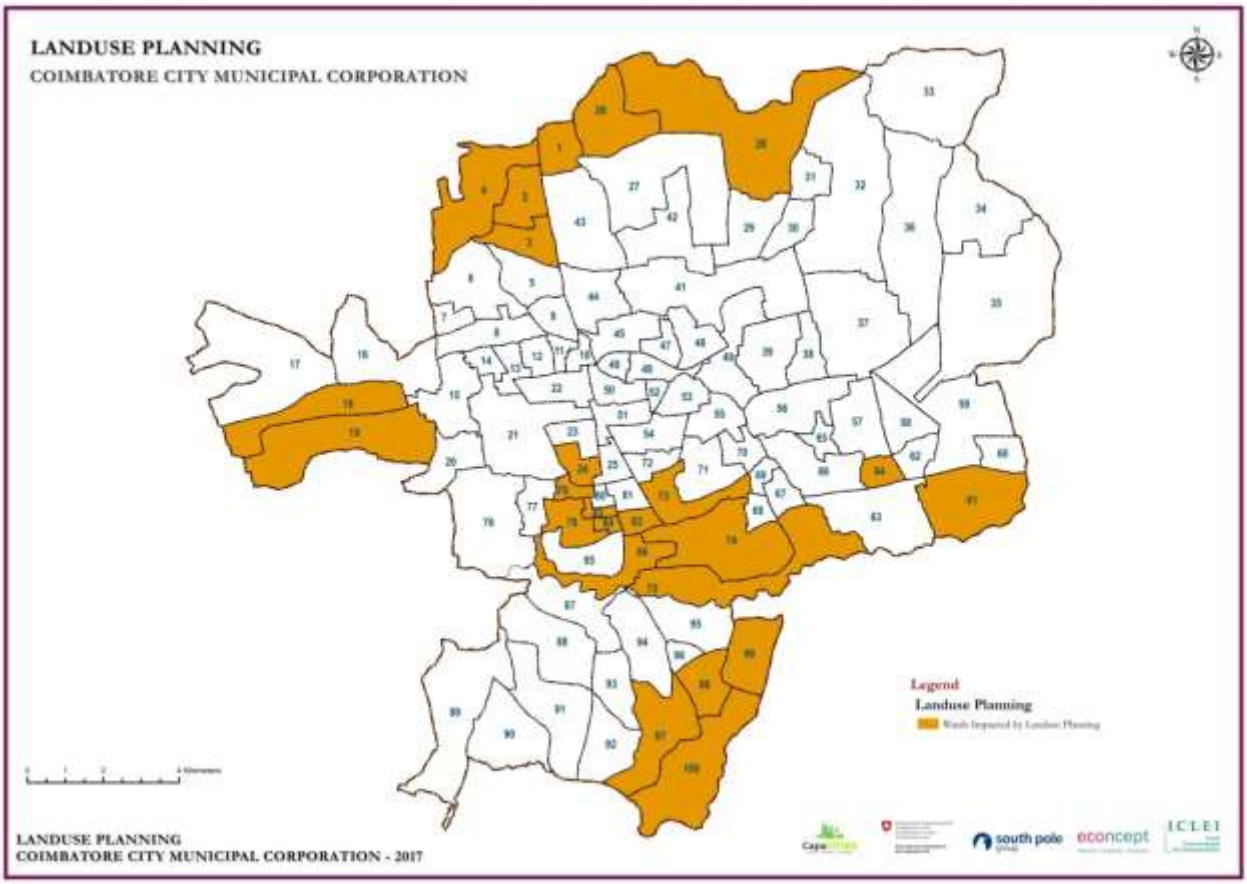


Figure 50: Wards most vulnerable to climate risks in the context of Land Use Planning in Coimbatore

Solid Waste Management

The vulnerable areas in Coimbatore for solid waste management as per the broad consensus in the SLD were identified as follows:

Climate Fragility Statements	Area/ward
Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.	86, 75, 94, 95, 99, 32, 96

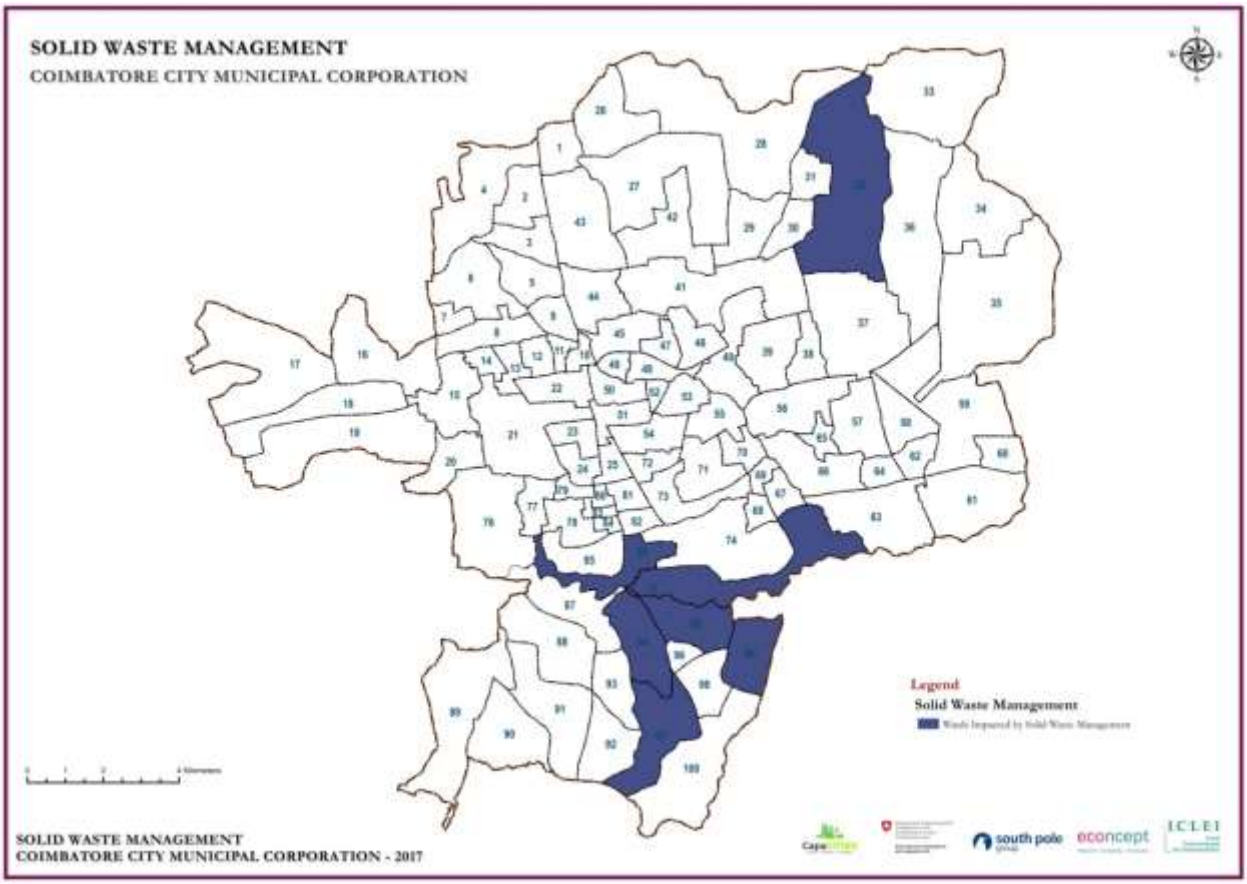


Figure 51: Wards most vulnerable to climate risks in the context of Solid Waste Management in Coimbatore

Transportation

The vulnerable areas in Coimbatore for transportation as per the broad consensus in the SLD were identified as follows:

Climate Fragility Statements	Area/ward
Increased temperatures will lead to use of more private vehicles indirectly, which will increase the heat and emissions.	All city

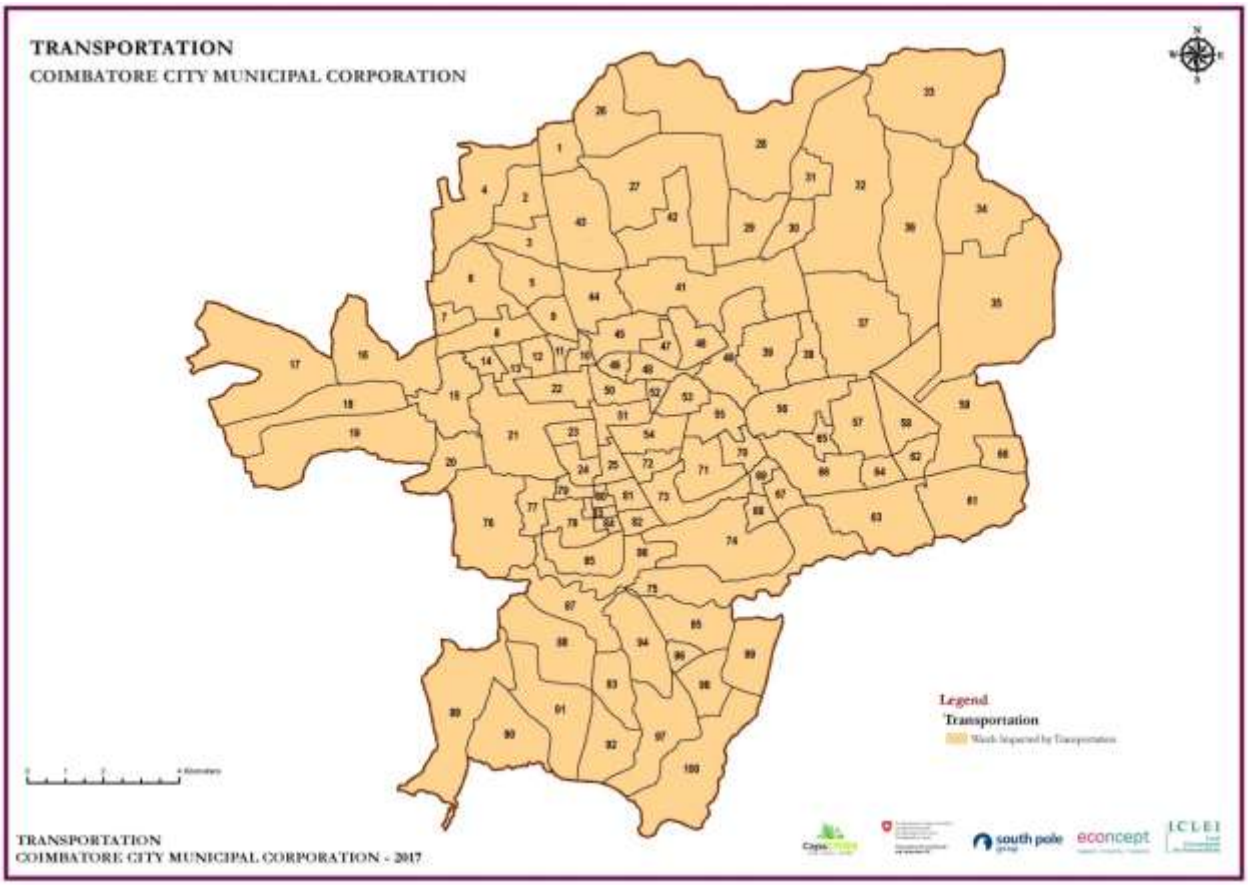


Figure 52: Wards most vulnerable to climate risks in the context of Transportation in Coimbatore

The Vulnerability hotspot map (Figure 51) identifies ward numbers 61, 75, 86 and 83 as the most vulnerable wards with regard to climate impacts in the city. These wards are situated close to the lakes as well as the solid waste treatment and disposal facility and face the impacts on four out of the five fragile urban systems that have been analysed in this process. These must be immediately focused on to build resilience through resource mobilization in light of the interventions that are identified in the following stages.

In addition, almost 50% of the remaining wards are impacted by multiple climate impacts as well. As such, interventions need to be identified for the fragile systems that can cover a majority of the area in the city as well.

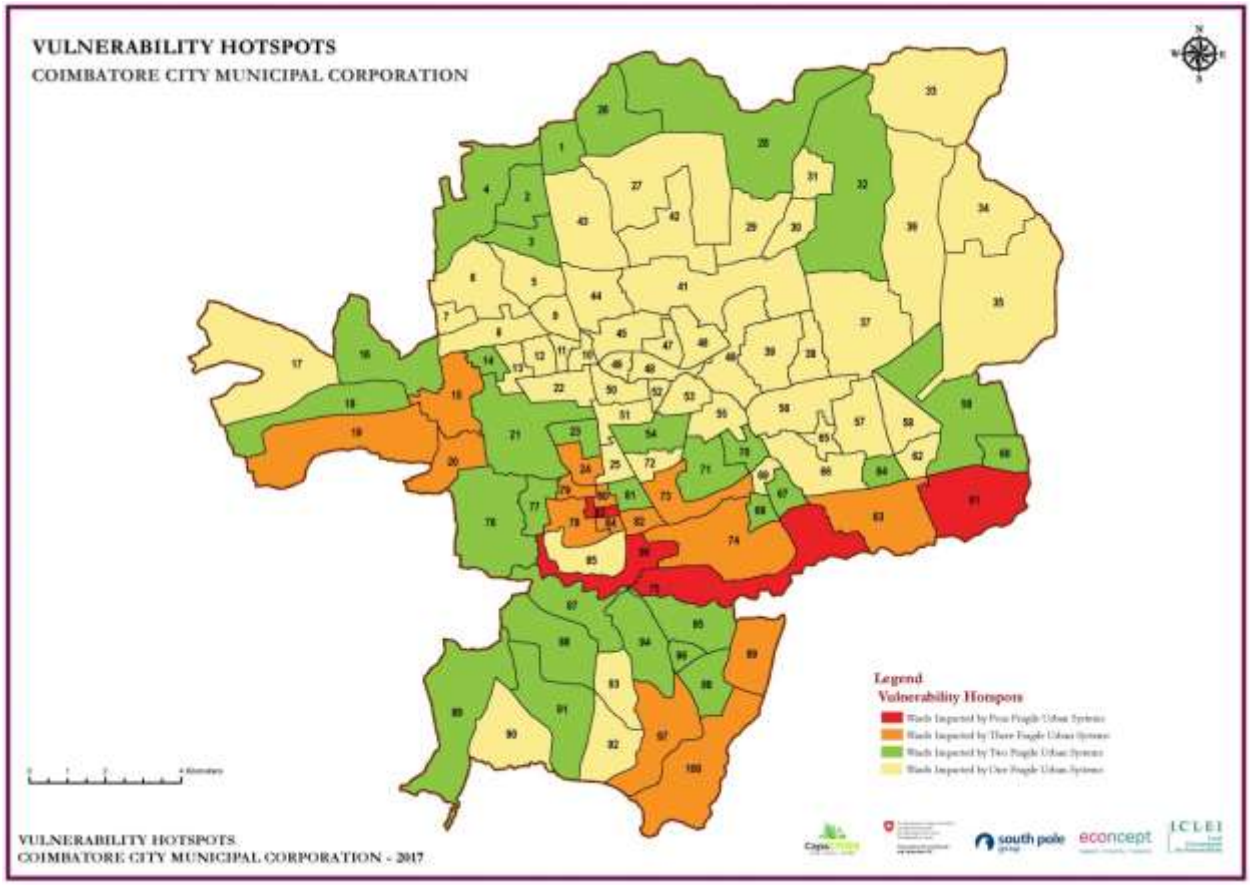


Figure 53: Consolidated Vulnerable Hotspots for Coimbatore

5.9 Actor Analysis

In addition to the wards, for each fragile urban system, the relevant actors were identified. This is shown in Table 23.

Table 23: Analysis of the adaptive capacities of local actors identified

Urban Systems	Climate fragility statement	Area	Actors
Water	With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table. Absence of adequate water will impact GDP, economy (industry and agriculture) and health.	80, 81, 82, 83, 85, 86, 72, 74, 78, 54, 59, 60, 61, 63, 89, 94, 95, 96, 97, 98, 100, 16, 15, 14, 20, 21, 23, 24, 25, 39, 38, 41, 30, 31, 32, 33, 36, 28, 50, 51	Urban poor Lake area settlements Industry owners Corporation Gated communities Farmers Academic institutions NGOs and CBOs Corporates Slum clearance board Pollution control board Health department District administration Commercial establishments
Land use planning (including green spaces)	With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.	4, 2, 3, 1, 16, 17, 18, 19, 20, 21, 26, 28, 61, 62, 63, 64, 73, 80, 81, 82, 83, 84, 91, 97, 98, 99, 100, central zone near the water bodies- see sewerage map	Urban poor Lake area settlements Industry owners State govt MoUD Corporation Gated communities Academic institutions NGOs and CBOs Corporates Highways department Slum clearance board Pollution control board Health department District administration Migrant labour Commercial establishments
Sewerage Management	High intensity rainfall in short duration will lead to overflow of sewage lines, dilution of waste water, thereby impacting the efficiency of waste water treatment.	ABD area of smart city, drains and canals connecting the lakes , newly added areas - 1, 2, 3, 4, 5, 6, 7, 8, 9, 15, 16, 18, 19, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 89, 90, 91, 92, 97, 100, 74	Urban poor Lake area settlements Industry owners Corporation Gated communities Farmers Academic institutions NGOs and CBOs Corporates Slum clearance board Pollution control board Health department District administration

Urban Systems	Climate fragility statement	Area	Actors
			Commercial establishments Migrant labour High income group
Solid Waste Management	Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.	86, 75, 94, 95, 99, 32, 96	Urban poor Lake area settlements Industry owners State govt MoUD Corporation Gated communities Farmers Self Help Groups Academic institutions NGOs and CBOs Corporates Street Vendors Slum clearance board Pollution control board Health department District administration Migrant labour Commercial establishments High income group Technology partners, funders- people who are capable of designing, funding, building and operating companies
Transportation	Increased temperatures will lead to use of more private vehicles indirectly, which will increase the heat and emissions.	All city	All residents School children Urban poor Highways department Pollution control board Health department District administration NGOs and CBOs

An analysis of the actors within the wards identified as vulnerable revealed that they had relatively good levels of adaptive capacities. This should be taken advantage of while implementing the resilience interventions that are identified in later stages. Table 24 below shows the adaptive capacities of the actors for each fragile urban system (Annexure 5 gives the details of the analysis).

Table 24: Analysis of the adaptive capacities of local actors identified

Actors	Adaptive capacity score	Adaptive Capacity
Urban poor	2	low
Lake area settlements	2	low
Industry owners	18	high

Actors	Adaptive capacity score	Adaptive Capacity
State govt	3	low
MoUD	27	high
Corporation	27	high
Panchayat	2	low
Gated communities	27	high
Farmers	2	low
Industry workers	1	low
Self help gropus	8	medium
Academic institutions	27	high
NGOs and CBOs	18	high
Corporates	27	high
Street vendors	1	low
People living near factories and industries	1	low
Highways department	18	high
Slum clearance board	18	high
Pollution control board	9	high
Health department	27	high
District administration	18	high
Migrant labour	1	low
High income group	27	high
Commercial establishments	18	high
Technology partners	27	high
Funders- people who are capable of desigining, fund, bulid and operate companies	27	high

A large number of government departments, both state level and local level, have relatively high adaptive capacity. The majority of the actors with low adaptive capacity are the ones who are financially vulnerable and lack awareness and education. The resilience interventions must therefore specifically address these groups while taking advantage of the stronger supportive groups in the city.

Table 25: Consolidated vulnerability analysis of Fragile Urban Systems identified for Coimbatore

Fragile Urban System	Climate Fragility Statements	Sector GHG Emission Profile 2015-16 (Tonnes of CO2e)	Vulnerable Areas	Urban Actors	
				Vulnerable Actors	Potential Supporting Actor
Water	With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table. Absence of adequate water will impact GDP, economy (industry and agriculture) and health.	1141	80, 81, 82, 83, 85, 86, 72, 74, 78, 54, 59, 60, 61, 63, 89, 94, 95, 96, 97, 98, 100, 16, 15, 14, 20, 21, 23, 24, 25, 39, 38, 41, 30, 31, 32, 33, 36, 28, 50, 51	Urban poor Lake area settlements Farmers	Industry owners Corporation Gated communities Academic institutions NGOs and CBOs Corporates Slum clearance board Pollution control board Health department District administration Commercial establishments
Land use planning (including green spaces)	With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.	2802822 (stationary energy consumption in all built space in the City)	4, 2, 3, 1, 16, 17, 18, 19, 20, 21, 26, 28, 61, 62, 63, 64, 73, 80, 81, 82, 83, 84, 91, 97, 98, 99, 100, central zone near the water bodies-see sewerage map	Urban poor Lake area settlements Migrant labour	Industry owners State govt MoUD Corporation Gated communities Academic institutions NGOs and CBOs Corporates Highways department Slum clearance board Pollution control board Health department District administration Commercial establishments
Sewerage Management	High intensity rainfall in short duration will lead to overflow of sewage lines, dilution of waste	69922	ABD area of smart city, drains and canals connecting the lakes ,	Urban poor Lake area settlements	Industry owners Corporation Gated communities

Fragile Urban System	Climate Fragility Statements	Sector GHG Emission Profile 2015-16 (Tonnes of CO2e)	Vulnerable Areas	Urban Actors	
				Vulnerable Actors	Potential Supporting Actor
	water, thereby impacting the efficiency of waste water treatment.		newly added areas - 1, 2, 3, 4, 5, 6, 7, 8, 9, 15, 16, 18, 19, 26, 27, 28, 29, 30, 31, 32, 33, 34, 35, 36, 89, 90, 91, 92, 97, 100, 74	Farmers Migrant labour	Academic institutions NGOs and CBOs Corporates Slum clearance board Pollution control board Health department District administration Commercial establishments High income group
Solid Waste Management	Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.	363156	86, 75, 94, 95, 99, 32, 96	Urban poor Lake area settlements Farmers Self Help Groups Street Vendors Migrant labour	Industry owners State govt MoUD Corporation Gated communities Academic institutions NGOs and CBOs Corporates Slum clearance board Pollution control board Health department District administration Commercial establishments High income group Technology partners, funders- people who are capable of desigining, funding, building and operating companies
Transportation	Increased temperatures will lead to more vehicles indirectly, which will increase the heat and emissions.	2138767	All city	All residents School children Urban poor	Highways department Pollution control board Health department District administration NGOs and CBOs

6. RESILIENCE INTERVENTIONS

Potential Climate Resilience interventions were identified for the fragile urban systems of water, sewerage management, solid waste management, land use planning, buildings, industry, street lighting and transportation in Coimbatore on the basis of their GHG emissions and climate vulnerabilities. Once the sectoral potential interventions were identified, they were prioritized on the basis of their resilience capacity assessed in terms of their contributions to increased Redundancy, Flexibility, Responsiveness, Access to information and GHG reduction potential. The interventions were then assessed for feasibility (technical, financial and political) and their impact (short, medium or long term) through a multi-stakeholder consultation process. As far as possible, the prioritized interventions were linked to existing city plans and schemes so as to determine whether the required interventions can be integrated with little or no additional resources into existing departmental programs or projects.

The Climate Resilient City Action Plan for Coimbatore proposes actions that will reduce annual GHG emissions in 2022-23 by 25% of the baseline GHG emissions in 2015-16 and a reduction in energy consumption of 12% from the baseline of 2015-16.

Table 26 lists the interventions that will help in reducing the emissions from different sectors, primarily buildings, municipal services, and transportation. The table gives estimates of the amount of money that will be required for implementation of these interventions as well, to the extent possible. In order to assess the bankability of the interventions, an assessment is required to determine the ability of the CCMC to access budgetary resources as well as repay loans and generate revenue. An example of the assessment of bankability is provided in Annexure 6.

Table 26: Prioritised Resilience Interventions for GHG Emission Reduction

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
Residential Building Sector **Baseline (2015-16)** **Total Energy consumption – 6,134,792 Giga Joule (Total Electricity consumption – 1704 Million kWh)** **Total GHG emission – 824,510 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 577.39 Million kWh** **Total GHG emission mitigation potential – 475,067.43 tCO2e**					
Replacement of CFLs with LED Tubelights (For Next 5	4.1	NA	3367.1	14.95	"Unnat Jyoti by Affordable LEDs for All

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
years)					(UJALA)" – Central Government Scheme
Replacement of conventional ceiling fan with Energy Efficient DC ceiling fans	49.7	NA	40,921.6	921.1	"Unnat Jyoti by Affordable LEDs for All (UJALA)" – Central Government Scheme
Replacement of conventional air conditioners with EE star rated ACs	1.6	NA	1341.9	283.1	
Replacing Conventional (3 Star) Electric Geysers with Heat Pump Geyser	63.6	NA	52,334	713.54	
Replacing Existing Pumps with EE Pumps in Societies	19.8	NA	16,326.7	90.6	
Replacing Common Lighting with LED Lighting in Societies	9.1	NA	7483.1	42.5	
Energy Efficiency in Lifts using Regenerative Lifts	12.7	NA	10460.4	396.4	
Solar Water Heater System (SWHS) 100 LPD	147.2	NA	121,146	1698.9	
Solar Home Lighting System (3 Wp) for Low Income Housing Group	0.035	NA	28.64	28.9	
Solar Home Lighting System (250 Wp) for Medium Income Housing Group (MIG)	22.99	NA	18921.62	687.7	
Solar PV 1 kW with Net Metering for MIG	45.99	NA	37843.23	2,435.8	
Solar PV 2 kW with Net	39.42	NA	32437.06	491.3	

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
Metering for High Income Housing Group (HIG)					
Solar PV Systems for Bunglows on RESCO Mode	79	NA	64874	3684.4	
Solar PV systems with Net Metering for Common Meter	82.13	NA	67577.21	3,837.9	
Total (1)	577.39	NA	475,067.43	15,327.09	
Commercial and Institutional Buildings/Facilities **Baseline (2015-16)** **Total Energy consumption – 2,177,916 Giga Joule (Total Electricity consumption 604.97 Million kWh)** **Total GHG emission – 374,515 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 45.88 Million kWh** **Total GHG emission mitigation potential – 37,748.47 tCO2e**					
Energy Efficiency at Public Worship Places (potential next 5 years)	1.76	NA	1452.0	4.7	
Replacement of conventional ceiling fan with Energy Efficient ceiling fans	9.51	NA	7822.3	88	
Replacement of Conventional Fittings with LED Fittings in HOTELS	0.97		802.1	0.225	
Replacement of Conventional Fittings with LED Fittings in Educational Institutions	2.98		2450.7	19.13	
Replacement of Conventional Fittings with LED Fittings in Hospitals	1.25	NA	1027.1	6.41	
Replacement of Conventional	10.67	NA	8782.9	926.6	

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
ACs with 5 Star labelled ACs in Offices/ Shops					
Replacement of Conventional ACs with 5 Star Labelled ACs in Hospitals	0.39	NA	319.9	33.8	
Replacement of Conventional Acs with 5 Star labelled Acs in Hotels/ Lodges/ Guesthouse	0.16		128	8.1	
Energy Efficiency in Pumping System for Commercial Establishments	6.85		5634.9	32.6	
250 W PV Power Backup for Restaurants	0.112		91.8	3.6	
Solar Water Heaters for Lodges and Hotels	3.1		2540.3	19.4	
Solar PV System for Bus Stands under RESCO	0.4		297.1	1.1	
Solar PV System for Hospitals under Self fund	0.7		610.1	1.1	
Solar PV System for Hospitals under RESCO	0.7		610.1	1.1	
Solar PV System for School/ Colleges under CAPEX	2.5		2033.7	1.4	
Solar PV System for School/ Colleges under RESCO	2.5		2033.7	1.4	
Solar PV System for Vegetable Market through RESCO mode	0.08		66.0	0.4	
Solar PV System for Cinema	1.03		845.2	1.5	

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
Theatres through CAPEX					
Total (2)	45.88		37,748.47	1149.465	
Manufacturing Industry and Construction (i.e. Industrial sector) **Baseline (2015-16)** **Total Energy consumption – 11,667,336 Giga Joule (Total Electricity consumption – 3240 Million kWh)** **Total GHG emission – 1,545,795 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 700.01 Million kWh** **Total GHG emission mitigation potential – 575,960.50 tCO2e**					
Replacement of Conventional Fittings with LED fittings	5.56		4572.6	1.6	Replacement of Conventional Fittings with LED fittings
Energy Efficiency by Reducing Transformer Rating from 420 V to 400 V	130.35		107247.3	None	Energy Efficiency by Reducing Transformer Rating from 420 V to 400 V
Efficiency by replacing machine motor with energy efficient motor (7.5 HP with 5 HP)	2.29		1882.9	133.1	Efficiency by replacing machine motor with energy efficient motor (7.5 HP with 5 HP)
Energy Efficiency in Fabrication Shops	2.0		1642.3	116.1	Energy Efficiency in Fabrication Shops
Energy Efficiency by use of power factor correction panels in large scale industries	0.24		195.5	0.9	Energy Efficiency by use of power factor correction panels in large scale industries
Microgrid Solar PV Plants in SEZs	7.22		5942.5	32.5	Microgrid Solar PV Plants in SEZs
Rooftop Solar PV System for SEZs in Coimbatore	4		3665.5	175.5	Rooftop Solar PV System for SEZs in Coimbatore

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
Rooftop Solar PV system for industrial units	98.7763		81271.1641	4,735.85	
Solar Water Heating systems for industrial units	245.115		201675.72	3,771	
Solar Steam Generating System for industrial units	122.56		2828.3	2,828.3	
EE cooling appliances for industrial units	81		67022		
Total (3)	152.1		125,149.11	459.7	
Municipal Services					
Water Supply **Baseline (2015-16)** **Total Energy consumption – 58,503 Giga Joule (Total Electricity consumption – 16.25 Million kWh)** **Total GHG emission – 13,376 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 11.07 Million kWh** **Total GHG emission mitigation potential –9109.07 tCO2e**					
NRW reduction from 56% to 20% (Proposed)	5.81		4,784	4560	Coimbatore Municipal Corporation
Installation of Captive Solar PV Plants at Velliyankadu and Pillur Water Pumping Stations	1.86		1533.17	71.4	Coimbatore Municipal Corporation
Installation of Captive Solar PV Plants at Pillur Water Pumping Stations	3.11		2557.9	119.1	Coimbatore Municipal Corporation
Use of power factor correction panel to reduce power loss at WTP	0.26		210	1.59	Coimbatore Municipal Corporation
Use of power factor correction panel to reduce	0.03		24	0.18	Coimbatore Municipal Corporation

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
power loss in Sewage Pumping					
Total (4)	11.07		9109.07	4752.27	
Street lighting **Baseline (2015-16)** **Total Electricity consumption – 46.37 Million kWh** **Total GHG emission - 38,167 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 13.653 Million kWh** **Total GHG emission mitigation potential – 11,187.1 tCO2e**					
ESCo. Replacement of existing Street lighting with LED (21,000 nos.) (on-going project)	3.3726		2774.9	273.00	Coimbatore Municipal Corporation
ESCo. Replacement of existing Street lighting with LED (41,292 nos.)	10		8184.4	536.8	Coimbatore Municipal Corporation
Solar PV System for Lighting in Parks	0.28		227.8	0.4	Coimbatore Municipal Corporation
Total (5)	13.653		11187.1	810.2	
Transportation **Baseline (2015-16)** **Total Energy consumption – 96,044 Giga Joule** **Total GHG emission – 6,970 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 12.71 Million kWh** **Total Diesel savings – 23,883 KL** **Total GHG emission mitigation potential – 23368.73 tCO2e**					
Rooftop SPV for renewable energy for electric buses (6	9.63		7923.38	Through PPP	Coimbatore Municipal Corporation

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
MW)					
Replacement of all 500 diesel operated city buses with electric buses		18980[15]	727.88	12500	Coimbatore Municipal Corporation 2018 and FAME scheme
Smart City					
Solar PV System at Abandoned Dumping Ground (on-going project, annual potential)	3		2468.34	11	Coimbatore Municipal Corporation
Smart Solar Tree (6 nos X 300 W) at 30 locations - annual years potential	0.081		66.65	1.35	Coimbatore Municipal Corporation
Public Bicycle Sharing System (7000 bikes)		4903[16]	12182.48	175	Through PPP
Total (6)	12.711	23883	23368.73	18,249.42	
Municipal corporation buildings **Baseline (2015-16)** **Total Energy consumption – 53,757 GJ i.e. 149.32 Million kWh** **Total GHG emission – 122,858 tCO2e** **Climate Resilience Potential (2022-23)** **Total Electricity savings – 3.82 Million kWh** **Total GHG emission mitigation potential – 3,141.74 tCO2e**					
Rooftop Solar PV in Municipal Building	0.24		198.08	10.5	Coimbatore Municipal Corporation
Additional Solar PV System	3.21		2641.12	450	Coimbatore

[15] Diesel in kilo Liters

[16] Kilo Liters Petrol

Sector-wise Solutions	Mitigation Potential (2022-23)			Cost of interventions (Lakhs INR)	Implementation mode
	Potential Energy Saving (Million kWh)	Potential Fuel Saving (KL)	Potential GHG emission reduction (tCO2e)		
on Ukkadam Dumping Ground					MunicipalCorporation
Total (7)	3.45		2839.2	460.5	
Solid Waste Management **Baseline (2015-16)** **Total Solid Waste Generation- 156,138.0 Tonnes** **Total GHG emission – 363,156.38 tCO2e** **Climate Resilience Potential (2022-23)** **Total Energy Generation Potential- 43.89 Million kWh** **Total GHG emission mitigation potential- 233,600 tCO2e**					
Improving Waste Management System like vermicomposting, Aerobic Composting Incineration Sanitary Waste Incineration Sanitary Waste Disposal to sanitary landfill site			1,029,446.00		Coimbatore Municipal Corporation
Waste to energy from biomethanation Plant	21.24		17,474.00	1300	Coimbatore Municipal Corporation
Potential Electricity Generation from RDF	22.65		18,638		Coimbatore Municipal Corporation
Total (8)	43.89		1,065,557.38		
Grand Total (Total 1+2+3+4+5+6+7+8)	1,539.7	23883	1,369,060	493,457.7	

A total of 1539.7 Million kWh of electricity will be saved by implementing proposed priority actions across different sectors, which will reduce 1,369,060 tCO2e GHG emissions for the city. The total investment required for the proposed actions is INR 49345.7 Million INR. Mitigation potential of industrial sector (42%) is highest followed by building (residential, commercial and institutional) sector (38%), solid waste management (17%), transport (1.5%), street lighting (0.8%), municipal buildings (0.7%) and water (0.4%). (See figure 53, 54)

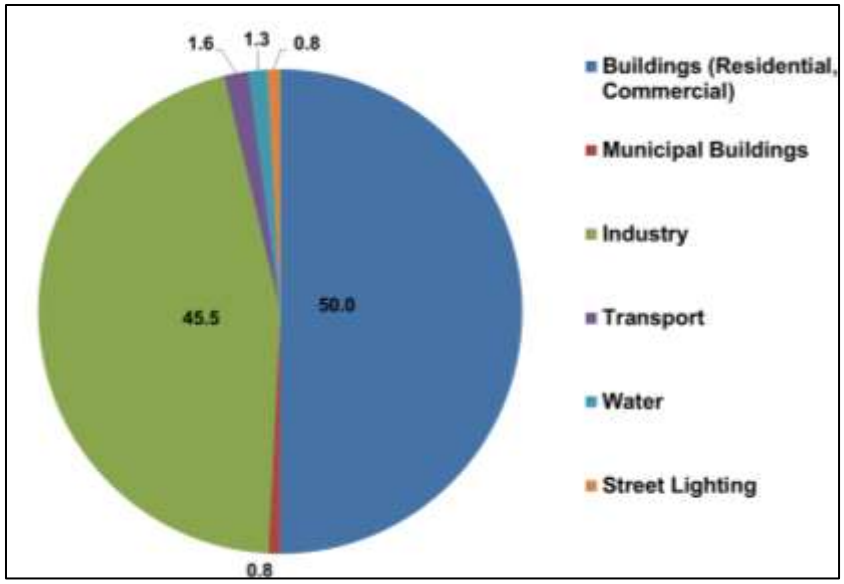


Figure 54: Total annual energy saving potential of CRCAP (Million kWh)

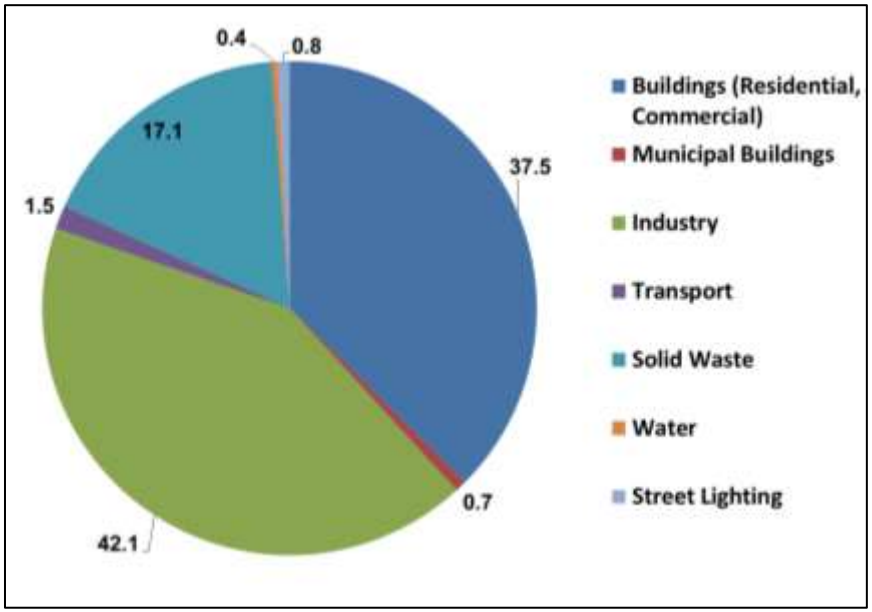


Figure 55 Total annual mitigation potential of CRCAP 2022-23 (tonnes CO2e)

Table 29 lists the interventions that will help the city to adapt to climate impacts addressing the fragile systems of water, sewerage, solid waste and land use planning. These were also assessed in terms of their overall resilience score, feasibility and impact.

Table 27: Adaptation Interventions with overall resilience score and feasibility

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
Water and Sewerage	Pricing policy of water is needed to inculcate proper usage habits among public.	Average	High	Medium	High	Medium
	Analysis of available water sources so as to plan for water usage and supply. Aquifer maps should be developed to analyse the water quantity and flow.	Medium	High	High	Medium	Medium
	Mapping of water logging areas and geo-tagging for specific interventions at required areas.	Medium	High	High	High	Short
	Rain water harvesting in homes, institutions, lakes and ponds, as well as restoring the channels and their catchment areas. Restoration will include proper sewage lines and connection to households as well as treatment of sewage, to avoid contamination of lakes.	High	High	High	High	Short - Medium
	Waste water treatment plant connections to households, institutions and to lakes should ensure no sewage flows into drains and is untreated.	High	High	High	Low	Short
	Dual plumbing must be encouraged. As per by laws, for properties above 5 acres, private treatment of sewage must be ensured and zero discharge must be made.	High	High	High	Low	Short

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	Economic use of water to prevent wastage and reduce demand.	High	High	High	High	Medium
	Drinking water and kitchen supply should be separated from other water supply. Ground water and treated sewage water can be used for other purposes. Integrated Urban Water Management policies should be enforced	High	High	High	Low	Short-Medium
	Waste water tariff should be set, particularly for development and not just operation and maintenance.	Average	High	Medium	High	Long
	Improving urban greenery to 30% of land area to improve water catchment areas.	Medium	High	High	Low	Medium
	Checking the leakages and tapping the losses through pipelines	High	High	High	High	Short
	Proper solid waste management to avoid contamination and drainage blockages that causes water logging.	Average	High	High	Low	Short
	Conservation and restoration of degraded lakes and their maintenance	High	High	High	Medium	Short
	Strategic Planning of sewerage management for the city	High	High	High	High	Long
Land Use	Identification of reserved sites for corporation for development into green areas. There is available information on the sites and their geo referencing with NGOs.	Medium	High	High	High	Medium
	Declare reserved sites as Urban Green Spaces. Provide facilities like water, electricity, fencing, signage for maintenance.	High	High	High	High	Short

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	Identifying potential park developers and care takers from corporates, NGOs, communities, residential associations and supporting them for maintenance of these areas.	Average	High	High	High	Short
	Master plan must be synced with smart city plan of Coimbatore to ease implementation.	Average	High	High	High	Short
	Professional and logical classification of landuse has to be incorporated with community consultation in the master plan.	Average	High	High	High	Medium
	Drastic land use change shouldn't be allowed in the smart area (ABD)	Average	High	Medium	High	Long
	Already pending scheme road plans should be implemented soon; width of the road should always be maintained	High	High	High	Low	Short
	Avenue trees on the road side could be transplanted nearby	Average	High	High	Low	Medium
	Have proper policy to lay the utilities on the road sides so that the other side could be used for tree planting	Medium	High	High	High	Short
Solid Waste Management	Source segregation of waste to be made compulsory as per SWM Rules 2016. Ward wise incremental process can be followed. Bulk waste generators and commercial organisations and institutions can be enjoined to begin segregation by June 2018, while households level segregation can begin by Dec 2018 for the entire city.	Medium	High	High	High	Medium

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	Awareness generation programmes at the ward level must be initiated for segregation of waste and recycling. This can be done through SBM scheme, with schools, or communities either through action learning or through exhibitions, displays, etc.	Medium	High	High	Medium	Long
	Segregated collection of waste in 3 categories - wet, dry and sanitary. Door to door collection of waste is to be introduced to all wards. However for organised communities and apartment complexes, there would be a single pick up point. Create clusters for primary collection using ecarts or autos.	Very High	High	High	Low	Medium
	Establish zonewise collection centres, with material recovery facility for dry waste, decentralised treatment for wet waste through composting, biogas generation, mulching and reserve site enrichment, etc. Sanitary waste should be incinerated. SBM can be utilised for implementation.	High	High	High	Low	Short
	Practical implementation strategy for removal of dustbins from all wards in the city by 2019.	Medium	High	High	High	Short
	Encourage community driven private start ups to manage solid waste in the city, to bring in new ideas on segregation, collection, handling, transportation and scientific disposal.	High	High	High	High	Short

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	Develop and implement user changes as discussed and decided in 2016.	Average	High	High	High	Short
	Construction and demolition waste should be handled by separate agencies, with minimal impact on environment and maximum reuse.	Medium	High	High	Low	Short
	Reduce the usage of materials such as plastic where disposal is a challenge, through regulatory mechanisms. Use of recyclable packaging material should be encouraged.	Very High	High	High	Low	Short
	For industrial waste, guidelines and rules should be enforced for collection and treatment. A policy for the city can be developed.	Very High	High	High	Low	Long
	Building intra-departmental coordination and cooperation between public health engineering, finance, engineering and administration.	Average	High	High	High	Short
	Appropriate technical solutions need to be provided for wet waste - biogas or composting, dry waste - reduce, reuse, recycle and refuse and for sanitary waste - alternative solutions	Very High	High	High	Low	Long
	E-waste collection centres should be established to properly treat and dispose e-waste.	Very High	High	High	Low	Long
	Medical waste has to be collected and incinerated properly to avoid pollution. TNPCB deals with medical waste, but the city needs to develop a policy.	High	High	High	Low	Long
	Training on management of industrial	High	High	High	Low	Medium

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	waste, foundry waste, etc. Prevention of disposal of this waste in water bodies. TNPCB needs to be engaged with for such training.					
	Training on roof gardening and organic farming and linking it to composting facilities in the city. TNAU with CCMC and NGOs and farmers can be involved in the trainings that can be supported by SBM.	High	High	High	Medium	Medium
	Strategic planning for solid waste management in the city for overall management	High	High	High	High	Long
Health	Strictly enforce Panchayat Act & Corporation Municipal Act for giving priority for disposal of solid and liquid waste to avoid mosquito breeding	Medium	High	High	High	Short
	Strengthen The Integrated Disease Surveillance Program by Instituting Rapid Response Cell including non-communicable diseases such as heat stress and other impacts of CC	Medium	Low	High	High	Medium
	Conduct training and awareness for different target audiences on CC and health and incorporate in the curriculum of medical education	Medium	High	High	High	Long
	Ensure 100% sanitized toilets and elimination of open defecation	Medium	High	High	Low	Long
Energy	Energy efficiency by replacement and retrofitting of appliances and equipment	High	High	High	Low	Short

Sector	Interventions	Overall Resilience Score	Feasibility of the intervention			Impact (Short/Medium/Long Term) - when will the impact be seen in the city
			Technical	Political	Financial	
	Alternate sources of energy, such as solar PV	High	High	High	Low	Short
	Energy efficiency in municipal buildings and municipal services	High	High	High	Low	Short
Transportation	Change of fuel in buses	High	High	High	Low	Short

7. CONCLUSION

The Climate Resilient City Action Plan for Coimbatore City Municipal Corporation was developed using the Climate Resilient Cities Methodology. The plan identifies 2 major impacts of climate change – increased temperature and slightly increased precipitation with high frequency and intensity of rainfall. The primary urban services, which will most severely be impacted by climate impacts include water supply systems, sewerage management systems, land use planning, solid waste management systems, energy and transportation. These fragile urban systems and their fragility has been identified by the Core Team and the Stakeholder Committee through Shared Learning Dialogues (SLDs).

The methodology helped identify the broad climate risks to these fragile urban systems and helped the core team to identify the most vulnerable areas within the city and the most vulnerable actors in the city that will be impacted by them. Baseline GHG emissions have been recorded in the city through the HEAT+ tool to identify the sectors that are mainly responsible for carbon emissions within the city, both at the municipal level as well as community level. The sectors responsible for the majority of emissions in the city, and therefore also providing the maximum potential to reduce emissions, include building sector and transport. On the basis of the vulnerable urban systems, areas, and actors, and the GHG emissions information, resilience actions have been identified to help the city to reduce carbon emissions on one hand and successfully adapt to potential climate impacts in the future.

The resilience strategies identified have been assessed in terms of their technical, political and financial feasibility and the time that is taken by the intervention to show its impact on the resilience of the city in general. A large number of emission reduction interventions have been proposed for building sector, transport, street lighting, among others that can give huge benefits in terms of reducing GHG emissions from the city by reducing energy consumption, as well as reducing municipal expenditure on fuel and electricity. Apart from the structural strategies to counter the climate impacts of these fragile urban systems, the process also recognized the importance of developing and implementing plans for these urban services keeping in mind the possible future impacts. City level plans have also been developed for the solid waste management system and the sewerage system through the CapaCITIES Project and their implementation will facilitate building resilience in the city. Coimbatore has a largely responsive population, IEC and awareness generation activities can yield substantial results in changing behaviour for the better and towards a climate friendly city.

An important aspect that evolved from the discussions of the core team members was the need for better coordination among different government agencies. Since some of the urban services are under the control of different government agencies (for instance, transportation is largely handled by the TNSTC), it is necessary for the different government bodies to coordinate their activities so as not to work at cross purposes. Stricter implementation of regulatory provisions for Solid Waste Management and sewerage connections, conservation of water bodies, littering, encroachment of water bodies, maintenance of green spaces within the city and traffic control could also help the municipal corporation to reduce the impacts of sudden disruption to services because of climate impacts and be more resource efficient. It is observed that improvement in the regulatory mechanisms of urban services will go a long way in improving basic services in the city and its resilience. Simple policies on tariff of water supply and waste management can encourage better civic behaviour and help improve resilience.

Energy efficiency in municipal buildings, municipal services and transportation, residential buildings and industrial sector can create a substantial reduction in GHG emissions in the city. Most of these

interventions also provide co-benefits. In case of buildings, there is a very high mitigation potential by using energy efficient fixtures and using solar power. Mitigation potential is not very high for only municipal buildings, and this means that they can serve as demonstration sites to encourage uptake of energy efficient measures at the residential level. Policies promoting energy efficiency can also help in this matter. Industries can support GHG emission footprint reduction through improved process efficiency. In case of transportation, the change of fuel from diesel to CNG may result in higher emissions, however, there are substantial benefits in terms of improved air quality and thereby better public health to warrant a thorough debate on the same for the city to take action. Emission reduction in water supply systems and solid waste systems have distinct co-benefits of improved public health as well as socio-economic benefits of livelihood for the poor and vulnerable.

Several structural improvements are also required in the city, including electrical retrofitting and refurbishments, decentralised systems of solid and liquid waste treatment and disposal, public transport facilities, maintenance and conservation of urban green and blue spaces. The city is already undertaking development work through the Smart City Mission, AMRUT Mission and the Swachh Bharat Mission, that can be used to initiate resilience actions that are integrated with the developmental projects.

Annexure 1: Core Team of Coimbatore

The Climate Core Team of Coimbatore was formed in August 2016 consisting of Municipal staff who will be steering the formation of the CRCAP for Coimbatore. The current Climate Core Team is given below:

S. No.	Name	Designation
1	Dr. K.Vijayakarthikeyan IAS.	Commissioner
2	Tmt..P.Gandhimathi	Deputy Commissioner
3	Thiru.Natarajan	Superintending Engineer (JNNURM)
4	Tmt.V. Parvathi	Executive Engineer & City Engineer (In-charge)
5	Thiru. A. Lakshmanan	Executive Engineer Smart City
6	Thiru. K.Saravanakumar	Assistant Executive Engineer (SWM) &Executive Engineer (West) i/c
7	Dr.Santhosh Kumar	City Health Officer
8	Thiru. S.P.Ravikannan	Assistant Engineer (SWM)
9	Thiru.P.Arunagiri	ZSO (North)
10	Thiru.K.V.Thirumal	Sanitary Officer & SBM Nodal Officer
11	Thiru.Manivannan	ZSO (East) i/c
12	Thiru.R.Radhakrishnan	ZSO (West) i/c
13	Thiru.Gunasekaran	ZSO (Central) i/c
14	Thiru.Loganathan	ZSO (South) i/c
15	Thiru.Sendilkumar	Sanitary Inspector & SBM Nodal officer
16	District Environmental Engineer or his representative	Tamil Nadu Pollution Control Board

Annexure 2: Stakeholder Group

The Stakeholders Committee consisting of representatives from the Coimbatore city parastatal bodies, educational institutions, NGOs and CBOs was identified in 2016. This is modified as per changing needs and currently consists of the following persons:

S.No.	Name and Designation	Organization
1	Thiru. S.Basker	IC Centre for Governance, Coimbatore
2	Thiru.Raveendran, Secretary	Residential Awareness Association of Coimbatore (RAAC)
3	Thiru.SureshBandari, SWM Adviser	Clean Cities Foundation (CCF), Coimbatore
4	Thiru. Chandrasekhar, Assistant Professor	Coimbatore Institute of Technology (CIT)
5	Thiru. Nagaraj, Assistant Engineer	Tamilnadu Energy Development Agency (TEDA)
6	Thiru.B.Muthuram, Director	M/s ESPEN Clean Energy, Coimbatore
7	One Representative	M/s Vardhaan Infrastructure, Coimbatore
8	One Representative	M/s Coimbatore Integrated Waste Management Company Private Limited, Coimbatore
9	Thiru.Padmanabhan	No Food Waste – NGO
10	Thiru.Saranraj	Meiporul Trust – NGO
11	Mrs. Roopaprasanth	No Dumping –NGO
12	Dr.RadhaDamodaran, Assistant Professor	CMS College, Coimbatore
13	Mrs.Anitha	Architect, Coimbatore
14	Mrs.Rajalakshmi	Community Representative
15	Mrs.Preethi	Kolam Foundation

Annexure 3: Urban Systems Analysis

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Part of city function (Completely / Shared / No)	Fragility statement	Climate Fragility Statement
Water	*Flexibility & Diversity: Lack of adequate water storage facilities. Policy changes required for protection of water sources and regulation of water use.* *Redundancy: Several water sources available in the city, but they are getting constricted. Encroachment of lakes, loss of connectivity of lakes is leading to loss of water resources* *Safe failure:*	Water scarcity is a major issue in Coimbatore, caused by indiscriminate use, lack of conservation efforts, encraochment of water bodies. There is no management of NRW. Intergrated water management with neighbouring areas and states at the catchment level are needed (inter and intra state coordination for catchment area management).	Municipal corporation, PWD	Coimbatore faces severe water shortage due to indiscriminate use, lack of conservation efforts, encraochment of water bodies, poor management of NRW as well as poor regulatory policies for water use.	With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table. Absence of adequate water will impact GDP, economy (industry and agriculture) and health.
Land use planning (including green spaces)	*Flexibility & Diversity: Policy changes required to ensure incorporation of minimum open spaces in land use.* *Redundancy:* *Safe failure: Encroachment of lakes; cutting of trees, green area reduction*	Unplanned developmental changes have led to loss of greenery and water body encraochment, impacting micro-climate in the city. Land use planning should include open spaces and space for municipal utilities such as waste facitilies or water treatment plants.	Town Planning Department and Local Planning Authority (LPA)	City requires a land use plan that provides space for open areas and space for municipal utilities, and that needs to be followed so that there is minimum loss of greenery and water body encraochment, that can impact the micro-climate in the city.	With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.
Transportation	*Flexibility & Diversity: Policy changes required* *Redundancy: Private vehicles are increasing, need more public transport options – for example - metro* *Safe failure:*		Transport Department	Increased private vehicle usage due to lack of public transport mechanisms leading to increased emissions.	Increased temperatures will lead to more vehicles indirectly, which will increase the heat and emissions.

Urban system	Why is it critical or fragile?	What are the existing and anticipated problems caused by the fragility of this system?	Part of city function (Completely / Shared / No)	Fragility statement	Climate Fragility Statement
Sewerage Management	*Flexibility & Diversity: At present, there is inadequate capacity to treat sewage in the city.* *Redundancy: There is no treatment and reuse of sewage. Policy level changes need to be made for reuse of water from Ros, industrial waste water, etc.* *Safe failure:*	Increased temperatures will lead to more algal bloom in the water bodies where sewage is released which will decrease the DO in the water bodies leading to death of fish.	Municipal corporation	There is inadequate collection and treatment of sewage and policy regulations for reuse of sewerage and waste water (RO waste water) is lacking.	Increased temperatures will impact the treatment mechanism. Decreased rainfall will cause TDS levels to increase (as ground water level goes down), leading to increased costs of treatment of water.
Solid Waste Management	*Flexibility & Diversity: Centralised system, no leachate management* *Redundancy: Single treatment option, no decentralised treatment systems.* *Safe failure:*	Centralised managmeent of waste is conducted. Decentralised management options are lacking and needs to be developed for better management. Segregation of waste is not done at household level to a full extent. Secondary segregation is important. Garbage is dumped in the dumpyards leading to odour and hygiene issues. Policy level changes and enforcement mechanisms are missing. Awareness generation among community for behaviuoral change is required. Facilities for disposal of waste including hazardous waste, e-waste,C&D waste, animal waste etc is lacking. Extended producer responsibility needs to be designed.	Municipal corporation	The exisitng system of centralised waste management does not include facilities for proper segregation of waste, and for treatment of hazardous waste, e-waste, C&D waste, and animal waste, and lacks decentralised systems and policy level support regarding household segregation, extended producer responsbility, etc.	Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.

Annexure 4: Risk Assessment

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
Water	With increase in temperature and decreased rainfall, there will be increase in demand of water. This will lead to more ground water extraction lowering ground water table.	4	5	20	Extreme
	Absence of adequate water will impact GDP, economy (industry and agriculture) and health.	4	5	20	Extreme
Land use planning (including green spaces)	With increase in temperatures and decrease in rainfall, poor green and blue cover in the city will change the micro-climate. Increased heat island effects will lead to impacts on health, food and cattle feed production.	4	4	16	High
Sewerage Management	Increased temperatures will impact the treatment mechanism.	1	1	1	Low
	Decreased rainfall will cause TDS levels to increase (as ground water level goes down), leading to increased costs of treatment of water.	5	5	25	Extreme
Solid Waste Management	Increased temperatures and decreased rainfall will affect decomposition rates in treatment facilities, that will impact ecosystems, and cause odour, sanitation and health issues.	**4**	**3**	12	High
Transportation	Increased temperatures will lead to more vehicles indirectly, which will increase the heat and emissions.	**3**	**4**	12	High

Annexure 5: Actors Analysis

Actors	Capacity to respond (a)	Resources available (b)	Capacity to access information (c)	Adaptive capacity score (a*b*c)	Adaptive Capacity Status
Urban poor	2	1	1	2	low
Lake area settlements	2	1	1	2	low
Industry owners	2	3	3	18	high
State govt	1	1	3	3	low
MoUD	3	3	3	27	high
Corporation	3	3	3	27	high
Panchayat	2	1	1	2	low
Gated communities	3	3	3	27	high
Farmers	2	1	1	2	low
Industry workers	1	1	1	1	low
Self help gropus	2	2	2	8	medium
Academic institutions	3	3	3	27	high
NGOs and CBOs	3	2	3	18	high
Corporates	3	3	3	27	high
Street vendors	1	1	1	1	low
People living near factories and industries	1	1	1	1	low
Highways department	2	3	3	18	high
Slum clearance board	2	3	3	18	high
Pollution control board	1	3	3	9	high
Health department	3	3	3	27	high
District administration	3	2	3	18	high
Migrant labour	1	1	1	1	low
High income group	3	3	3	27	high
Commercial establishments	2	3	3	18	high
Technology partners	3	3	3	27	high
Funders- people who are capable of desigining, fund, bulid and operate companies	3	3	3	27	high

Annexure 6: Bankability assessment formatG

Project Name:	Waste-to-Energy (Incineration)
Project Owner:	Coimbatore City Municipal Corporation (CCMC)
Contact person & position	K.Saravanakumar, Executive Engineer
Reference:	CapaCITIES projects #7
City:	Coimbatore
Date:	25-07-17

Please fill out the project information in the Input boxes:

INPUT		Y/N or #	Description			Detail
Project budget		0	Not known (technology not decided); in future, Smart cities programme may be used for funding			*Investment required for the project Crore INR*
Secured budget		0	not available			*Either city budget or external budget Crore INR*
Creditworthiness	Municipality	N	Already existing loans from TUFIDCO, from TNUIFSL, for JNNURM projects and Smart City projects,			*Credit score of public entity:*
	State	Y	Political decisions on how MCs can access the funding			*Equal or higher than BBB- -> Y // Lower than BBB- -> N*
Revenues		Y	Currently charges for commerical users (bulk fee), User charges may need to be increased with increasing cost and additional infra			*Revenues from product sales, usage fees ... -> Yes/No*
			Potential Grant	*Potential Loan*	Other Grants & Loans	
Grants / Public Loans	Municipal Funding	N	Solid waste collection fee			
	State	Y	None	None	JNNURM and Smart City Program - city has contribution in this.	*Available grants (Y/N)*
	National	Y	None	None		
	International	Y	None	None		
			funding from where?			

DATA COMPLETE

Information	
Minimum credit score	BBB-
Maximum Debt (can be dependant on sector)	70%

* more than one item can be selected off list? Others written down if not enough?

Recommended Financing Strategy

Public-Private Financing (project-based or state balanced sheet)

Description:
- Securitized revenue stream
- Credit rating of state
- Balance Sheet Financing
- **Action: Evaluate level and**

Actions agreed upon

The project will be executed in the Vellalore compost plant site. The CCMC is working on the detailed project report and they would set it up based on public private partnership mode.

the Corporation had decided to establish a waste-to-energy project as announced in the Corporation Budget 2012-13. The resolution said that the Corporation could establish the waste-to-energy plant at the Vellalore yard in the public-private partnership mode.

Project Name:	Waste-to-Energy (Incineration)
Project Owner:	Coimbatore City Municipal Corporation (CCMC)
Contact person & position	K.Saravanakumar, Executive Engineer
Reference:	CapaCITIES projects #7
City:	Coimbatore
Date:	25-07-17

PLEASE EVALUATE THE FOLLOWING RISKS FOR THIS PARTICULAR PROJECT

INPUT

PRE-COMPLETION	*CITY*	*EXPERT*	*AGREED ASSESSMENT*	*Further information*
How confident are you on the design and schedule of the project?	Not applicable	Not applicable	Not applicable	Incineration technology not yet decided
How confident are you about the proper construction of the infrastructure?	Confident	Not confident	Not confident	Little know-how in Coimbatore on incineration plants
How confident are you on smooth supply of the most important inputs (e.g. waste, fuel)?	Confident	Confident	Confident	600t/day, little fluctuation
POST-COMPLETION				
How confident are you in the planned Operations & Management Team?	Not applicable	Not confident	Not confident	Technology partners not decided yet. No experience in CCMC
How well can you predict the level of revenues the project will have per year?	Low possibility	Low possibility	Low possibility	Power production can be predicted but market price uncertain; depends on agreement with city and electricity board
How likely are your counterparties (offtaker, supplier, engineer) at risk of defaulting?	Low possibility	Low possibility	Low possibility	CCMC is both supplier and potential offtaker of power, engineer not known
How stable is your state and country's political system?	Not very stable	Not very stable	Not very stable	Soon, political change in Coimbatore
ENTIRE PROJECT				
How likely will administrative (e.g building permits) or regulatory changes affect the project ?	Low possibility	Low possibility	Low possibility	State involved + tender as likely > 1 Crore of investment, land is available, permissions are possible
Will the project likelly cause any major environmental damange, social unrest or governance problem?	Probable	Probable	Probable	30 people currently working from segregating waste (open dumps), with permission; requires constant monitoring and regulation

Risk	*Description*
Planning Risk	*Design of project / schedule*
Construction Risk	*Delays, quality issues, cost estimation*
Supply chain risk	*Unreliable suppliers*
Operational / Perfo	*Maintenance neglect, poor management,...*
Revenue Risk	*No securitized revenue stream, uncertainty on quantity and price*
Counterparty Risk	*One or more parties do not keep up their obligations*
Political Risk	*Upcoming election, Change of power, Disorder, War*
Regulatory Risk	*Trouble obtaining building permit*
ESG Risk	*Natural disasters, droughts,... Public opposition, contamination risk,...*

DATA COMPLETE

LEGEND

- High Priority
- Medium Priority
- Low Priority

TOP RISK PRIORITIES TO ADRESS

RISK	POTENTIAL MITIGATION MEASURES	ACTIONS AGREED UPON
Planning Risk	Hire experienced Project developer	
Construction Risk	TKCC - Turnkey construction contract (contractor takes over responsibilities in construction phase)	
Supply chain risk	Put or pay agreements (supply or find other supplier and pay supplement)	Agreement needs to be made to avoid excessive costs to CCMC while ensuring regular supply of waste.
Operational / Performance Risk	Tech warranties, Operation contract	Operational contract will be developed once technology is finalised and tendered.
Revenue Risk	Agreement with buyer for certain quantity at certain price: cash flow securitization / guarantee off-take or payment as a city	Agreement of CCMC with TNEB for power uptake, fixed rate of power uptake by Tamil Nadu Electricity Board as per Tamilnadu Electricity Regulatory Commission (TNERC)
Counterparty Risk	Legal due diligence, guarantees/insurances	Operational Contract will be strengthened to address risks
Political Risk	Political risk insurance / guarantees	
Regulatory Risk	Guarantee for government / insurance	
ESG Risk	Clear and efficient public communication on benefits for development and the environment (in that order); insurance for weather risks	NOC from Pollution Control Board will be obtained for construction of plant. EIA report to be prepared before exection of project and stakeholders committee will be established.

Complete list of potential grant providers: municipal, state, national, international

Municipal funding		State-level	National-level	International-level
Property tax		Ordinary loans from state government	SIDBI	KfW
Waste water disposal fee		Tamil Nadu Water & Sewerage Fund	IDFC	AFD
Solid waste bulk collection fee		Tamil Nadu Urban Development Fund	Ordinary loans from natior	World Bank
Water supply fee		Water and Sanitation Pooled Fund		ADB
Profession tax		TUFIDCO		(EIB)
Service charges		TNUIFSL		Swedfund
None		IUDM - Integrated Urban Development M	None	USEXIM
		Tamil Nadu Urban Road Infrastructure Fund (TURIF)		None
	LOANS			
		None	Swachh Bharat Mission	GIZ
		MLA (Member of Legislative Assembly) Gı	Smart City Program	AFD
		SFC (State Finance Commission) Infra and	AMRUT Scheme	SDC
			MP (Member of Parliamen	DANIDA
			Central Government Natio	NORAD
			14th Finance Commission (	SIDA
			LED Program	USAID
			None	None
	GRANTS			

	Potential Risk	Description	Potential mitigation measures	Priority 1 (	Priority 2 (	Priority 3 (Depending on requests from investors)
PRE-COMPLETION	Planning Risk	Design of project / schedule	Hire experienced Project developer	x		
	Construction Risk	Delays, quality issues, cost estimation	TKCC - Turnkey construction contract (contractor takes over responsibilities in construction phase)	x		
	Supply chain risk	Unreliable suppliers	Put or pay agreements (supply or find other supplier and pay supplement)	x		
POST-COMPLETION	Operational / Performance Risk	Maintenance neglect, poor management,...	Tech warranties, Operation contract	x		
	Revenue Risk	No securitized revenue stream, uncertainty on quantity and price	Agreement with buyer for certain quantity at certain price: cash flow securitization / guarantee off-take or payment as a city	x		
	Counterparty Risk	One or more parties do not keep up their obligations	Legal due diligence, guarantees/insurances	x		
	Political Risk	Upcoming election, Change of power, Disorder, War	Political risk insurance / guarantees			x
ALL PHASES	Currency / Macro-econ. Risk	Depreciation of revenue currency	FX hedging			x
	Regulatory Risk	Trouble obtaining building permit	Guarantee for government / insurance		x	
	ESG Risk	Natural disasters, droughts,... Public opposition, contamination risk,...	Clear and efficient public communication on benefits for development and the environment (in that order); insurance for weather risks		x	
	Financial Sector Risk	Interest rates, inflation	Financial instruments such as Derivatives			x

DASHBOARD

1st Knot	Y2					
Available Grants	Y	State, National, International				
City Equity	N					
Validated Data	Y					
					Reasons Why	
Option 1	N	Public-Private Financing (project-based / SPV)	Securitized revenue stream	Healthy credit history	Project level financing	**Action:** decide on public vs. Private (tender) vs. PPP model
Option 2a	N	Public-Private Financing (balance sheet of city)	No revenue stream	Credit rating of municipality	Balance Sheet Financing	**Action:** issue municipal bond
Option 2b	N	Public-Private Financing (balance sheet of state)	No revenue stream	Credit rating of state	Balance Sheet Financing	**Action:** negotiate with state on financing
Option 3	N	Full public financing (including debt)	Securitized revenue stream	Poor credit history	Access to public equity and debt	**Action:** consider to involve private investors, to free budget
Option 4	N	Private Financing with Public Support	Securitized revenue stream	Poor credit history	Open bid process to private sectore to ta	**Action:** Open bid process to private sectore to take over project
Option 5	N	Full public financing (grants only)	No revenue stream	Poor credit history	Debt or Equity not accessible	**Action:** Secure Grants
Option 6a	N	Public-Private Financing (project-based or city balanced shee	Securitized revenue stream	Credit rating of municipality	Balance Sheet Financing	**Action:** Evaluate level and security of revenues, to decide on SPV vs. Balanced sheet financing
Option 6b	Y	Public-Private Financing (project-based or state balanced she	Securitized revenue stream	Credit rating of state	Balance Sheet Financing	**Action:** Evaluate level and security of revenues, to decide on SPV vs. Balanced sheet financing
Option 7	N	Project cannot be financed	No revenue stream	Poor credit history	Grants, Debt or Equity not accessible	**Action:** identify: revenue or grants

Different terminology

Option 1	Engineering, Procurement and Construction contract
Option 2	Debt - Private or Public
Option 3	City Project (SPV) - Public Equity / Private or Public Debt
Option 4	Full tendering - Private Equity and Debt
	Grant:
Option 5	State, National, International

RISK ANALYSIS

Validated Data Y

Validation List

Y

N

Validation Lists

Not applicable	1
Almost impossible	2
Low possibility	3
Probable	4
Highly Probable	5

Not applicable	1
Very Stable	2
Stable	3
Not very stable	4
Unstable	5

Not applicable	1
Very confident	2
Confident	3
Not confident	4
Highly concerned	5

	Municipal	State	National	International
# of Loans	8	9	4	9
# of Grants	1	4	9	9
Data Validation List				

Project Name:	(14?) new Sewage Treatment Plants (STP) in Lake area / integrated in long-term Wastewater management planning
Project Owner:	Coimbatore MC
Contact person & position	A.Lakshmanan, Executive Engineer, JNNURM
Reference:	CapaCITIES projects #1 & #2
City:	Coimbatore
Date:	25-07-17

Please fill out the project information in the Input boxes:

INPUT		Y/N or #	Description			*Detail*
Project budget		100				*Investment required for the project Crore INR*
Secured budget		1				*Either city budget or external budget Crore INR*
Creditworthiness	Municipality	N				*Credit score of public entity:*
	State	Y				*Equal or higher than BBB- -> Y // Lower than BBB- -> N*
Revenues		Y	Waste water charge of 5000-1000 INR (once per household) and monthly charges, sale of recycled water to industries			*Revenues from product sales, usage fees ... -> Yes/No*
			Potential Grant	*Potential Loan*	Other Grants & Loans	
Grants / Public Loans	Municipal Funding	N	Property tax			*Available grants (Y/N)*
	State	N	None	None	Tamil Nadu Urban Finance and Infrastructure Development Corporation Ltd(TUFIDCO) and TNUIFSL	
	National	N	Swachh Bharat Mission	None	Smart City Program	
	International	N	GIZ	KfW		

DATA COMPLETE

Information	
Minimum credit score	BBB-
Maximum Debt (can be dependant on sector)	70%

Recommended Financing Strategy

Public-Private Financing (project-based or state balanced sheet)

Description:
- Securitized revenue stream
- Credit rating of state
- Balance Sheet Financing
- **Action: Evaluate level and**

Actions agreed upon

Actions agreed by the city on the ppp model - plans of using ppp in STP
The CCMC has decided to set up sewage treatment plants at each lake in the city and the lakes have been given importance in the smart city plan that the CCMC is preparing the DPR report through the consultant.

Project Name:	ı / integrated in long-term Wastewater management planning
Project Owner:	Coimbatore MC
Contact person & position	A.Lakshmanan, Executive Engineer, JNNURM
Reference:	CapaCITIES projects #1 & #2
City:	Coimbatore
Date:	25-07-17

PLEASE EVALUATE THE FOLLOWING RISKS FOR THIS PARTICULAR PROJECT

INPUT

PRE-COMPLETION	*CITY*	*EXPERT*	*AGREED ASSESSMENT*	*Further information*
How confident are you on the design and schedule of the project?	Confident	Not confident	Not confident	Ongoing discussion about design
How confident are you about the proper construction of the infrastructure?	Confident	Not confident	Not confident	Simone Bützer has been construction issues with existing plants
How confident are you on smooth supply of the most important inputs (e.g. waste, fuel)?	Confident	Confident	Confident	After the planned assessment, data should be available; waste water pipelines are being laid and CCMC will ensure HH connections
POST-COMPLETION				
How confident are you in the planned Operations & Management Team?	Confident	Not confident	Not confident	Swiss expert suggest to have larger plants to improve quality
How well can you predict the level of revenues the project will have per year?	Low possibility	Almost impossible	Almost impossible	Simone Bützer has been construction issues with existing plants
How likely are your counterparties (offtaker, supplier, engineer) at risk of defaulting?	Not applicable	Not applicable	Not applicable	Counterparties (offtaker, engineering company) not yet knwon
How stable is your state and country's political system?	Not very stable	Not very stable	Not very stable	Coming election in Tamil Nadu
ENTIRE PROJECT				
How likely will administrative (e.g building permits) or regulatory changes affect the project ?	Low possibility	Low possibility	Low possibility	Depends on whether >1 Crore, so tender
Will the project likelly cause any major environmental damage, social unrest or governance problem?	Probable	Probable	Probable	Potential ozone emissions, land issues with existing STPs

Risk	*Description*
Planning Risk	*Design of project / schedule*
Construction Risk	*Delays, quality issues, cost estimation*
Supply chain risk	*Unreliable suppliers*
Operational / Perfo	*Maintenance neglect, poor management,...*
Revenue Risk	*No securitized revenue stream, uncertainty on quantity and price*
Counterparty Risk	*One or more parties do not keep up their obligations*
Political Risk	*Upcoming election, Change of power, Disorder, War*
Regulatory Risk	*Trouble obtaining building permit*
ESG Risk	*Natural disasters, droughts,... Public opposition, contamination risk,...*

DATA COMPLETE

LEGEND

- High Priority
- Medium Priority
- Low Priority

TOP RISK PRIORITIES TO ADRESS

RISK	POTENTIAL MITIGATION MEASURES	ACTIONS AGREED UPON
Planning Risk	Hire experienced Project developer	City is in the process of developing DPR for detailed study
Construction Risk	TKCC - Turnkey construction contract (contractor takes over responsibilities in construction phase)	Agreement with PPP contractor for monitoring
Supply chain risk	Put or pay agreements (supply or find other supplier and pay supplement)	Agreement with PPP contractor for supply of waste water; CCMC to ensure HH connections to the pipes.
Operational / Performance Risk	Tech warranties, Operation contract	Agreement with PPP contractor
Revenue Risk	Agreement with buyer for certain quantity at certain price: cash flow securitization / guarantee off-take or payment as a city	
Counterparty Risk	Legal due diligence, guarantees/insurances	
Political Risk	Political risk insurance / guarantees	
Regulatory Risk	Guarantee for government / insurance	
ESG Risk	Clear and efficient public communication on benefits for development and the environment (in that order); insurance for weather risks	NOC from Pollution Control Board. EIA report to be prepared before execution of project and stakeholders committee will be established.

Complete list of potential grant providers: municipal, state, national, international

Municipal funding		State-level	National-level	International-level
Property tax		Ordinary loans from state government	SIDBI	KfW
Waste water disposal fee		Tamil Nadu Water & Sewerage Fund	IDFC	AFD
Solid waste bulk collection fee		Tamil Nadu Urban Development Fund	Ordinary loans from natior	World Bank
Water supply fee		Water and Sanitation Pooled Fund		ADB
Profession tax		TUFIDCO		(EIB)
Service charges		TNUIFSL		Swedfund
None		IUDM - Integrated Urban Development M	None	USEXIM
		Tamil Nadu Urban Road Infrastructure Fund (TURIF)		None
	LOANS			
		None	Swachh Bharat Mission	GIZ
		MLA (Member of Legislative Assembly) Gr	Smart City Program	AFD
		SFC (State Finance Commission) Infra and	AMRUT Scheme	SDC
			MP (Member of Parliamen	DANIDA
			Central Govt. National Urb	NORAD
			14th Finance Commission (	SIDA
			LED Program	USAID
			None	None
	GRANTS			

	Potential Risk	Description	Potential mitigation measures	Priority 1 (	Priority 2 (	Priority 3 (Depending on requests from investors)
PRE-COMPLETION	Planning Risk	Design of project / schedule	Hire experienced Project developer	x		
	Construction Risk	Delays, quality issues, cost estimation	TKCC - Turnkey construction contract (contractor takes over responsibilities in construction phase)	x		
	Supply chain risk	Unreliable suppliers	Put or pay agreements (supply or find other supplier and pay supplement)	x		
POST-COMPLETION	Operational / Performance Risk	Maintenance neglect, poor management,...	Tech warranties, Operation contract	x		
	Revenue Risk	No securitized revenue stream, uncertainty on quantity and price	Agreement with buyer for certain quantity at certain price: cash flow securitization / guarantee off-take or payment as a city	x		
	Counterparty Risk	One or more parties do not keep up their obligations	Legal due diligence, guarantees/insurances	x		
	Political Risk	Upcoming election, Change of power, Disorder, War	Political risk insurance / guarantees			x
ALL PHASES	Currency / Macro-econ. Risk	Depreciation of revenue currency	FX hedging			x
	Regulatory Risk	Trouble obtaining building permit	Guarantee for government / insurance		x	
	ESG Risk	Natural disasters, droughts,... Public opposition, contamination risk,...	Clear and efficient public communication on benefits for development and the environment (in that order); insurance for weather risks		x	
	Financial Sector Risk	Interest rates, inflation	Financial instruments such as Derivatives			x

DASHBOARD

		Validation List
1st Knot	Y2	Y
Available Grants	N	N
City Equity	N	
Validated Data	Y	

					Reasons Why	
Option 1	N	Public-Private Financing (project-based / SPV)	Securitized revenue stream	Healthy credit history	Project level financing	**Action:** decide on public vs. Private (tender) vs. PPP model
Option 2a	N	Public-Private Financing (balance sheet of city)	No revenue stream	Credit rating of municipality	Balance Sheet Financing	**Action:** issue municipal bond
Option 2b	N	Public-Private Financing (balance sheet of state)	No revenue stream	Credit rating of state	Balance Sheet Financing	**Action:** negotiate with state on financing
Option 3	N	Full public financing (including debt)	Securitized revenue stream	Poor credit history	Access to public equity and debt	**Action:** consider to involve private investors, to free budget
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Option 5	

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