Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

Climate Resilient City Action Plan - Udaipur

June 2019

CapaCITIES
LOW CARBON • CLIMATE RESILIENT • CITY DEVELOPMENT

Table of Contents

List of Tables

List of Figures

1 Udaipur City Commitment to Climate Action

1.1 Brief Introduction

Fast-growing energy demand, increase in infrastructure demand due to rapid urbanization, limited resources and deep traditional roots are some of the challenges and opportunities that call for decisive action and innovation in Udaipur. Though a tier two city, Udaipur is working to be at the forefront among Indian cities preparing for a sustainable, low carbon and climate resilient future.

The Udaipur Municipal Corporation (UMC) has undertaken a number of initiatives towards a sustainable future by conceiving and implementing initiatives covering renewable energy, energy efficiency, sustainable transport and solid waste management, aiming to achieve low emissions development and city climate resilience over the recent few years.

Located in the water scarce region of Rajasthan Udaipur has traditionally developed innovative interventions to regulate micro climate and store rainwater for harsh summer months and year long. The city has been traditionally designed to collect rain overflows through a network of catchments into a number of man-made lakes spread across the city. Change in climate has impacted the incidence patterns of precipitation as well as affected the temperature peaks in the city which has in turn noticeably also affected life in the city through flooding incidents and health impacts by heat strokes for instance.

With increasing population and spread of the city, providing efficient municipal services is another challenge that the city faces which further aggravates due to climate impacts. The city still does not have an efficient public transport system, sewerage network is not available citywide and waste generated by the city has not yet managed sustainably. Flooding and increasing temperatures worsen the emissions profile of the city and impact the city's life and economy substantially.

Udaipur and its administration acknowledges climate as an important consideration for life in the city and agreed to be part of the Capacity Building for Low Carbon and Climate Resilient City Development project (CapaCITIES) knowing the project approach that looked at scientifically mapping the climate vulnerability and emissions of the city and developing a plan to address the same. The city team highly appreciates the feet-on -ground nature of the CapaCITIES project and welcomes the CRCAP analysis and its recommendations wholeheartedly.

Figure 1 Past and On-going Initiatives on Climate Change in Udaipur

Development of Smart City

- Udaipur was recognized by the Ministry of Housing and Urban Development, Government of India as a Smart City in the year 2016
- UMC has set a target of reducing the total energy demand, from 2017 values, by 10%, by the year 2022

Low Carbon Mobility Plan (LCMP)

- LCMP of Udaipur city has been prepared for the horizon year 2031 and within the horizon of 20 years
- LCMP focuses more on the reduction of Green House Gas (GHG) emissions without compromising the accessibility and mobility needs of people. Low Carbon Comprehensive Mobility Plans (LCMP) adds the additional indicators of inclusiveness and measures that would lead to lower carbon emissions from transport to the existing methodology of CMP to make urban transport inclusive and low carbon.

Swachh Bharat Mission

- Launched in December, 2014. The programme includes elimination of open defecation, conversion of unsanitary toilets to pour flush toilets, eradication of manual scavenging, municipal solid waste management and bringing about a behavioural change in people regarding healthy sanitation practices.

CapaCITIES

- Udaipur is one of 4 model cities which will be participating in the CapaCITIES project, supported by the Swiss Agency for Development & Coordination, which seeks to technically support fast track implementation of mitigation actions and also develop climate resilience strategies for Udaipur, with a specific focus on water resilience. This project will build upon the progress achieved by Udaipur under their previous programmes.

Technical support for Sustainable Transportation by SSEF

- Udaipur is one of 4 smart cities which are being supported by the Shakti Sustainable Energy Foundation to provide technical inputs for improving public transport, last mile connectivity and Parking issues in the city. The city sees Transport as a key sector for improvement and is working to improve existing conditions.

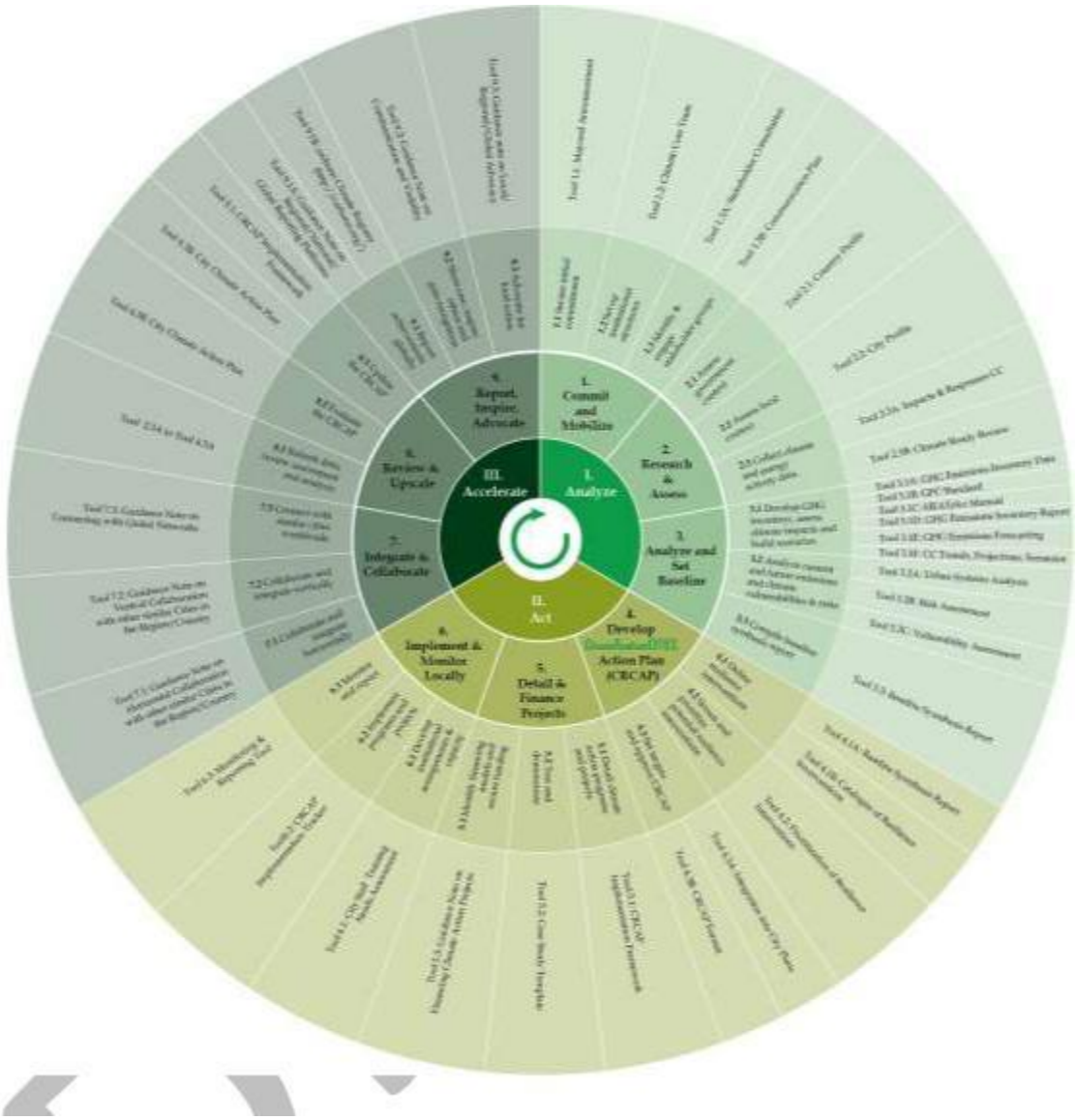
Technical support by BEEP

- Udaipur is also receiving technical support for developing energy efficient buildings by the Swiss Development Cooperation Agency's Building Energy Efficiency Project. Officials of the Udaipur Improvement Trust and UMC recently received training of energy efficiency in housing projects for the under development housing projects by the city authorities

Methodology followed to prepare the Climate Resilience City Action Plan

The Climate Resilient Cities methodology was followed to develop to the Climate Resilient City Action Plan for Udaipur. The Climate Resilient Cities Action Plan Process is a 9-step process in 3 phases: Analyse, 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.

Figure 2 ClimateResilientCITIES Methodology



Udaipur City has adapted this methodology for preparing its Climate Resilient City Action Plan. The Climate Resilient City Action Plan is the result of implementing steps 1 to 4 in Udaipur City. The tools provided in the tool-kit have been adapted to suite the purposes of the City.

Step: 1 – Commit and mobilize

1.1 Secure initial commitment – It is very important to ensure senior political and local government buy-in to kick-start the process for climate resilient development in the community and provide clear leadership. As political, executive and administrative support are required for successful planning and implementation of climate action plans, A Mayoral Announcement has been made by using Tool 1.1 , which clearly states the intent of the UMC to address climate change through mitigation and adaptation measures.

1.2 Set up institutional structures - A Climate Core Team has been setup by UMC on 25th October, 2016 by using Tool 1.2 (Climate Core Team – See Annexure 1), which comprises of Mayor, Commissioner and Additional Chief Engineer of UMC. They nominated officers and officials from various relevant departments of UMC as per the projects requirement on as and when basis for the discussions and their inputs (See Annexure 1). Climate Core Committee was involved in all steps of preparation of Climate Action Plan and support internal institutional capacity building to effectively fulfil the long-term climate resilience plan requirements by effective integration of planned initiatives into the city's developmental plans.

1.3 Identify and engage stakeholder groups - The Climate Action Planning Process should be supported by consultations with other groups in the city such as government agencies, local NGOs, community leaders, university partners and private sector organizations, to appropriately share responsibilities and ensure ownership. City level stakeholder committee was formed and notified by UMC by using Tool 1.3A (Stakeholder Committee – See Annexure 1) on 25th October, 2016 comprising of 43 members chaired by Municipal Commissioner for multi-way process of dialogue and deliberation within the Climate Core Team and with other stakeholders, as well as amongst stakeholders themselves.

A Communication Plan was prepared to communicate within the core team, with other departments of the UMC and with the external stakeholder committee and the community at large.

Step 2: Research and Assess

2.2 Assess local context - It is very important to assess local policies, on-going projects, economic, social and environmental contexts at the local level, which would impact climate resilient development in the City. Local issues with respect to the environment and urban development (socio-economic status, demography, municipal services, energy consumption (electricity and fuel) within the city limit) are also identified and discussed with core team. A baseline assessment of the urban systems was conducted for assessment of climate change impacts and influences urban development activities, and to identify the kind of support required by the UMC to address such impacts. Based on information collected, city profile has been developed for an assessment of climate vulnerable urban systems and carbon intensive activities by using Tool 2.2 City Profile (See Chapter - 2).

Step 3: Analyze and set baseline

3.1 Develop GHG inventory, assess climate impacts and build scenarios

- Base data has been collected by using (Tool 3.1A Energy and GHG Emission Inventory – Data Format) for stationary fuel and electricity consumption by all community and government sectors. This necessitates relevant data collection from UMC and external agencies which have the required information (utilities), as well as determining data gaps. UMC staff members engaged through meetings and letters with a number of municipal, local and sub-national stakeholders to source the relevant energy consumption data focusing on the large carbon emitters within the municipal area. Supply and demand-side data was therefore collected and analyzed.
- A GHG emissions inventory report is developed to determine sources of GHG emissions in UMC operations and the whole community using the HEAT+ GHG inventory online software tool and protocols by using (Tool 3.1B: Global Protocol for Community Scale GHG Emission Inventories, Tool 3.1C: HEAT+ Manual) (See Section– 3.1).
- The Community inventory includes emissions from community/city-wide activities within the UMC jurisdiction, including emissions from UMC activities and use. This includes emissions from sources and/or activities from stationary units (residential, commercial/institutional facilities, industrial and constructions, agricultural), mobile transportation units, waste. This is a useful planning tool in developing mitigation actions for the entire community.
- The Local Government operations inventory includes emissions from all of the operations that UMC owns or controls. Sectors included in a local government operations inventory include UMC buildings, facilities such as street lighting and traffic lighting, water, waste and sewage facilities, municipal vehicle fleet.
- GHG emission inventory report was developed by using Tool 3.1D GHG Emissions Inventory Report.
- Energy consumption has been done for medium term (till 2025) and long term (for 2050) planning. Energy consumption from municipal services been forecasted based on population projections and municipal service delivery based on existing and future city planning. Based on a forecasting of the energy consumption, the corresponding GHG emissions are calculated using the HEAT+ software by using Tool 3.1E - GHG emissions forecasting.

3.2 Identify fragile urban systems, climate vulnerabilities and risks

Core and secondary urban systems are examined to identify fragile urban systems and to examine the impact of climate change on these fragile urban systems by using Tool 3.2A: Urban Systems Analysis (See section 3.2). For each fragile urban system, key vulnerable areas (geographical areas) and the vulnerable population for each system are assessed and identified. Both the qualitative information gathered from stakeholder group through SLD and quantitative information from the city was assessed to assess vulnerability by using Tool 3.2C: Vulnerability Assessment (See section 3.4). The adaptive capacities of the urban systems are also assessed after close consultations with stakeholders. Risk for all critical fragile urban systems has been assessed after close consultation with stake holder committee and climate core team based on likelihood and consequences. Some of the qualitative attributes of the fragile sectors have been analysed to identify climate risk for Udaipur city by using Tool 3.2B Risk Assessment (See section 3.3).

Step 4: Develop Climate Resilient Cities Action Plan

4.1 Define resilience interventions

Various mitigation and adaptation interventions have been identified for Udaipur based on GHG emission inventory and urban system analysis in line with existing city planning. Mitigation and adaptation potential for each intervention along with financial aspect and implementation mode have been identified in line with ongoing projects and future planning of UMC by using Tool 4.1A Resilience Interventions (See Chapter 4).

4.2 Screen and prioritize potential resilience interventions

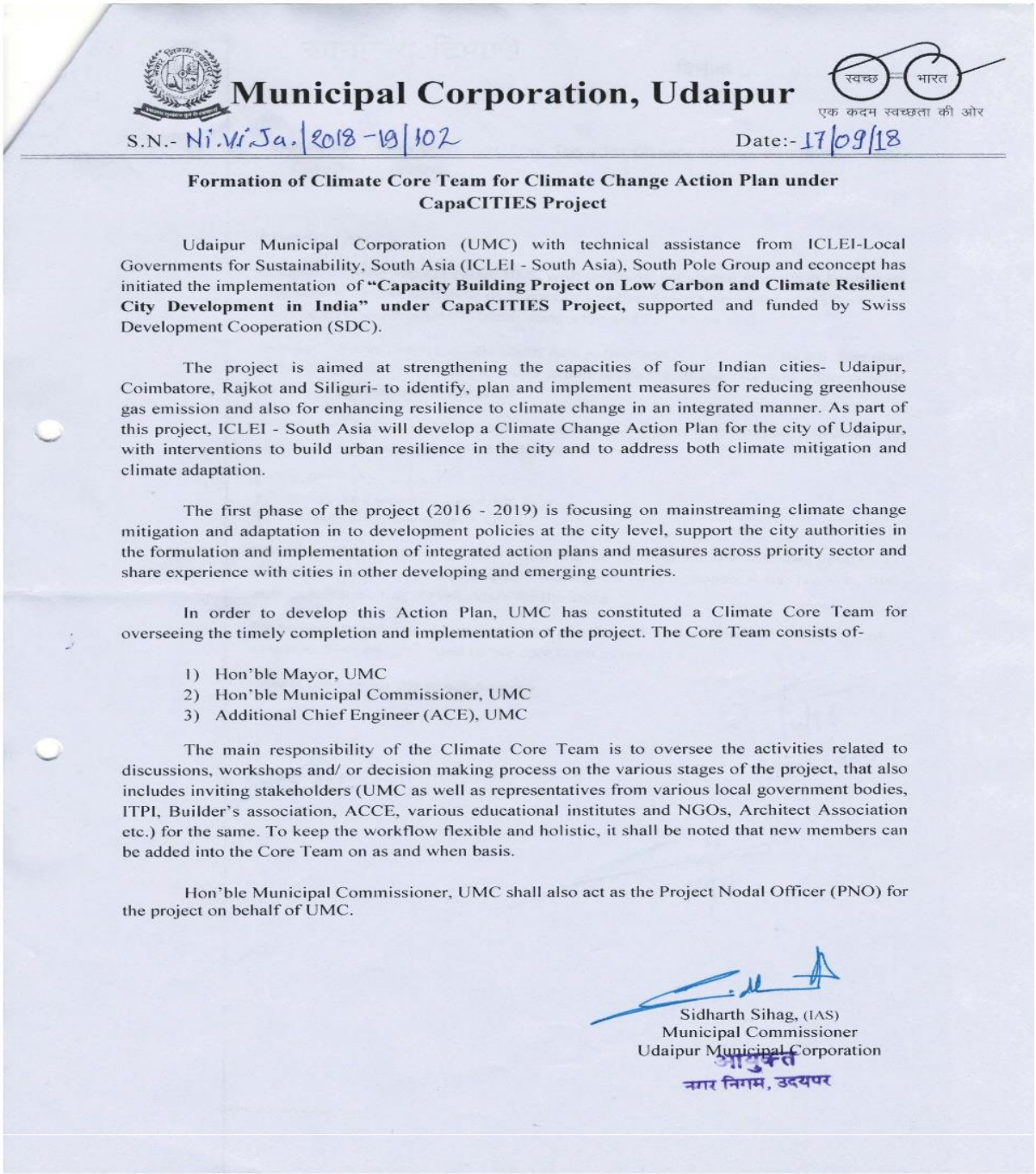
Prioritization of Resilience Interventions has been done based on feasibility and impact assessment by using Tool 4.2 Prioritization of Resilience Interventions.

4.3 Set targets and approve CRCAP

- The resilience interventions has been linked to existing/ongoing/planned initiatives within the city to assess possibilities of leveraging existing funding opportunities to implement the action plan (Tool 4.3 A Integration into city plans). Targets are set to move towards outcomes under climate action plan, which can relate to GHG “avoidance” or “reduction” and/or achievement of adaptation measures and also to socio-economic indicators.
- A formal Council approval is pending, which offers an opportunity for political review, recommendations and adoption of the Action Plan.

1.2 Climate Core Committee of the City

Climate Action Planning is not just linked to the environment so an effective and slim Core Team was formed for Udaipur that included the Additional Chief Engineer, Commissioner and Honorable Mayor as the Chair. The climate core committee involved representatives from departments that have responsibilities for, or an impact on, energy use, pollution, waste, food security, resilience in water sector and water security, public health, drainage and sanitation, local economic development, infrastructure, mitigation actions in transportation, and development planning from time to time. Climate Core Committee was involved in all steps of preparation of Climate Action Plan and support internal institutional capacity building to effectively fulfill the long-term climate resilience plan requirements by effective integration of planned initiatives into the city's



Municipal Corporation, Udaipur

स्वच्छ भारत
एक कदम स्वच्छता की ओर

S.N.- Ni.Vi.Ja./2018-19/102 Date:- 17/09/18

Formation of Climate Core Team for Climate Change Action Plan under CapaCITIES Project

Udaipur Municipal Corporation (UMC) with technical assistance from ICLEI-Local Governments for Sustainability, South Asia (ICLEI - South Asia), South Pole Group and econcept has initiated the implementation of **"Capacity Building Project on Low Carbon and Climate Resilient City Development in India" under CapaCITIES Project,** supported and funded by Swiss Development Cooperation (SDC).

The project is aimed at strengthening the capacities of four Indian cities- Udaipur, Coimbatore, Rajkot and Siliguri- to identify, plan and implement measures for reducing greenhouse gas emission and also for enhancing resilience to climate change in an integrated manner. As part of this project, ICLEI - South Asia will develop a Climate Change Action Plan for the city of Udaipur, with interventions to build urban resilience in the city and to address both climate mitigation and climate adaptation.

The first phase of the project (2016 - 2019) is focusing on mainstreaming climate change mitigation and adaptation in to development policies at the city level, support the city authorities in the formulation and implementation of integrated action plans and measures across priority sector and share experience with cities in other developing and emerging countries.

In order to develop this Action Plan, UMC has constituted a Climate Core Team for overseeing the timely completion and implementation of the project. The Core Team consists of-

1) Hon'ble Mayor, UMC
2) Hon'ble Municipal Commissioner, UMC
3) Additional Chief Engineer (ACE), UMC

The main responsibility of the Climate Core Team is to oversee the activities related to discussions, workshops and/ or decision making process on the various stages of the project, that also includes inviting stakeholders (UMC as well as representatives from various local government bodies, ITPI, Builder's association, ACCE, various educational institutes and NGOs, Architect Association etc.) for the same. To keep the workflow flexible and holistic, it shall be noted that new members can be added into the Core Team on as and when basis.

Hon'ble Municipal Commissioner, UMC shall also act as the Project Nodal Officer (PNO) for the project on behalf of UMC.

Sidharth Sihag, (IAS)
Municipal Commissioner
Udaipur Municipal Corporation
आयुक्त
नगर निगम, उदयपुर

developmental plans.

1.3 Stakeholder Committee for Climate Action

The Climate Action Planning Process should be supported by consultations with other groups in the city such as government agencies, local NGOs, community leaders, university partners and private sector organizations, to appropriately share responsibilities and ensure ownership. City level stakeholder committee was brought together by the Core committee during the development of the CRCAP report. The 'Stakeholder's Committee' includes key decision makers and administrators from UMC, Urban Improvement Trust, Town planning Department, Regional Transportation Office, Ajmer Vidhyut Vitaran Nigam (AVVNL), Public Health Engineering Department (PHED), Para State agencies as well as representatives from Builder's Association, Industrial Association, Udaipur Chamber of Commerce & Industries, Association of Consulting Civil Engineers (ACCE), Indian institute of town planners (ITPI), Local Architects, various educational institutions and Universities, , Various NGOs and visionaries form the city. Stakeholder concerns and feedback were considered through series of one to one meetings and a SLD consultation. Valuable information from various stakeholders has improved the design and outcome of the project in Udaipur city.

1.4 Communication Plan for Climate Action

- Launch workshop
- Information on City Level Dialogues

2 Background Research

2.1 City Profile

2.1.1 Location

Udaipur, also known as 'City of Lakes', is a major city and administrative headquarters of Udaipur District in Indian state of Rajasthan. Udaipur had been the capital of the Mewar Rulers for centuries. The foundation of Udaipur city was laid by Maharana Udai Singh of Sisodia Clan of Rajput. In geographical terms, it covers an area that lies between 24°28'49'' and 24°42'56'' N latitudes and 73°36'51'' and 73°49'46'' E longitude. It has an altitude of 598 meter from Mean Sea Level.

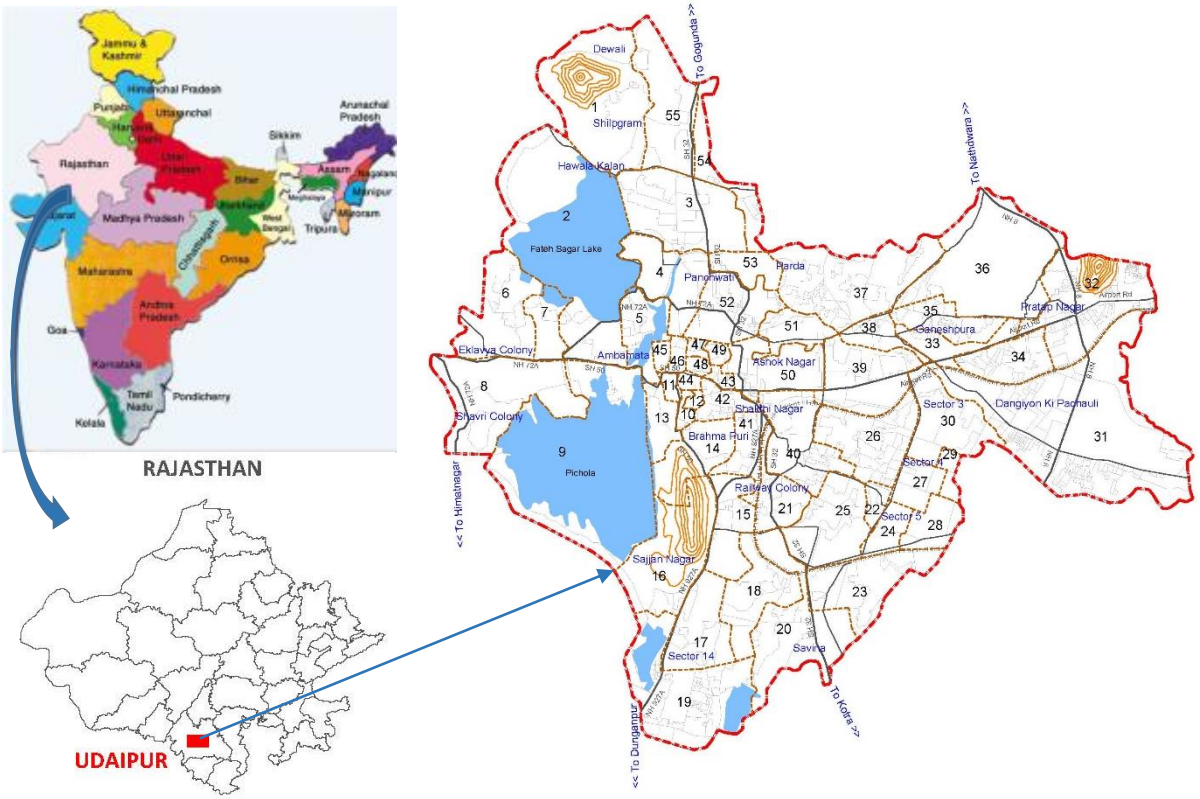


Figure 4 Location Map of Udaipur

Udaipur is spread across an area of 200 Km² and is the sixth largest city of Rajasthan by population, supporting a population of nearly 0.45 million as of 2011. It is located in the southern part of Rajasthan just near the Gujrat border and is surrounded by the Aravalli range which separates it from the Thar Desert. It is at a distance of 655 km from the national capital New Delhi and about 800 Km from Mumbai. Jaipur, the state capital of Rajasthan is at located at a distance of about 393 Km from Udaipur city.

Udaipur is a popular tourist destination and is known for its history, culture, scenic location and Rajput-era palaces. It is known as a 'City of Lakes' due to its sophisticated lake system with five major lakes namely - Fateh Sagar Lake, Lake Pichola, Swaroop Sagar Lake, Rangsagar and Doodh Talai Lake.

2.1.2 Connectivity

By Air: Udaipur has a domestic airport, Maharana Pratap Airport, named after the Maharana Pratap who was the ruler of princely state of Mewar. It is situated at Dabok, which is 22 Km east of Udaipur.

The airport connects Udaipur with Delhi, Mumbai, Jaipur and Chennai.

By Rail: The city is also connected by broad gauge railway lines to Delhi, Jaipur and Mumbai, the national capital city, the state capital city and the commercial capital city respectively.

By Road: Udaipur lies on the intersection point of East West Corridor, Golden Quadrilateral, National Highway (NH) 76 and National Highway (NH) 8. This provide Udaipur great connectivity with metro cities of India like Delhi, Mumbai, Kolkata and Chennai and other cities like Ahmedabad, Surat, Jaipur, Chittor, Dungapur and Kota.

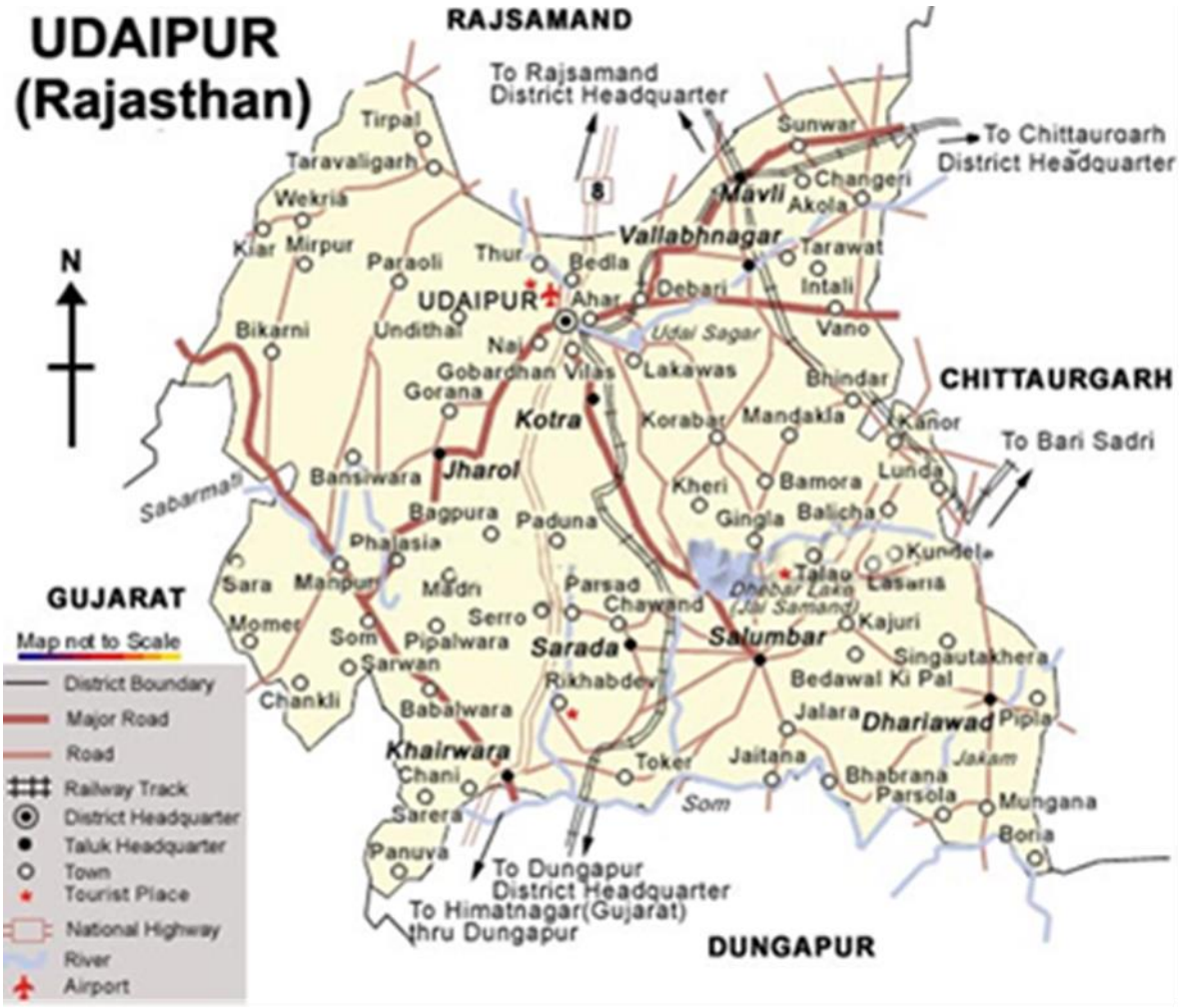


Figure 5 Regional linkages and area of Udaipur City

2.1.3 Demography

The population of Udaipur city is 451,100 (total 233,959 males and 217,141 females) as per census 2011. The population has grown at an average decadal growth rate of 15.81% since 2001. The population growth in the previous decade was influenced largely the expansion of the city area i.e. the area governed by the UMC. The population density of Udaipur city is 7,048 persons per sq. km as per Census 2011. The floating population of the city is 16,000 as per 2011 census. The city corporation is divide in to 55 wards since 2013, prior it to it the city was governed by a city council.

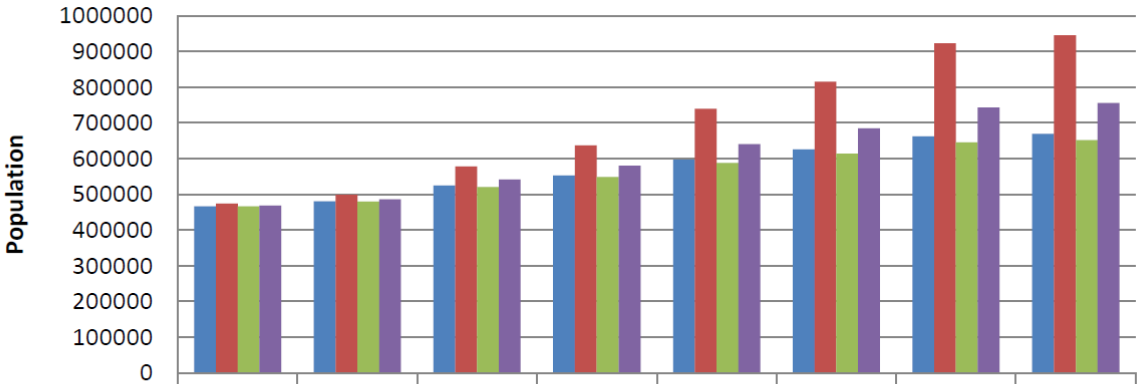
Table 1 Wardwise number of population and density

Wards	Population (2011)	Slum Household (2016)
Ward no - 1	9,012	427
Ward no – 2	8,124	
Ward no – 3	6,178	
Ward no – 4	6,549	
Ward no – 5	8,341	
Ward no – 6	9,092	
Ward no – 7	10,881	714
Ward no – 8	12,990	
Ward no – 9	6,774	
Ward no – 10	6,538	
Ward no – 11	6,488	
Ward no – 12	6,357	
Ward no – 13	5,510	
Ward no – 14	6,804	331
Ward no – 15	7,327	
Ward no – 16	12,964	751
Ward no – 17	10,941	
Ward no – 18	8,864	
Ward no – 19	12,124	259
Ward no – 20	13,829	
Ward no – 21	9,488	
Ward no – 22	9,589	
Ward no – 23	13,379	222
Ward no – 24	7,671	
Ward no – 25	3,314	
Ward no – 26	10,874	
Ward no – 27	6,568	
Ward no – 28	8,533	194
Ward no – 29	5,829	
Ward no – 30	10,987	
Ward no – 31	12,443	303
Ward no – 32	8,151	
Ward no – 33	10,596	
Ward no – 34	4,617	
Ward no – 35	8,856	
Ward no – 36	6,182	
Ward no – 37	17,182	
Ward no – 38	6,957	
Ward no – 39	7,176	
Ward no – 40	8,625	

Wards	Population (2011)	Slum Household (2016)
Ward no – 41	7,287	215
Ward no – 42	6,837	
Ward no – 43	5,096	
Ward no – 44	5,620	
Ward no – 45	6,105	
Ward no – 46	6,107	
Ward no – 47	6,640	
Ward no – 48	4,963	
Ward no – 49	5,895	
Ward no – 50	6,066	
Ward no – 51	6,779	
Ward no – 52	7,929	
Ward no – 53	6,752	
Ward no – 54	9,428	
Ward no – 55	6,928	
Total	**451,100**	**3416**

(Source –Census 2011 and UMC)

The projected population for Udaipur city in 2021 (based on 2011 population) is estimated to be 0.534million (8.30 lakhs) and 0.64 million (10.02 lakhs) in the years 2031.



	2013	2015	2021	2025	2031	2035	2040	2041
Arithmetic	466258	480781	524350	553395	596964	626010	662317	669578
Geometric	474555	498528	577959	637826	739452	816047	923042	946069
Incremental	465898	479940	521347	548351	587956	613759	645337	651562
Average	468904	486416	541219	579857	641457	685272	743565	755736

Figure 6 Population Growth and Projection for Udaipur city and Urban Agglomeration

(Source: City Sanitation Plan - Draft Report (Udaipur City)

2.1.4 Land Use

The first master plan was proposed in 1976 for a period of 20 years ending in 1996.The master plan proposed a land use pattern and, whereby 5,512 ha area was demarcated as urbanizable. The master plan – 2001 proposed land use pattern of 2022. Out of the total developed area, 37.42% was allocated for residential use, 10.61% under circulation, 10.35% as public and semi-public, 4.75% as

industrial, 5.22% as commercial, 10.39% as recreational and 1.4% as government land. As per the City Master Plan for 2032, proposed in 2011, the residential area is projected to go up from 57.23% to 62.62% and the water bodies are projected to decrease from 7% to 5% of the total area.

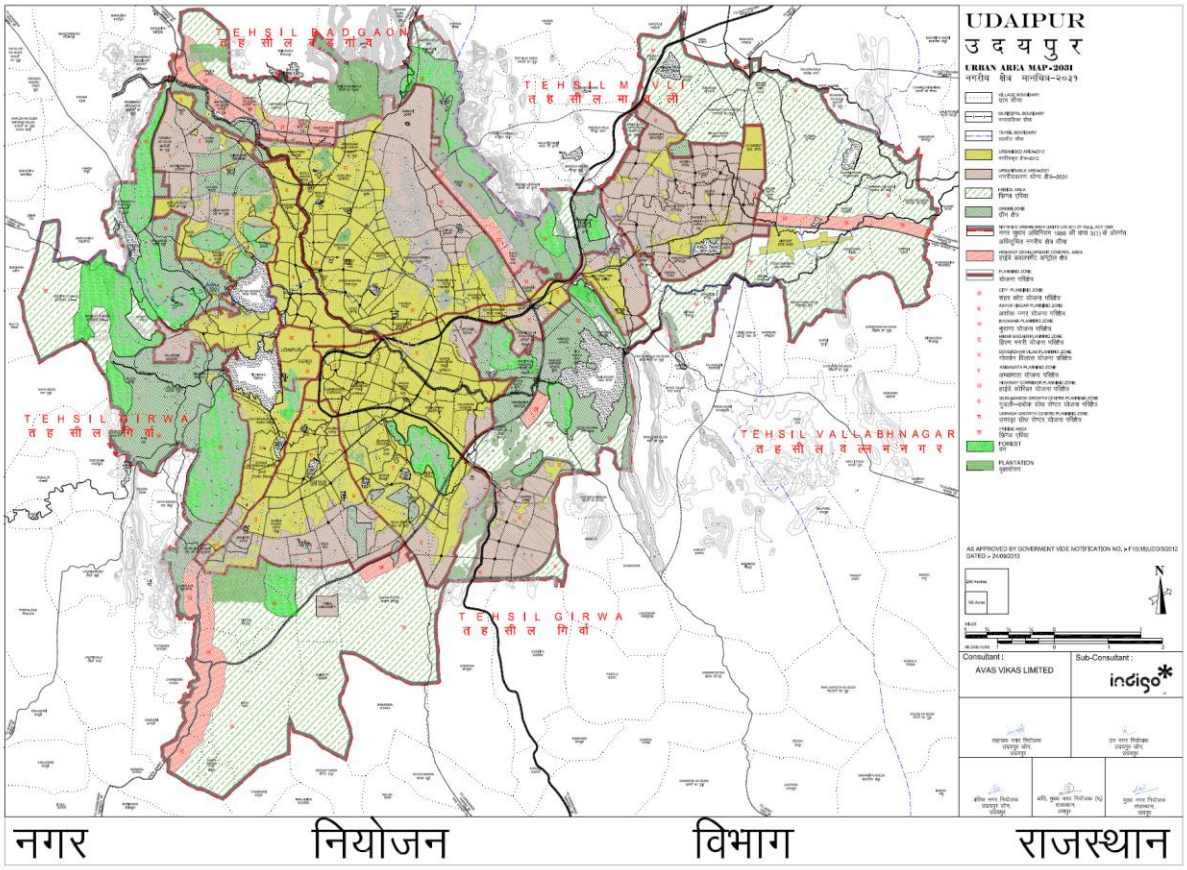


Figure 7 Proposed Development Plan, 2030

Table 2 Existing and proposed Land Use for Udaipur City

Land Use of Udaipur City	Existing Land Use (2011)			Land Use 2022			Land Use 2032		
	Area in Acre	% of Developed Area	% of Urbanized Area	Area in Acre	% of Developed Area	% of Urbanized Area	Area in Acre	% of Developed Area	% of Urbanized Area
Residential	8052	55.7	29.9	13380	57.23	49.23	27788	62.62	56.0
Commercial	659	4.6	2.4	1220	5.22	4.49	1382	3.11	3.0
Industrial	1553	10.7	5.8	1110	4.75	4.08	2852	6.43	6.0
Government and Semi Government	212	1.5	0.8	340	1.45	1.25	4552	1.02	1.0
Entertainment	534	3.7	2.0	2430	10.39	8.94	4512	10.17	9.0
Public and Semi-Public Places	2066	14.3	7.7	2420	10.35	8.90	2783	6.27	6.0
Circulation	1387	9.6	5.2	2480	10.61	9.12	4610	10.39	9.0
Developed Area	**14463**	**100**	**53.7**	**23380**	**100**	**86.02**	**44379**	**100**	**-**
Government Reserved	629	-	3.5	950	-	3.50	1196	-	2.0
Agriculture and Forest	1521	-	5.7	800	-	2.94	1521	-	3.0
Water Bodies	2354	-	9.0	2000	-	7.36	2354	-	5.0
Other Area	7560	-	28.1	50	-	0.18	-	-	-
Total	**26827**	**-**	**100.00**	**27180**	**-**	**100**	**49450**	**-**	**100**

(Source: Proposed Development Plan, 2030)

2.1.5 Economic Activities

The city forms the headquarters of Udaipur Division, which is comprised of five districts. The city is host to several state and regional public offices, including offices of the Director of Mines and Geology, Commissioner of Excise, Commissioner of Tribal Area Development, Hindustan Zinc Limited, and Rajasthan State Mines and Mineral Corporation Limited. Other district-level offices include the Collectorate, Public Works Department, Public Health and Engineering Department, Office of Senior Town Planner, etc.

The economy of Udaipur is diversified, with significant contributions from tourism, trade and commerce, and the industrial sector. Besides these, Udaipur is also an educational hub with three universities, six colleges and more than 160 high schools.

Service sector: The city being the district headquarter houses offices such as those of the Collectorate, taluka and revenue office, block development office, magistrate courts and other government and semi-government offices.

Trade and Commerce: Udaipur serves as a market center for smaller towns of the region. The city has wholesale markets for various commodities ranging from food grains to building materials. Krishi Upaj Mandi is a centralized wholesale market for grains. The major trade areas are around Chetak Circle, Jagdish Temple Street, Hathi Pole, Bada Bazaar, and Lake Palace Road. UIT has also planned to develop a large sub-city center. This is essential to meet the growing need for a formal and organized commercial space in the heart of the city and decentralization of commercial activities from the walled city.

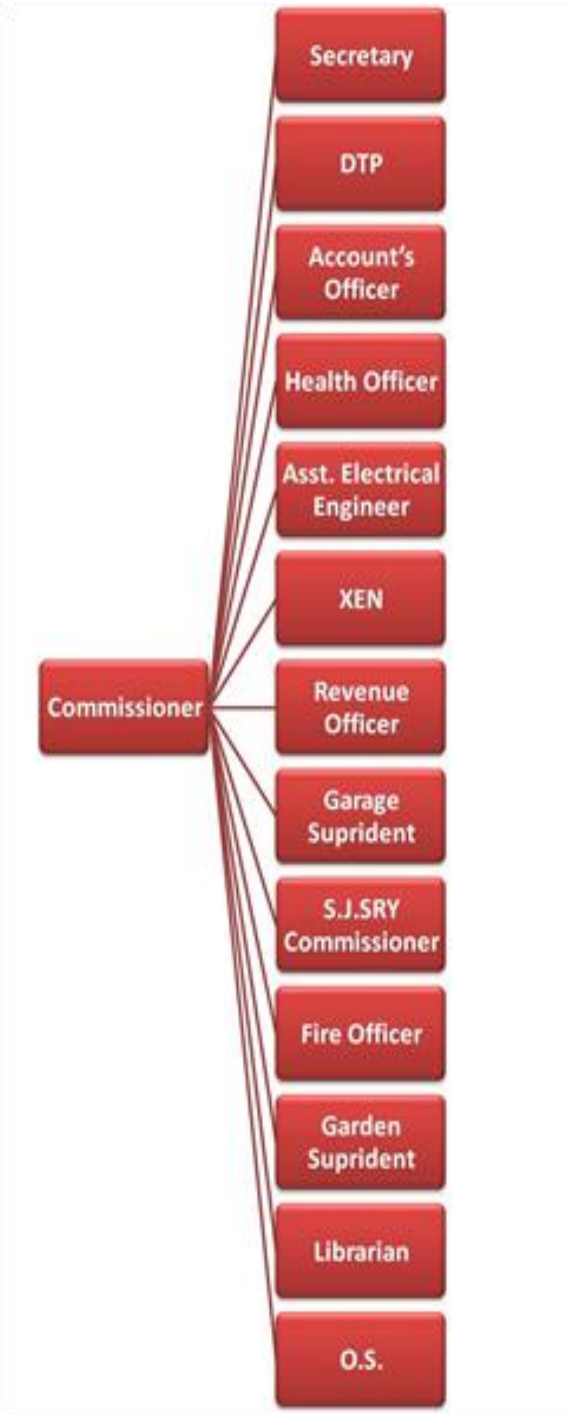
Health and Education sector: Further, there are several educational and health institutions in the city operated either by the government or the private sector. The majority of these institutions are located along Chittorgadh Road and in outer city growth areas.

Tourism sector: With its picturesque landscape, lakes, and historic significance, Udaipur is a major destination for most tourists visiting Rajasthan. Udaipur abounds in places of tourist interest like manmade lakes Pichola, Fatehsagar, City Palace, Lake Palace, Jag Mandir, Sajjangarh, and Shilp gram. Udaipur receives the fourth-largest number of tourists in Rajasthan following Mount Abu, Jaipur and Pushkar.

Industrial areas: The major industrial areas in and around Udaipur are Gudli, and Madari. Others include the Mewar IT park, Pratap nagar, and Bhamashah kaladwas. Gudli has been developed by Rajasthan State Industrial Development and Investment Corporation Ltd. It is located at a distance of 15 km from the core city area of Udaipur, which was set up in 1991. The top industries in Udaipur are M/s. Murli wala Agrotech, M/s. Econ Industries, M/s. Vakratunda Pharma, M/s. Friends Engg. and M/s. Ranka Organics, Pyrotech Electronics Pvt. Ltd., Advaiya, Sucure Meters Ltd, Lipi Data Systems Ltd., Wolkem India L, Tempsens Intruments etc.

2.1.6 Local Government Body

The Udaipur Municipal Council is the main civic body. Udaipur was constituted as a municipality in 1922 by the Mewar dynasty. The city council has been converted into the Municipal Corporation in 2013. UMC has an area of 64 sq km after the city's expansion, and is divided into 55 wards. The commissioner is the head of the administrative wing. The elected wing consists of Councilors elected by the citizens of UMC. A Deputy Mayor assist the Mayor and are elected from amongst the corporators. The term of these three mayors is for a period of five years. The structure of the administrative wing of the UMC is presented there.



Urban Improvement Trust (UIT) is responsible for overall development of Udaipur city. It is responsible for implementation of development plans and infrastructure in the notified UIT areas, which includes both, rural as well as urban areas. In addition to UMC and UIT, there are a number of Line Departments (such as Town Planning, PHED, PWD, Rajasthan Housing Board, RSRTC, Forest Department, Tourism Department), who are stakeholders in delivery of urban services, and infrastructure development.

The Public Health and Engineering Department (PHED) is responsible for all aspects relating to urban water supply, right from development to O&M. PHED is also responsible for the development of a sewerage system while O&M is the responsibility of the respective ULBs. Rajasthan Housing Board is responsible for provision for development of land and houses, new township, land bank etc. The Public Works Department is primarily responsible for construction and maintenance of roads, state government institutions and state government housing in the city.

2.1.7 Major Urban Systems

2.1.7.1 Water Supply

Lakes are the major sources of water supply in Udaipur city. Initially, the water supply scheme was commissioned from Pichola Lake as a source in 1968. The water supply scheme from Fatehsagar Lake as a source was subsequently commissioned in the year 1970. Further, in 1976, the Pichola Lake water supply scheme was augmented. During 1987, Badi Lake was considered for augmentation of the water supply scheme for the city. Pichola and Fatehsagar lakes were only reserved for water supply distribution in Udaipur since 1985. During 1988, when there was a drought, an emergency scheme for water supply was prepared, considering Jaisamand as the source. This scheme was commissioned in the year 1995 and was designed for 21 MLD. The water supply schemes from Pichola and Fatehsagar lakes were further augmented in 1996.

Another scheme was taken into consideration as a result from dewatering of Jhamerkotra mines in the year of 1996. Thus water from tube wells of Jhamarkotra mines played considerable role in water supply in the city. Water from 8 tube wells of Kharbadiya mines were pumped to Purohito ki Madri.

The Mansi Wakal dam's gross storage capacity is 24.37 million cum with 50% dependability. 23.35 MLD water supply started in the year 2007-08. The state government sanctioned the Dewas Stage II project in the year 2005. It involved construction of Akodra dam having a net storage capacity of 8.15 M.cum, Madri dam having a net storage capacity of 2.39 M.cum, a tunnel from Madri dam 1.33 km, and a tunnel from Akodra dam 11.05 km. The net storage of both dams with 90% dependability is 10.84 M.cum, which provides assured availability of water for the whole year.

2.1.7.1.1 Water Sources

At present, the city relies on surface as well as ground water sources for its daily water needs. The water supply system in the city is dependent on surface water to a large extent. Fatehsagar Lake, Pichola Lake, Jaisamand, and Mansi Wakal dam are the major sources of water for the city.

Besides this, PHED has 53 tube wells and 29 open wells/baories/step wells, which supplement the existing water supply system. The total ground water production is estimated to be 11 MLD. About 108 punghats and 2100 hand pumps have been developed in various localities of the city. Water from hand pumps and punghats is used for domestic purpose and is provided free of cost to the users. The present water supply scheme covers Udaipur city as well as seven peripheral villages (i.e., Bedla, Bargaon, Bhuvana, Sobhaggar, Saveenkhera, Saveenaand Govardhan villas). The existing average production from all sources is 90 MLD.

Table 3 Water Sources and Capacity

Water Source	Type of source	Distance from city	2010 (Source capacity in MLD)	2015 (Source capacity in MLD)
Pichola lake	Lake	5	41.8	41.8
Fateh Sagar	Lake	4	16.5	16.5
Jaisamndh Lake	Lake	55	24.5	24.5
Badi lake	Lake	15	1	1
Mansi Wakal Dam	Dam	42	23.35	23.35
Local Source		-	9.5	9.5
Total			**116.65**	**116.65**

(Source: PHED)

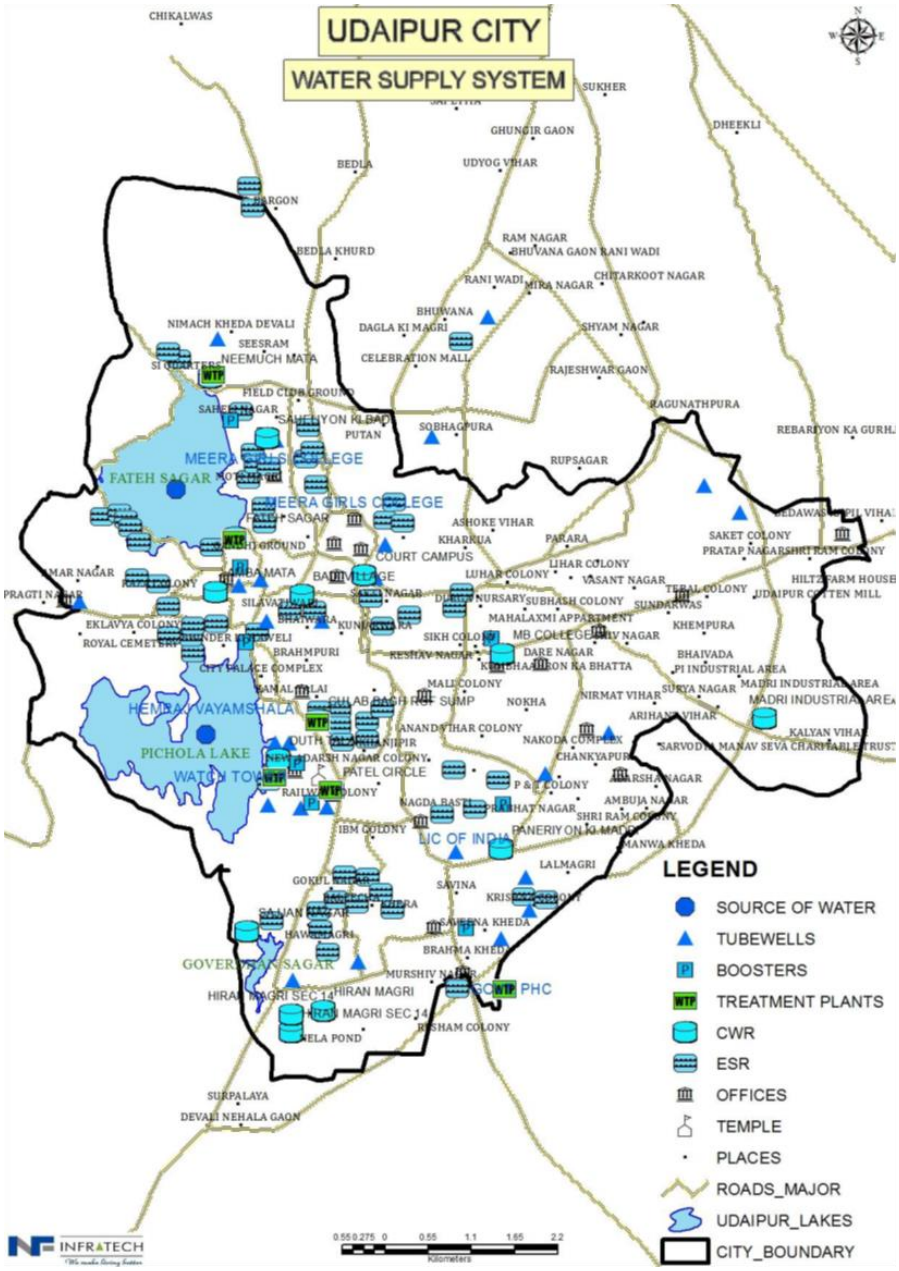


Figure 9 Water supply map

(Source – City sanitation plan, 2013)

2.1.7.1.2 Details of Pumping stations

Details of various pumping stations are as below. These pumping stations are more than 15 year old. The city has 10 water treatment plants (WTP) with a total treatment capacity of 84.24 MLD and 89% utilization. Of the 10 treatment plants, 6 plants are based on rapid gravity filters (RGF), while 3 are based on pressure filters (PF).

Table 4: Pumping Stations

Sr. No.	Name of the Pumping station	Zone	GSR Capacity (MLD)	ESR Capacity (MLD)	No. of pumps
1	Doodh Talai	City 1	13.62	-	7
2	Doodh Talai	City 1	2.85	-	3
3	Patel Circle	City 1	7.57	-	5
4	Gulab Bagh	City 1	4.54	-	3
5	Gulab Bagh	City 1	2.27	-	4
6	Teetardi	City 1	13.5	-	NA
7	Fateh Sagar	City 2	3.4	-	6
8	Fateh Sagar	City 2	1.72	-	8
9	Neemach mata	City 2	11.35	-	3
10	Nandeshwar	City 2	23.35	-	NA
11	Kanpur	City 1	NA	-	2
12	Purohiton ki Madri	City 1	NA	-	2
13	Madri Pump House	City 1	NA	-	2

(Source – PHED)

2.1.7.1.3 Water Network

For the supply of water in the city, there is a pipe line network of around 400 km of 250 to 800 mm dia pipes exists in the UMC. The water supply network covers almost 90% of the developed area within the Municipal Corporation Limit. There are pressure variations and water tested indicates that water supplied through the old line is not suitable for drinking. The water supply network laid in the old city area is more than 30 years old and most of them are broken and causes wastage of water.

2.1.7.1.4 Water taxes

Due to lack of metering of water connections, the cost recovery in water supply services is very low. Minimum water taxes for domestic connection, non-domestic and industrial connection of 15mm diameter are 22-55 INR per month, 220 INR per month and 550 INR per month respectively. They just got revised in year 2017.

Table 5 Water tariff structure, UMC

Size of Connection (mm)	Domestic Tariff (INR/ Month)	Non Domestic Tariff (INR/ Month)	Industrial
15	22-55	220	550
20	220	550	990
25	550	880	1540
40	1650	2640	4950
50	2750	4400	7700
80	6600	11000	18700
100	10450	17050	29700
150	23650	37950	66550

(Source : Tariff revision order PHED 2017)

2.1.7.1.5 Service level information - Water Supply

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit
Coverage of water supply connections	-	70	70	-	-	80.85	%
Per capita supply of water	-	132	126	128	125	130	lpcd
Existing total water supply	-	84.35	82.5	85	85.4	90	MLD
Existing water treatment plant capacity	-	83.04	83.04	83.04	83.04	87.00	MLD
Extent of metering of water connections	-	NA	95450	-	81509	82555	%
Extent of non-revenue water (NRW)	-	35-40	35-40	35-40	35-40	35-40	%
Continuity of water supply	-	at interval of 48 hrs	at interval of 48 hrs	at interval of 48 hrs	at interval of 48 hrs	at interval of 48 hrs	Time
Efficiency in redress of customer complaints	-	-	100	-	100	100	%
Quality of water supplied	-	Satisfactory as per norms	Satisfactory as per norms	Satisfactory as per norms	Satisfactory as per norms	Satisfactory as per norms	%
Cost recovery in water supply services	-	-	-	-	18	15.20	%
Efficiency in collection of water supply - related charges	-	89.64	84.45	76.12	63.97	76.43	%

(Source – PHED)

The gaps in these service levels and benchmarks prescribed by MoUD are coverage of water supply connections, per capita supply of water, extent of NRW, cost recovery in water supply services are 20%, 5 LPCD, 20% and 85 % respectively.

2.1.7.1.6 Upcoming new water projects and plans

Project Name	Budget Allocation through state or central government scheme (Crore)	Existing status	Expected start and end date
Avari Mata Colony	1.4	On going	2015
L Block	2	On going	2016
New Bhopalpura	2.6	On going	2016
Swami Nagar	0.5	On going	2016
Neemach Kheda	0.4	Completed	2016
Universal coverage of uncovered area of Udaipur	30	On going	2019
Rehabilitation of water supply under Udaipur Integrated Infrastructure Project for ABD area	65*	On going	2020

(Source :AMRUT final slip 2016 and Integrated package for ABD area)*

Key Issues

- **Inadequate water sources:** The large component of water for city supply is sourced from lakes. These lakes are dependent on rain for water. The recently augmented water sources are very far away from the city and therefore, revitalization of existing source and additional water sources need to be explored for reducing dependability over rain.
- **Ground depletion:** Tube wells draw water from a limited aquifer. It is mostly dependent on water level in lakes. Most of the tube wells have very low or negligible yield in summers when the demand is heavy.
- **Old Infrastructure:** In some areas, the water supply infrastructure is very old, resulting in water leakages and sudden breakdowns. Due to undulating topography of the city, there are many low-pressure points affecting the water supply pressure at the customer end. The storage facilities need augmentation.
- **Water supply time and duration:** Water is supplied at 2 to 3 day intervals. The daily water supply should be ensured.
- **Metering:** Even though 99% percent of water connections are metered there is no record available for non-revenue water.
- **Replacement of meters:** Majority metered connections need replacement in order to have correct meter reading.
- **Cost recovery:** Cost recovery is only 15%, which is very low and has an impact on the operation and maintenance of infrastructure.

2.1.7.2 Sewerage

Udaipur city is not fully covered by an integrated underground sewerage system. Previously, the city has a skeleton existing sewerage system, which covers the high density populated areas of the walled city. The old sewerage system in the catchment areas of the lakes consist of 3500m of sewers varying in diameters from 150-350mm covering a population of about 10,000 in Ambamata, Brahmapuri, Lalghat, Navghat, and Chandpole area. The sewage from these sewers used to flow by reaping up to Jhatwadi by a pump-house located at Chandpole (ridgeline) from where it was

gravitating to Hathipole through 400 mm diameter gravity sewers. The sewerage system spreads in 13 wards out of 55 wards of Municipal area of Udaipur i.e. ward nos. 22, 33 to 37, 42 to 47 & 50 with an outfall of 800mm diameter at Manwa Kheda at a distance of 4.5 Km from City.

At present sewerage network has been laid under two central government owned missions, AMRUT and Smart City Mission. First phase of the AMRUT is mostly completed it has been covered ward no. 3, 4, 39, 52 and 53 .The second phase has been started and running in ward no.26, 27, 28, 29 and 30.

After completion of both of the projects, 62.5%% of the UMC area will be covered by underground sewerage network.

One STP of 20 MLD capacity is located at Kaladwas which is operated by Hindustan zinc cooperation now UMC going to increase its capacity and going to construct three more STPs along Ayad river, a 5 MLD plant near Kazrali house, 10 MLD near FCI godown and 25 MLD STP at Eklingpura. At present sewerage plant covers only 20.3% of Udaipur city but after the completion of above projects, the coverage will increase to 62.5%.

Demand and supply gaps of household toilets: As per the present status, 96.48% households have toilet facilities; however, as per the SLB, 100% households should be covered by household toilet facilities. Hence, there is an existing gap of 3.5% in the provision of household toilets. At present only 20.3% of the households are connected with existing sewage network and very few with the underground sewerage network. Total sewerage generation is 61 MLD but existing sewage treatment capacity is only 20 MLD.

Future Sewage Generation: Sewage generation is estimated based on the assumption that 80% of the water supplied is used and thrown back to the sewers as sewage. Accordingly, sewage generation has been projected as 81 MLD for 2021, 98 MLD for 2031, and 118 MLD by 2041[1].

Institutional Framework for Sewerage and Sanitation System: As per the Rajasthan Municipal Act, provisioning of sewerage services in the city is the responsibility of UMC. However, UIT and PHED also play important role in service provisioning. The PHED has designed and implemented first sewerage project. UIT is still designing and implementing new sewerage and sanitation projects for city under NLCP.

2.1.7.2.1 Service level information- Sewerage

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit
Coverage of toilets	-	-	94.87	95.35	96.48	96.48	%
Coverage of sewage network services	-	-	20	20.3	20.3	20.3	%
Collection efficiency of sewage network	-	-	0	20	20	80	%
Total sewage	-	-		NA	50	61	MLD

[1] CDP 2014, Udaipur

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit
generation							
Existing sewage treatment capacity	-	-	0	NA	20	20	MLD
Adequacy of sewage treatment capacity	-	-	0	20	20	100	%
Quality of sewage treatment	-	-	0	0	0	100	%
Extent of reuse and recycling of sewage	-	-	0	0	0	100	%
Extent of cost recovery in sewage management	-	-	0	0	0	0	%
Efficiency in redress of customer complaints	-	-	82.22	84.44	93.33	95.07	%
Efficiency in collection of sewage charges	-	-	0	0	0	0	%
Total recovery of wastewater tax	-	-	0	0	0	0	INR

(Source: UMC service level benchmark)

2.1.7.2.2 Upcoming new drainage projects and plans

Project Name	Budget Allocation through state or central government scheme	Existing status	Expected start and end date
Laying of sewer network system, Household property connections & construction of STP	230 crores, under AMRUT	On going	2017-2020
Septage management with transfer station/ community septic tank/ bio digester	20 crores, under AMRUT	On going	2017-2020

Project Name	Budget Allocation through state or central government scheme	Existing status	Expected start and end date
Design, Rehabilitation, Upgradation and Construction of sewerage network in ABD area	169 crores, under Smart City mission	On going	2020

(Source: AMRUT slip report 2016)

Key issues:

- Though AMRUT and smart city scheme is covering 62.5% of the city, but a planned underground sewerage network is still missing from 38% area of the city (mainly southern part of the city).
- Technical and coordination issues in operation and maintenance of the existing system.
- Sewage is flows in to open channels in various stretches in the city.
- Silting is also an issue, due to garbage and C&D waste dumping in these open channels.
- Lack of regular cleaning increase logging in drains.
- Sewage flows in to storm water drains and water channels.
- Sewage treatment capacity is not sufficient (though UMC is constructing a total of 60 MLD decentralized treatment facility then also the projected demand will not met[2])
- Public participation is less due lack of IEC activities and awareness generation.
- There is no citizen charter system been defined and implemented.

2.1.7.3 Solid Waste Management

Solid waste Management is an obligatory function of UMC. However, this service is not properly performed, resulting in problems of health, sanitation and environmental degradation. The major draw backs in the management of solid waste in the city are:

- Lack of waste collection efficiency
- Improper choice of technology
- Improper site of solid waste dumping
- Lack of trained manpower and officials
- Poor public participation and cooperation

The Health department and Garage department of UMC are managing municipal solid waste from source to final dumping at Balicha landfill site, under the supervision of Municipal Commissioner. Udaipur generates 182.83 Metric Tonnes of municipal solid waste daily as of year 2016-17 per as per waste quantification and characteristic study done under CapaCITIES project in July 2017 which includes domestic waste, waste from commercial establishments, waste from institutions and waste from street sweeping. At present, there are no waste processing facility in the city. Waste is

[2] CDP, 2014

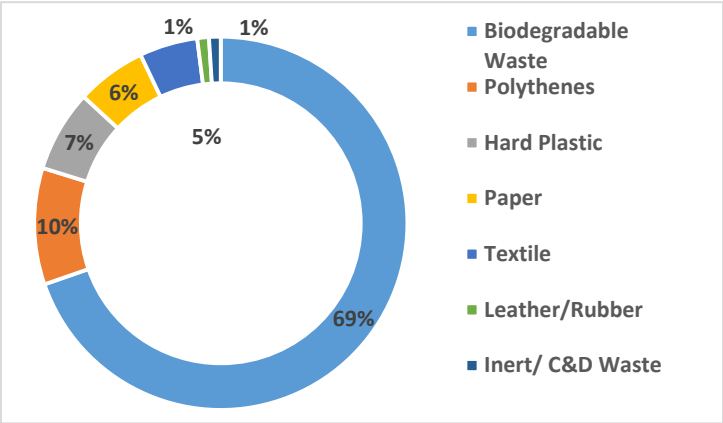
collected on source and dumped to Balicha landfill, which is approximately 20 km away from the city.

UMC proposed a city level compost and MRF facility of 60 TPD for the scientific disposal of the waste. A biomethanation plant of 2 TPD capacity has been also proposed on a decentralized waste treatment concept under CapaCITIES project. UMC had already started door to door collection of waste, a separate collection form commercial and institutional identities in year 2017 but getting segregated waste is still a major challenge for the UMC.

After successful implementation of Shunya Pilot in two municipal ward under CapaCITES project UMC had started this initiative in 10 municipal wards but it is not on an efficient level.

2.1.7.3.1 Composition of Waste

Waste characterization and quantification study was conducted under the CapaCITIES project. After a general recce of the city, along with the officials from UMC, different areas were selected for sample collection.



In order to ensure that the household samples represent all the socio-economic strata of the city viz. Lower Income Group (LIG), Middle Income Group (MIG), Higher Income Group (HIG), different wards were selected for the survey. Along with the residential areas, quantification and characterization of samples from vegetable markets, hotels and commercial areas was collected and analysed. The quantification and characterization on random samples was conducted for 7 days. (7th-13th March, 2017) wherein samples from different waste generation points were collected and sent to MoEF recognized and NABL accredited laboratory for analysis. A total of 27 waste samples were collected from the city and the dumpsite. Quartering Method was used for characterization of the collected samples.

Waste characterization from waste collected from transfer stations is shown below, 69% of total waste is bio-degradable waste followed by polythene (10%), hard plastic (7%), paper (6%), textile (5%) and inert (1%).

2.1.7.3.2 Source wise distribution of Solid Waste

Quantifying the waste being generated from various sources, it was estimated that the total municipal waste generated in the city of Udaipur 182.83 TPD3. The table below tabulates the sources and quantity of waste generated.

Table 6 Sources and Quantity of Waste Generated

Sr. No.	Sources of Waste Generation	Number of Entities	Rate of Waste Generation (kg/capita/day)	Quantity (tonnes/ day)
1.	Residents	5,65,095	0.180	102
2.	Commercial	7000	1.92	13.47
3.	Vegetable	-	-	2.76
4.	Institutional	170	15.8	2.69
5.	Hotel	-	-	45.25
Total				165.98
Add 10% to factor in unaccounted waste (assumption)				182.83
Total amount of waste generated in Udaipur				**182.83**

(Source: Waste characteristics and quantification study conducted under CapaCITIES Project)

2.1.7.3.3 Service Level Benchmark

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit
Total waste generation	NA	135	140	140	145	169	TPD
Household level coverage of SWM services	NA	NA	2.56	2.56	2.56	86.27	%
Efficiency of collection of municipal solid waste	NA	NA	95.79	95.79	95.79	95.79	%
Extent of segregation of municipal solid waste	NA	NA	0	0	0	0	%
Extent of solid waste recovered	NA	NA	0	0	0	0	%
Extent of scientific disposal of municipal solid waste	NA	NA	0	0	0	0	%
Extent of cost recovery in SWM	NA	NA	0	0	0	0	%

[3] There might be difference in waste generation by 10-20% accounting waste being collected from offices, open dumping points, municipal solid waste from hospitals and floating population.

Particulars	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	Unit
services							
Efficiency in redress of customer complaints	NA	NA	80	83.9	83.9	89	%
Efficiency in collection of SWM charges	NA	NA	0	0	0	0	%
HH level coverage of SWM services in slum settlements	NA	NA	NA	NA	NA	NA	%

(Source: Garage department and service level benchmark, UMC)

2.1.7.3.4 Upcoming new SWM projects and plans

Project Name	Budget Allocation through state or central government scheme	Existing status	Expected start and end date
Municipal Waste Treatment plant in Balicha	17 crore, UMC under SBM	NA	Not started
2 TPD Bio Methanation plant	CapaCITIES and UMC	On going	March 2019- May 2018
Compost plant in Savina Mandi	UMC under SBM	NA	Not started
Procurement of 50 new auto tippers for Door to door waste collection	3.5 crore, UMC	Procured	
Procurement of portable compactors	3.3 crore, UMC	NA	Not started
Decentralised waste treatment/ compost plants	UMC under SBM	NA	Not started
Capping of old landfill site at Teethardi	UMC under SBM	On going	2018-2019
Compost and MRF facility at Teethardi	UMC	NA	Not started
Transfer station	UMC	NA	Not started

(Source: UMC)

Key Issues

- Absence of source segregation of waste, waste processing, and scientific waste disposal facilities leads to pollution in air, surface & ground water and soil degradation.
- Poor public participation and awareness of citizens for waste management are the major factors affecting MSW management in Udaipur.
- Though UMC procured a number of waste collection vehicle however many households are throwing the waste in nearby open land and on roads due to lake of awareness.

- Open large container has been kept on various location in the city to collect the waste. The stray animals and birds are attracted by these wastes in the containers. These creatures will drag out the waste and make the surrounding ugly.
- Untrained sanitary worker effect the overall efficiency of waste collection and transportation.
- Manual sweeping of street and C&D waste is a cause to increase air pollution level (PM10 and PM2.5).
- UMC has procured new GPS enabled vehicles for the door to door waste collection but the efficiency of the waste collection is not up to the mark in absence of route rationalization/ mapping.
- UMC doesn't having a municipal solid waste expert who can plan, implement and monitor large SWM projects. It is also affecting the decision making on selection of appropriate technology for scientific disposal of waste.
- This service is not properly performed, resulting in problems of health, sanitation and environmental degradation.
  Public participation is less due lack of IEC activities for awareness generation about solid waste management.
- UMC is working on composting of wet waste but resale of byproduct will definitely become challenge for them.

2.1.7.4 Storm Water Drainage

Geographically Udaipur lies in the low lying area of Girva Tehsil and Ayad River and its tributaries drain Udaipur city. Ayad River bisects the city into two parts with its river line at lowest level, all the nallas/drainage terminate their journey either Ayad River or Gunmania Nala. The river passing across the town and falling in Udaisagar Lake. The Kotra River, one of the biggest tributaries of Ayad, commands an extensive catchment area in the southwestern part of the city. Most of the rainwater in Kotra River pour into Pichola Lake and enter the Ayad River through Swaroop Sagar Lake and Gumania drain. In general, undulating topography and existence of number of water bodies helps city to drain out the storm water.

The total drain length is 1,289 km, covering 80% of the total road length in the city. Primary drains are 176.69 km long; secondary, 439.50 km; and tertiary, 665.26 km. The storm water drainage system is managed by the Engineering Department of UMC.

Most of the existing city roads have lined drains alongside, and most part of the area runoff is discharged into the Ayad River. Main drains leading to storm water are irregular and mostly unlined. Drains are full of weeds, vegetation, silt, and rubbish. Drains are insufficient to carry runoff during storm resulting flooding of adjacent roads and colonies. These drains carry the runoff as well as domestic waste water from the city. Ultimately, these drains lead the total storm water and waste to Ayar River through agricultural lands with no definite alignment. They simply follow the contours of the land.

2.1.7.4.1 Upcoming new projects and plans

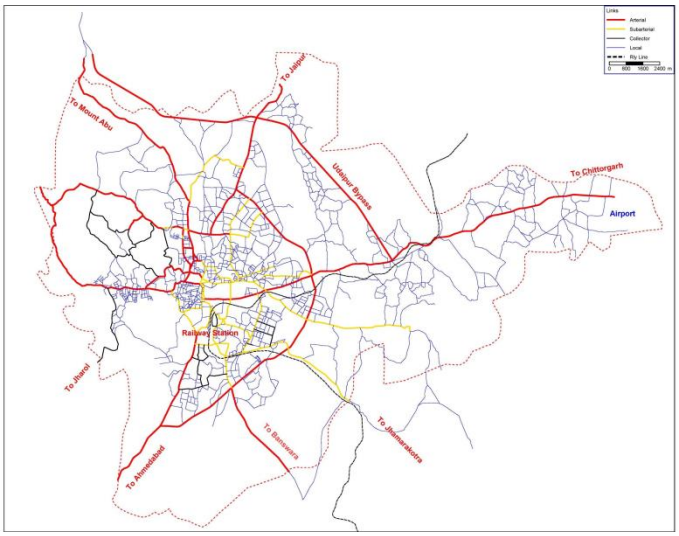
Project Name	Budget Allocation through state or central government scheme	Existing status
Ayad river front development	25 Cr, USCL	Started
Construction of Storm water drains in ABD area	USCL	NA

Key Issues

- Udaipur satellite map shows that the city is spreading just perpendicular to the natural drainage system. Due to urbanization, more permeable land surface with grass and vegetation is replaced by more impermeable land such as concrete, natural canals are replaced by concrete sewers.
- Haphazard growth in most of the pockets of the city.
- The existing major drains are mostly irregular and unlined.
- Encroachment in various starches of the drains.
- No separate drains for storm water and gray water.
- Blockage in drainage system due to disposal of solid waste and C&D waste in the drains.
- Most of the drains in the city is in dilapidated condition and/or choked due to high rate of silting.
- Poor motivation, lack of regulation and poor public awareness.
- Inadequate and irregular maintenance of existing storm water drains.
- A comprehensive plan for repair, revamping and de-silting of drains is required.
- Due to deforestation heavy siltation has reduced the depth of the lakes to a quarter of which it used to be 40 years ago.[4]
- Inadequate or no drainage facilities in some areas.

2.1.7.5 Transportation

Major modes of transportation include shared auto taxi, mini buses operated by private operators, auto rickshaws and private cars, 2 wheelers. Below section provide the details the traffic and transport profile of the city.



2.1.7.5.1 Road Network

Udaipur has 11 arterial roads and 26 sub-arterial roads, connecting the major residential areas to other areas of the city.

Major road in the city includes Hathipole, Surajpole, Delhi Gate Chauraha, Udaipole Chauraha, and Chetak Circle. Most of

[4] ijsrst.com/paper/2254.pdf

these roads caters intra and inter city traffic and have high vehicular movement. About 5% of road length has over 35 M right of way (RoW), 14% has RoW of 20 M to 30 M, 56% has RoW between 10 M to 20 M and rest 23% roads have RoW below 10 M.

Table 7 Road Length and RoW, Udaipur

Road Category	Length (KM)	Width of the road (Mt)	% to Total
Arterial Roads (NH, SH)	85	30 to 50	4%
Sub Arterial Roads	223	20 to 30	16%
Collector roads	365	15	18%
Other roads	912	10	62%
Total length of the Roads	**1585**		**100%**

2.1.7.5.2 Vehicular Growth

Number of registered vehicles in Udaipur has increased from 290567 in 2001- 11 to 571350 in 2015-16, i.e. an average growth rate of 7% per year[5], which is lesser than country's vehicular growth rate. Among these, 2 wheelers constitute about 78% of total registered vehicles. Car constitutes 9% while buses constitute only 1% of the total registered vehicles[6].

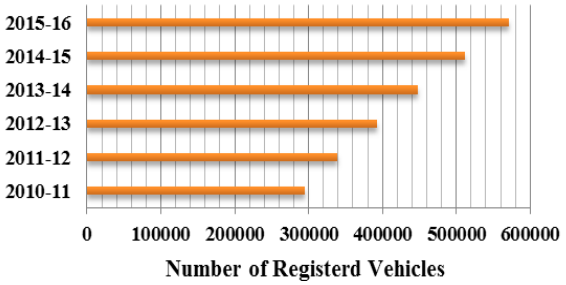


Table 8 Registered vehicles in city by vehicle type

Year wise vehicle population in RJ27 - Udaipur as on March 2016 (Vahan Data Only)RTO/ARTO : RJ27 - Udaipur, Data Updated Date: March 2016							
Sr. No	**Type of Vehicle**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
Goods Vehicle							
1	Truck/ Lorries	2227	2255	2040	1632	1666	1811
2	Tanker	-	-	-	-	-	-
3	Three wheeler Veh.	-	215	300	121	201	100
4	Other Light Veh.	-	-	-	-	-	-
Passenger Vehicle							
5	Buses	236	323	329	332	222	289
6	Maxi Cab	-	-	-	-	-	-
7	Cars/ State. Wagon	5249	5314	4971	6359	7564	6160
8	Taxi cab	579	637	832	619	615	472
9	School Bus	-	-	-	-	-	-
10	Ambulance	-	-	-	-	-	-
11	Private service vehicles	-	-	-	-	-	-
12	Jeep	1129	1323	1529	74	100	1845
13	Three wheeler Auto	431	602	707	640	806	700

[5] Regional Transport Office (RTO), Udaipur
[6] Interim CDP, 2014, Udaipur

Year wise vehicle population in RJ27 - Udaipur as on March 2016 (Vahan Data Only)RTO/ARTO : RJ27 - Udaipur, Data Updated Date: March 2016							
Sr. No	**Type of Vehicle**	**2010-11**	**2011-12**	**2012-13**	**2013-14**	**2014-15**	**2015-16**
	Rickshaw						
Two Wheeler							
14	Motorcycle	34463	38873	16636	21883	23049	19093
15	Scooter/Mopeds			24954	21882	28172	28641
Tractor							
16	Tractor	763	1092	1069	1174	1289	1012
Trailer							
17	Trailer	204	158	185	153	65	28
Others							
18	JCB, Crane, Tra.Loader etc.	97	150	172	229	98	164
Total		**15427**	**192269**	**166124**	**167441**	**63847**	**60315**

(Source: RTO)

Table 9 Registered vehicles by fuel type

Fuel Type	**Last three year total**
Petrol	182338
Diesel	36894
LPG	112
Electric	93

(Source: RTO)

2.1.7.5.3 Model Split

In the absence of organized and robust public transport (PT) system in Udaipur coupled with consumers purchasing power and accessibility to easy loans and innovative financing scheme (including loans at 0% interest rate), intermediate public transport (IPT), mainly shared autos and privatized modes (cars and two wheelers) plays an important role in city transport scenario. IPT in the city operates as an informal PT system without standard frequencies and adds to higher emission level in longer terms[7].

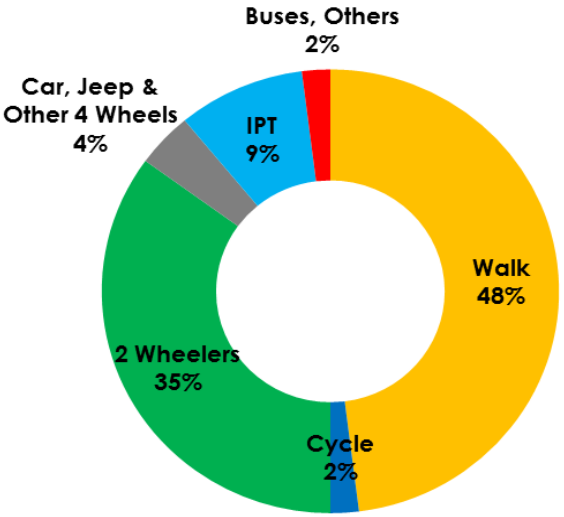


Figure 13 Trips by Modes (Source- LCMP, Udaipur, 2014)

The share of trips in favor of PT is as low as 2%, while walking and non- motorized trips (NMT) are observed at 50%, however significant improvements in NMT infrastructure facilities are required for Udaipur to improve the mode shares of walk and cycle.

[7] LCMP, 2014, Udaipur

2.1.7.5.4 Public Transport

The present PT system in Udaipur includes a limited supply of city bus services with only 13 buses plying on 5 different routes in the city. Presently the system is managed by private contractors under the contract signed between Udaipur Municipal Corporation (UMC) and Contractors.

From these 13 buses, 8 are owned by UMC and operated by contractor and 5 are privately owned and operated. Both the contractor has 3 year contract with UMC and are in their final year of operations of the current contract. The minimum and maximum fare on all the routes ranges from Rs. 5 to Rs. 20 respectively.

However, In order to improve the PT coverage in the city and to move towards more sustainable modes of transport, city is planning to add a fleet of 35 buses in its existing inventory under the smart city proposals via PPP. Udaipur City Transport Services Limited (UCTSL), a SPV formed under Companies Act 1956, will be responsible for managing the operations of city bus services in the city. The plan is to run these buses along the major routes, connecting residential neighborhoods, educational institutes, hospitals dense commercials areas and major market as well.

2.1.7.5.5 Intermediate Public Transport

The absence of a robust public transport system in the city has paved the way for conventional fossil fuels based IPT system in the city in form of smaller and bigger autos and tempos. At present 6,313 auto rickshaws operate in Udaipur city on an area-permit basis, and another 2,637 tempos operate on 27 designated routes[8].

Currently, the IPT system in Udaipur is not organized properly and is also major sources of emissions, as these vehicles are old (40% of the overall IPT fleet is more than 10 years old) and do not comply with the current emission norms.

In order to reduce the pollution levels of the city and to improve the mobility needs of the city and also to introduce e- mobility in the city, city authorities has unveil the operations of e- rickshaws in the city under its smart city projects and also with support from CapaCITIES Project. However, the e-rickshaw operations are still in nascent stage and lot more needs to be done in further scaling up of the same.

2.1.7.5.6 Pedestrian and Non Motorize Transport

The city has high volume of pedestrian movement; however, only 4% of the road network has footpaths, while 96% is devoid of the same9. Majority of footpaths have widths less than 1.5 m, making it inconvenient to walk. City also has a 2.5 km of dedicated bicycle track at Rani Road, but is devoid of bicycle-friendly facilities such as dedicated cycle tracks or other allied infrastructure in other parts of the city for encouraging environment-friendly NMT movements.

However, in order to improve its pedestrian and NMT infrastructure, UMC in recent past has taken various initiatives under its smart city projects and otherwise. Pilot implementation of “No Vehicular Zone” or “Pedestrianization Plan in Walled City”, conceptualized by ICLEI- SA was one such initiative, aimed at reducing traffic congestion and vehicular emission from the walled city. Floating of Public Bicycle Sharing (PBS) tender to introduce bicycle sharing system in the city is another way of encouraging environment-friendly NMT movements in the city.

[8] LCMP, 2014, Udaipur
[9] LCMP 2014, Udaipur

2.1.7.5.7 Parking

The existing parking system of Udaipur is decentralized, unmanaged and largely dysfunctional. A large number of small parking lots dominate the scenario. Many of these facilities are generally poorly maintained and lack basic infrastructure.

The current practice of providing and managing parking as well as creating parking infrastructure in Udaipur lies with UMC as well as Urban Improvement Trust (UIT), and traffic police is responsible for enforcing it. On- street parking in Udaipur is free on almost all the major corridors in the city and only few parking lots in and around the walled city are paid parking lots.

In order to improve the parking situation in the city, UMC in past had taken various initiative to curb parking problems in the city and also to effectively manage the parking needs. Among the many initiatives by city authorities, few initiatives were effective in fulfilling the objective of curbing the parking woes and providing the safe parking infrastructure.

2.1.7.5.8 Important Junctions

There are several rotary intersections in the city that provide one way circulatory system around a central island. These intersections provide high capacity, cause little delay in off peak hours, result in orderly movement and require little maintenance.

Many intersections of city roads have control system with traffic lights. Regulation and phasing of traffic signals is however unplanned and not in proportion to the requirements of approaching traffic. Absence of planned traffic system in the city has led to traffic problems and high probability of accidents. Footpaths are being curtailed indiscriminately for road widening. This makes pedestrian unsafe. Moreover, encroachment and ill planned location of hand-pumps, electricity poles, and transformers also results into frequent accidents besides adversely affecting the aesthetic look.

2.1.7.5.9 Street lights

There are 35,949 street lights in the city, over a road length of 1585 km. The average spacing between streets light is 44.58 meter which exceeds the standard norm of 30 meter. The city needs 30% more street lights at present.

2.1.7.5.10 Safety and Traffic Management Measures

Road safety in Udaipur has become a major concern due to rapid urban development and increased traffic. Major accident prone zone is; Delhi gate to Nehru bazaar, Parastirahe mod, Shakti nagar corner, Macchi cut from Bapu bazaar to Surajpole, Mewar motors gali mod, Hathipole, Teen khambha gali and Jagdish chowk marg.

2.1.7.5.11 Institutional Framework for transportation

Urban transport sector is managed by UMC, UIT, PWD and Traffic Police. Engineering department of UMC looks after of roads and transportation related works and projects.

Traffic Management Committee (TMC), headed by District Magistrate (DM) and constitute of UMC, UIT, city traffic police, RTO, and DM office is responsible for policy development.

2.1.7.5.12 Service Level Benchmark

Particulars	Levels of service as per SLB, MoUD	Present Service level	Current Gap
Availability of public transport	>60 %	10%	50%
Available Pedestrian facilities- Percentage of City Covered (%) by footpaths	>75	9 %	16%
Non-Motorized Transport Facilities			
a) % of network covered	>50	3%	47%
b) Encroachment on NMT roads by vehicle parking (%)	<10	35%	25%
c) NMT parking facilities at interchanges (%)	>75	0%	75%
Level of usage of Intelligent Transport System(ITS) Facilities			
a) Availability of Traffic Surveillance (%)	>75	05%	70%
b) Passenger Information System (%)	>75	0%	75%
c) Global Positioning System (GPS)/ General Pocket Radio Service (GPRS) (%)	>75	0%	75%
Parking: Availability of On-street paid public parking spaces (%)	>75	10%	65%

(Source: Slip Report AMRUT, 2016)

2.1.7.5.13 Upcoming new transportation projects and plans

Project Name	Budget Allocation through state or central government scheme	Existing status
Operation of bus service	40 Cr, USCL	NA
Development of transport and mobility facility	20 Cr, USCL	NA
Construction of smart bus shelter	5 Cr, USCL	Started
Construction of new bridges	USCL	Completed
Junction improvement	18 Cr, USCL	Started
Construction of smart parking	USCL	First phase Completed
Development of smart road	20 Cr, USCL	NA
PBS operations	2 Cr, USCL	NA
Low carbon IPT Action plan	CapaCITIES, UMC	Policy document submitted

(Source: USCL)

Key Issues:

- Poor road condition and improper maintenance.
- Due to the lack of the organized public transport, the current share of public transport is only 2%, resulting in a dependency on other private and IPT modes which is increasing pollution in the city.
- Most of the shared autos do not meet the desirable emission norms and constitute outdated technology. Though shared autos have designated routes of operation, they do not operate on the same designated routes and create a chaotic scenario, which is visible in almost every part of the city.
- Udaipur as a city is still has approx. significant mode share of walking and cycling (~50%) and has high pedestrian movement in most parts of the city. However, the city lacks in terms of pedestrian and bicycle friendly facilities such as footpaths and dedicated cycle tracks (only 4% of the road network has footpaths, while 96% is devoid of the same[10])
- Lack in NMT infrastructure that would otherwise encourage the environment for the NMT movements as well as ensure the safety of the people.
- The existing parking system is decentralized, unmanaged and largely dysfunctional. Large numbers of small parking lots dominate the scenario. The carriageway widths in major markets are further reduced due to the haphazard on-road parking across the various stretches in the city resulting in reducing the overall traffic carrying capacity of roads.
- Improperly planned junction increases traffic congestion and accidents.
- Low level of awareness in citizens and improper driving pattern increases pollution as well as accidents.
- The stray cattle account for a major reason for traffic congestion on city roads, and give rise to accidents. Straying of cattle on city roads is a very common feature and a major cause for traffic hazards.

[10] LCMP 2014, Udaipur

- Encroachment of roads and footpath has come across as a major problem in smooth flow of traffic. People have encroached upon ROW by construction of various type of structures. Shopkeepers use the foot paths for advertising, displaying their products etc.
- Absence of traffic camming majors like zebra crossing, traffic singes, etc.
- Rapid growth of vehicles has been observed in city and in absence of a good mass public transportation system this is bound to increase exponentially in years ahead.

2.1.7.6 Public Housing and Urban Poverty

The city is characterized by low, medium and high density housing in the core city and low rise, moderate dense housing in peripheral areas. City has witnessed boost in development of multi rise residential and commercial structures during last few years.

Economic Weaker Section (EWS)	**Unit**
Number of Population	4240
Number of Household	848
Current Housing Stock	848
Household Size	5
Forecasted Population (if any available in the statutory documents)	NA
Number of Shortage for EWS	9173
Low Income Group (LIG)	
Number of Population	2920
Number of Household	584
Current Housing Stock	584
Household Size	5
Forecasted Population (if any available in the statutary documents)	NA
Number of Shortage LIG	

The city developed towards east, south east and north east. Housing in the old Udaipur area is predominantly vernacular in nature with low rise and inters connected structures. In new city area, houses are mainly low rise and having a bungalow typology (individual houses). The fringe areas and newly merged areas are classified as urban villages. Medium to High-rise residential projects are coming up in these areas. There are total 9 slum pockets in the city inhabiting 3416 house-holds and 17080 people.

Table 10 Ward wise slum population

Ward No.	**Name of the Slum**	**Population (2011)**	**Slum Household (2016)**
Ward no - 1	Nimachkheda, Manoharpura	9,012	427
Ward no – 7	Sajjan Nagar, Harijan Basti, Bhilurana	10,881	714
Ward no – 14	Kishanpole uttar	6,804	331
Ward no – 15		7,327	

Ward No.	Name of the Slum	Population (2011)	Slum Household (2016)
Ward no – 16	Machla Magra	12,964	751
Ward no – 19	Govardhan vilas, Indra Colony	12,124	259
Ward no – 23	Paneriyon ki Madri	13,379	222
Ward no – 28	Banjara basti	8,533	194
Ward no – 31	Math Madri	12,443	303
Ward no – 41	Baghri Basti	7,287	215
Total		**451,100**	**3416**

(Source: UMC)

Average household size in slums is about 5 persons per family. Average household size in slums is about 5 persons per family.

As per the CDP, status of urban services in slums is as under:

Table 11 Basic services to Urban Poor

Sl. No.	Services		No. of HHs covered	% of HHs covered
1	Water supply	Individual taps	5029	52.78
		Public taps	90	0.94
		Tube well	490	5.14
2	Drainage and Sewerage	Not connected to Sewer	9529	100
3	Sanitation	Public septic tank	50	0.52
		Service seat public	14	0.15
		Own septic tank/flush	5293	55.55
		Shared	29	0.30
		Open defecation	1702	17.86

(Source: CDP, 2014)

2.1.7.6.1 Current status of affordable housing scheme

Total 1432 dwelling units are constructed and 10605 units have to be constructed to match the need of affordable housing.

Under PMAY scheme	
Economic Weaker Section (EWS)	**Unit**
Number of Population	4240
Number of Household	848
Current Housing Stock	848
Household Size	5
Forecasted Population (if any available in the statutary documents)	NA
Number of Shortage for EWS (including LIG)	9173
Low Income Group (LIG)	
Number of Population	2920

Number of Household	584
Current Housing Stock	584
Household Size	5
Forecasted Population (if any available in the statutary documents)	NA
Number of Shortage LIG	NA

(Source: UIT)

Key Issues

- The process of implementation of project for in situ up gradation of housing for urban poor is very slow and one of the reasons behind is the lack of administration and monitoring staff.
- Delayed technical handholding to beneficiaries from UMC, absence of complaints registration system, and ineffective project costing, have resulted in unwillingness amongst beneficiaries which is affecting the proper implementation of the project.
- IHSDP's basic component which is to include beneficiaries in project implementation is not being achieved. The financial capability of the urban slum dwellers is a major constraint. The loans given by UMC and UIT for this reason have no possibilities for being repaid.
- Poor basic infrastructure in slums. More than 45% households in slums are not connected with proper sanitation facilities.
- Approximately 45% households have no water supply source.

3 Baseline Assessment

3.1 GHG Emissions Inventory Report

GHG emission inventory for year 2011 to 2016 was prepared under CapaCITIES project. 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 analyzing 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, analyzing 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 Udaipur and are therefore contributing to the Municipality's carbon footprint, as well as to the local air pollution.

3.1.1 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. 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.

3.1.2 Data Sources and Collection

The baseline year for this study was the financial year of 2016-17 (i.e. April 2016-March 2017**)**. A full GHG inventory includes emissions from energy, waste, agriculture, forestry and land-use change, however, the direct emissions from agriculture, land-use change and forestry sectors were not included due to limited data availability. The basic inventory as per the GPC methodology was prepared for Udaipur covering the stationary, mobile and waste sectors for the six years (2011-12 to 2016-17).

ICLEI South Asia and UMC staff members sourced the relevant energy consumption and activity data from municipal, local and sub-national stakeholders through data requests and meetings, focusing on the large carbon emitters within the municipal area. Supply and demand-side data was thereby 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 energy & other relevant data used in the report are elaborated in table below.

Table 12 Supply and demand side Energy Data Sources

Fuel Type	Sector	Source of Data
Electricity	Residential	Ajmer Vidyut Vitran Nigam Ltd. (AVVNL)
	Commercial and Institutional buildings/facilities	AVVNL
	Manufacturing Industry and Construction	AVVNL
	Municipal Buildings	AVVNL
	Water works department – Water treatment plant and pumping stations	Public Health and Engineering Department (PHED), UMC
	Drainage department – drainage pumping stations and sewage treatment plants	PHED, UMC
	Street lights	AVVNL
	Solid waste management – waste transfer stations	Solid Waste Management Department, UMC
Diesel	Community Transport	Oil Marketing Companies (Hindustan Petroleum Corporation Ltd, Bharat Petroleum Corporation Ltd, and Indian Oil Corporation Ltd.)
	Manufacturing Industry and Construction	Regional Office, Rajasthan Pollution Control Board (RPCB), Udaipur
	Municipal Vehicles	Oswal Data Centre, UMC
	DG sets at water pumping stations and water treatment plants	PHED, UMC
	DG sets at drainage pumping stations and Sewage treatment plants	Drainage Department, UMC
Petrol	Community Transport	Oil Marketing Companies (Hindustan Petroleum Corporation Ltd, Bharat Petroleum Corporation Ltd, and Indian Oil Corporation Ltd.)
	Municipal Vehicles	Workshop, UMC
LPG	Residential	Solar City Report and Department of Food and Civil Supply
	Commercial and Institutional buildings/facilities	Solar City Report and Oil Marketing Companies (Hindustan Petroleum Corporation Ltd, Bharat Petroleum Corporation Ltd, and Indian Oil Corporation Ltd.)
	Auto LPG - Transportation	AEGIS Logistics Ltd., Udaipur
Kerosene	Residential	Department of Civil Supply, Udaipur
Coal	Manufacturing Industry and Construction	Regional Office, Rajasthan Pollution Control Board (RPCB), Udaipur

Fuel Type	Sector	Source of Data
Bio-gas	Manufacturing Industry and Construction	Regional Office, Rajasthan Pollution Control Board (RPCB), Udaipur
Transport Sector		Regional Transport Office (RTO) – Udaipur
Solid Waste Management		Solid Waste Management Department, UMC
Municipal Water Supply		PHED, Government of Rajasthan
Municipal STP		Hindustan Zinc Ltd., Udaipur
Municipal Street Lighting		Light Department, UMC and AVVNL
Municipal Vehicle Fleet		Oswal Data Centre, UMC

3.1.3 Summary of Economy wide Energy Consumption and GHG Emission Baseline

Overall sector wide Energy consumption trend has been shown below. The total energy consumption across different sectors in Udaipur city in 2016-17 amounted to 9,967,089 GJ. Trend of energy consumption is increased at 3.3% CAGR from 2011-12 to 2016-17. The Agriculture, forestry and fishing activities (i.e mainly agriculture) sector had the highest CAGR in energy consumption (9.1%), followed by Commercial & Institutional buildings/facilities (8.6%), Residential buildings (7.6%), Transport (1.6%), Non-specified sources (1.5%), and Manufacturing industries and construction (0.5%).

The total GHG emission of Udaipur city was 1,252,856 tonnes of carbon dioxide equivalent (tCO_2e) in the year 2016-17 (see Table 14). Taking this into consideration, the average per capita GHG emission for the year 2016-17 for Udaipur city was 2.57 tonnes of CO_2e, which is higher than the India's per capita GHG emission 1.56 tCO_2e for the year 2010[11]. Sector-wise trend of Energy use and GHG emission has been shown in Table 13 and 14.

Table 13 Sector-wise annual energy use (GJ) per year

Sector	Energy Consumption (GJ)					
	2011-12	**2012-13**	**2013-14**	**2014-15**	**2015-16**	**2016-17**
Residential Buildings	1,810,370	1,942,458	1,970,943	2,117,240	2,600,465	2,804,109
Commercial and Institutional buildings/facilities	602,783	695,268	677,089	762,983	875,735	991,445
Manufacturing Industries and Construction	2,987,940	3,047,610	3,099,313	3,114,264	3,050,415	3,085,599
Agriculture, forestry and fishing activities (i.e mainly agriculture)	26,280	26,820	27,396	38,088	43,200	44,334
Transport	2,715,259	2,768,998	2,993,010	2,912,170	3,019,167	2,979,428

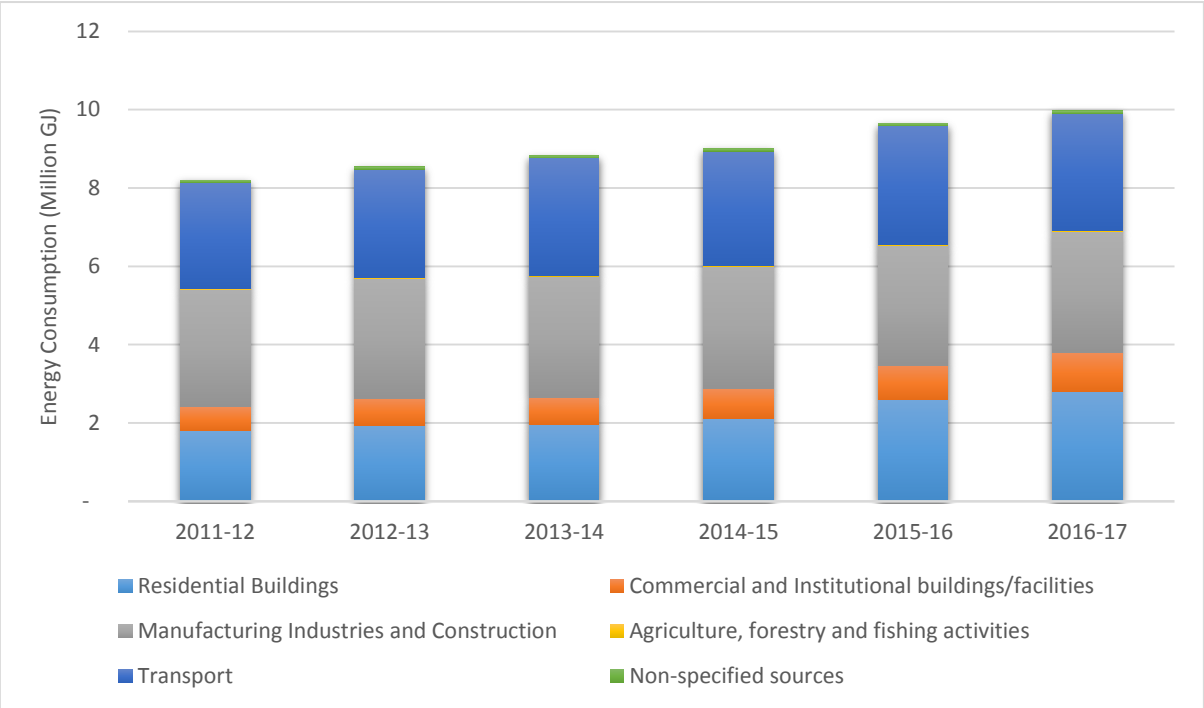
[11] India: First Biennial Update Report to the United Nations Framework Convention on Climate Change (2016), http://unfccc.int/essential_background/library/items/3599.php?rec=j&priref=7828#beg

Sector	Energy Consumption (GJ)					
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Non-specified sources[12]	56,937	58,626	60,364	62,154	62,442	62,174
Total	**8,199,569**	**8,539,778**	**8,828,116**	**9,006,899**	**9,651,423**	**9,967,089**

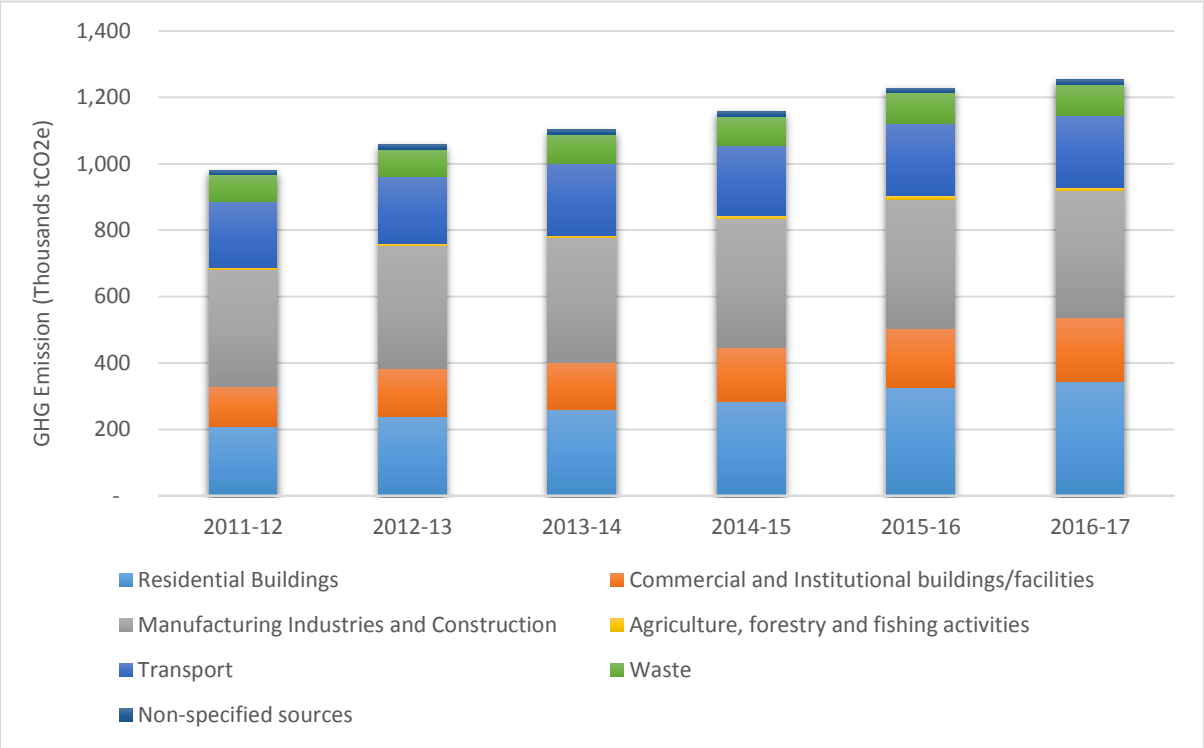
Table 14 Sector-wise trend of GHG emission (tCO2e) per year

Sector	GHG Emission (tCO_2e)					
	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17
Residential Buildings	209,772	239,138	261,131	285,218	325,044	343,409
Commercial and Institutional buildings/facilities	118,566	144,781	141,324	162,004	178,295	191,985
Manufacturing Industries and Construction	353,894	369,052	375,785	386,955	389,841	383,196
Agriculture, forestry and fishing activities (i.e mainly agriculture)	5,714	6,130	6,261	8,705	9,873	10,128
Transport	196,742	200,962	216,944	210,750	218,226	215,212
Waste	81,385	83,932	86,536	89,201	91,927	94,716
Non-specified sources	12,381	13,395	13,798	14,209	14,275	14,209
Total	**978,453**	**1,057,389**	**1,101,779**	**1,157,044**	**1,227,710**	**1,252,856**

[12] It includes electricity sales by AVVNL to consumer category called "Other".

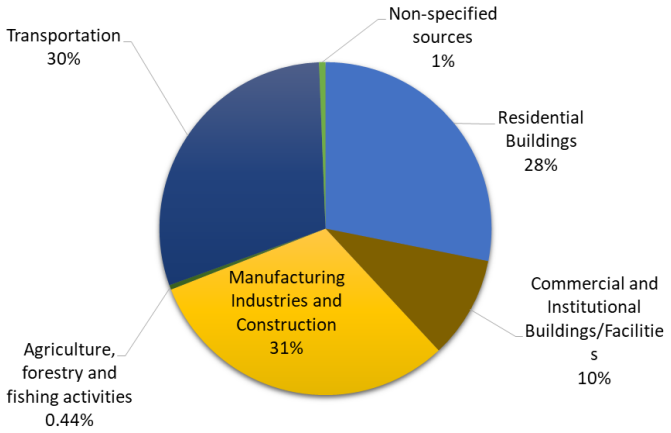


Overall sector wise trend of GHG emission has been shown in Figure 15. Trend of GHG emission is increasing at 4.21% CAGR from 2011-12 to 2016-17. The Agriculture, forestry and fishing activities (i.e mainly agriculture) sector witnessed the highest 10.01% CAGR, followed by Residential buildings (8.56%), Commercial and institutional buildings/facilities (8.36%), Waste (2.56%), Non-specified sources (2.23%), Transport (1.51%), and Manufacturing industries and construction (1.33%).



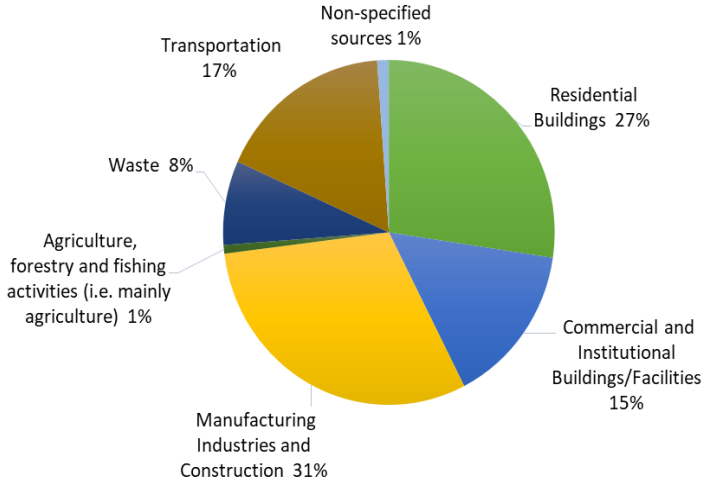
3.1.4 Energy Consumption and GHG emission baseline

The year of 2016-2017 is considered as the baseline for the Climate Resilient City Action Plan in Udaipur. Manufacturing Industries and Construction sector is the largest consumer of energy in Udaipur, accounting for 31% of the energy use. This is followed by energy use in On-road transportation which accounts for 30% of the total energy use.



Residential Buildings, and Commercial and Institutional buildings/facilities account for 28% and 10% of the energy use respectively. The Agriculture, forestry and fishing activities (i.e mainly agriculture) and the Non-specified sources sectors together contribute to around 1.5% of the city's total energy consumption.

In line with the trends of energy demand, the major contributor to GHG emission is the Manufacturing Industry and Construction sector which accounts for 31% of total GHG emissions. This is followed by Residential buildings (28%), Transportation (17%), Commercial and institutional buildings/facilities (15%) Waste (8%), Agriculture, forestry and fishing activities (i.e mainly agriculture) (1%) and non-specified sources sector (1%)



3.1.5 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 and Institutional buildings/facilities 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.

Electricity is the predominant energy type in Udaipur city and makes up 32% of the energy mix, being used prominently in all sectors (See figure 18). Electricity is followed by diesel, LPG, petrol, kerosene and bio-gas. It is interesting to note that although electricity accounts for 32% of the

energy mix it contributes to 60% of the GHG emission in Udaipur, largely due to India's GHG intensive thermal power based generation system.

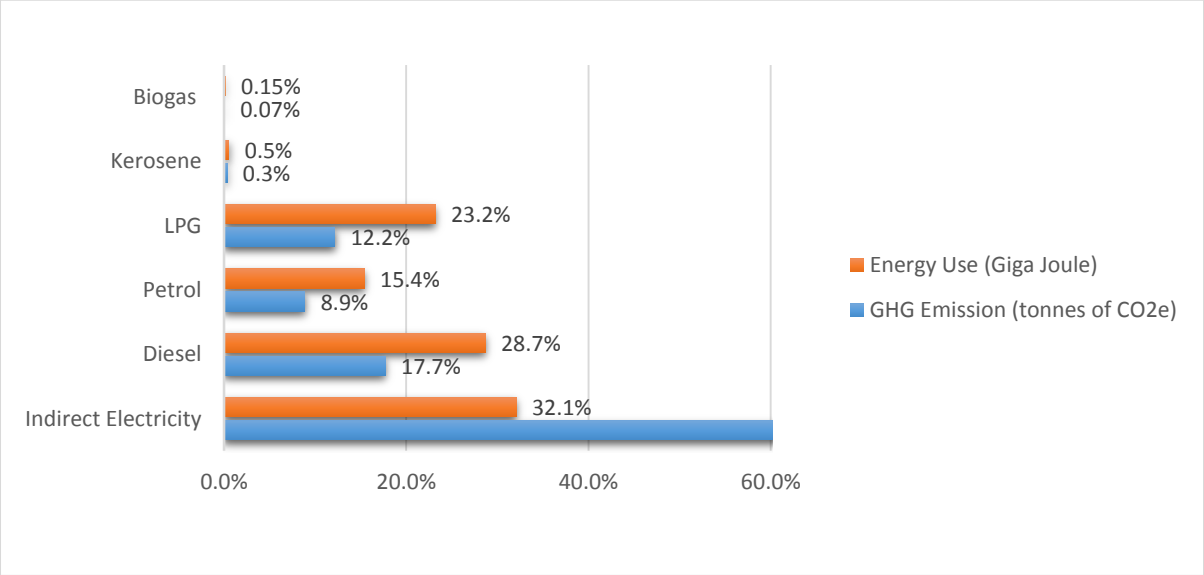


Figure 18 Share of Energy Consumption and GHG Emission by Energy Source

3.1.6 Energy Indirect Emissions from Grid Electricity at the Community Level

The pattern of electricity use within the city has undergone significant changes in the last few years; the consumption grew by over 213 million kWh in the period of 2011-12 to 2016-17 (534 million kWh in 2011-12 to 747 million kWh in 2016–17).

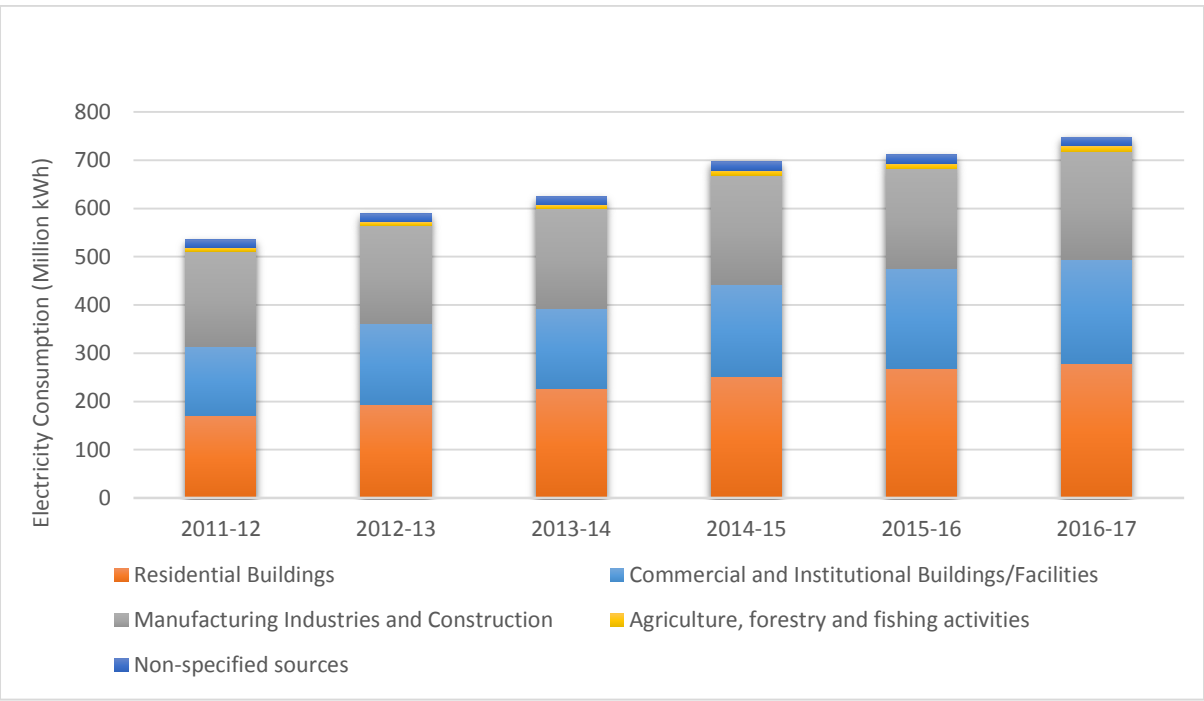


Figure 19 Trend of Electricity Consumption by Sectors

The Residential Buildings sector is the largest end user of electricity accounting for approximately 37% of the city-wide electricity consumption. This is followed by Manufacturing Industry and Construction (i.e. industrial) sector and the Commercial and Institutional Sector buildings/facilities, which consume 30% and 29% of the city-wide electricity respectively (See figure 20).

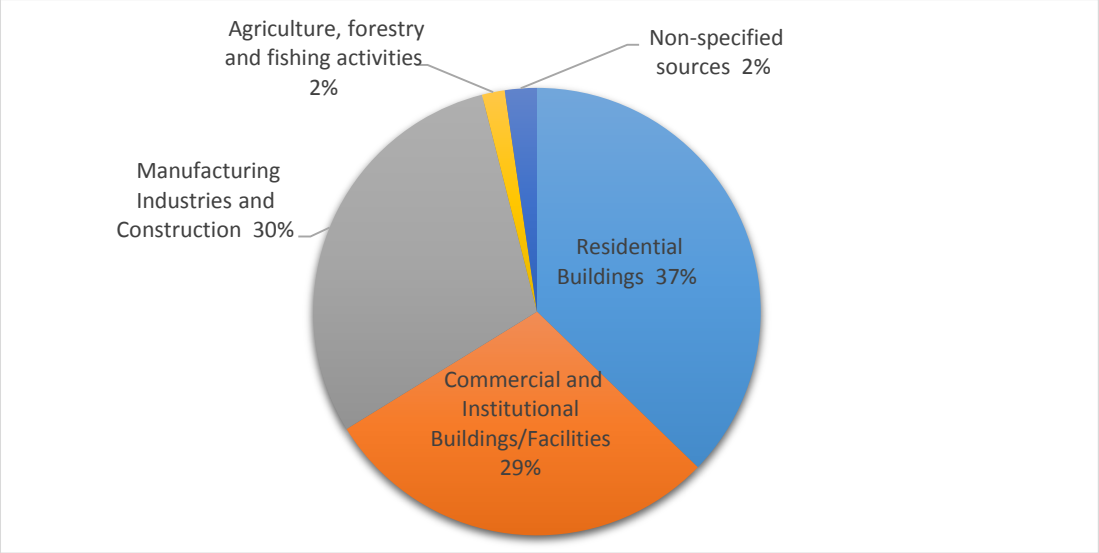


Figure 20 Share of Electricity Consumption by sector in 2016-17

3.1.6.1 GHG Emissions from Electricity Consumption

The total GHG emission from electricity use in the year 2016-17 in Udaipur was 614,961 tCO_2e. 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 residential sector is the largest contributor, emitting 228,997 tCO_2e (37%). It is followed by Manufacturing Industry & Construction and Commercial and Institutional buildings/facilities sectors that emit 183,448 tCO_2e (30%) and 178,178 tCO_2e (29%) respectively. The Non-specified sources and Agriculture, forestry and fishing activities (i.e mainly agriculture) sectors contributed 14,209 tCO_2e (2%) and 10,128 tCO_2e (2%) respectively.

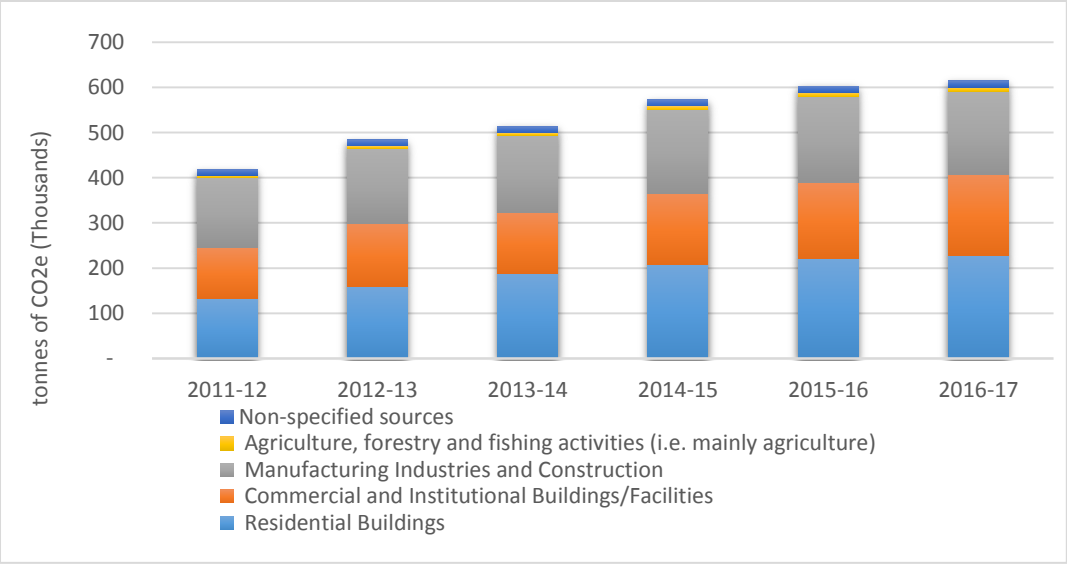


Figure 21 Sector-wise trend of GHG Emission from Electricity Consumption in Udaipur

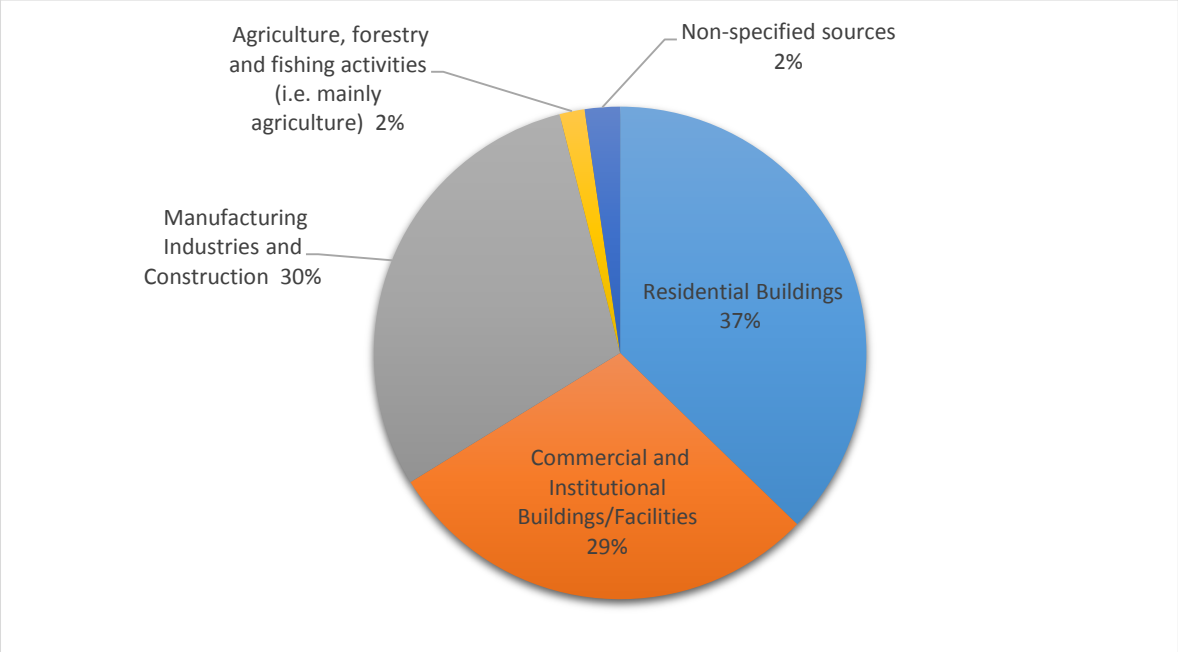


Figure 22 Sector-wise share of GHG emission from electricity consumption in 2016-17

3.1.7 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 and Institutional buildings/facilities and industrial. The direct emissions are estimated by multiplying the fuel consumption by the specific GHG emission factor for the fuel.

3.1.7.1 Residential Buildings Sector

The fuels used to meet cooking and heating requirements in the Residential Buildings sector in the city are kerosene and LPG. In Udaipur, LPG is retailed by the Indane, Hindustan Gas and Bharat Gas and subsidized kerosene is supplied through Public Distribution System (PDS) and plays an important role in meeting energy demands, particularly for low income households. Udaipur does not have piped natural gas (PNG) supply as of now.

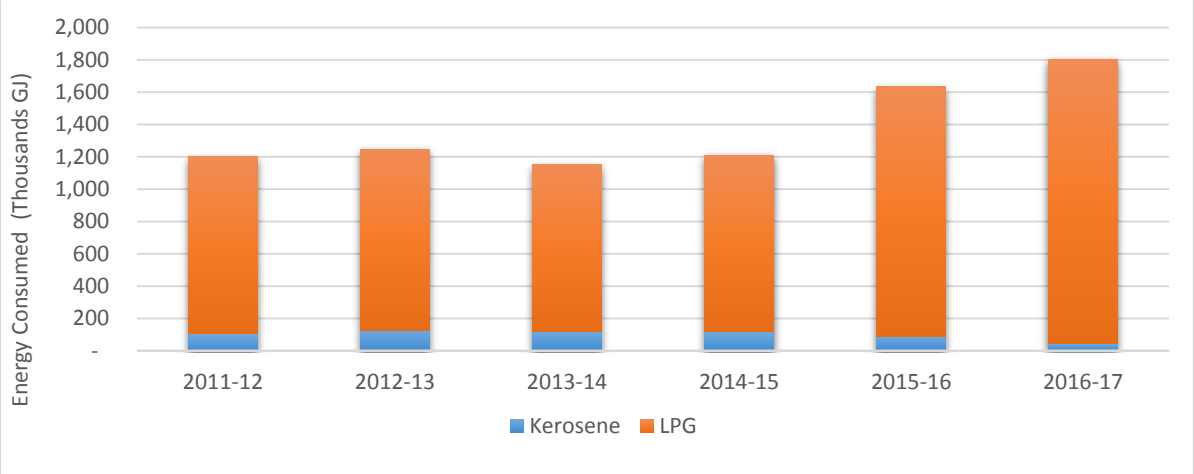


Figure 23 Trend of Fuel (Kerosene and LPG) Consumption by Residential Buildings Sector

LPG is the major source of stationary energy use in the residential sector in Udaipur and accounts for 97% (1,756,368 GJ) of the total stationary energy consumption in the sector. Kerosene's use as a stationary energy source has declined with time and its share in the overall residential energy consumption has reduced to 3% (45,798 GJ) in 2016-17.

3.1.7.1.1 GHG Emissions from Stationary Fuel-use in Residential Buildings Sector

In the last six years, there has been a significant increase in the overall emissions from residential stationary fuel use in Udaipur, rising from 76,780 tCO_2e in 2011-12 to 114,410 tCO_2e in 2016-17, with the exception of 2013-14 and 2015-16 when emissions dipped marginally. This rise in GHG emission in from stationary fuel use in the residential building sector can be largely attributed to rising LPG consumption.

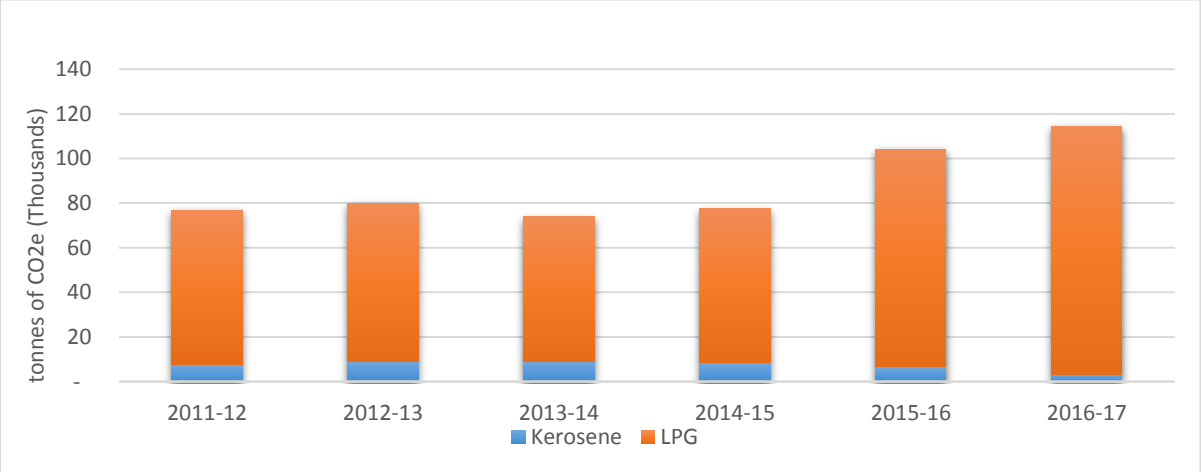


Figure 24 Trend of GHG emissions by Stationary Fuel in the Residential Buildings Sector

3.1.7.2 Commercial and Institutional Buildings/Facilities Sector

The primary fuels used by commercial end users in Udaipur such as hotels, shops, malls, educational institutes, private office buildings etc. are LPG and diesel. LPG is used mainly to meet energy requirements for cooking and water heating purposes while diesel is combusted primarily to run back-up generators for power. Bharat Gas, Hindustan Gas and Indane are the companies supplying LPG to Commercial and Institutional buildings/facilities sector in Udaipur city, through a network of dealers.

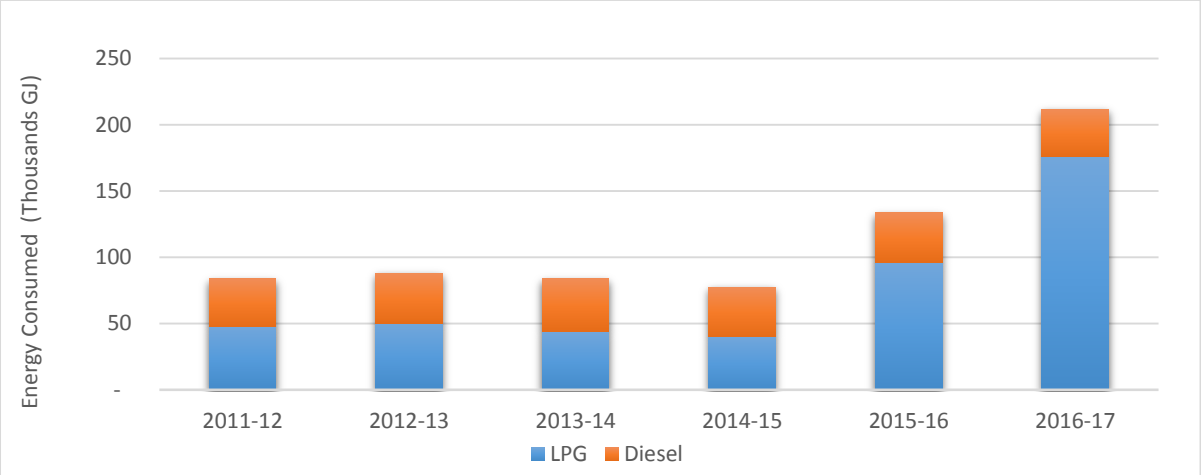
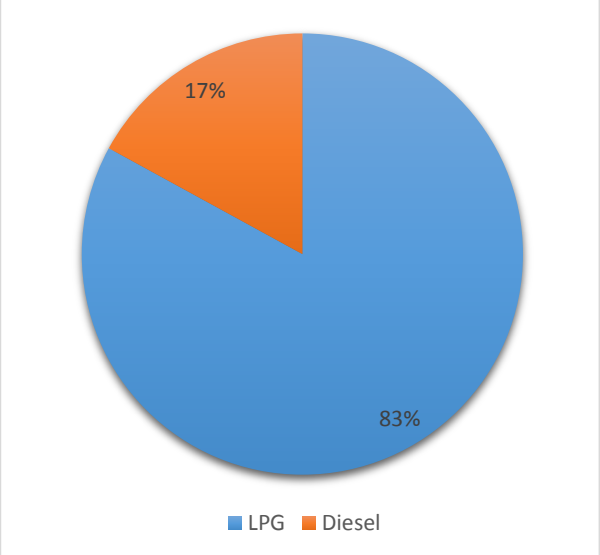


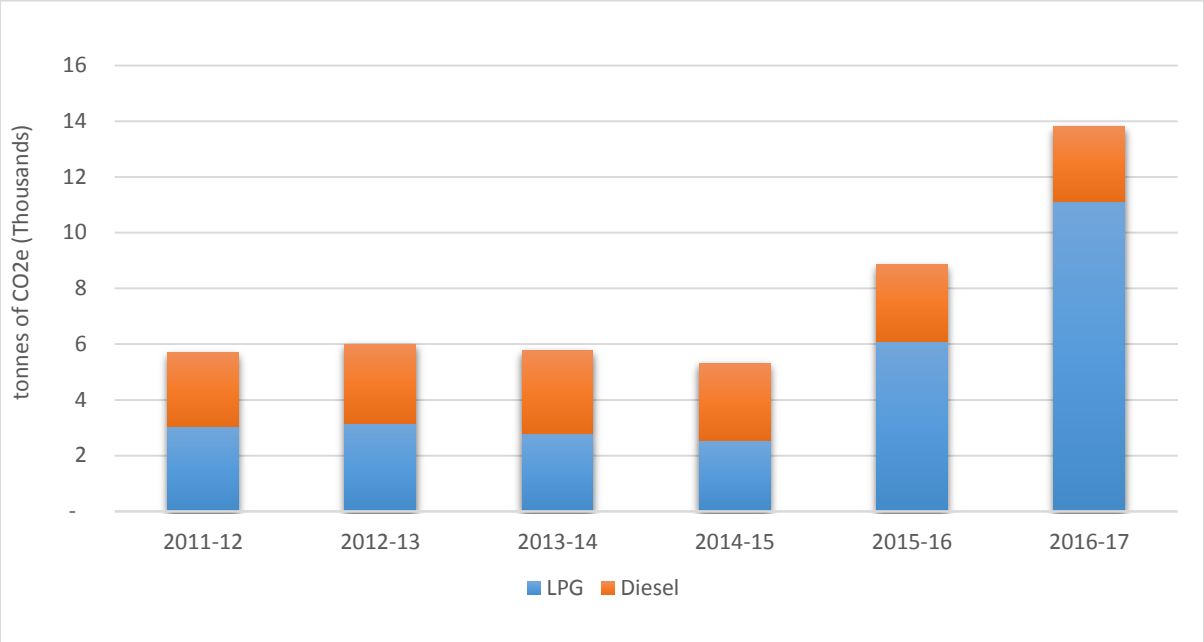
Figure 25 Trend of fuel Consumption in the Commercial and Institutional buildings/facilities Sector

Over the inventory period of 6 years, from 2011-12 to 2016-17, consumption of stationary fuel in commercial and institutional buildings/facilities witnessed a notable growth of 213.43%. During this period, LPG consumption experienced a yearly growth of 20.97%. Diesel consumption in the Commercial and Institutional buildings/facilities sector has a varying trend, mainly due to its use as a secondary fuel for power back-up. LPG thus came out as the dominant fuel in Commercial and Institutional buildings/facilities sector, with a share of 83% in energy use as compared to diesel's share of 17%.



3.1.7.2.1 GHG Emissions from Stationary Fuel-use in Commercial and Institutional buildings/facilities Sector

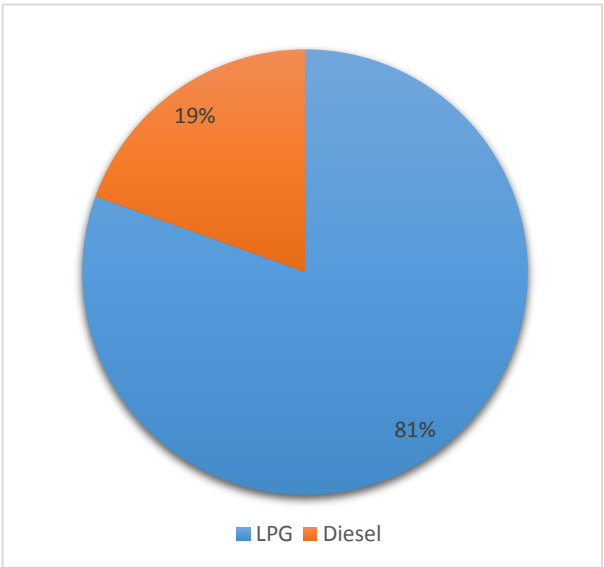
In the last six years, there has been a significant increase in the overall emissions generated from stationary fuel use in Commercial and Institutional buildings/facilities sector in Udaipur. The GHG emissions from stationary fuel use increased from 5,698 tCO_2e in 2011-12 to 13,807 tCO_2e in 2016-17. This trend has been demonstrated in figure below.



LPG is the dominant fuel in GHG emission from stationary fuel use in Commercial and Institutional buildings/facilities sector and accounts for 81% of the total GHG emissions. Diesel contributes around 19% of the total emission from stationary fuels use.

3.1.7.3 Manufacturing Industries and Construction Sector

Udaipur is particularly rich in mineral resources as a large variety of important minerals are found there and is the driving force behind the resource based industries based in the city. Besides, Udaipur is home to many electronic and electrical equipment design and manufacturing industries. The major fuels consumed to meet industrial energy demand in the city are biogas, LPG, coal and diesel. Coal is the major industrial fuel and accounts for over 68% of the total stationary fuel use in manufacturing industries sector. In contrast, diesel accounts for 31% of the energy use and bio-gas accounts for 1% of the energy use, whereas contribution of LPG in the energy use in industries is negligible.



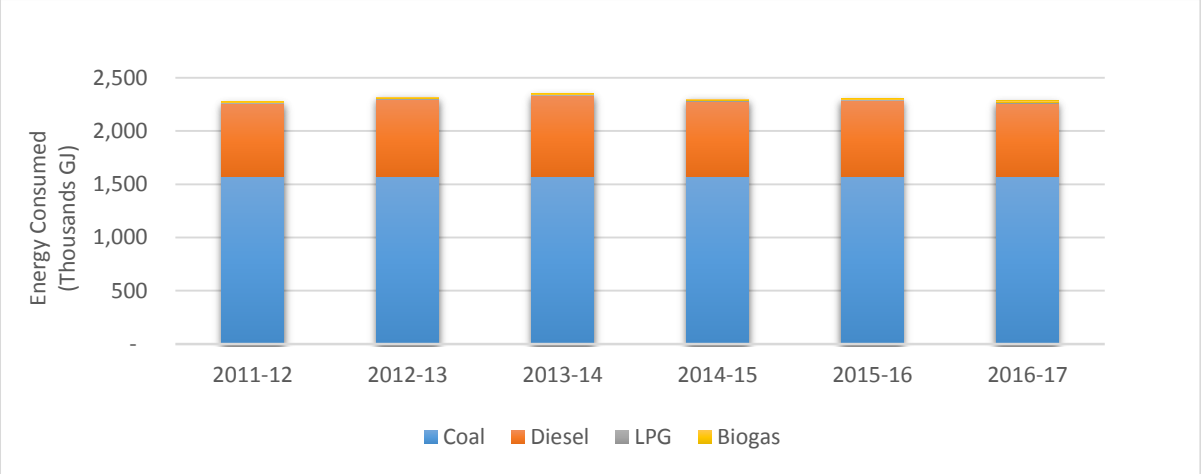


Figure 29 Trend of Fuel Consumption in Manufacturing Industries and Construction Sector

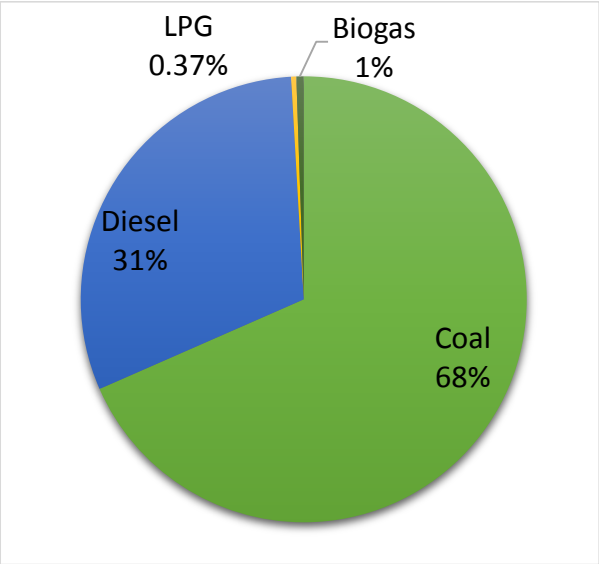


Figure 30 Share of Stationary Energy Use by Fuel in the Manufacturing

3.1.7.3.1 GHG Emissions from Stationary Fuel-use in Manufacturing Industry and Construction Sector

In the last six years there has been a marginal increase in the level of GHG emission from the manufacturing industries sector in Udaipur. The GHG emissions from stationary fuel use in manufacturing industries sector increased marginally from 199,302 tCO_2e in 2011-12 to 199,748 tCO_2e in 2016-17.

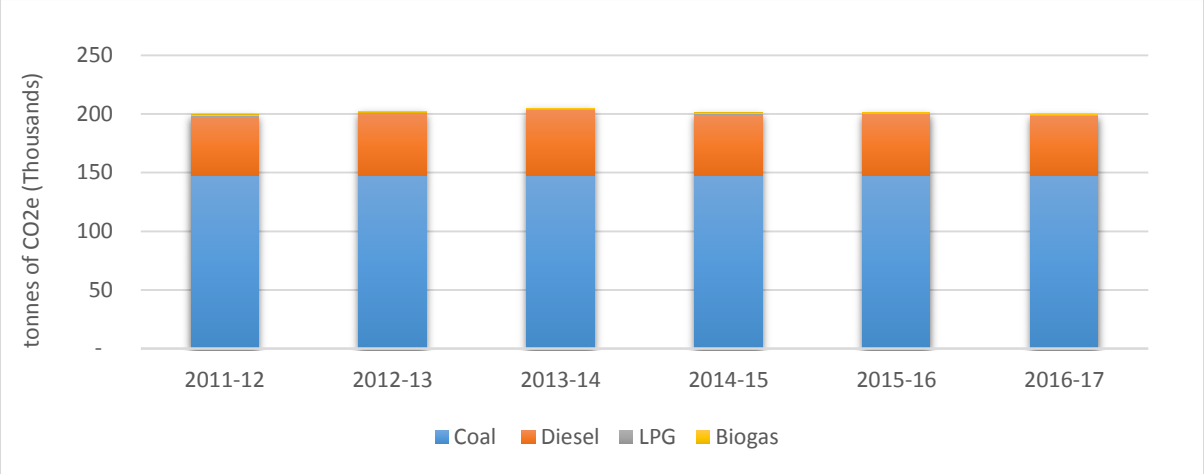
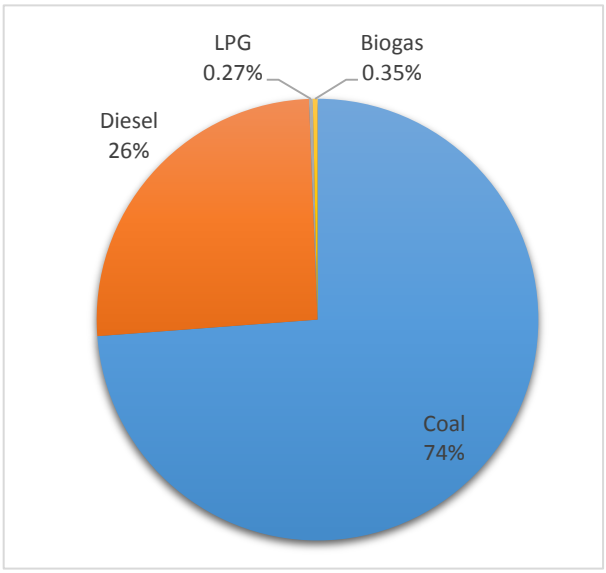


Figure 31 Trend of GHG Emission from Stationary Fuel Use

Coal being the dominant industrial fuel contributes around 74% of the total emission from manufacturing industries. It is followed by diesel oil which contributes approximately 26%. The contribution of bio-gas and LPG in the total emission from industrial sector is almost negligible (Figure 31)



3.1.7.4 On-road Transportation

The major fuels used for on-road transportation in Udaipur are diesel and petrol. BPCL, HPCL, and IOCL are the oil companies retailing these fuels across petrol pumps and gas stations in the city. Auto LPG is being supplied by the Aegis Logistic Pvt. Ltd in the city of Udaipur. The overall fuel consumption in on-road transport shows an annual growth rate of 2% between the years 2011-12 to 2016-17. The trend also portrays a significant decline in auto-LPG consumption.

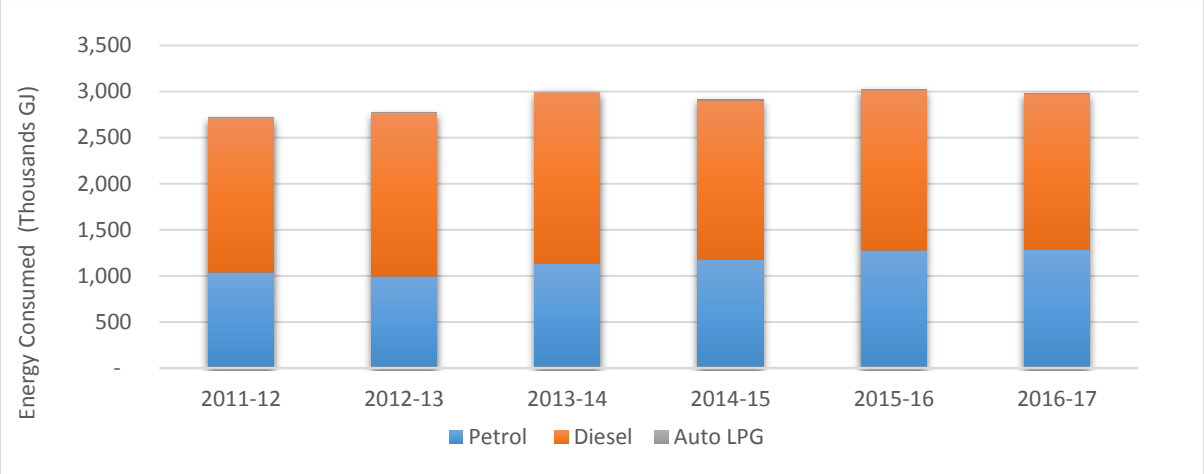
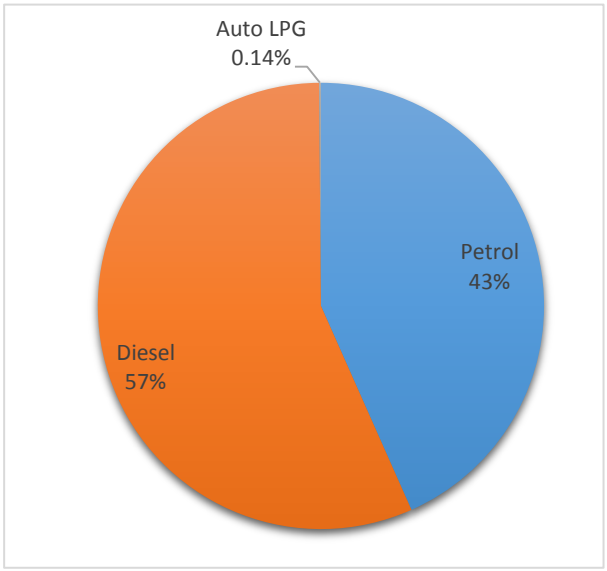


Figure 33 Trend of Fuel Consumption for Road Transportation

Diesel is the dominant fuel in transportation sector, contributing to 57% of total energy use followed by petrol which has a share of 43%. Auto-LPG's contribution in the total energy use is relatively negligible.



3.1.7.4.1 GHG Emissions from On-road Mobile Sources

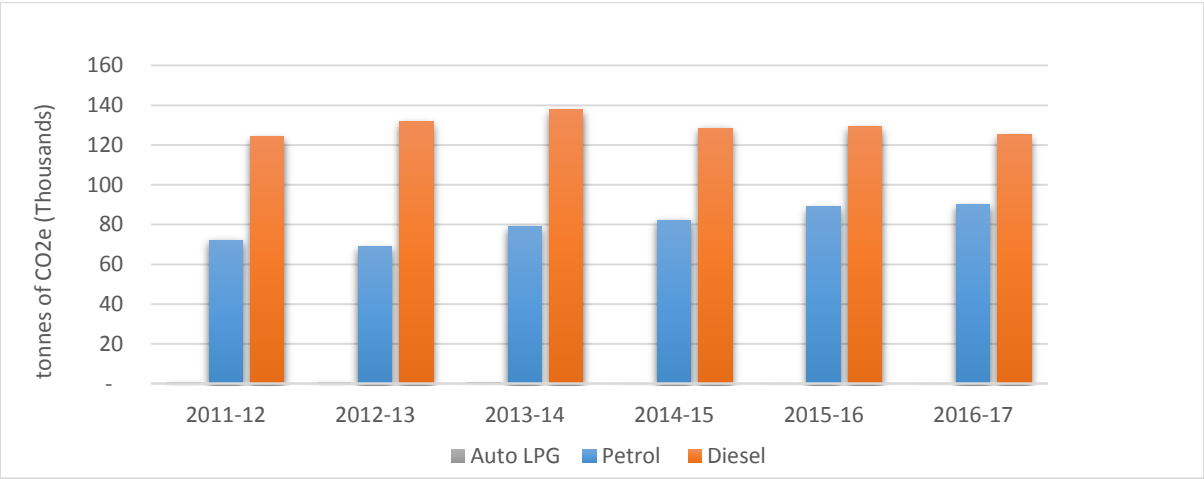
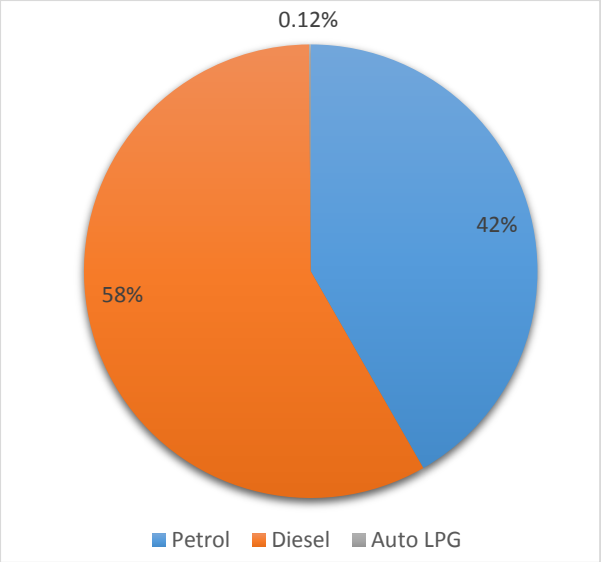


Figure 35 Trend of GHG emissions from On-road Mobile Sources

Transportation sector is the third major contributor to the total GHG emission in Udaipur city and accounts for 17% (215,212 tCO_2e) of the total GHG emission in Udaipur in the year 2016-17. GHG emissions from the transportation sector have grown at 1.49% CAGR from 2011-12 to 2016-17.

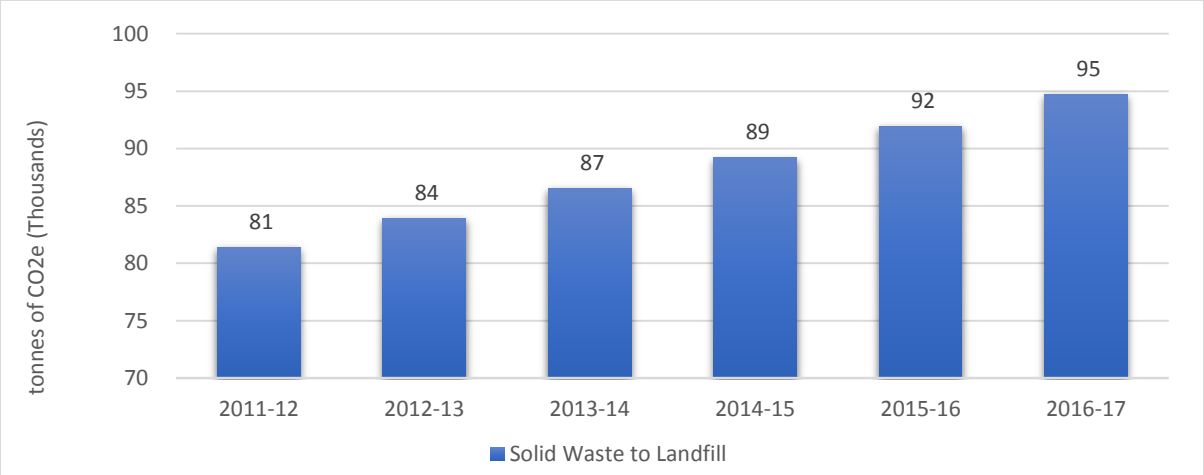
As mentioned above, being the dominant stationary fuel in the transportation sector, diesel accounts for 58% of the total emission from this sector followed by petrol which contributes to 42% of the emissions. Emissions due to auto-LPG is negligible as compared to the two precedent fuels.



3.1.7.5 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). Anaerobic decomposition of bio-degradable matter present in MSW generates GHG emission. CH4 emissions from solid waste disposal sites are the largest source of GHG emission in the Waste Sector. The direct GHG emissions from solid waste can be estimated based on parameters such as the solid waste generation, its composition and management of the landfill site.

Udaipur's annual waste generation in the baseline year 2016-17, was 61,294 tonnes (i.e. 168 TPD)[13] in contrast to 52,667 tonnes (i.e. 144 TPD) during the period 2011-12. The mixed waste generated by the city was disposed at the Teethardi dumpsite until the year 2013. Since then UMC is disposing the city's waste at the Baleecha dumpsite.



[13] Considering that 10% of waste generated is not captured in this study- especially from the vegetable markets and the commercial entities.

Figure 37 Trend of GHG Emission from Disposal of Municipal Solid Waste in Udaipur

The city has experienced a significant growth in the GHG emissions from waste disposal during the inventory period, with total sector emissions rising from 81,385 tCO_2e to 94,716 tCO_2e.

3.1.8 Key sustainability indicators for Udaipur city

The key sustainability indicators for Udaipur city have been provided in table 15. 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 15 Key Sustainability Indicators for Udaipur City

Sustainability Indicator	Unit of Measure	Udaipur (2016-17)
Total Energy Consumption	GJ	9,966,826
Total GHG Emission	tCO_2e	1,255,074
Energy consumption per capita	GJ/capita	20
GHG emission per capita	tCO_2e/capita	2.57
Energy consumption per household	GJ/HH	102
GHG emission per household	t CO_2e/HH	13
Energy consumption per unit area	GJ/sq. km	155,732
GHG emission per unit area	t CO_2e/sq. km	19,611

3.2 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) (See Annexure 4).

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 population projection by arithmetical increase method) and future planning of UMC (See Annexure 3). Based on a forecast of the energy consumption, the corresponding GHG emissions are calculated using the HEAT+ software (See Annexure 4).

3.2.1 Assumptions for forecasting and projections

Sector	Assumption
Water Supply	Based on existing city planning, below assumptions have been taken into consideration. • 115 LPCD water supply with 42% NRW has been considered until 2019 based on baseline situation • It is assumed to reduce NRW from 42% to 30% due to possible service upgradation consideration in AMRUT phase 2 by the year 2022 • It is assumed to reduce NRW from 30% to 20% in year 2030, with 135

Sector	Assumption
	LPCD water supply and 100% water connection coverage
Waste water	• 80% of total water supply has been considered for respective years
Solid Waste Management	• Based on waste quantification and characteristic report, 169 TPD (2016-17) of solid waste generation has been taken into consideration • Annual increase of 1.5% is assumed due to life style changes
Street lights	• Future projection for streetlights has been done based on the 1% average increase in the number of luminaires in the city of Udaipur based on the new road construction and outer growth scenario. • Considered retrofitting of approximately 90% HPSV lights with LED lights between the years 2015 to 2017 has been done by UMC through EESL's National Street Lighting Program, which has reduced energy consumption by 45% from this sector.

Projected energy usage as per business as usual scenario for year 2050-51 is 7698.85M Giga Joule, which is 780 times higher as compared with baseline of 9.90M Giga Joule in year 2016-17. Projected GHG emission based on projected energy consumption as per business as usual scenario for year 2050-51 is 495.75M tCO2e, which is 396 times higher as compared with baseline of 1.25M tCO2e in year 2016-17. That much increase in GHG emission in next 35 years shows the need to prepare and implement Climate Resilient City Action Plan for Udaipur to mitigate GHG emission cause and impact within city limit.

Table 16 Projected medium and long term Energy use scenario

Sectors	Energy Source/ Activity	Energy use scenario (GJ)						
		Baseline	Projected Energy Use (Medium Term Scenario)			Projected Energy Use (Long Term Scenario)		
		2016-17	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
Residential Buildings	Electricity	1001942.8	1441492.5	1729008.5	2271298.5	3578788.5	8885045.8	22058872.6
	Kerosene	45798.3	16516.8	9918.9	4616.1	1290.1	100.8	7.9
	LPG	1756367.6	2756664.8	3453569.7	4842778.7	8507565.3	26255882.6	81030394.3
Commercial and Institutional Buildings	Electricity	601027.9	943329.0	1181809.4	1657195.9	2911283.6	8984747.0	27728551.4
	LPG	175759.8	616569.9	1154818.6	2960130.9	14211485.8	327564350.6	7550118632.1
	Diesel	36087.4	34335.9	33492.3	32265.6	30320.2	26774.1	23642.8
Facilities	Electricity	88370.9	100621.6	103283.5	107292.0	110402.9	123577.3	137000.2
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	802640.2	883457.5	926868.3	996016.6	1122916.5	1427280.4	1814141.4
	Coal	1576157.6	1576157.6	1576157.6	1576157.6	1576157.6	1576157.6	1576157.6
	Diesel	685506.3	651812.6	635591.9	612014.7	574646.8	506616.4	446639.9
	LPG	8634.2	8634.2	8634.2	8634.2	8634.2	8634.2	8634.2
	Biogas	13870.0	13870.0	13870.0	13870.0	13870.0	13870.0	13870.0
Agriculture, forestry and fishing activities (i.e. mainly agriculture)	Electricity	44333.8	73284.3	94221.3	137358.6	155748.9	200245.6	257454.8
Waste	Solid Waste to Landfill	-	-	-	-	-	-	-
Transportation	Petrol	1291605.1	1687727.3	1929250.1	2357859.4	3294075.5	6429316.9	12548624.3
	Diesel	1683756.8	1601051.3	1561234.7	1503358.7	1411627.0	1244614.0	1097360.7
	Auto - LPG	8042.8	3334.8	2147.4	1109.6	369.2	40.9	4.5
Non-specified sources	Electricity	62174.1	67628.3	70532.3	75123.8	76719.8	80014.2	83450.0
Total		**9882075**	**12476488**	**14484408**	**19157081**	**37585902**	**383327268**	**7698943438**

Table 17 Projected medium and long term GHG emission scenario

Sectors	Energy Source/ Activity	GHG emission scenario (tCO2e)						
		Baseline	Projected GHG emission (Medium Term scenario)			Projected GHG emission (LongTerm scenario)		
		2016-17	2020-21	2022-23	2025-26	2030-31	2040-41	2050-51
Residential Buildings	Electricity	228997.3	329455	395167	519108	817936	2030688	5041582
	Kerosene	3311.2	1195	717	334	93	7	1
	LPG	111098.7	174372	218455	306329	538144	1660810	5125561
Commercial and Institutional Buildings	Electricity	157563.2	215599	270104	378754	665377	2053475	6337394
	LPG	9501.6	39001	73048	187242	898945	20720015	477581195
	Diesel	2689.5	2552	2489	2398	2254	1990	1757
Facilities	Electricity	10718.6	22997	23606	24522	25233	28244	31312
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	183448.0	201915	211837	227641	256644	326207	414624
	Coal	147421.6	156016	156016	156016	156016	156016	156016
	Diesel	51090.0	48448	47243	45490	42713	37656	33198
	LPG	547.7	546	546	546	546	546	546
	Biogas	689.9	694	694	694	694	694	694
Agriculture, forestry and fishing activities (i.e. mainly agriculture)	Electricity	10128.5	16749	21534	31393	35597	45766	58842
Waste	Solid Waste to Landfill	104339.8	-	-	-	-	-	-
Mobile (Transportation)	Petrol	89597.1	117346	134138	163939	229033	447023	872491
	Diesel	125151.6	119004	116045	111743	104925	92511	81566
	Auto LPG	256.9	107	69	35	12	1	0
Non-specified Sources	Electricity	14209.5	15457	16120	17170	17534	18287	19073
Total		**1250760.8**	**1461452**	**1687827**	**2173354**	**3791695**	**27619936**	**495755850**

3.3 Analysis of Fragile Urban Systems

3.3.1 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 Udaipur, the major urban systems that have been identified as fragile and that have been assessed include:

A. Water

B. Sewerage

C. Storm Water Drainage

D. Solid Waste Management

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 5 and the Risk Assessment is attached in Annexure 6.

3.3.1.1 Water supply

Fragility Statement:

Water Supply system of the Udaipur city is dependent on the surface water (especially from the lakes). These lakes are getting polluted due to disposal of sewerage and solid waste directly into surface drains of surface water bodies. Moreover, these lakes are dependent on rain for water and face water stress in case of low rain.

Climate Fragility Statement:

1. Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system.
2. Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge.

3.3.1.2 Sewerage

Fragility Statement:

Large area of the city is still not covered with sewerage network and treatment facility. Many residents are dependent on septic tanks for disposal of sewage. However illegal dumping of sewage, garbage and C&D waste in drains causes blockage of drains and dumping of untreated sewage pollute surface as well as ground water.

Climate Fragility Statement:

1. An increase in temperature can provide favourable environment to water polluting bacteria (such as E.Coli) leading to health problem in surrounding areas.
2. In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which will lead to greater ‘knock-on’ impacts on health.

3.3.1.3 Storm water Drainage

Fragility Statement

The city has an open storm water drainage system, which gets clogged with solid waste and construction waste dumped in it leading to water logging in the monsoons. The drainage network does not cover the entire city[14].

Climate Fragility Statement

1. Short duration high intensity rainfall may increase chances of water logging, particularly in underserved areas, increasing the chances of greater 'knock-on' impacts on health.

3.3.1.4 Solid Waste Management

Fragility Statement

The solid waste generated in the city is collected without segregation and disposed in an open dump with no treatment or processing. Though city has taken some measure to improve current situation. But efficiency of waste collection facilities are not up to the mark and waste openly dumped.

Climate Fragility Statement

1. Increasing temperatures may cause waste to decompose in open dumps creating health hazards.
2. High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.

3.3.1.5 Transportation

Fragility Statement

The transportation system in the city is heavily dependent on private modes, with an inadequate public transport system that is fossil fuel dependent and poorly planned road infrastructure. There is requirement of parking facilities and development of PT and IPT systems to improve the condition in the city.

Climate Fragility Statement

1. Increase in short duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion (generating emissions).

[14] As per *AMRUT final slip 2016 only 13.24% of the town is covered with proper storm water drainage system*

3.4 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 6. Table 16 shows the risk status of the five climate fragility statements.

Table 18 Risk Assessment of Climate Fragility Statements

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
Water Supply	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	3	3	9	Medium
	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge	3	3	9	Medium
Sewerage	An increase in temperature can provide favourable environment to water polluting bacteria (such as E.Coli) leading to health problem in surrounding areas.	5	4	20	Extreme
	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which will lead to greater 'knock-on' impacts on health.	3	3	9	Medium
Storm Water Drainage	Short duration high intensity rainfall may increase chances of water logging, particularly in underserved areas, increasing the chances of greater 'knock-on' impacts on health.	3	1	3	Low
Solid Waste Management	Increasing temperature may cause waste to decompose in open dumps	4	3	12	High

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
	creating health hazards.				
	High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.	4	3	12	High
Transportation	Increase in short duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion (generating emissions).	4	3	12	High

Based on this risk assessment Sewerage, Solid waste Management and Transpiration are three fragile urban systems extreme and high risk which require urgent attention.

3.5 Climate Vulnerability Assessment

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:

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.

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.

3.5.1 Identification of vulnerable areas of Fragile Urban Systems

3.5.1.1 Water Supply

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

Urban system	Climate Fragility Statement	Vulnerable Wards
Water Supply	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	22,20, 23, 24, 25, 26, 27, 28, 29, 30,14, 19,4, 11, 12, 13, 42, 44 , 45, 46, 47, 48, 49, 52
	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge	

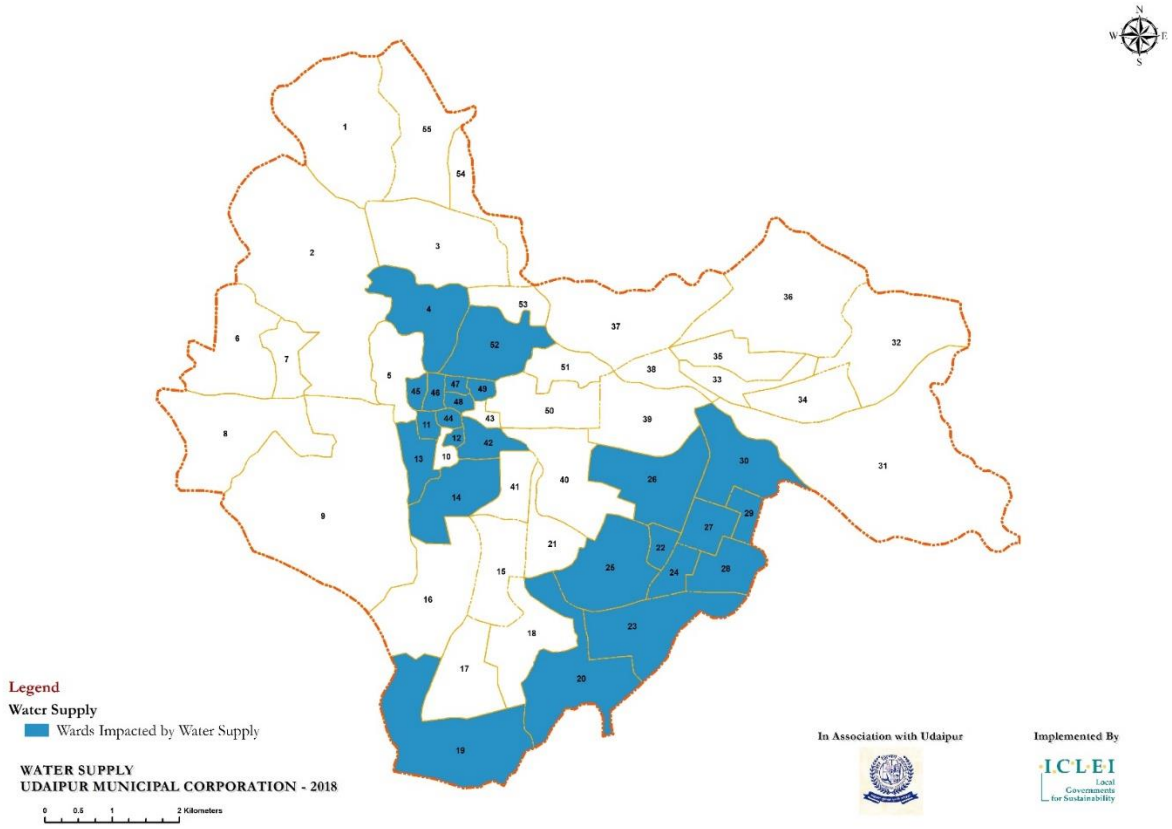


Figure 38 Wards most vulnerable to climate risks in the context of water supply in Udaipur

3.5.1.2 Sewerage

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

Urban system	Climate Fragility Statement	Vulnerable Wards
Sewerage	An increase in temperature can provide favourable environment to water polluting bacteria (such as E.Coli) leading to health problem in surrounding areas.	17, 15, 16, 18, 19, 20, 21, 22, 23,24, 25, 54, 27, 29, 30, 31, 38, 39, 53

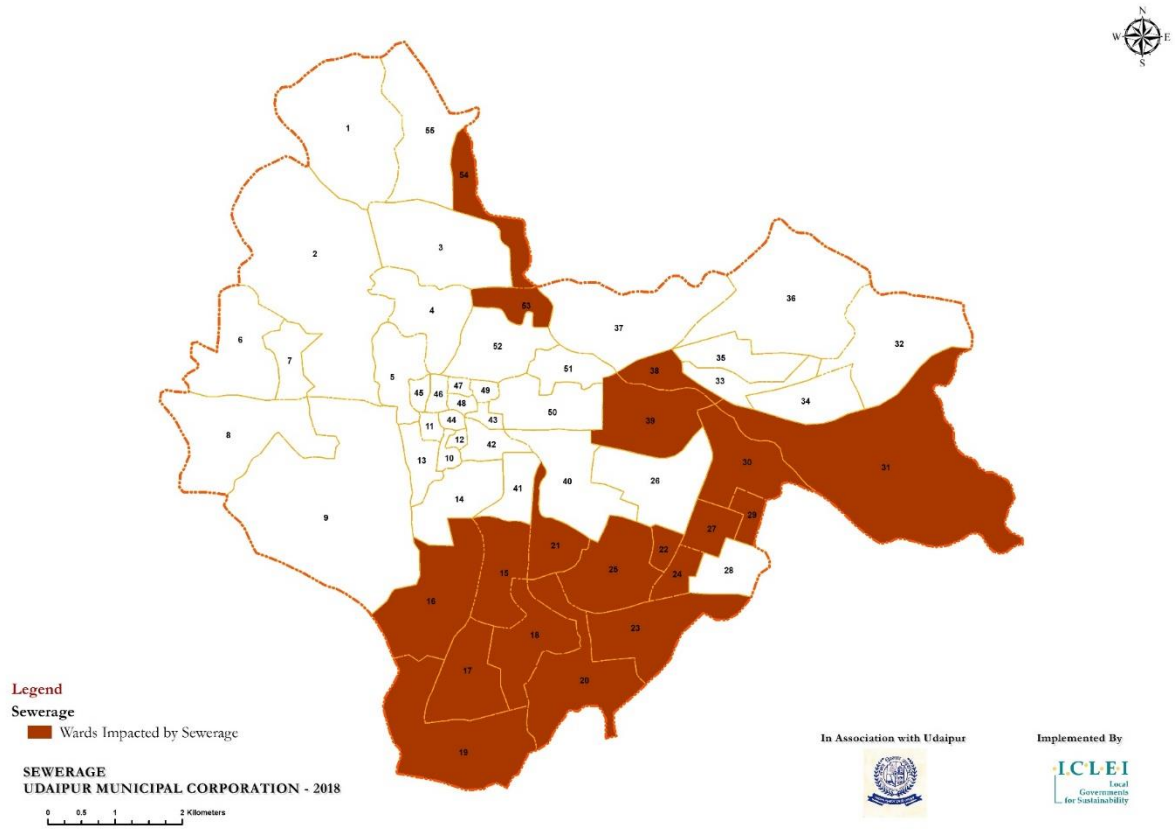


Figure 39 Wards most vulnerable to climate risks in the context of Sewerage in Udaipur

3.5.1.3 Storm Water Drainage

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

Urban system	Climate Fragility Statement	Vulnerable Wards
Storm Water Drainage	Short duration high intensity rainfall may increase chances of water logging, particularly in underserved areas, increasing the chances of greater 'knock-on' impacts on health.	17, 18, 20, 22, 51, 50, 42

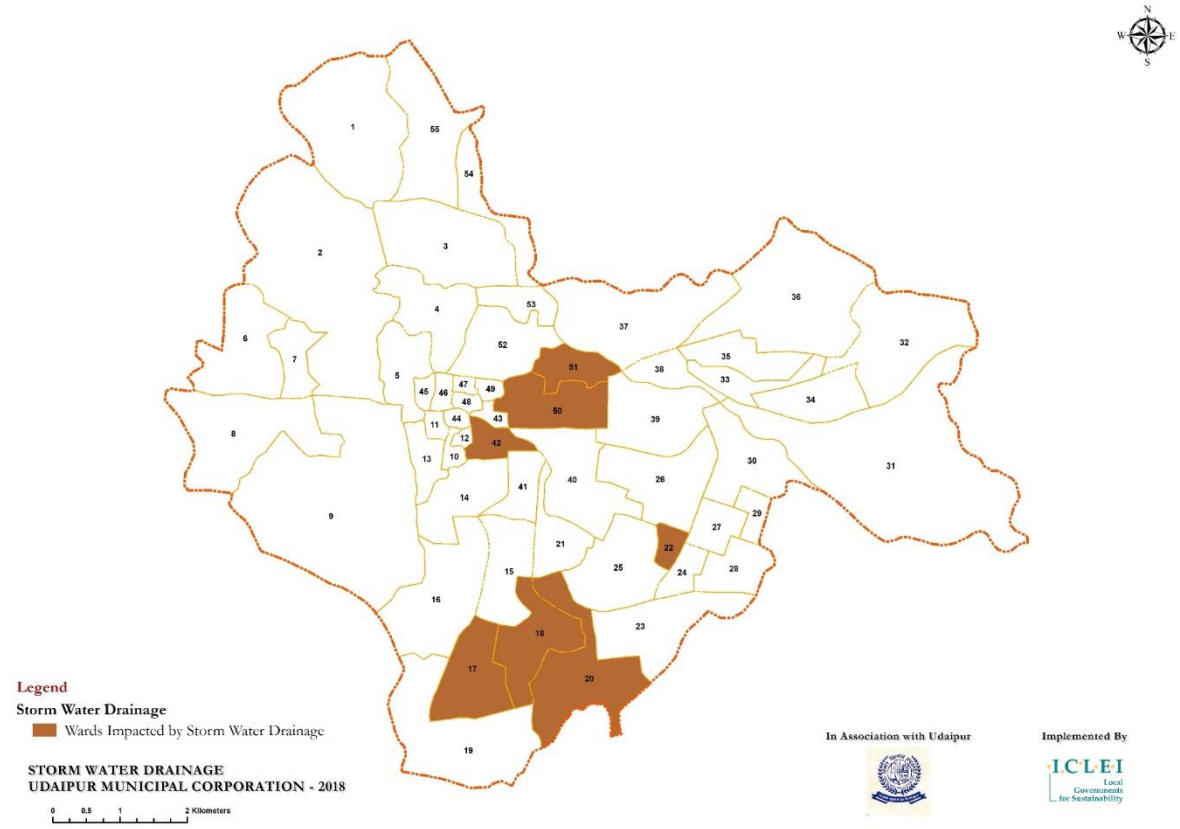


Figure 40 Wards most vulnerable to climate risks in the context of Storm Water Drainage in Udaipur

3.5.1.4 Solid Waste Management

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

Urban system	Climate Fragility Statement	Vulnerable Wards
Solid Waste Management	Increasing temperatures may cause waste to decompose in open dumps creating health hazards.	30, 31, 38, 39, 17, 6, 7, 8, 9, 31, 32, 33,39, 22, 2, 9, 5, 46
	High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.	

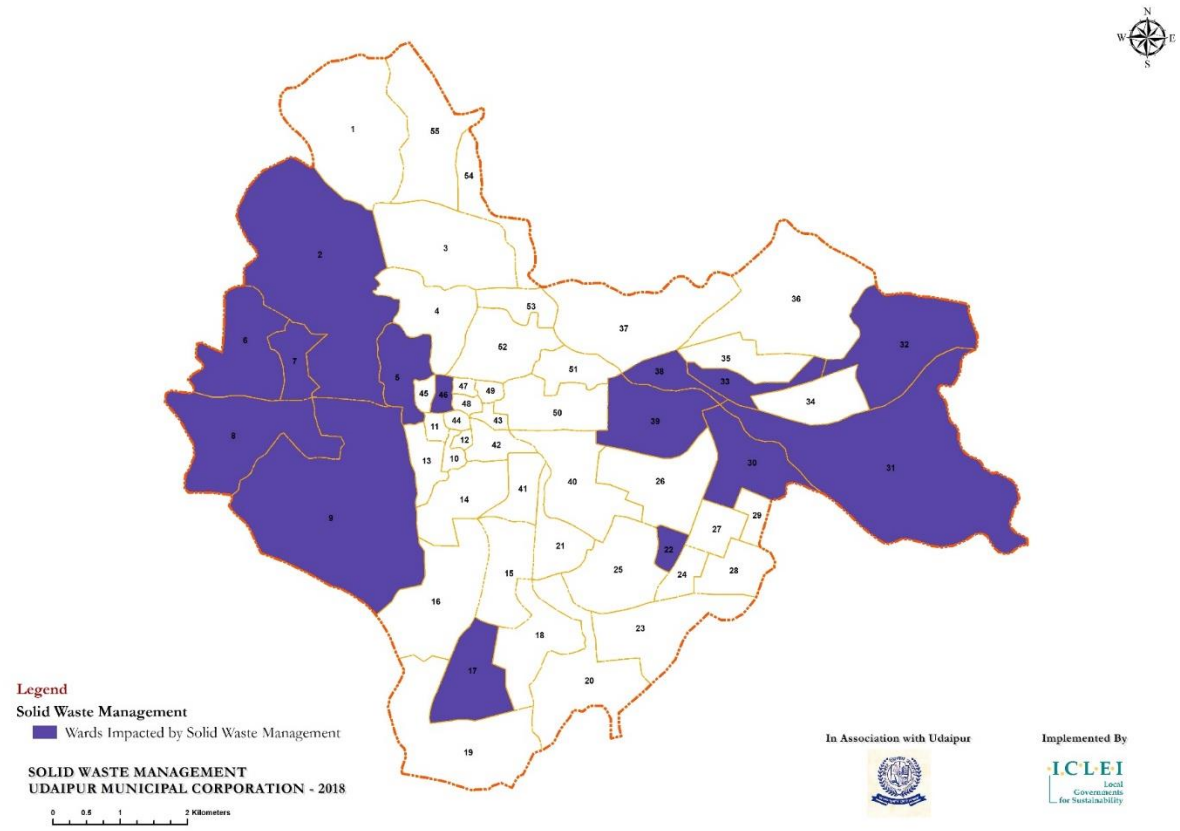


Figure 41 Wards most vulnerable to climate risks in the context of Solid Waste Management in Udaipur

3.5.1.5 Transportation

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

Urban system	Climate Fragility Statement	Vulnerable Places
Transportation	Increase in short duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion (generating emissions).	Udiapol , Paras Circle Fatepura , Chandpol, Tokar choraha, Surajpol, Kalaji Goraji, Rung niwas choke, Ghanta ghar, Bada Bazar, Hathipol

The Vulnerability hotspot map (Figure no. 42) identifies ward number 22 as the most vulnerable, followed by 17, 20 and 30 with regard to climate impacts in the city. These must be immediately focused on to build resilience through resource mobilization in light of the interventions that are identified in the following stages.

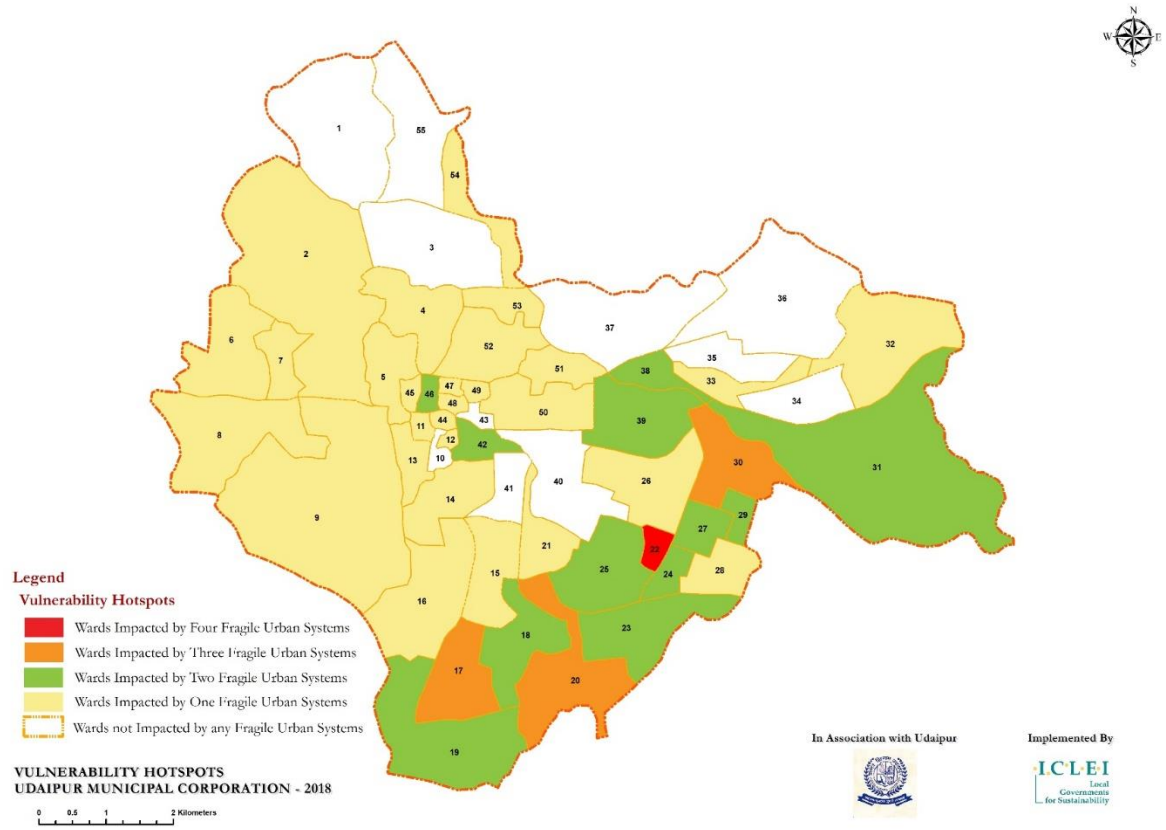


Figure 42 Consolidated Vulnerable Hotspots for Udaipur

3.5.2 Actor Analysis

In addition to the wards, for each fragile urban system, the relevant actors were identified. This is shown in Table 17.

Table 19 Analysis of the adaptive capacities of local actors identified

Urban System	Climate Fragility Statement	Actors
Water Supply	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	PHED, Local Community, Educational Institutions, Tourist, Slum, Labour, UIT
	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge	
Sewerage	An increase in temperature can provide favourable environment to water polluting bacteria (such as E.Coli) leading to health problem in surrounding areas.	UMC, PHED, Hindustan Zinc Vedanta, USCL, UIT, Local Community, Women, Elderly, Labour, Educational Institution, RUDIP, IHUWash, Jheel Sanrakshan Society, Disaster Management Cell, Govt. Hospital
	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which will lead to greater 'knock-on' impacts on health.	
Storm Water Drainage	Short duration high intensity rainfall may increase chances of water logging, particularly in underserved areas, increasing the chances of greater 'knock-on' impacts on health.	UMC, USCL, Local Community, Slum Population, Educational Institute, Jheel Sanrakshan Society, Disaster Management Cell, Govt. Hospital
Solid Waste Management	Increasing temperatures may cause waste to decompose in open dumps creating health hazards.	UMC, Finish Society, Local Community, Rotary Club, Women, Children, Govt. Hospital
	High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.	Local Community, Slum Population, Women, Children, Informal Rag pickers, Educational Institutions, Govt. Hospital
Transportation	Increase in short duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion (generating emissions).	Traffic Police, UMC, Collectorate/Traffic management Committee (TMC), Disaster Management Cell, Students, Residential, Tourist, Commercials establishments, Govt. Hospital

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 18 below shows the adaptive capacities of the actors for each fragile urban system (Annexure 7 gives the details of the analysis).

Table 20 Analysis of the adaptive capacities of local actors identified

Actors	Adaptive capacity score	Level of adaptive capacity
UMC	8	High
Slum Dwellers	2	Low
Residents	2	Low
PHED	8	High
Educational Institutions	6	Medium
Women	2	Low
Children	2	Low
Elderly	2	Low
Rag pickers	2	Low
Pollution Control Board	6	Medium
Disaster Management Cell	18	High
Traffic Police	2	Low
Collectorate	8	High
Govt. Hospital	6	Medium

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.

3.5.3 Resilience Interventions

Potential Climate Resilience interventions were identified for the urban systems of water Supply, solid waste management, storm water drainage, sewerage management and transportation in Udaipur 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.

Table 19 lists the interventions that will help in reducing the emissions from different sectors, the table no. 20 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 UMC to access budgetary resources as well as repay loans and generate revenue. An example of the assessment of bankability is provided in Annexure 8.

Table 19 lists the interventions that will help the city to adapt to climate impacts addressing the fragile systems of water, sewerage, solid waste, transportation and storm water drainage. These were also assessed in terms of their overall resilience score, feasibility and impact.

Table 21 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 Supply	Awareness generation for economic use of water to prevent wastage and reduce demand.	High	High	High	High	Medium
	Pricing policy of water is needed to inculcate proper usage habits among public.	Medium	High	Medium	High	Medium
	Smart metering and SCADA system for water supply 1. Implementation of SCADA system at WTP, CWPH, GLSRs, DMAs and pumping stations to monitor level in reservoirs, flow, chlorine analyzer data, battery power indicators, status of motors, voltage, amperage etc. are on-going under AMRUT	Medium	Medium	Medium	Medium	Short
	Analysis of available water sources and alternatives as Udaipur is totally dependent on surface water	High	High	High	Medium	Medium
	Mapping of water logging areas and geo-tagging for specific interventions at required areas.	Medium	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	
	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	Medium
	Roof top water harvesting and water recycling has to be mandatory for state owned buildings of plot size 300 sq.mt.	High	High	High	High	Medium
	Rejuvenation of traditional water bodies and sources, including water quality check of natural water bodies Few projects are already under planning by UMC; 1. UMC has already installed water quality monitoring sensors in Pichola lack under Smart City Project. 2. UMC has proposed Ayad River Front Development project to rejuvenate river	High	Medium	Low	Medium	Long
	Conservation of existing stepwells in ABD area	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	
	Dual plumbing must be encouraged in new construction. By laws for private treatment of sewage can be developed to ensure zero discharge.	High	High	High	Low	Short
	Drinking water and kitchen supply should be separated from other water supply. Ground water and treated water can be used for other purposes.	High	High	High	Low	Short
	Waste water tariff should be set, particularly for future development plans, and not just operation and maintenance.	Average	High	Medium	High	Long
	Improving urban greenery to 30% of land area to improve water catchment areas. (done by UIT and UMC)	High	High	High	Medium	Medium
	Cleaning, conservation and restoration of degraded lakes and their maintenance like Udaisagar, Gauvardhan sagar, Nila talab etc.	High	High	Medium	Medium	Short
Sewerage	Waste water treatment plant connections to households, institutions and to lakes should ensure no sewage flows into drains	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	
	and is untreated. 1. Waste water dumping in Pichola lack from Sisarma village has been trapped by UMC and sent to STP 2. Work of lying the underground intercepting wastewater pipeline on bank of Ayad river in ward number 34,35,38 is in progress by UMC 3. Work is in progress to laying new sewerage network in city, which will cover ~62.6% of total city area under AMRUT and SMART City ABD project by UMC 4. Commissioning of 3 new STP of total 40MLD capacity is proposed based on PPP model by UMC along with Hindustan Zinc under their CSR					
	Systematic plan for cleaning and maintenance	High	High	High	High	Short
	Proper solid waste management to avoid contamination and drainage blockages.	Average	High	High	Low	Short
	Strategic Planning of sewerage	High	High	High	High	Long

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	
	management for the city					
	Strategic Planning and treatment plant for septic sludge management for the city (which is not covered under AMRUT and Smart city mission)	High	High	High	High	Medium
Transportation	Proper levelling of roads to reduce damages in rainy season	Average	High	High	High	Medium
	Geo tagging of water logging prone areas	Medium	Medium	High	High	Medium
	Introducing PT and IPT and strengthening of existing transport system 1. Development of 100 new bus stands for bus system in city is proposed under SMART City Projects 2. Additional 35 bus fleet is proposed by UMC based on PPP model in high density areas of city 3. Development of smart junctions including existing junction improvements, orientation, planning, horticulture	High	High	High	High	Long

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	
	interventions is proposed by UMC to provide safe and secure transportation 4. 500 cycles with 50 docking stations is proposed by UMC under SMART City planning 5. Implementation of Low carbon IPT action plan					
	Providing NMT and pedestrian infrastructure	Medium	High	Medium	High	Long
	Awareness generation in public to use public transport	High	High	High	High	Medium
	Construction of dedicated parking lots and implement parking policy and flyovers for congested area 1. Construction of 3 new parking lots is already proposed by UMC under SMART City project to reduce encroachment due to parked vehicles on roads 2. Construction of flyover in congested areas for ease of traffic is already proposed by UMC					
	Increase road side plantation will reduce road damage	Average	High	High	High	Long

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	
	Scientific construction of roads along with covered drainage and percolation pits, green belt along the roads to reduce damage in road 1. Alignment and resurfacing of roads for smooth traffic movement, VMS display boards to display traffic movement, separation of road lanes, green corridors is already proposed by UMC under Smart city Plan	High	High	High	Medium	Medium
Solid Waste Management	Source segregation of waste to be made compulsory as per SWM Rules 2016. Ward wise incremental process can be followed.	Medium	High	High	High	Medium
	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. 1. Awareness generation for source segregation and open defecation has been done in 10 wards by	High	High	High	Medium	Long

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	
	UMC with support from CapaCITIES project in 2 wards					
	Segregated collection of waste in 3 categories - wet, dry and sanitary. Door to door collection of waste is to be introduced to all wards. 1. Procurement of 60 Auto tippers for Door to door waste collection is already planned by UMC	Very High	High	High	Medium	Medium
	Establish zone-wise 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. 1. Material recovery facility along with 60TPD waste to composting plant is already proposed by UMC 2. Construction of 150TPD waste to composting and RDF plant is proposed by UMC 3. Waste transfer station at Balicha and bio mining is proposed by UMC	High	High	Medium	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	
	4. Scientific covering and capping of old dump site at Tithardi is proposed by UMC					
	Practical implementation strategy for removal of dustbins from all wards in the city.	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.	Medium	High	High	High	Short
	Develop and implement user charges and fines.	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	Medium	Low	Short
	Awareness generation to 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	Medium	Short
	For industrial, commercial and hotel waste, guidelines and rules should be	Very High	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	
	enforced for collection and treatment.					
	Building intra-departmental coordination and cooperation between public health, finance, engineering, Garage section 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.	Average	High	High	Low	Long
	Medical waste has to be collected and incinerated properly to avoid pollution.	High	High	High	Low	Long
	Training on management of industrial waste, foundry waste, etc. Prevention of disposal of this waste in water bodies.	High	High	High	High	Medium
	Training on roof gardening and organic farming and linking it to composting facilities in the city.	High	Medium	Medium	Low	Low

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	
	Strategic planning for solid waste management in the city for overall management	High	High	High	High	Long
	Windrow composting for wet waste at existing landfill site	Average	High	Medium	Medium	Medium
	Awareness generation for house hold level composting	Average	High	High	Low	Short
	Implementation of 3R concept to reduce overall production of waste	High	Medium	High	High	Long
	Impose and strongly implement huge fines for open dumping	High	High	High	High	Medium
Strom Water Drainage	Conservation and restoration of natural drainage 1. Construction of storm water drain from Udaipole to Ayad river is proposed by UMC 2. Construction of 99kms storm water drainage in ABD area under SMART City Project	High	High	High	High	Long
	Strengthen and improve the infrastructure to reduce pollution from combined sewer	High	High	High	High	Short
	Rainwater harvesting reduce water run off on the road surface	High	High	High	Low	Medium
	Map the entire water regime of the	High	High	Medium	Medium	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	
	city and changes in natural course.					
	Effective implementation of the building bye-laws and development control regulations to avoid constructions along lakes and natural drainage system.	High	High	Medium	High	Short
	Improvement in solid waste management practices	High	High	High	High	Medium
	Develop a new covered storm drainage system (separate from sewerage system) with proper manhole (with jail to filter rubbish) and soakpits to increase the coverage in the city	High	High	High	High	Short-Long
	Ensure timely and proper cleaning of drainage	High	High	High	High	Short
	Proper cleaning of roads and drainages to reduce water contamination	High	High	High	High	Medium

4 City Climate Action Plan

4.1 Identification & Prioritization of Resilience Interventions

Various mitigation and adaptation interventions have been identified for Udaipur based on GHG emission inventory and urban system analysis in line with existing city planning. Mitigation and adaptation potential for each intervention along with financial aspect and implementation mode have been identified under Climate Action Plan. Prioritization of Resilience Interventions, feasibility and impact assessment has been done by using tool 4.2.

Table 22 Resilience Interventions proposed under Climate Action Plan, Udaipur

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
Residential Building Sector					
Energy Efficient star rated appliance retrofits in High-income and mid-income group households	7.0		5,776.2	–	UMC will explore incentive options or other mechanism to facilitate this project execution
Replacement of CFL lights with LED bulbs in Residential HHs Under UJALA Scheme	2.5		2,030.7	1.5	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of CFL lights with LED tube lights in Residential HHs Under UJALA Scheme	1.1		883	2.6	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of existing fans with EE fans under UJALA Scheme	0.5		378.4	6.7	To be implemented under UJALA Scheme of EESL of Government of India
Use of Solar water heater in place of conventional geyser	34.2		28,141.5	410.4	UMC will explore incentive options or other mechanism to facilitate this project execution
Rooftop Solar PV in Residential buildings	2.3		1,851.2	75.0	Ministry of New and Renewable Energy (MNRE)

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
					Rooftop Solar Power Plant and Rajasthan Renewable Energy Corporation LTD (RRECL) Subsidy Schemes Or Renewable Energy Service Company (RESCO) will borne capital expenditure of the project with agreement of UMC
Implementation of Piped Natural Gas network in city by PNGRB (fuel shift from LPG to PNG)			34,631.4		Project will be implemented by PNGRB in District, which will cover 100% household of UMC area in next 5 years
Total (1)	**47**		**73,692**	**496**	
Commercial and Institutional Buildings/ Facilities					
Energy Efficient star rated Air Conditioners retrofits	7.6		6,212.4		UMC will explore funding/incentive options
Replacement of CFL lights with LED bulbs in commercial units Under UJALA Scheme	0.5		373.0	0.2	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of CFL lights with LED tube lights in commercial units Under UJALA Scheme	0.6		473.0	1.1	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of existing fans with EE fans in commercial units under UJALA Scheme	0.2		202.7	2.8	To be implemented under UJALA Scheme of EESL of Government of India
Use of Solar water heater in	10.3		8,437.2	123.1	UMC will explore

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
place of conventional geyser for hotels and hospitals					incentive options or other mechanism to facilitate this project execution
Rooftop Solar PV in commercial buildings and institutions	3.8		3,085.4	122.5	MNRE Rooftop Solar Power Plant and RRECL subsidy schemes or RESCO will borne capital expenditure of the project with agreement of UMC
Total (2)	**23**		**18,784**	**250**	
Manufacturing Industry and Construction (i.e. Industrial Sector)					
Energy Efficient star rated appliance retrofits	0.2		169		UMC
Replacement of CFL lights with LED bulbs in industrial units Under UJALA Scheme	0.9		746	0.4	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of CFL lights with LED tube lights in industrial units Under UJALA Scheme	0.3		284	0.7	To be implemented under UJALA Scheme of EESL of Government of India
Replacement of existing fans with EE fans in industrial units under UJALA Scheme	0.1		61	0.8	To be implemented under UJALA Scheme of EESL of Government of India
Solar PV in industrial units	2.3		1,851	122	UMC will explore incentive options or other mechanism to facilitate this project execution
Total (3)	**3.8**		**3,111**	**124**	
Municipal Services					
A. Water Supply					

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
NRW reduction from 42% to 30% (Proposed)	1.51		1,245	-	AMRUT Mission of Government of India
Replacement of all water supply pumps with EE pumps	4.2		3,455.68	-	PHED and UMC can do it on cost sharing model
Rooftop Solar PV installation on pumping stations and water treatment plant	1		617	35	MNRE Rooftop Solar Power Plant and RRECL subsidy schemes or RESCO will borne capital expenditure of the project with agreement of UMC
B. **Sewerage**					
Energy efficiency in pumping and SCADA implementation	3.2		2,651.0	-	AMRUT Mission of Government of India
Rooftop Solar PV for Hindustan Zinc Sewage Treatment plant	0.4		308.5	18	MNRE Rooftop Solar Power Plant and RRECL subsidy schemes or RESCO will borne capital expenditure of the project with agreement of UMC
Feacal sludge management and Anaerobic Digestion - Biogas to electricity generation potential (based on technical study done under CapaCITIES)	4.0		3,297.6	-	UMC
C. Street Lighting					
ESCo. Replacement of existing Street lighting with LED - Proposed	0.25		208	3.6	UMC with EESL based on ESCo model
D. Transportation					
Rooftop SPV for renewable energy for electric buses	0.8		630.6	36	MNRE Rooftop Solar Power Plant and RRECL subsidy schemes or RESCO will borne

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
					capital expenditure of the project with agreement of UMC
Rooftop SPV for renewable energy for electric powered IPT	3		2,468.3	140	MNRE Rooftop Solar Power Plant and RRECL subsidy schemes or RESCO will borne capital expenditure of the project with agreement of UMC
E. **Smart City**					
Installation of rooftop SPV system in Smart City Area	2.0		1,604	52	Funding secured for implementation under the Smart City Mission of Government of India.
Ground mounted Solar PV plant at Alsigarh under smart city	1.5		1,234	40	Under the Smart City Mission of Government of India.
Total (4)	**22**		**17,720**	**324**	
Municipal Buildings and Office Transfer					
Rooftop Solar PV in Municipal Building (Potential next 5 years)	3		2,468.2	120	UMC
Transportation for Office Work (E-cars in place of conventional cars)	0.02		19.35	0.77	UMC
Replacement of all existing CFL lights with LED bulbs in all municipal buildings	0.001		1,76		UMC
Replacement of all existing tube lights with LED lights in all municipal buildings	0.01		7.80		UMC
Replacement of all existing fans with super EE fans in municipal buildings	0.04		36.04	0.72	UMC
Installation of AC energy savers in split Air conditioners	0.11		92.02	2.84	UMC
Total (5)	**3.2**		**2,625**	**124**	
Solid Waste					

Sector wise Resilience Interventions	Mitigation Potential (2022-23)			Cost of Interve-ntions (Million INR)	Implementation Mode
	Potential Energy Saving (Million kWh)	Fuel Saving (KL)	Potential GHG Emission Reduction (tCO2e)		
Composting and RDF integrated plant and sanitary landfill	5.1		55,768	120	Public Private partnership project
Waste to biomethanation plant (implemented under CapaCITIES project)	0.1		1,437.4	7.1	SDC funded CapaCITIES project and UMC
Waste to biomethanation plant (Replication by UMC)	0.4		7,186.8	35.4	UMC
Total (6)	**6.0**		**64,392**	**162**	
Transportation					
Electric buses in place of diesel buses		86	245	220	UMC
Replacement of traditional auto-rickshaws across the city by electricity powered IPT		15,628	44,546	1,863	UMC
Transportation for Office Work (E-cars in place of diesel cars)		24	67	11	UMC
E-Garbage Vehicles in place of Tippers		10	15	4	UMC
Total (7)		**15,747**	**44,872**	**2,098**	
Grand Total (Total 1+2+3+4+5+6+7)	**104**	**15,747**	**2,25,197.5**	**3,578**	

4.1.1 Potential and GHG Emission Mitigation Share of Proposed Mitigation Actions

The Climate Action Plan for Udaipur City has been prepared under the CapaCITIES project. The cumulative potential GHG emission reduction from the actions proposed across the various sectors for the Community and for Municipal operations stands at 225,197 tonnes of CO2e by year 2022-23, aggregating to about 18% of Udaipur City's baseline annual GHG emissions in the year 2016-17.

A total of 104 Million kWh of electricity, 15,747 kilolitres of diesel will be saved by implementing proposed priority actions across different sectors, which will reduce 225,197 tCO2e GHG emissions for the city. The total investment required for the proposed actions is INR 3,578 Million INR.

Mitigation potential of solid waste management sector (27%) is highest followed by energy efficiency (26%), renewable energy (25%), transport (21%), and water (1%) (See figure 43)

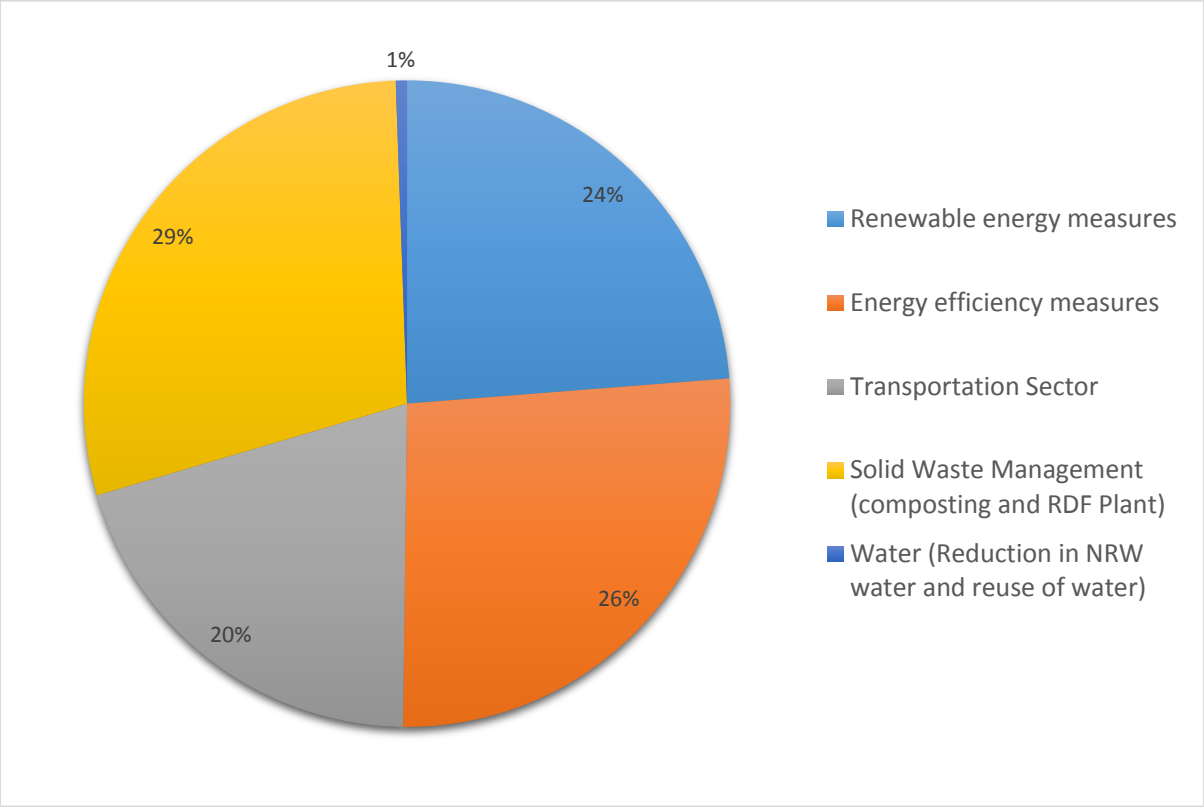


Figure 43 Sector-wise share of mitigation potential

4.2 Way Forward

The Udaipur CRCAP has been developed based on interactions with the city core team and various stakeholders through in person individual interactions and group dialogues to reach its current form. In the next steps this draft document will be presented to the core team for their comments and revision. Subsequently the CRCAP report will be tabled at the council for approval and vetting by the city council.

It is expected that these steps take place during S2 2018 under the CapaCITIES project.

Annexure

Annexure 1 Stakeholder committee and climate core team under CapaCITIES project

Annexure 2 Detailed waste quantification and characterization report

Annexure 3 Energy consumption Projections (2016 to 2050)

Annexure 4 GHG emission Projections (2016 to 2050)

Annexure 5 Tool 3.2B Urban System Analysis

Annexure 6 Risk Assessment

Annexure 7 Tool 3.2D Actors Analysis

Annexure 8 Tool 4.2 Prioritization of Resilience Interventions

Annexure 1: Core Team of Udaipur

Municipal Corporation, Udaipur

स्वच्छ भारत
एक कदम स्वच्छता की ओर

S.N.- Ni.Vi.Ja./2018-19/102 Date:- 17/09/18

Formation of Climate Core Team for Climate Change Action Plan under CapaCITIES Project

Udaipur Municipal Corporation (UMC) with technical assistance from ICLEI-Local Governments for Sustainability, South Asia (ICLEI - South Asia), South Pole Group and econcept has initiated the implementation of **"Capacity Building Project on Low Carbon and Climate Resilient City Development in India" under CapaCITIES Project,** supported and funded by Swiss Development Cooperation (SDC).

The project is aimed at strengthening the capacities of four Indian cities- Udaipur, Coimbatore, Rajkot and Siliguri- to identify, plan and implement measures for reducing greenhouse gas emission and also for enhancing resilience to climate change in an integrated manner. As part of this project, ICLEI - South Asia will develop a Climate Change Action Plan for the city of Udaipur, with interventions to build urban resilience in the city and to address both climate mitigation and climate adaptation.

The first phase of the project (2016 - 2019) is focusing on mainstreaming climate change mitigation and adaptation in to development policies at the city level, support the city authorities in the formulation and implementation of integrated action plans and measures across priority sector and share experience with cities in other developing and emerging countries.

In order to develop this Action Plan, UMC has constituted a Climate Core Team for overseeing the timely completion and implementation of the project. The Core Team consists of-

1) Hon'ble Mayor, UMC
2) Hon'ble Municipal Commissioner, UMC
3) Additional Chief Engineer (ACE), UMC

The main responsibility of the Climate Core Team is to oversee the activities related to discussions, workshops and/ or decision making process on the various stages of the project, that also includes inviting stakeholders (UMC as well as representatives from various local government bodies, ITPI, Builder's association, ACCE, various educational institutes and NGOs, Architect Association etc.) for the same. To keep the workflow flexible and holistic, it shall be noted that new members can be added into the Core Team on as and when basis.

Hon'ble Municipal Commissioner, UMC shall also act as the Project Nodal Officer (PNO) for the project on behalf of UMC.

Sidharth Sihag, (IAS)
Municipal Commissioner
Udaipur Municipal Corporation
आयुक्त
नगर निगम, उदयपुर

Schweizerische Eidgenossenschaft
Confédération suisse
Confederazione Svizzera
Confederaziun svizra

Swiss Agency for Development and Cooperation SDC

CapaCITIES
LOW CARBON • CLIMATE RESILIENT • CITY DEVELOPMENT

ICLEI Local Governments for Sustainability

Municipal Solid Waste Quantification and Characterization for Udaipur, Rajasthan

Table of Contents

List of Tables

List of Figures

1. City Profile

Udaipur, also known as City of Lakes, is a historic city was founded by Maharana Uday Singh II of the Mewar dynasty in 1559. Presently, it is the sixth largest city in Rajasthan state. The Udaipur Nagar Parishad was converted to Udaipur Municipal Corporation (UMC) in April 2013. As per census 2011, the total population of the Udaipur city is 451,735 persons spread across 55 wards. The city is a famous tourist attraction, with approximately 15 to 18 thousand tourists visiting it daily and is often called as the "Venice of the East". The economy of Udaipur is diversified with significant contributions from tourism, trade and commerce, and industrial Sector.

Figure 1: Location of Udaipur

Table 1: City Profile for Udaipur

Location	**Western India**
District	Udaipur
State	Rajasthan
Class of City	Tier II
Area of City	64 sq. kms
No. of Administrative Wards	55
Population (Census 2011)	451736
Decadal Growth Rate	15.99
Climate	Tropical

1.1. Demographic Profile

The total geographical area of the city is 64 Sq. km and was dived into 55 wards in year 2011 for administrative purposes.

Table 2: Distribution of Ward Wise Population

Ward No.	Population	Ward No.	Population	Ward No.	Population
1.	9112	21.	9488	41.	7278
2.	8124	22.	9589	42.	6837
3.	6178	23.	13379	43.	5069
4.	6549	24.	7671	44.	5620
5.	8341	25.	3314	45.	6105
6.	9092	26.	10874	46.	6107
7.	10881	27.	6468	47.	6640
8.	12990	28.	8533	48.	4963
9.	6774	29.	5829	49.	5895
10.	6538	30.	10987	50.	6066
11.	6488	31.	12443	51.	6779
12.	6357	32.	8151	52.	7929
13.	5510	33.	10596	53.	6752
14.	6804	34.	4617	54.	9428
15.	7327	35.	8856	55.	6928
16.	12964	36.	6182	**Total**	**451100**
17.	10941	37.	17182		
18.	8864	38.	6957		
19.	12124	39.	7176		
20.	13829	40.	8625		

(Source: Udaipur Nagar Nigam, 2011)

2. Present Scenario of MSWM in Udaipur

1.2. Waste Generation Quantity and its Composition

Since the city did not had any recent reliable data on municipal solid waste management, ICLEI SA conducted quantification and characterization study of municipal solid waste being generated from different sources in the city. The survey was conducted for a period of one week.

After a general recee of the city, along with the officials from Udaipur Municipal Corporation, different areas for sample collection were selected.

In order to ensure that the household samples represent all the socio-economic strata of the city viz. Lower Income Group (LIG), Middle Income Group (MIG), Higher Income Group (HIG), different wards were selected for the survey. Along with the residential areas, quantification and characterization of samples from vegetable markets, hotels and commercial areas was collected and analysed. **The quantification and characterization on random samples was conducted for 7 days. (7th-13th March, 2017)** wherein samples from different waste generation points were collected and sent to MoEF recognized and NABL accredited laboratory for analysis. **A total of 27 waste samples were collected from the city and the dumpsite**. Quartering Method was used for characterization of the collected samples.

Presently, it was found that the total municipal waste generated in the city is approximately 165.98 TPD.

1.3. Sampling of Municipal Solid Waste:

Waste samples were collected from residential areas of Udaipur, four Transfer Stations at Nala Khada, Kali Bawdi, Amal ka Kaanta and Chandpole, secondary bins and dumpsite at Balicha. The general procedures followed for waste sampling are briefly discussed below:

- Identification of major sample collection points representing diverse types of waste generation sources, such as residential, commercial, markets (vegetable market), hotels and institutional. The economic status of the areas representing high, middle and low-income groups, was also taken into consideration during the selection of sampling locations. In addition, samples were also collected from the four transfer stations, secondary bins and Balicha dump site.

- Almost 10 kg of waste were collected from each identified point and mixed thoroughly to get a homogenous sample. The quarter and coning method recommended in the Manual for Municipal Solid Waste Management, 20166 (CPHEEO) was used for sampling.

- The physical composition of MSW for residential areas was determined at the site itself for first three days. The collected samples were separated into various major components, such as, paper, glass, plastics, etc. and weighed and expressed as a percentage of the original sample.

- Further, 5 kg of MSW samples were collected, packed, sealed and sent to the laboratory for physical and chemical analysis.

1.4. Residential Wastes

In order to ensure that the household samples represent all the socio-economic strata of the city viz. Lower Income Group (LIG), Middle Income Group (MIG), Higher Income Group (HIG), different wards in each zone was selected for the survey.

Following areas were selected for collecting samples from residential areas:

- **LIG: Ward No 1: Neemach Kheda Colony**
- **MIG: Ward No 41: Saifi Colony, Khanjipeer**
- **HIG: Ward No 41: Sarvritu Vihar**

As per the quantification study carried for the residential areas for one week, it was found that the rate of generation of waste varies substantially across different sections of society:

- **LIG: 124.79 g/c/d**
- **MIG: 178.97 g/c/d**
- **HIG: 239.19 g/c/d**

The variation in waste generation rate could be attributed to the difference in income, life style and household size.

Physical Composition: The composition of waste collected from households from LIG, MIG and HIG are tabulated below. Organic waste/biodegradables constitutes the major portion of waste i.e. more than 50 percent which implies that different types of composting/bio-methanation should be explored and assessed to be considered as processing technology for the city. There is no waste segregation practice in the city. Bio-medical waste, hazardous waste (tubelights, batteries etc.), diapers, sanitary pads are not stored separately and is mixed with the household waste.

Table 3: Physical Composition of Waste from Households in Udaipur

Waste Type	LIG	MIG	HIG
Organic (%)	59.75	52.4	54
Recyclables (%)			
Hard Plastic	10.4	10.51	10.315
Polythene	9	11.8	10.38
Paper	6.1	4.40	7.19
Rubber/Leather	0.32	0.26	0.43
Textiles	5.94	12.3	10.41
Metals	0.11	0.17	0.15
Glass	0.45	0.31	0.23

Cardboard	0.19	0.14	0.12
Wood	0.22	0.23	0.22
Inert (C&D Waste) (%)	2.26	2.4	2.03
Inert (Sweeping) (%)	5.17	5.08	4.64

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

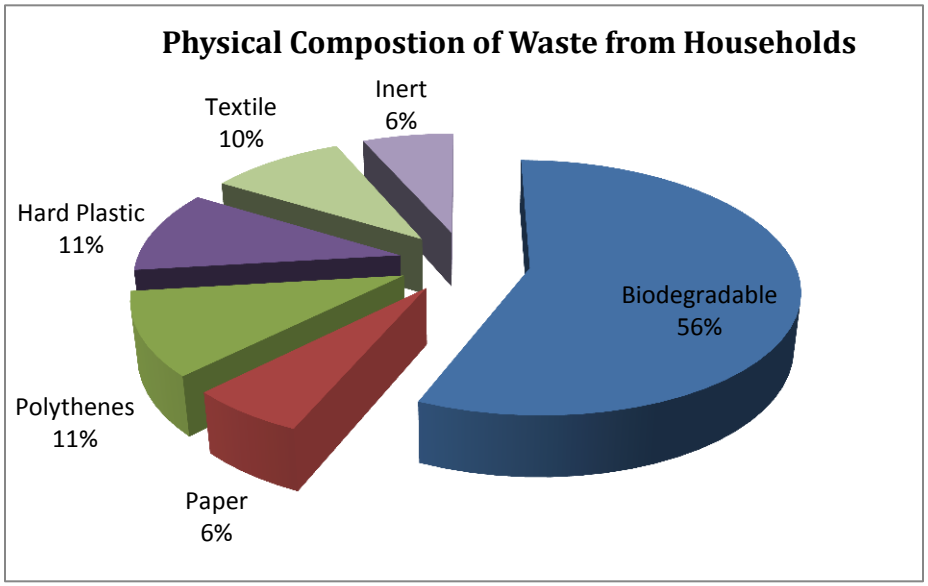


Figure 2: Average Physical Composition of Waste from Households in Udaipur

Chemical Composition: Proximate and Ultimate Analysis of garb samples from households was conducted to derive chemical composition of waste and is tabulated below. With almost 38% of waste comprising of plastics and textiles, the calorific value of waste is high (more than 1100; however higher moisture content of the waste (almost 70%) makes it uneconomical to use such waste as input in the waste to energy plants.

Table 4: Chemical Composition of Waste Collected from Residential Areas

Parameters		**LIG**	**MIG**	**HIG**
PROXIMATE ANALYSIS	Moisture (%)	75.41	71.45	71
	Volatile Combustible Matter (%)	20.4	24.3	24.8
	Fixed Carbon	0.7	0.55	0.45
	Ash (%)	3.4	3.7	3.75
ULTIMATE ANALYSIS	Carbon (%)	12.08	14.16	13.47
	Hydrogen (%)	5	6.4	6.05
	Oxygen (%)	30.67	22.68	26.28
	Nitrogen (%)	0.95	1.32	1.14

	Sulphur (%)	0.37	0.5	0.455
	Ash (%)	3.4	3.85	3.65
	Total Carbon Analysis (%)	45	48.2	46.25
	Total Nitrogen (Kjeldahl Method)(%)	1.3	1.6	1.4
	Gross Calorific Value (GCV)(Kcal/kg)	1007.5	1180	1125.5
	C:N Ratio	11.06	11.58	12.05
	Phosphorous as P2O5 (%)	0.64	0.7	0.675
	Potassium as K2O (%)	0.605	0.57	0.615
	Chlorides (%)	0.012	0.013	0.011

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

1.5. Commercial Areas

Quantification of waste for commercial areas like Janta Market and Bapu Bazaar was conducted by weighing the tipper trucks catering to these areas. Tippers serving in these areas were weighed for three days continuously to provide an average of waste being generated in the commercial areas. Approximate number of commercial entities present in the main roads in these areas is 400, out of which only 150 shops dump waste in the tipper while the rest usually dump along the street and in open areas. **The average rate of waste generation in the commercial areas was estimated to be 1.92 kg per capita per day**.

Table 5: Quantification of Waste from Commercial Area

Days	**Weight (Kg)**		
	Day 1	Day 2	Day 3
Janta Market	30	30.2	40
Bapu Bazar	30	45	40
Number of shops in Janta Market	130		
Number of shops in Bapu Bazaar who puts waste in tipper	23		
Per capita waste generation (kg/c/d)	1.92		
Total number of commercial entities in Udaipur	7000[1]		

[1] City Sanitation Report for Udaipur

Total amount of waste generated from commercial areas (TPD)	**13.44**

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

Physical Composition: The physical composition of waste generated from commercial areas represents no organic present and higher fraction of recyclables. With almost 80 percent of recyclables, UMC has an opportunity to generate revenue by involving potential recyclers.

Table 6: Physical Composition of Waste from Commercial Area

Waste Type	Commercial Area
Organic (%)	-
Recyclables (%)	
Hard Plastic	30.37
Polythene	15.6
Paper	10.9
Rubber/Leather	3.21
Textiles	14.19
Metals	6.73
Glass	2.6
Wood	3.08
Cardboard	0.22
Inert (C&D Waste) (%)	11.8
Inert (Sweepings) (%)	1.28

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

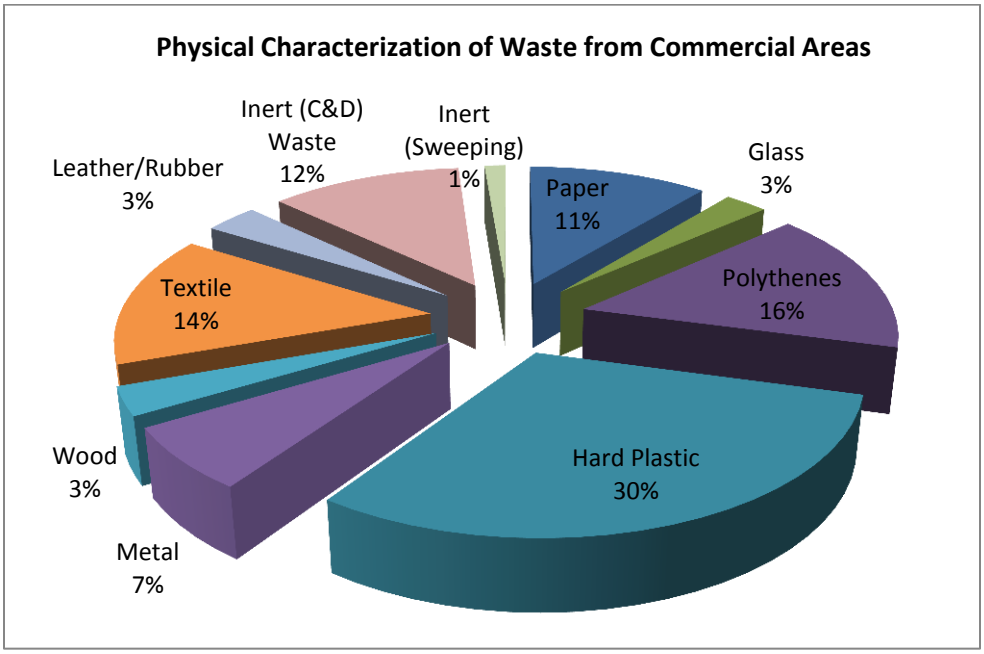


Figure 3: Average Physical Composition of Waste from Commercial Areas in Udaipur

Chemical Composition: Proximate and Ultimate Analysis of garb samples from commercial areas (Janta Market and Bapu Bazaar) was conducted to derive chemical composition of waste and is tabulated below:

Table 7: Chemical Composition of Waste from Commercial Area

Parameters		**Janta Market**	**Bapu Bazaar**
PROXIMATE ANALYSIS	Moisture (%)	48.2	37.6
	Volatile Combustible Matter (%)	45.1	54.8
	Fixed Carbon	2.8	3.4
	Ash (%)	3.9	4.2
ULTIMATE ANALYSIS	Carbon (%)	13.1	3.53
	Hydrogen (%)	6.4	6.7
	Oxygen (%)	24.02	22.21
	Nitrogen (%)	0.98	0.93
	Sulphur	0.32	0.39
	Ash	3.9	4.2
	Total Carbon Analysis	48.21	49.62
	Total Nitrogen (Kjeldahl Method)	1.3	1.1
	Gross Calorific Value (GCV)	1092	1128
	C:N Ratio	13.36	14.54
	Phosphorous as P2O5 (%)	0.78	0.74
	Potassium as K2O (%)	0.98	0.56
	Chlorides (%)	0.019	0.017

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

1.6. Vegetable Markets

Quantification of waste from main vegetable market at Saveena Mandi was arrived by weighing the tippers that were collecting waste in the market. The tippers were weighed for three days continuously to be able to arrive at the average amount of vegetable waste. Along with it, waste from smaller vegetable markets at Mukhadia Chowk, Pratapnagar Mandi, Hathipole Mandi was also

quantified for three days. **It was found that approximately 2.76 tonnes of vegetable waste was being generated and collected in Udaipur**.

Physical Composition: The physical composition of waste generated from vegetable market is provided below. Very high value of organic fraction (as high as 88.16%) clearly indicates suitability of waste for composting/biomethanation.

Table 8: Physical Composition of Waste from Vegetable Market

Waste Type	Vegetable Market
Organic (%)	81.47
Recyclables (%)	
Hard Plastic	3.075
Polythene	8.43
Paper	5.38
Textiles	1.49

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

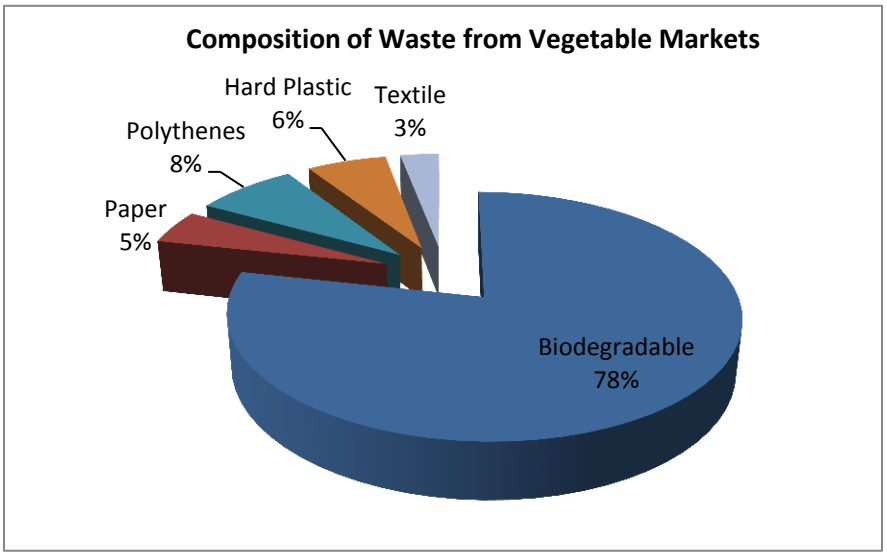


Figure 4: Physical Composition of Waste from Vegetable Markets in Udaipur

Chemical Composition: Proximate and Ultimate Analysis of garb samples of waste from vegetable markets was conducted to derive chemical composition of waste and is tabulated below:

Table 9: Chemical Composition of Waste from Vegetable Markets

Parameters		Saveena Mandi	Mukhadia Chowk
PROXIMATE ANALYSIS	Moisture (%)	85.8	81.3
	Volatile Combustible Matter (%)	10.7	14.6
	Fixed Carbon	0.8	1.1
	Ash (%)	2.7	3.2
ULTIMATE ANALYSIS	Carbon (%)	12.02	12.5
	Hydrogen (%)	6.2	5.8
	Oxygen (%)	25.27	26.01
	Nitrogen (%)	1.4	1.2
	Sulphur (%)	0.28	0.21
	Ash (%)	2.7	3.2
	Total Carbon Analysis (%)	49.2	48.34
	Total Nitrogen (Kjeldahl Method) (%)	1.6	1.4
	Gross Calorific Value (GCV) (kCal/Kg)	1002	1042
	C:N Ratio	8.58	10.42
	Phosphorous as P2O5 (%)	0.64	0.66
	Potassium as K2O (%)	0.67	0.67
	Chlorides (%)	0.02	0.01

1.7. Institutional Waste

To have an idea about the waste being generated from institutes, a quick survey at Vidya Bhawan Polytechnic College was conducted. During the day of survey there were only 150 students and 60 faculties present in the campus. Quantification of waste generated in the premises amounted to 15.8 kg of waste. There are more than 160 schools, 6 colleges and 5 universities in Udaipur which is estimated to **generate 2.69 tons of waste every day**.

Table 10: Physical Composition of Waste from Institutions

Waste Type	Commercial Area
Organic (%)	40
Recyclables (%)	
Plastic	2.35
Polythene	3.51
Paper	36.93

Cardboard	8.33
Wood	0.86
Domestic Hazardous Waste	1.68
Inert	7.11

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

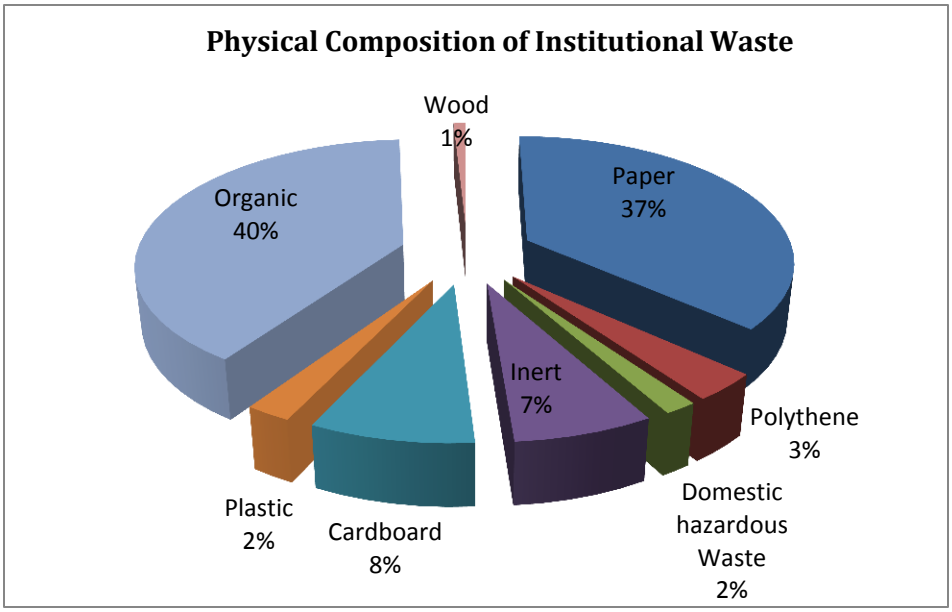


Figure 5: Physical Composition of Waste from Vegetable Markets in Udaipur

1.8. Hotel Waste

Udaipur is one of the most sought after tourist destinations in India attracting huge floating population. There are more than 400 budget hotels and 25 luxury hotels. Waste generated from hotels was quantified using the tipper collecting waste from hotels. Presently, UMC is collecting waste from only 75 budget hotels/restaurants while luxury hotels have private contractors who collect and dump waste from their premises. Tippers were weighed for three days to provide an average estimation of waste being collected from both types of hotels i.e budget and luxury. **It was estimated that almost 45 tons of waste is being generated from hotels per day in Udaipur.** This amount could increase to additional 50 to 100% during the peak tourist/wedding season

Table 11: Quantification of Waste from Hotels

Days	Weight (Kg)		
	Day 1	Day 2	Day 3
Budget hotels (75 hotels)	500	530	510

Luxury Hotels (2 hotels)	1500	1450	1700
Total number of budget hotels	400		
Total number of luxury hotels	25		
Average amount of hotel waste collected per day	45		

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

Physical Composition: Organic waste constitutes almost 75% of the waste from hotels which indicates the suitability of waste to be used for composting/bio-methanation purposes. Presently, waste from hotels is dumped at Baleecha dumping ground.

Waste Type	**Commercial Area**
Organic (%)	75.10
Recyclables (%)	
Hard Plastic	7.04
Polythene	7.16
Paper	4.99
Rubber/Leather	0.9
Textiles	3.65
Glass	1.08

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

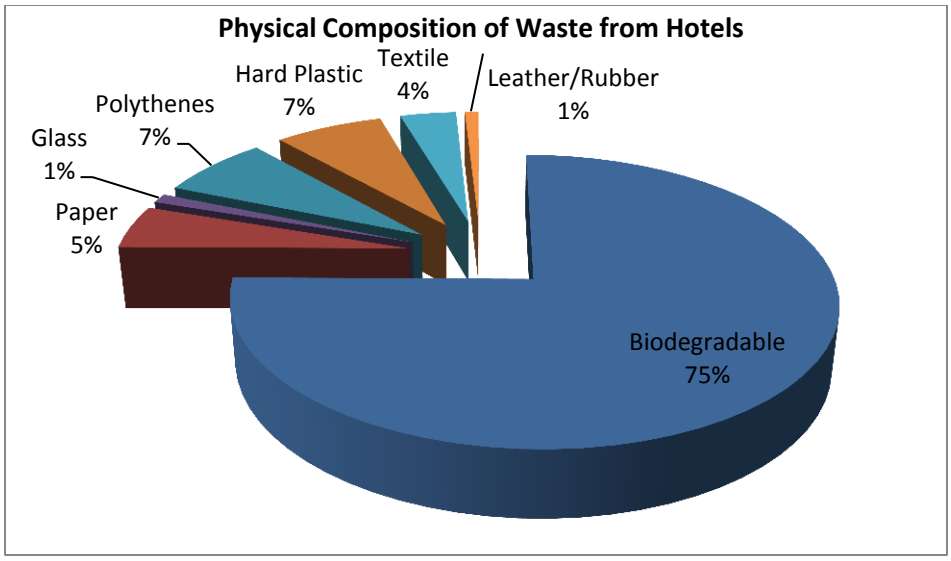


Figure 6: Physical Composition of Waste from Vegetable Markets in Udaipur

Chemical Analysis: Proximate and Ultimate Analysis of garb samples of waste from hotels was conducted to derive chemical composition of waste and is tabulated below:

Table 12: Chemical Composition of Waste from Hotels

Parameters		Hotel Waste
PROXIMATE ANALYSIS	Moisture (%)	90.85
	Volatile Combustible Matter (%)	7.2
	Fixed Carbon	0.35
	Ash (%)	1.6
ULTIMATE ANALYSIS	Carbon (%)	9.57
	Hydrogen (%)	6.05
	Oxygen (%)	31.35
	Nitrogen (%)	1.205
	Sulphur (%)	0.295
	Ash (%)	1.6
	Total Carbon Analysis (%)	47.12
	Total Nitrogen (Kjeldahl Method) (%)	1.3
	Gross Calorific Value (GCV) (kCal/Kg)	798

	C:N Ratio	1:8
	Phosphorous as P2O5 (%)	0.65
	Potassium as K2O (%)	0.835
	Chlorides (%)	0.017

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

1.9. Waste at Transfer Stations and Secondary Bins

There are four transfer stations in Udaipur and more than 500 secondary bins, where the municipal solid waste from the city is aggregated and safely transported to the final disposal site at Baleecha.

In order to have a complete overview of the waste composition of the city, samples were collected from each of the transfer stations and few secondary bins and analysed for their physical and chemical composition.

Physical Composition: Physical composition of waste accumulated at the four transfer stations and secondary bins are tabulated below depicting high organic content and hence high moisture. Recyclables are usually sorted out by ragpickers at transfers stations and community bins.

Table 13: Physical Composition of Waste from Transfer Stations and Secondary Bins

Physical Characterization (%)									
	Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**	**Average**
Biodegradable	58.49	54.96	47.94	62.93	63.07	57.35	53.08	67.64	58.18
Paper	4.36	3.96	7.18	5.28	5.48	3.29	8.14	4.48	5.27
Cardboard	0.18	0.19	0.16	0.14	0.19	0.11	0.22	0.15	0.16
Glass	0.86	1.24	1.46	1.38	1.21	1.43	1.17	0.98	1.21
Polythene	10.21	14.3	12.78	9.32	4.3	7.2	11.33	5.57	9.37
Hard Plastic (PVC, HDPE, LDPE, Polypropylene, Polystyrene)	8.31	7.33	11.13	8.19	9.36	10.2	8.27	7.07	8.73
Metal	1.21	1.16	1.43	1.32	1.29	0.98	1.16	0.9	1.18
Wood	1.08	2.49	2.19	1.98	1.46	0.86	2.39	1.77	1.77
Textile	8.32	7.81	9.12	4.37	7.37	10.31	8.17	5.64	7.63
Leather/Rubber	1.29	0.96	1.23	0.98	1.41	1.23	1.84	0.98	1.24

Inert (C&D) Waste	4.31	3.89	4.16	2.94	3.49	5.87	2.76	3.12	3.81
Inert (Sweeping)	1.28	1.69	1.19	1.12	1.29	1.16	1.42	1.66	1.35
Moisture (LoI at 105° C)	86.5	83.6	77.4	91.6	93.5	84.3	83.1	96.7	87.08

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

Where, the locations of sites are as follows:

- Site A: Nala Khada, Transfer Station
- Site B: Kali Bawdi, Transfer Station
- Site C: Kala data Amal ka Kata, Transfer Station
- Site D: Secondary Bin at Sukhadia Circle
- Site E: Secondary Bin at Simplapul
- Site F: Chandpol, Jagdish Chowk, Transfer Station
- Site G: Secondary Bin at Kishanpole Gate
- Site H: Secondary Bin at Lala Mishtan

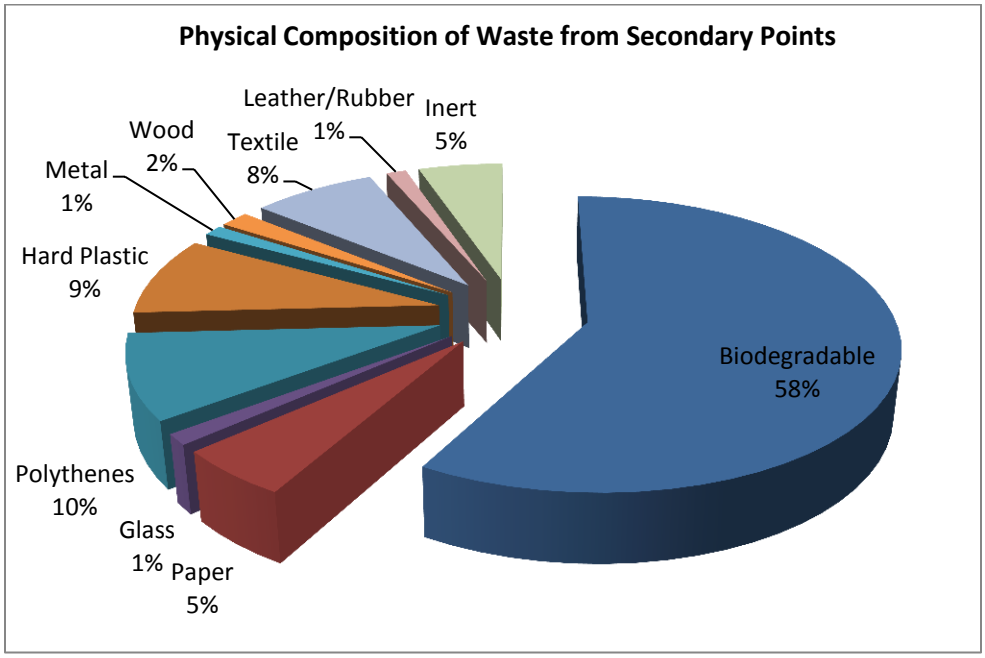


Figure 7: Physical Composition of Waste from Vegetable Markets in Udaipur

Chemical Analysis: Proximate and Ultimate Analysis of garb samples of waste from transfer stations and secondary bins was conducted to derive chemical composition of waste and is tabulated below:

Table 14: Physical Composition of Waste from Transfer Stations and Secondary Bins

	Chemical Characterization								
		Site A	**Site B**	**Site C**	**Site D**	**Site E**	**Site F**	**Site G**	**Site H**
Proximate Analysis	Moisture (%)	85.2	82.4	76.3	90.3	92.1	83.1	81.8	95.3
	Volatile Combustible Matter (%)	10.2	13.6	17.2	8.4	7.1	11.9	12.4	4.2
	Fixed Carbon (%)	0.7	0.5	1.2	0.4	0.2	0.8	1.1	0.2
	Ash (%)	3.9	3.5	5.3	0.9	0.6	4.2	4.7	0.3
Ultimate Analysis	Carbon (%)	12.28	14.66	14.94	9.62	10.38	13.99	14.98	10.04
	Hydrogen (%)	4.9	4.2	3.8	5.1	4.8	5.4	5.7	4.6
	Oxygen (%)	30.95	32.26	28.62	30.95	31.09	26.04	21.21	31.6
	Nitrogen (%)	0.97	0.99	1	1.21	0.94	0.98	1.1	0.97
	Sulphur (%)	0.21	0.3	0.26	0.34	0.24	0.27	0.31	0.26
	Ash (%)	3.9	3.5	5.3	0.9	0.6	4.2	4.7	0.3
	Total Carbon Analysis (%)	44.28	41.81	43.81	49.26	49.48	46.81	49.2	49.5
	Total Nitrogen (%)	1.1	0.99	0.97	1.3	1.4	1.2	1.5	1.4
	GCV (Kcal/kg)	1024	1222	1245	802	865	1166	1248	837
	C:N Ratio	1.12	1.14	1.14	1.70	1.11	14.27	13.61	10.35
	Phosphorus as P2O5 (%)	0.61	0.62	0.67	0.64	0.52	0.67	0.62	0.64
	Potassium as K2O (%)	0.79	0.66	0.62	0.67	0.54	0.42	0.66	0.67
	Chlorides (%)	0.01	0.014	0.013	0.012	0.014	0.019	0.021	0.019

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

1.10. Waste at Landfill Site

There is no processing facility in Udaipur. All the waste is presently dumped at Baleecha ground. Samples were collected from dumping site from different locations to assess the waste characteristics.

Physical Composition: The physical composition of waste samples from dumping site is tabulated below:

Table 15: Physical Composition of Waste from Transfer Stations and Secondary Bins

Waste Type	Landfill Site
Organic (%)	68.13
Recyclables (%)	
Hard Plastic	7.02
Polythene	9.91
Paper	6.41
Rubber/Leather	0.88
Textiles	5.05
Metals	0.21
Glass	0.27
Wood	0.39
Cardboard	0.34
Inert (C&D Waste) (%)	1.322
Moisture (LoI at 105°C)	85.10

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

Chemical Composition: Proximate and Ultimate Analysis of garb samples of waste from landfill site is tabulated below:

Table 16: Chemical Composition of Waste from Transfer Stations and Secondary Bins

Parameters		Landfill Site
PROXIMATE ANALYSIS	Moisture (%)	83.5
	Volatile Combustible Matter (%)	13.35
	Fixed Carbon	0.82
	Ash (%)	2.17
ULTIMATE ANALYSIS	Carbon (%)	11.90
	Hydrogen (%)	5.80
	Oxygen (%)	29.61
	Nitrogen (%)	1.05
	Sulphur	0.25
	Ash	2.15
	Total Carbon Analysis	46.855
	Total Nitrogen (Kjeldahl Method)	1.195
	Gross Calorific Value (GCV) (kCal/Kg)	999
	C:N Ratio	1.12

	Phosphorous as P2O5 (%)	0.50
	Potassium as K2O (%)	0.64
	Chlorides (%)	0.01

(Source: Survey Conducted by ICLEI South Asia, March, 2017)

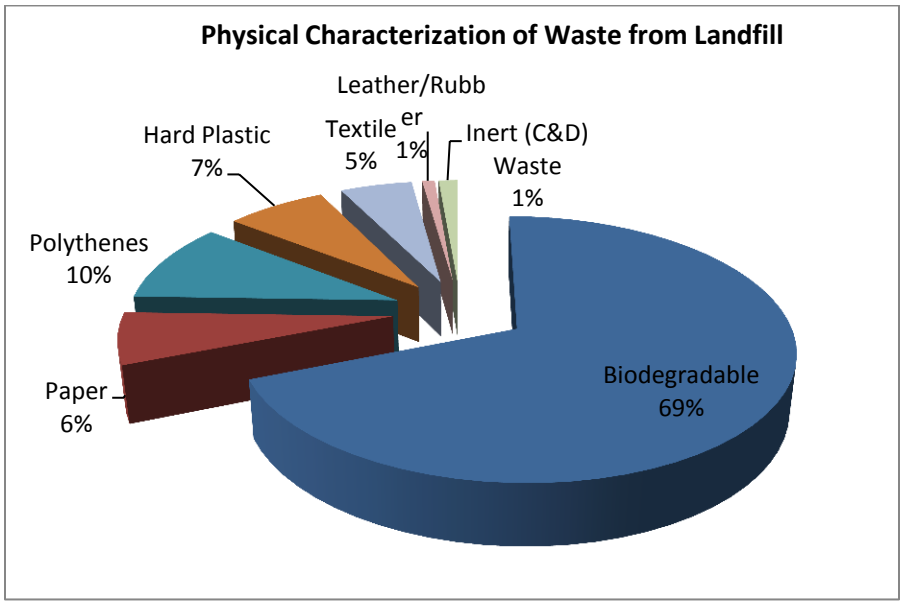


Figure 8: Physical Composition of Waste at Baleecha Dumping Ground

3. Total Amount of Waste Generated in Udaipur

Quantifying the waste being generated from various sources, it was estimated that the total municipal waste generated in the city of Udaipur 165.98 TPD. The table below tabulates the sources and quantity of waste generated.

Table 17: Sources of Waste and Quantity of Waste Generated

S. No.	Sources of Waste Generation	Number of Entities	Rate of Waste Generation (kg/c/d)	Quantity (TPD)
1.	Residential Population (2016)	565095	0.180	102
2.	Commercial	7000	1.92	13.44
3.	Vegetable	-	-	2.76
4.	Institutional	170	15.8	2.68
5.	Hotel	-	-	45.10

	Total			**165.98**

(*There might be difference in waste generation by 10-20% accounting waste being collected from offices, open dumping points, municipal solid waste from hospitals and floating population.)

Annexure 3: Energy consumption projection (2017 to 2050)

Community

Sectors	Energy Source/Activity	Baseline Activity Data							Projected Energy Use (Medium Term Scenario)									Projected Energy Use (Long Term Scenario)				
		Unit	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2030-31	2035-36	2040-41	2045-46	2050-51
Residential Buildings	Electricity	MU	170	193	227	252	268	278	304.81	333.83	365.61	400.41	438.53	480.28	526.00	576.08	630.92	994.11	1,566.37	2,468.07	3,888.83	6,127.46
	Kerosene	kL	2,940	3,552	3,408	3,272	2,561	1,281	992.70	769.28	596.15	461.98	358.01	277.44	215.00	166.61	129.11	36.08	10.08	2.82	0.79	0.22
	LPG	tonnes	23,116	23,653	21,776	23,069	32,606	37,124	41,552.48	46,509.22	52,057.24	58,267.09	65,217.69	72,997.43	81,705.20	91,451.71	1,02,360.87	1,79,822.75	3,15,904.12	5,54,965.46	9,74,937.16	17,12,723.62
Commercial and Institutional Buildings	Electricity	MU	107.27	130.70	125.52	139.72	151.95	166.95	186.87	209.16	234.11	262.04	293.29	328.28	367.44	411.27	460.33	808.69	1,420.67	2,495.76	4,384.44	7,702.38
	LPG	tonnes	1,013	1,059	935	853	2,033	3,715	5,084.22	6,958.09	9,522.61	13,032.32	17,835.59	24,409.18	33,405.56	45,717.72	62,567.71	3,00,385.40	14,42,139.90	69,23,663.72	3,32,40,269.68	15,95,85,383.28
	Diesel	cubic m	933	989	1,035	966	970	941	929.37	917.88	906.54	895.33	884.26	873.33	862.54	851.88	841.35	790.62	742.95	698.15	656.06	616.50
Facilities	Electricity	MU	18.31	18.76	19.44	25.15	26.87	24.55	26.59	25.87	26.47	27.95	28.32	28.69	29.06	29.43	29.80	30.67	32.49	34.33	36.18	38.06
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	MU	197	203	208	226	207	223	228.37	233.91	239.59	245.40	251.36	257.46	263.71	270.11	276.67	311.92	351.66	396.47	446.98	503.93
	Coal	KL	1,00,010	1,00,010	1,00,010	1,00,010	1,00,010	1,00,010	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00	1,00,010.00
	Diesel	KL	17,719	18,799	19,660	18,347	18,430	17,875	17,651.19	17,430.17	17,211.93	16,996.42	16,783.60	16,573.45	16,365.94	16,161.02	15,958.66	14,984.27	14,069.37	13,210.34	12,403.75	11,646.41
	LPG	tonnes	183	183	183	183	183	183	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50	182.50
	Biogas	cubic m	3,65,000	3,65,000	3,65,000	3,65,000	3,65,000	3,65,000	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00	3,65,000.00
Agriculture, forestry and fishing activities (i.e. mainly agriculture)	Electricity	MU	7	7	8	11	12	12	13.96	15.83	17.95	20.36	23.08	26.17	29.68	33.65	38.16	43.26	49.06	55.62	63.07	71.52
Waste	Solid Waste to Landfill	tonnes	52,667	54,315	56,000	57,725	59,489	61,294														
Mobile (Transportation)	Petrol	KL	31,397	29,926	34,335	35,729	38,725	39,104	41,808.47	44,699.99	47,791.49	51,096.80	54,630.71	58,409.02	62,448.65	66,767.67	71,385.39	99,729.81	1,39,328.71	1,94,650.83	2,71,939.25	3,79,915.96
	Diesel	KL	43,521	46,173	48,288	45,063	45,267	43,905	43,355.63	42,813.12	42,277.41	41,748.40	41,226.01	40,710.16	40,200.76	39,697.74	39,201.01	36,809.05	34,563.04	32,454.08	30,473.80	28,614.36
	Auto LPG	KL	384	410	296	162	171	170	136.42	109.47	87.84	70.49	56.56	45.39	36.42	29.23	23.45	7.80	2.60	0.86	0.29	0.10
Non-specified sources	Electricity	MU	16	16	17	17	17	17	17.64	18.01	18.39	18.79	19.18	19.59	20.01	20.43	20.87	21.31	21.76	22.23	22.70	23.18
Total	-	-																				

Local Government

Sectors	Energy Source/Activity	Activity Data							Projected Energy Use (Medium Term Scenario)									Projected Energy Use (Long Term Scenario)				
		Unit	2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2030-31	2035-36	2040-41	2045-46	2050-51
Buildings	Electricity	MU	0.07	0.06	0.07	0.10	0.11	0.07	0.1	0.10	0.13	0.16	0.19	0.23	0.29	0.35	0.43	1.18	3.23	8.87	24.32	66.69
Facilities	Waste Water (Electricity)	MU	-	-	-	2	3	2	2.6	5.86	6.19	6.30	6.39	6.48	6.57	6.65	6.74	7.58	8.05	8.51	8.98	9.45
	Water Supply (Electricity)	MU	10.15	10.45	10.95	12.95	14.00	14.00	15.4	14.42	14.62	15.94	16.17	16.39	16.61	16.84	17.06	16.78	17.81	18.85	19.88	20.91
	Street Lighting	MU	8.1	8.3	8.4	9.9	10.0	8.0	8.5	5.60	5.65	5.71	5.77	5.82	5.88	5.94	6.00	6.31	6.63	6.96	7.32	7.69
Mobile (Transportation) (Local Government vehicles)	Petrol	kL	3.1	0.8	0.4	0.5	0.5	0.6	0.5	0.53	0.57	0.61	0.65	0.69	0.74	0.79	0.84	0.90	0.96	1.02	1.09	1.16
	Diesel	kL	211	223	212	255	282	339	366.2	396.19	428.59	463.64	501.55	542.56	586.93	634.93	686.84	1,017.51	1,507.37	2,233.05	3,308.10	4,900.71
Total	-	-	-	-	-	-	-															

Annexure 4: GHG emission projections (2017 to 2050)

Community Inventory

Sectors	Energy Source/Activity	Baseline GHG Emission (tonnes of CO2e) (using HEAT+)						Projected GHG emission (Medium Term scenario)									Projected GHG emission (LongTerm scenario)				
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2030-31	2035-36	2040-41	2045-46	2050-51
Residential Buildings	Electricity	132995.1	159167.6	187150.5	207720.1	220843.6	228997.3	2,50,795	2,74,670	3,00,818	3,29,455	3,60,818	3,95,167	4,32,786	4,73,986	5,19,108	8,17,936	12,88,788	20,30,688	31,99,669	50,41,582
	Kerosene	7602.5	9185.1	8812.7	8461.1	6622.5	3311.2	2,567	1,989	1,542	1,195	926	717	556	431	334	93	26	7	2	1
	LPG	69177.8	70784.9	65167.7	69037.2	70150.4	111098.7	1,24,351	1,39,185	1,55,788	1,74,372	1,95,173	2,18,455	2,44,514	2,73,682	3,06,329	5,38,144	9,45,387	16,60,810	29,17,633	51,25,561
Commercial and Institutional Buildings	Electricity	98309.9	122973.4	138655.6	135652.5	147130.3	157563.2	1,53,752	1,72,093	1,92,621	2,15,599	2,41,318	2,70,104	3,02,324	3,38,388	3,78,754	6,65,377	11,68,904	20,53,475	36,07,448	63,37,394
	LPG	3031.5	3169.2	2798.1	2552.7	3028.5	9501.6	15,215	20,823	28,498	39,001	53,375	73,048	99,971	1,36,817	1,87,242	8,98,945	43,15,802	2,07,20,015	9,94,76,076	47,75,81,195
	Diesel	2666.7	2826.7	2958.2	2761.0	2772.4	2689.5	2,649	2,616	2,584	2,552	2,521	2,489	2,459	2,428	2,398	2,254	2,118	1,990	1,870	1,757
Facilities	Electricity	6387.0	6840.3	6986.8	11865.6	12832.4	10718.6	21,877	21,288	21,779	22,997	23,301	23,606	23,910	24,216	24,522	25,233	26,731	28,244	29,770	31,312
Manufacturing Industry and Construction (i.e. Industrial sector)	Electricity	154592.1	166663.2	170935.1	185858.8	188507.3	183448.0	1,87,897	1,92,458	1,97,130	2,01,915	2,06,817	2,11,837	2,16,979	2,22,246	2,27,641	2,56,644	2,89,342	3,26,207	3,67,768	4,14,624
	Coal	147421.6	147421.6	147421.6	147421.6	147421.6	147421.6	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016	1,56,016
	Diesel	50644.1	53730.9	56191.8	52439.0	52676.2	51090.0	50,315	49,685	49,063	48,448	47,842	47,243	46,651	46,067	45,490	42,713	40,105	37,656	35,357	33,198
	LPG	547.7	547.7	547.7	547.7	547.7	547.7	546	546	546	546	546	546	546	546	546	546	546	546	546	546
	Biogas	689.9	689.9	689.9	689.9	689.9	689.9	694	694	694	694	694	694	694	694	694	694	694	694	694	694
Agriculture, forestry and fishing activities (i.e. mainly agriculture)	Electricity	5479.5	5759.5	6582.3	8680.4	9848.7	10128.5	11,489	13,027	14,772	16,749	18,992	21,534	24,418	27,687	31,393	35,597	40,362	45,766	51,894	58,842
Waste	Solid Waste to Landfill	89654.2	92459.5	95327.9	98264.3	101267.2	104339.8														
Mobile (Transportation)	Petrol	72104.3	68726.1	78851.6	82052.9	88933.4	89597.1	96,015	1,02,655	1,09,755	1,17,346	1,25,461	1,34,138	1,43,416	1,53,334	1,63,939	2,29,033	3,19,973	4,47,023	6,24,518	8,72,491
	Diesel	124057.0	131616.6	137645.4	128452.5	129034.0	125151.6	1,23,586	1,22,039	1,20,512	1,19,004	1,17,515	1,16,045	1,14,593	1,13,159	1,11,743	1,04,925	98,522	92,511	86,866	81,566
	Auto LPG	580.3	619.6	447.3	244.8	258.4	256.9	206	165	133	107	85	69	55	44	35	12	4	1	0	0
Non-specified Sources	Electricity	11741.8	13164.6	13164.6	13987.3	13987.3	14209.5	14,512	14,820	15,135	15,457	15,785	16,120	16,463	16,812	17,170	17,534	17,907	18,287	18,676	19,073
Total	-	**9,77,683.06**	**10,56,346.42**	**11,20,334.87**	**11,56,689.44**	**11,96,551.87**	**12,50,760.76**	**12,12,482**	**12,84,771**	**13,67,385**	**14,61,452**	**15,67,184**	**16,87,827**	**18,26,349**	**19,86,552**	**21,73,354**	**37,91,695**	**87,11,227**	**2,76,19,936**	**11,05,74,803**	**49,57,55,850**

Local Govt Inventory

Sectors	Energy Source/Activity	Baseline GHG Emission (tonnes of CO2e) (using HEAT+)						Projected GHG emission (Medium Term scenario)									Projected GHG emission (LongTerm scenario)				
		2011-12	2012-13	2013-14	2014-15	2015-16	2016-17	2017-18	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	2025-26	2030-31	2035-36	2040-41	2045-46	2050-51
Buildings	Electricity	57.0	51.0	59.0	85.0	94.0	57.6	70.4	86.2	105.4	129.0	157.9	193.2	236.3	289.2	353.8	970.3	2,660.7	7,296.6	20,009.4	54,871.8
Facilities	Waste Water Treatment (Electricity)	0.00	0.00	0.00	1,832	2,242	2,040	2,153.4	4,822.4	5,095.9	5,184.3	5,257.1	5,329.9	5,402.7	5,475.5	5,548.3	6,237.2	6,621.2	7,005.3	7,389.3	7,773.3
	Water Supply (Electricity)	7,948	8,594	9,012	10,659	11,519	11,519	12,700.6	11,861.8	12,033.1	13,116.3	13,300.5	13,484.7	13,668.9	13,853.1	14,037.3	13,807.6	14,657.7	15,507.8	16,357.9	17,208.1
	Street Light	6,330	6,789	6,928	8,117	8,254	6,580	7,023.3	4,604.0	4,650.0	4,696.5	4,743.5	4,790.9	4,838.8	4,887.2	4,936.1	5,187.9	5,452.5	5,730.7	6,023.0	6,330.2
Mobile (Transportation) (Local Government vehicles)	Petrol	7.0	1.9	1.0	1.2	1.3	1.3	1.1	1.2	1.3	1.4	1.5	1.6	1.7	1.8	1.9	2.1	2.2	2.3	2.5	2.7
	Diesel	602.0	635.5	603.8	726.3	804.5	965.1	1,044.0	1,129.4	1,221.7	1,321.6	1,429.7	1,546.6	1,673.1	1,809.9	1,957.9	2,900.4	4,296.8	6,365.3	9,429.8	13,969.5
TOTAL		**14,944.36**	**16,071.82**	**16,603.13**	**21,420.27**	**22,915.34**	**21,163.69**	**22,992.77**	**22,504.91**	**23,107.55**	**24,449.20**	**24,890.16**	**25,346.89**	**25,821.55**	**26,316.69**	**26,835.32**	**29,105.46**	**33,691.19**	**41,908.00**	**59,211.89**	**1,00,155.55**

Annexure 5 - Tool 3.2B Urban System Analysis

Urban system	Fragility statement	Climate Fragility Statement - Increased Temperature	Climate Fragility Statement - Increased Short duration high intensity rainfall
Water Supply	Water Supply system of the Udaipur city is dependent on the surface water (especially from the lakes). These lakes are getting polluted due to disposal of sewerage and solid waste directly into surface drains of surface water bodies. Moreover, these lakes are dependent on rain for water and face water stress in case of low rain.	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge
Sewerage	Large area of the city is still not covered with sewerage network and treatment facility. Many residents are dependent on septic tanks for disposal of sewage. However illegal dumping of sewage, garbage and C&D waste in drains causes blockage of drains and dumping of untreated sewage pollute surface as well as ground water.	An increase in temperature can provide favourble environment to water polluting bacteria (such as E.Coli) leading to health probelm in surounding areas.	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which will lead to greater 'knock-on' impacts on health.
Storm Water Drainage	The city has an open storm water drainage system, which gets clogged with solid waste and construction waste dumped in it leading to water logging in the monsoons. The drainage network does not cover the entire city.		This system would not necessarily be directly impacted by climate change threats, but would increase the chances of greater 'knock-on' impacts on health and contamination of potable water during flood events that could be caused by changes in precipitation.
Solid Waste	The solid waste generated in the	Increasing	High intensity short

Management	city is collected without segregation and disposed in an open dump with no treatment or processing. Though city has taken some measure to improve current situation. But efficiency of waste collection facilities are not up to the mark and waste openly dumped.	temperatures may cause waste to decompose in open dumps creating health hazards.	duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.
Transportation	The transportation system in the city is heavily dependent on private modes, with an inadequate public transport system that is fossil fuel dependent and poorly planned road infrastructure. There is requirement of parking facilities and development of PT and IPT systems to improve the condition in the city.	Increase in temperature can lead to increased use of private vehicle (as public vehicles do not have AC facility in general) in order to maintain comfort, which may lead to more traffic congestion and increased GHG emissions.	Increase in short duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion.

Annexure 6 - Rick Assessment

Risk Assessment Detail						
Name	**Designation**	**Department**	**Sector**	**Climate Risk**	**Likelihood**	**Consequence**
Mr. Gaurav Dhing	AEN (Environment and SWM)	Municipality	Solid Waste management	Increase Temperature	4	2
				High Intesity Rainfall	4	2
Mr. Mukesh Pujari	AEN	Municipality	Solid Waste management	Increase Temperature	3	2
				High Intesity Rainfall	3	2
			Sanitation and Sewerage	Increase Temperature	3	2
				High Intesity Rainfall	3	2
Mr. Lalit Nagori	AEN	PHED	Water Supply	Increase Temperature	3	3
				High Intesity Rainfall	3	3
Mr. Narendra Shrimali and Mr. Subhash	Health Officer and SI	Municipality	Solid Waste management	Increase Temperature	2	3
				High Intesity Rainfall	2	3
Dr. Anil Mehta	Principal	Vidhya Bhawan Poly tech	Water Supply	Increase Temperature	3	4
				High Intesity Rainfall	3	4
			Sanitation and Sewera	Increase Temperature	3	4

			ge	High Intesity Rainfall	3	4
			Solid Waste management	Increase Temperature	5	4
				High Intesity Rainfall	5	4
			Transportation	High Intesity Rainfall	4	3
Prof. Nidhi Rai	Prof Environment department	Sukhariya University	Water Supply	Increase Temperature	3	3
				High Intesity Rainfall	5	3
			Sanitation and Sewerage	Increase Temperature	4	2
				High Intesity Rainfall	5	3
			Solid Waste management	Increase Temperature	4	4
				High Intesity Rainfall	3	4
Mr. B.K Soni	Scientist	Pollution Control Board	Sanitation and Sewerage	Increase Temperature	3	4
Mr. C.R. Dewasi	ADM City	Distaster Management Cell	Strom Water Drainage	High Intesity Rainfall	3	3
Mr. Parsoon Chaturvedi	Town Planner (DTP Smart City Udaipur)	Municipality	Water Supply	Increase Temperature	5	3
				High Intesity Rainfall	5	3

			Strom Water Drainage	High Intesity Rainfall	3	1
Yugal Tank	Assi Manager	ICLEI SA	Transportation	Increase Temperature	5	3
				High Intesity Rainfall	4	3
Mr. Manish Arora	AEN	Municipality	Solid Waste management	Increase Temperature	4	3
				High Intesity Rainfall	4	3

Urban Systems	Climate fragility statement	Likelihood	Consequence	Risk Score	Risk Status
Water Supply	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	3	3	9	Medium
	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge	3	3	9	Medium
Sewerage	An increase in temperature can provide favourble environment to water polluting bacteria (such as E.Coli) leading to health probelm in surounding areas.	3	4	12	High
	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which	3	3	9	Medium

	will lead to greater 'knock-on' impacts on health.				
Storm Water Drainage	This system would not necessarily be directly impacted by climate change threats, but would increase the chances of greater 'knock-on' impacts on health and contamination of potable water during flood events that could be caused by changes in precipitation.	3	1	3	Low
Solid Waste Management	Increasing temperatures may cause waste to decompose in open dumps creating health hazards.	4	3	12	High
	High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.	4	3	12	High
Transportation	Increase in temperature can lead to increased use of private vehicle (as public vehicles do not have AC facility in general) in order to maintain comfort, which may lead to more traffic congestion and increased GHG emissions.	3	3	9	Medium
	Increase inshort duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion.	4	3	12	High

Annexure 6 - Tool 3.2D Actors Analysis

Urban Systems	Climate Fragility Statement	Area	Actors
Water Supply	Increased temperatures will lead to increased demand for water thereby posing additional stress on the supply system	Ward 22,20, 23, 24, 25, 26, 27, 28, 29, 30,14, 19, Old City (4, 11, 12, 13, 42, 44 to 49) and Delhi gate 52	PHED, Local Community, Educational Institutions, Tourist, Slum, Labour, UIT
Water Supply	Increased short duration high intensity rainfall would result in greater run-off and lesser ground water recharge		
Sewerage	This vulnerable system of Udaipur would not necessarily be directly impacted by climate change threats, but would increase the chances of greater 'knock-on' impacts on health and due to increased temperatures.	Ward 17, 15, 16, 18, 19, 20, 21, 22, 23,24, 25, Shahid Bhagat Singh Kachi Basti (54), Tagore Nagar (27 and 29), Wards near Ayad river (30, 31, 38, 39), Krishanapura (53)	RUDIP, Municipal Corporation of Udaipur, Hindustan Zinc, IHUWash, Vedanta, Local Community, Women, Elderly, Labour, Educational Institution, UIT
Sewerage	In case of increased short duration-high intensity rainfall events the water logging and flooding situation in these areas would only get worse which will lead to greater 'knock-on' impacts on health.		
Storm Water Drainage	This system would not necessarily be directly impacted by climate change threats, but would increase the chances of greater 'knock-on' impacts on health and contamination of potable water during flood events that could be caused by changes in precipitation.	Ward 17, 18, 20, 22, Ashok Nagar & Shakti Nagar (51, 50), Udaipol (42)	Municipal Corporation of Udaipur, Local Community, Slum Population, Educational Institute
Solid Waste Management	Increasing temperatures may cause waste to decompose in open dumps creating health hazards.	Wards around Ayad river (30, 31, 38, 39), ward 17, ward 6, 7, 8, 9, 31, 32, 33,39,	Municipal Corporation of Udaipur, Rotary Club, Finish Society, Jheel Sanrakshan

Solid Waste Management	High intensity short duration rainfall will cause flooding and choking of drains, leading to health impacts and water logging.	22, Pratap Nagar Choraha (32), Area around lakes (2, 9, 5, 46)	Society, Local Communnity, Slum Population, Women, Children, Informal Ragpickers, Educational Institutions
Transportation	Increase in temperature can lead to increased use of private vehicle (as public vehicles do not have AC facility in general) in order to maintain comfort, which may lead to more traffic congestion and increased GHG emissions.	Udiapol (42), Paras Circle (15, 16) Fatepura (3, 55), Chandpol (5, 46), Tokar choraha (34), Surajpol (42,43,50), Kalaji Goraji (13), Rung niwas choke, Ghanta ghar, Bada Bazar, Hathipol (5, 10, 11, 45, 46, 47)	Traffic Police, Municipal Corporation of Udaipur, Collectorate, Disatser Management Cell, Students, Residential, Tourist, Commercials esatblishments,
Transportation	Increase inshort duration high intensity rainfall in the future may lead to increased flooding, resulting in damage to roads etc, thereby leading to increased maintenance cost and an increase in traffic congestion.		

Actors	Capacity to respond (a)	Resources available (b)	Capacity to access information (c)	Adaptive capacity score (a*b*c)
City Corporation	2	2	2	8
Slum Dwellers	1	1	2	2
Residents	1	1	2	2
PHED	2	2	2	8
Educational Institutions	2	1	3	6
Women	1	1	2	2
Children	1	1	2	2

Elderly	1	1	2	2
Ragpickers	1	1	2	2
Pollution Control Board	1	2	3	6
Disaster Management Cell	3	2	3	18
Traffic Police	2	1	1	2
Collectorate	2	2	2	8

Annexure 8 - Prioritisation of Resilience Interventions

Sector	Potential Climate Resilience Interventions	Resilience Indicators				Overall Resilience **4/4:**High **3/4:** Medium **2/4:** Average **1/4:** Low
		Redundancy	**Flexibility**	**Responsiveness/ re-organization**	**Access to Information**	
		(yes/no)	**(yes/no)**	**(yes/no)**	**(yes/no)**	
Water and Sewerage	Awareness generation for economic use of water to prevent wastage and reduce demand.	Yes	Yes	Yes	Yes	High
		It will help out not only reduce the regular requirement of water at household level, a behavioral change also help out at the crises time.	helps in efficient usage of water at local (household) level as well as create awareness at larger scale of reporting of any leakage etc.	In case of wastage by any means, citizenry can take proper measures (at household- repairing; at city level- informing concerned authorities)	Awareness generation or IEC always done through the information and experiences	
	Pricing policy of water and smart metering is needed to inculcate proper usage habits among public.	Yes	No	Yes	Yes	Medium

		Can change uses habit and reduce wastage of fresh water		actually data can help to forecast the futuristic demand	Can improve the data availability regarding the actual demand	
	Analysis of available water sources and alternatives as Udaipur is totally depend on surface water	Yes	Yes	Yes	Yes	High
		Supports the current and futuristic requiremen t of the city and identificatio n of alternative sources helps to overcome in a crisis period	Alternative resources helps to continue the water supply in different conditions	Alternative resources helps to continue the water supply in different conditions	Various studies done by PHED and other department s are available to built a resilient system	
	Mapping of water logging areas and geo-tagging for specific interventions at required areas.	Yes	Yes	Yes	No	Medium

		supports water contaminati on issue as well as plan out the sewerage system in efficient way	special attention can take prior for the rescue in case of flood kind situation for the geo tagged areas		Information and technology can be done at govt. level but the system is totally depend on support of communitie s, eg. Dumping of waste in drainage can be reduce only by self motivated civilians	
	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.	Yes	Yes	Yes	Yes	High

		Supports a higher degree of self sufficiency at the household level	System allows for water to be channelized towards recharging groundwater as well	In case of shutdown of the city's water supply system, households have stored rainwater for use	City authorities has the guidelines for it, and it can be mandatory for each house hold.	
	Roof top water harvesting and water recycling has to be mandatory for state own buildings of plot size 300 sqmt.	Yes	Yes	Yes	Yes	High
		supports self suffiency	will improve ground water level			
	Waste water treatment plant connections to households, institutions and to lakes should ensure no sewage flows into drains and is untreated.	Yes	Yes	Yes	Yes	High
		Treated water can be use to avoid water crises situation	Treated water can be use for drinking to reduce the stress over existing water sources	A sustainable WWTP can be planned in a way that can be able to respond and change to meet unexpected shocks	PHED and UMC	
	Rejuvenation of traditional	Yes	Yes	Yes	Yes	High

	water bodies and sources					
		reduce the dependency over external sources. Eg. In case of Udaipur, in water crises period PHED have to pump water from Jai samandh lake which is 80 Km far from the city so rejuvenation of Udaisagar lake will reduce the dependency	System allows for water to be channelized towards recharging groundwater as well	It will make the water supply system self sustainable		
	Dual plumbing must be encouraged. As per by laws, private treatment of sewage must be ensured and zero discharge must be made.	Yes	Yes	Yes	Yes	High
		recycling will be easy and reduce potable water demand	separate collection of grey and black water reduce the pressure on treatment plant	will reduce overall pressure on the fresh water resources		
	Drinking water and kitchen supply should be separated from other	Yes	Yes	Yes	Yes	High

	water supply. Ground water and treated water can be used for other purposes					
		recycling will be easy and reduce potable water demand	separate collection of grey and black water reduce the pressure on treatment plant	will reduce overall pressure on the fresh water resources		
	Waste water tariff should be set, particularly for development and not just operation and maintenance.	Yes	Yes	No	No	Average
		efficient use of water, reduce wastage	make the treatment plant financially sustainable	If plant failed if will increase pressure on regular supply		
	Improving urban greenery to 30% of land area to improve water catchment areas. (done by UIT and UMC)	Yes	Yes	Yes	Yes	High
		reduce growing urban temperatur e	able to work under both the scenarios (temp rise and rainfall)		already doing by UIT and UMC	
	Proper solid waste management to avoid contamination and drainage	Yes	Yes	Yes	No	Average

	blockages.					
		reduce water contaminati on	reduce pressure on treatment plant	Improve availability of fresh water incrics time	City des not have sufficient information	
	Conservation and restoration of degraded lakes and their maintenance like Udaisagar, Gauvardhan sagar, Nila talab etc.	Yes	Yes	Yes	Yes	High
		reduce the dependency over external sources.	System stops contaminati on of surface water, improve green coverage	It will make the water supply system self sustainable		
	Strategic Planning of sewerage management for the city	Yes	Yes	Yes	Yes	High
			Reduce contaminati on of surface and ground water sources	Proper treatment of wastewater will improve condition of natural drains and lakes and reduce water pollution	AMRUT phase 1 and AMRUT phase 2	
	City level systematic faecal sludge management plan	Yes	Yes	Yes	Yes	High

			Reduce contamination of surface and ground water sources	Proper treatment of wastewater will improve condition of natural drains and reduce water pollution		
Transportation	Proper levelling of roads to reduce damages in rainy season	Yes	Yes	No	No	Average
		undamaged road reduce traffic congestion	Improve share of PT users			
	Geo tagging of water logging prone areas	Yes	Yes	Yes	No	Medium
		information of city level geo tagging can help distribution of traffic	understand changing flood conditions to avoid hazardous areas	will help to plan the roads accordingly	UMC does not having information	
	Introducing PT and IPT and strengthening of existing transport system	Yes	Yes	Yes	Yes	High
		reduce traffic congestion	reduce carbon foot prints	Reduce intensity of air pollution due to traffic congestion	having multiple studies on PT and IPT demand	
	Awareness generation in public to use public transport and effective	Yes	Yes	Yes	Yes	High

	Traffic management					
		reduce traffic congestion and accidents in city	Smooth mobilization of traffic in case of any critical situation in city	Reduce pressure on natural resources		
	Increase road side plantation will reduce road damage	Yes	Yes	No	No	Average
		reduce damage	Improve share of NMT users			
	construction of covered drainage and percolation pits, green belt along the roads to reduce damage in road	Yes	Yes	Yes	No	High
		reduce damage	improve ground water level, vegetation cover	reduce storm pressure on storm water treatment		
Solid Waste Management	Source segregation of waste to be made compulsory as per SWM Rules 2016. Ward wise incremental process can be followed.	Yes	Yes	No	Yes	Medium
		Reducing the energy consumption needed for waste treatment	treatment efficiency will be enhanced due to waste quality	not possible in extreme conditions		

	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.	Yes	Yes	Yes	Yes	High
		Increase cleanliness of ward	reduction in open dumping will effect positively on waste and storm water treatment plants		various good studies available	
	Segregated collection of waste in 3 categories - wet, dry and sanitary. Door to door collection of waste is already there in all wards. Single pick point for organized communities and apartment complexes, there would be a single pick up point. Create clusters for primary	Yes	Yes	Yes	Yes	High

	collection using ecarts or autos.					
		Effective waste treatment	treatment efficiency will be enhanced due to waste quality	Easy the collection process		
	Establish zonewise collection centers, with material recovery facility for dry waste, decentralized treatment for wet waste through composting, biogas generation, mulching and reserve site enrichment, etc. Sanitary waste should be incinerated.	Yes	Yes	Yes	Yes	High
		Efficient waste treatment	reduces emission due to transportation, employment generation for rag pickers	Shutdown of one facility do not pressurizes whole city		

	Practical implementation strategy for removal of dustbins from all wards in the city.	Yes	Yes	Yes	-	Medium
		improve cleanliness, reduce vector diseases	Improve quantity of waste collected for scientific disposal	In situation of flood if it will reduce contamination of water sources		
	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.	Yes	Yes	Yes	No	Medium
		connect more people to SWM	Generate awareness	In any extreme situation it will reduce pressure on ULB owned treatment plants	local startups not available	
	Develop and implement user changes	Yes	No	Yes	Yes	Medium
		make SWM financially feasible and more sustainable		Improve the participation from community side	having guidelines and policies	
	Construction and demolition waste should be handled by separate	Yes	Yes	Yes	No	Medium

	agencies, with minimal impact on environment and maximum reuse.					
		reduce the pressure on natural resources (construction activities)	make C&D waste useable for construction		UMC do not having information	
	Awareness generation for reduce the usage of materials such as plastic where disposal is a challenge, through regulatory mechanisms. Use of recyclable packaging material should be encouraged.	Yes	Yes	Yes	Yes	High
		Improve cleanliness of lakes Pichola and fatehsagar	Improve efficiency of biomethanation or composting plant	reduce water logging		
	For industrial, commercial and hotel waste, guidelines and rules should be enforced for collection and treatment.	Yes	Yes	Yes	Yes	High

		as a tourist city Udaipur is having issues mainly commercial and hotel waste	Reduce fuel consumption of transportation of waste to treatment facility	Will reduce pressure on waste treatment facilities	Guidelines are available	
	Building intra-departmental coordination and cooperation between public health engineering, finance, engineering, garage and administration.	Yes	-	Yes	Yes	Average
		Improve efficiency		Optimal utilization of human, technical and financial resources		
	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	Yes	Yes	Yes	Yes	High
		Improve efficiency of waste treatment		most sustainable	Various organization, universities and NGOs are locally available	

	E-waste collection centers should be established to properly treat and dispose e-waste.	Yes	Yes	-	No	Average
		Efficient treatment for the waste category	E-waste disposal is not only a hardware part (dismantling), it will also deal with plastic, metal and different verities of wastes materials		No information available on city level	
	Medical waste has to be collected separately and incinerated properly to avoid pollution.	Yes	Yes	Yes	Yes	High
		reduce hazardous impact on human health	Reduce contamination of ground water sources		Information and technology available	
	Training on management of industrial waste, foundry waste, etc. Prevention of disposal of this waste in water bodies.	Yes	Yes	Yes	Yes	High

		reduce stress on biodiversity of lakes	Improve condition of locally available surface water sources (Udaisagar lake)	improve quality and quantity of treatment on individual level (industry)	Info of defaulters available with UMC, UIT and RPCB departments and guidelines are there	
	Training on roof gardening and organic farming and linking it to composting facilities in the city.	Yes	Yes	Yes	No	Medium
		City is planning to establish composting plant, composting may be utilize optimally	Reduce direct heat from roof and hence cooling requirement	Improve availability of food	City helplines exist, but responsibility lies with individual households	
	Strategic planning for solid waste management in the city for overall management	Yes	Yes	Yes	Yes	High
	Windrow composting for wet waste at existing landfill site	Yes	Yes	No	No	Average
		Can be start easily to boost up the treatment	reduce pressure on proposed treatment plant at the landfill			
	Awareness generation for house hold level	Yes	Yes	No	No	Average

	composting					
		composting may be utilize for roof gardening	Improve green cover			
	Implementation of 3R concept to reduce overall production of waste	Yes	Yes	Yes	Yes	High
		Reducing the energy consumption needed for waste treatment	treatment efficiency will be enhanced due to waste quality	reduce overall production of waste	Guidelines are available under SBM	
	Impose and strongly implement huge fines for open dumping	Yes	Yes	Yes	Yes	High
		noticeable change in cleanliness	Reduce the expenditure doing by ULB over SWM	reduce contamination of water sources		
Strom Water Drainage	Conservation and restoration of natural drainage and lakes	Yes	Yes	Yes	Yes	High
		Natural drains are being used for waste water and solid waste dumping, degraded environmental condition leads to severe	Rejuvenated natural drains may be utilize for effective storm water management in city	Intervention has potential to reduce health hazards due to degraded environmental quality		

		health issues				
	Strengthen and improve the infrastructure to reduce pollution from combined sewer	Yes	Yes	Yes	Yes	High
		reducing the energy consumption needed for recycling		reduce lake water contamination		
	Rainwater harvesting reduce water run off on the road surface	Yes	Yes	Yes	Yes	High
		Supports a higher degree of self sufficiency at the household level	System allows for water to be channelized towards recharging groundwater as well	In case of shutdown of the city's water supply system, households have stored rainwater for use	City authorities has the guidelines for it, and it can be mandatory for each house hold.	
	Improvement in solid waste management practices	Yes	Yes	Yes	Yes	High
		Reduce vector disease				
	Develop a new covered storm drainage system (separate from sewerage system) with proper manhole (with jail to filter rubbish) and soak pits	Yes	Yes	Yes	Yes	High

		easy recycling of water	Improver ground water level and green cover	reduce stress on biodiversity of lakes		
	Proper cleaning of roads and drainages	Yes	Yes	Yes	Yes	High
		reduce water contaminati on	improve water quality which is collected in lakes through surface run off	improve availability of potable water		