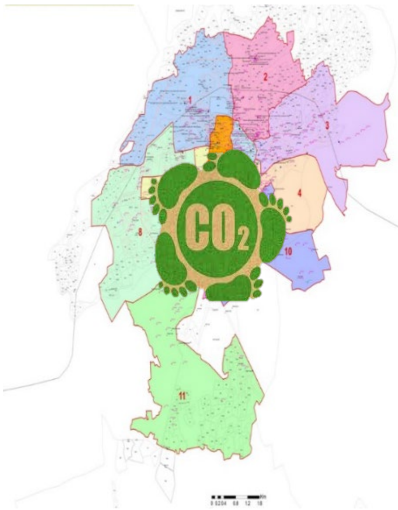
# Study Report



# Carbon Footprint Analysis
# of
# Two Wards of Bhuj City

## October, 2021

**Prepared by:**
**Samuchit Enviro Tech**
**(www.samuchit.com)**
**Pune, Maharashtra**

**Prepared for:**
**Homes in the City**
**(www.homesinthecity.org)**
**Bhuj, Gujarat**

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# Preface

## Personal carbon footprinting: A boomerang in the fight against Climate Change

The concept of personal carbon footprinting was originally introduced by fossil fuel businesses as an attempt to divert attention from their own role in causing global warming and climate change. Through 1990s, the narrative pushed by the fossil fuel industry was that people's lifestyles were main cause of increasing greenhouse gas (GHG) emissions and therefore people have the power to solve climate change by making 'right choices'. This approach totally masked the reality that the fossil fuel industry was using its economic power to create a political and governance system globally that ensured that alternatives to fossil energy-based lifestyle choices were neither economically competitive nor easily accessible.

However, in the modern times, the concept of personal carbon footprinting can be effectively used to throw light on the relative contributions of people's choices vs political and economic systems controlled by big businesses as well as on ethical and equity issues around climate change. This is the reason we call it a 'boomerang'.

Since 2008 onwards, Samuchit Enviro Tech — a social enterprise working towards enabling sustainability — has been using Personal Carbon Footprinting as a tool for raising awareness around climate change in a constructive way. In this case, data on actual fossil energy use and few other lifestyle related factors is collated by individuals/families to estimate their actual carbon footprint through a calculator. In this way, it becomes a self-assessment tool for the upper urban Indian society. The calculation invariably shows that most people belonging to this class have consistently higher carbon footprint than the national average. The experience so far has been that this proves to be a trigger for greater awareness on the consequences of an individual's choices and has led to actual lifestyle changes in many cases.

Going a step ahead, this same tool can be used for a closer examination of the linkages between economic status, lifestyle and GHG emissions. Data collected from representative samples of different socio-economic groups in a specific city shows how citizens belonging to different socio-economic segments are contributing to the total GHG emissions in the city. This is a more scientific and socially just approach compared to the top-down approach typically used for calculating per capita carbon footprint of a city. Typically, when the total GHG emissions of a city are divided by the total population of the city to calculate the per capita value; it masks the fact that the urban poor are actually contributing negligible to the problem, while the urban rich are the biggest culprits.

Samuchit Enviro Tech is happy that this approach could be finetuned and launched in Bhuj city in collaboration with Homes in the City (HIC) in 2020.

In case of cities where emission inventories are available (and this is increasingly becoming the case in Indian cities), calculations based on actual sample data also highlight that the average carbon footprint of prosperous (upper-middle class) individuals is also lower than that of the typical 'per capita' carbon footprint calculation at the city level! The difference is the emissions caused by the businesses and industries for running economic activities (e.g., centrally airconditioned commercial spaces, energy-intensive factories, commercial construction related activities, etc.) plus the emissions associated with basic infrastructural services essential for wellbeing of the citizens (e.g., schools, hospitals, public transport, water treatment, etc.).

The personal carbon footprint approach evolved by Samuchit Enviro Tech and its various collaborators, therefore, achieves the following purposes:

(a) clearly and quantifiably show the relative share of the 'blame' for causing climate change across different socio-economic groups. This can change the narrative around what does the city owe to its poor.

(b) clearly and quantifiably show what personal-level change is likely to be achieved and what responsibilities are needed to be undertaken by the economic and governance systems to mitigate the GHG emissions from the city. This can help chalk out a time bound and target-oriented action plan towards carbon neutrality through specific actions to be undertaken by all stakeholders.

By Dr. Priyadarshini Karve
Samuchit Enviro Tech, Pune, India.

## Abbreviations

| | |
|---|---|
| BHADA | Bhuj Area Development Authority |
| CF | Carbon Footprint |
| DEWATS | Decentralized Wastewater Treatment Systems |
| GHG | Greenhouse Gas |
| GTPUDA | Gujarat Town Planning and Urban Development Act |
| HIC | Homes in the City |
| LED | Light Emitting Diode |
| PV | Photo Voltaic |

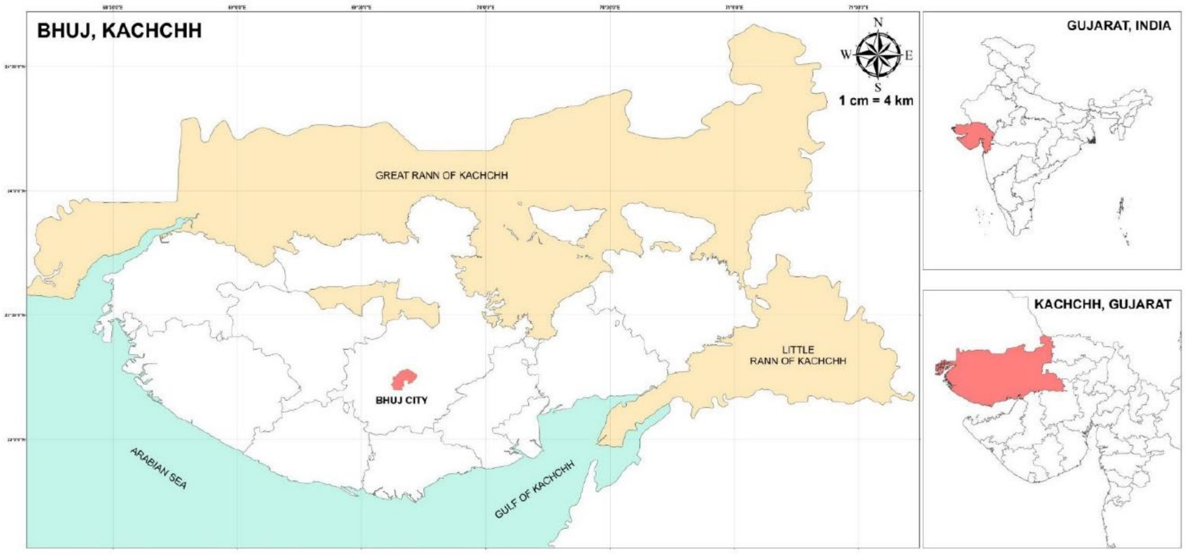
## Contents

# 1.Background

## 1.1Bhuj City

The city of Bhuj is an administrative headquarter of Kachchh district and was established by Rao Hamirji in 1510. Spanning across 56 $km^2$, it has a population close to 200,000 and is governed by the Bhuj Municipality. It is located in north-west part of Gujarat with a distance of around 400 kms from Gandhinagar, the state capital. Being centrally situated in the district, and second largest city of Kachchh, Bhuj is of strategic importance for development of the region. Situated at a height of around 100 mts. from the sea level, Bhuj is well connected with other cities of Kachchh and Gujarat by road and rail. It serves as an important centre for trade and commerce for the region. Bhuj has borderline hot desert climate characterized by both low and erratic rainfall.

Map 1: Location of Bhuj, Kachchh, Gujarat



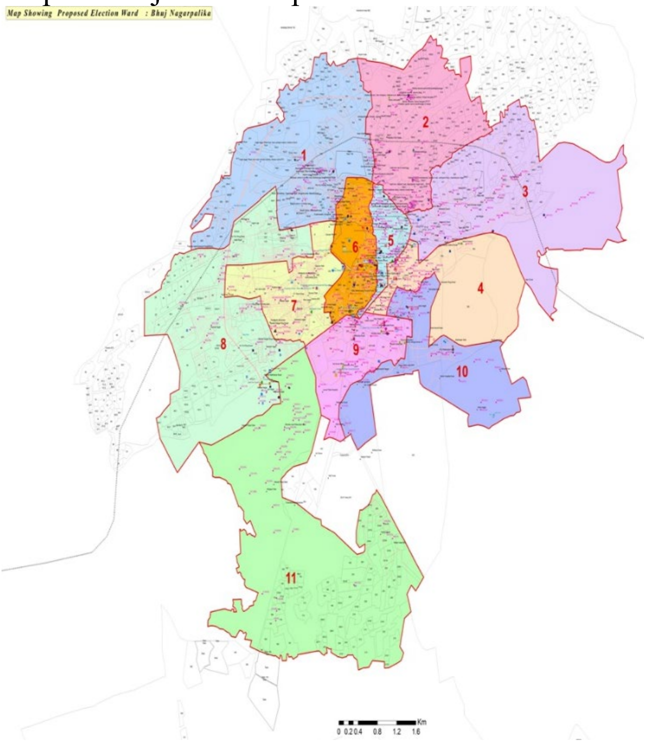

Source: K-Link Foundation

In 2001, Kachchh witnessed a massive earthquake of 7.7 magnitude which killed about 12,300 people in the district. In Bhuj city itself, 2,370 people died, 3,187 suffered massive injuries, 11,036 houses fully collapsed and 27,617 houses partially collapsed.[1] Bhuj Area Development Authority, well-known as 'BHADA', was established after this disastrous earthquake, under the Section 22 of the Gujarat Town Planning and Urban Development Act (GTPUDA), 1976 on 9 May 2001 for rehabilitation and reconstruction of the city. BHADA had prepared a Bhuj

[1] Source: http://bhujada.com/earthquake-2001/

Development Plan for 2011. The city witnessed massive investments in construction, post-earthquake. In 2015, BHADA prepared a Bhuj Development Plan for 2025. Like other Indian cities, Bhuj is also facing severe crises of lack of access to basic services, poor housing, waste generation, water scarcity and contamination, and resultant health hazards. In 2018, there were (and continues to exist) around 77 slum settlements covering 31% of the city's population on only 6% (270 ha) of Bhuj's land.

Map 2: Bhuj Ward Map




Source: K-Link Foundation

### 1.2 Need for Carbon Footprint Analysis

Climate change, better known as climate crisis, is the biggest global threat in this century. Indian cities have a dual role to play in combating this crisis as on one hand, cities are contributing more to GHG emissions compared to their rural counterparts, and on the other hand, cities are also more vulnerable to short-term and long-term impacts of climate change. Population density, income levels and infrastructure are some of the factors affecting us. Therefore, in order to make cities climate resilient, appropriate mitigation as well as adaptation strategies need to be identified and implemented. From this perspective, we have chosen to calculate the carbon footprint of representative families in a couple of wards in the city of Bhuj to get an idea of the emissions contributed by households at city-level. This is the first step in understanding how citizens of a city are contributing in accelerating the impacts of climate change.

### 1.3 Objectives

a. To quantify the GHG emissions at the ward level.

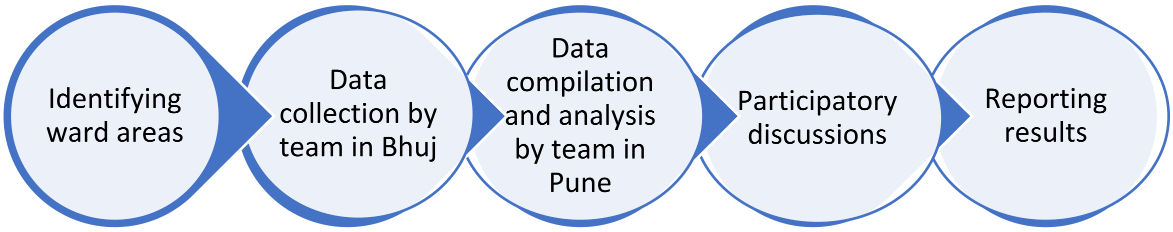
b. To establish a correlation with emission data and lifestyle of the individuals in the ward.

c. To design ward-specific strategies for reducing overall emissions in a participatory manner.

## 2. Methodology adopted for calculating Carbon Footprint in Bhuj

This study was conducted in two ward areas in the city of Bhuj, Ward No. 2 having mostly low-income group households and Ward No. 11 having mostly middle- and high-income group households. Family carbon footprint (CF) calculator in MS Excel format developed and designed by Dr. Priyadarshini Karve has been used for this purpose. This calculator was translated in Gujarati language for ease of conducting this study in Bhuj. The calculator focuses on four main sources – electricity, cooking, transport & indirect emissions. Along with GHG emissions, incurring annual expenditure on direct energy use was also captured for each household. A total 50 families from each ward were interviewed for data collection. The data was further compiled and analysed and the results have been computed in this report.

Picture 1: Methodology adopted




Source: Prepared by the team

Based on the results, strategies for better management of GHG emissions have been discussed with the team in Bhuj. The study results were also disseminated to the stakeholders.

# 3.Profile of Ward Areas under the Study

## 3.1 Ward No. 2

Of the total 11 electoral wards in Bhuj, Ward No. 2 is located in the northern part of the city. The southwest side of the ward lies adjacent to the walled city on the outer side of 'Sarpat Gate' and 'Bhid Gate'. The west and southeast boundaries of the ward overlap with boundaries of Ward No. 1 and Ward No. 3, respectively. The north and northeast boundaries of the ward are defined by the end of the municipal city limits. After the earthquake in 2001, the city's population was around 100,000 (Census 2001) which increased to 150,000 in 2011 (Census 2011). As the city limits grew, these areas were absorbed within the city limits. Existing Ward No. 2 is constituted majorly by slum settlements.

Picture 2: (i) Waste dumping site (top) and (ii) Typical housing structure (bottom) in Ward No. 2


Source: Primary Survey

Majority of inhabitants are working class involved in different daily wage occupations such as masonry, carpentry, livestock rearing, street vending, domestic help. Presently, the ward is beset with problems of congested settlements, inadequate infrastructure, inefficient utility networks, encroachments, unorganised municipal service provisions and deteriorating water bodies. With around 17,000 population, more than half of the ward is unurbanized or undeveloped. The land use of this ward is mostly residential having around 5 lakes within the ward. There are no green areas in this ward, however ample area is occupied by *Prosopis Julifera (Vilayati Babul)* plantation.

### 3.2 Ward No. 11

Ward No. 11 is located in the southern-most side of Bhuj. Comparatively, it is a newly developed ward which witnessed development post-2001 as these areas were absorbed within the city limits. Spread over an area of 920 ha with a population of about 20,000 people, it majorly comprises of authorized development with wide roads and organized structures, signifying planned development.

Picture 3: (i) Waste dumping site (left) and (ii) Typical housing structure (right) in Ward No. 11

Source: Primary Survey

Slum settlements constitute about 5% of the total development in Ward No. 11. In entire Bhuj city, forest land is present only in this ward. About 4% of land area of Ward No. 11 is currently forest area. There are some unauthorised settlements having no access to water and sanitation facilities in this area. Apart from this, the ward has pockets of lower and upper middle-class households. A relatively higher number of educational and research institutes are located here, compared to other wards of Bhuj. There are 8 lakes and 4 water channels in and nearby of the ward.

## 4. Data Analysis

The global per capita average carbon footprint value is 5 $tCO_2$ eq. The desired average value for compliance with the Paris Agreement (keeping increase in the average temperature of the planet to be less than 2 degrees Celsius by the end of 21$^{st}$ century) is 2 $tCO_2$ eq. The current per capita average carbon footprint for India is just above 2 $tCO_2$ eq. The calculations for the two wards are shown in Table 4.1. The average per capita emission of Ward No. 2 was of 0.32 $CO_2$ eq and Ward No. 11 was 1.61 $CO_2$ eq. It clearly evident that the ward with low-income residents has significantly lower average per capita carbon footprint compared to the ward with economically better-off residents.

The average of emissions for each source - electricity, cooking fuel, transport – along with indirect sources were also calculated, and are listed in Table 4.1. Following two assumptions have been made while doing these calculations:

1. According to the collected data, households in Ward No. 11 only use cooking gas, whereas the households in Ward No. 2 use LPG and firewood for cooking. The firewood used for household cooking is assumed to be sustainably harvested from the fast-growing Prosopis in the surrounding wilderness. Therefore, no carbon emissions have been associated with the firewood use.

2. For all surveyed households in Ward No. 2, most of the households' vehicles were three-wheeler three/six-seaters; very few of them were two-wheelers. However, the vehicle was primarily used for livelihood generation (e.g., selling vegetables, delivering goods, providing a paid public transport service, etc.). Therefore, while average carbon emissions associated with vehicle use as reported by the respondents was calculated to be 2.01 $tCO_2$eq; we have assumed that only 20% of these emissions are associated for personal use of these vehicles.

With this assumption, the average carbon emission from transport included in the personal carbon footprinting calculation is 0.40 $tCO_2eq$.

Table 4.1: Average emissions in Ward No. 2 and Ward No. 11

| | Average emissions | |
|---|---|---|
| **Sources** | **Ward No. 2** | **Ward No. 11** |
| **Electricity** | 0.32 | 2.02 |
| **Cooking fuel** | 0.26 | 0.36 |
| **Transport** | 0.40 | 1.39 |
| **Indirect** | 0.47 | 1.96 |
| **Total** | **1.45** | **5.73** |

Source: Calculated from Primary Survey.

The average expenditures incurred by households in each ward due to the direct use of energy services in given in Table 4.2.

Table 4.2: Average annual expenses in Ward No. 2 and Ward No. 11 (in INR)

| Average Annual Expenses (in INR) | | |
|---|---|---|
| **Sources** | **Ward No. 2** | **Ward No. 11** |
| **Electricity** | 2,100 | 13,784 |
| **Cooking fuel** | 3,603 | 5,096 |
| **Transport** | 10,601 | 21,871 |
| **Total** | **16,304** | **40,751** |

Source: Calculated from Primary Survey.

The average expenses for Ward No. 2 are obviously less than Ward No. 11. In case of transport-related expenses for Ward No. 2, based on data reported by the respondents, the corresponding annual expense incurred is INR 53,007 — higher than the corresponding expense incurred by residents of Ward No. 11. This can be attributed to the fact that the residents of Ward No. 2 use their vehicles for livelihood generation. Therefore, similar to the calculation for emissions, in this case too we have considered 20% of expenses for personal use. As a result, INR 10,601 has been taken as the average expenses for transport in the calculation for Ward No. 2.

## 5.Discussions and Conclusions

Based on the above calculation and considering the socio-economic information from the wards, a correlation between carbon emissions, income levels and lifestyle is clearly seen from the data. This data is generally in line with what is observed across the world – the larger contributors to climate change are the economically well-off segments of the population. However, it must be acknowledged that the low emissions from the poor are not because of freely making wise choices, but due to lack of access and opportunity to use more energy and resources. Therefore, as the households come out of the vicious cycle of poverty with increased income levels, it is likely possible that their consumption patterns change and they may contribute to higher emissions (as compared previously). Efforts focused on creating aspirational models of low-carbon high-quality lifestyles at all income levels are therefore essential.

The three/six-seater three-wheeler vehicles being used by residents of Ward No. 2 are creating a substantially high carbon footprint. Because these vehicles are being primarily used for livelihood generation, their daily usage is fairly high. At the same time, it is noted that the fuel economy (km/lit) of the vehicles as reported by the respondents is typically very low (typically 5-6 km/lit). This may be due the fact that these vehicles are old and poorly maintained, or the fuel consumed is a mixture of kerosene and diesel due to relatively higher price of diesel.

We should also highlight that the data on indirect emissions is only an indicative ball park figure for the following reasons:

- To calculate indirect emissions, we have used a couple of proxies - carpet area of the household's structure and a linear relationship between consumption of goods and consumption of energy.
- The assumption for using carpet area of the household's structure is based on the fact that typically, a higher carpet area correlates with higher income level and more energy intensive lifestyle. However, in semi-traditional cities, this may not be the case. Traditional type of housing structure typically has a larger carpet area, but the household may be living in abject poverty. However, a lot of old infrastructure in Bhuj was destroyed during the 2001 earthquake, and therefore most of the current private and public infrastructure is newly developed. We are therefore fairly confident of the validity of our assumption.
- The second assumption is based on the reasoning that a household having higher consumption of electricity, is more likely to have more electrical appliances, and so on for each type of energy usage. A part of the indirect emissions is therefore an estimate of the emissions associated with the lifecycle of various goods and services being consumed by the household. In this case too, based on the data from the field, we are reasonably confident of the validity of the assumption that this component of indirect emissions would be about 40% of the total direct emissions.

- The third part of the indirect emissions is linked with whether organic waste is scientifically managed within the premises of the residence. In this case, since practices of waste segregation, composting etc., are not being followed, we have assumed that the organic waste ends up in the landfill. Feedback from the field indicates that the organic waste may be fed to the stray cattle in the city. However, this is being done in an unplanned and unorganised manner (the organic waste is just kept out in the open and the stray cattle consume it). Also, since the cattle is roaming around, the cattle excreta is decomposing in the open (usually on the streets) leading to GHG emissions. We are therefore going with the assumption that there would be carbon emissions associated with the organic waste disposal.

Picture 4: (i) Interaction with residents of Ward No. 11 by the survey team (top); and (ii) Focus Group Discussion (FGD) with residents in the same ward by the survey team


Source: Primary Survey

From the data in Tables 4.1 and 4.2, it is evident that for Ward No. 2, the annual expenditure per tonne of GHG emission is about INR 11,229; whereas for Ward No. 11, it is INR 7,108. This is also in line with the global observation that the poor spend relatively more money for relatively less and often inferior energy services. Thus, shifting to more efficient and/or renewable modes for accessing various energy services is desirable for Ward No. 2 residents for financial reasons.

Based on the data and above considerations, we believe that several interventions are possible with the residents of these two wards, either within individual households, or as communities. Some interventions at the city administration-level too will help the residents to reduce their carbon footprint.

Picture 5: Interaction with city-level administration representatives of both wards (top and bottom)


Source: Primary Survey

# 6. Recommendations

## 6.1 Household level (applicable to Ward No. 11)

- Use of energy efficient appliances such as light emitting diode (LED) lighting and recognized star rated electrical appliances (preferably 3 or higher).
- Following good energy conservation practices including switching off lights, fans, appliances, etc., when not in use, unplugging the cell phone chargers after completion of charging, etc.
- Use of rooftop solar photo-voltaic (PV) systems, wherever it is economically viable.
- Use energy efficient cooking practices.[2]
- Use of solar water heaters.
- Use of walking, cycling, public transport, wherever possible.
- Regular servicing and maintenance of personal vehicles in order to achieve highest efficiency during use.
- Ensure that water taps and other water outlets are leakproof and well maintained.
- Use of water saving taps, flush tanks, etc.
- Employ good practices in waste management – waste minimisation, segregation, dealing with organic waste at source to the best extent possible, recycling paper, plastic, metal, glass, waste, etc.
- Explore the option of energy efficient architecture and construction processes during housing construction.

Some of these measures will require certain systems to be available for the community (e.g., availability of public transport service, easy access to cyclists, etc.). Either providing these services, or creating an enabling environment for green entrepreneurs who may provide the necessary services, are issues that should be pursued with the local administration.

For measures involving behaviour changes, community-level trainings/orientation programmes may be undertaken at residents of these wards.

[2] Refer http://www.pcra.org/pages/display/41-Make-Gas-and-Kerosene-last-longer/20

For Ward No. 2, if some upgradation of existing houses or rehabilitation to a new location is being planned either through HIC or through the local administration, these above measures may be implemented for the newly constructed homes, and trainings may be undertaken with the residents for energy and resource saving good practices.

### 6.2 Community level (applicable to both wards)

- Use of rainwater harvesting for drinking water storage or recharging of local borewell for community use.
- Community vegetable garden will enable people's participation and engagement. The local sewage and organic waste management may also be integrated within this system. The produced vegetables will provide food security and nutrition for the poorest and vulnerable in the community.
- If the supply chain of organic waste and cattle feed is established in a more systematic and planned way, carbon emissions associated with this process would reduce substantially. This will be a win-win situation for both citizens and the cattle rearers. The citizens will benefit from a cleaner city, and the cattle rearers will get feed for their cattle.
- Establishing a community vegetable garden along with a food processing unit using renewable energy as a green livelihood generation option for the women and youth from the poorest and vulnerable families in the wards. Handholding support will have to be provided for establishing such a set up and marketing the products.[3]
- Community-level organic waste and wastewater management systems based on decentralized wastewater treatment systems (DEWATS) or biogas generation, biocharring, etc. Climate-friendly livelihood options for the poorest and most vulnerable members of the community can be created around providing these organic waste management services.[4]
- Community-level collection centre for recyclable waste, e-waste, hazardous waste (e.g., used diapers, sanitary pads, contraceptives, etc.) and creating linkages with recyclers and safe waste disposal systems. Green livelihoods may be built around these processes too.[5]

[3] Potential technology partner: https://orjabox.com/
[4] For example: organic food waste + sewage biogas system: https://vaayu-mitra.com/
[5] Potential advisor/mentor: https://swachcoop.com/

### 6.3 Government/Municipal/HIC level (applicable at ward-level and city-level)

- Enabling policies for above-mentioned individual and community-level measures.
- Support for DEWATS and other eco-friendly decentralised sewage and organic waste management technologies, rainwater harvesting systems, community food production systems, roof top solar PV systems, etc., through tax rebates, subsidies, grant support.
- Extending piped gas supply to the entire city on an urgent basis.
- Exploring the option of e-bus shuttle services in the city with solar charging facility.
- Encouraging shift from diesel powered six- and three-seater public transport services to CNG powered or electricity/battery powered vehicles.
- Undertaking long-term campaigns to raise awareness about environmental issues, solutions, etc., for different community groups.
- Working with local banks to develop loan options for capital costs involved in implementing low-carbon interventions at both household and community-level.

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## 7. Study Team

A. Members of the Homes in the City (HIC) Programme, Bhuj

- Ms. Prachi Patel
- Mr. Aseem Mishra
- Mr. Vinod Pargadu
- Ms. Samira Jat
- Mr. Nitu Gor

B. Members of Samuchit Enviro Tech, Pune

- Ms. Pournima Agarkar
- Dr. Priyadarshini Karve

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