# GUJARAT

# STATE ACTION PLAN ON CLIMATE CHANGE

## GOVERNMENT OF GUJARAT

## CLIMATE CHANGE DEPARTMENT

Supported by

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# Section 1
# Introduction

Gujarat is recognized for the pace of its economic growth. Although primarily an industrial economy, large sections of population are dependent on climate sensitive sectors such as agriculture. Its long coastline supports large section of poor vulnerable populations. These factors contribute to Gujarat's vulnerability to impacts of Climate Change.

The Government of Gujarat is committed to building a sustainable and climate resilient future for its people. Gujarat has already demonstrated its leadership through a range of policies and that have the potential to counter some of the challenges of Climate Change. The State Action Plan on Climate Change (SAPCC) has been prepared following a consultative process and aims to ensuring success of these measures and realization of the 'ambitious and progressive' vision for development.

This section provides a brief introduction to preparation of SAPCC in the given socio-economic context of Gujarat.

# 1.0 Introduction to Gujarat State Action Plan on Climate Change

## 1.1 Background

Gujarat stands out, amongst all the Indian states, for its economic growth. With only five per cent of the country's population and six per cent of the country's geographical area, Gujarat contributes to about 16 per cent of industrial and 12 per cent of agricultural production in India, and is dominant in the manufacturing and infrastructure sectors. However, in the backdrop of mounting global concern regarding potential risks of future Climate Change, there is a need to ensure that Gujarat's economic performance and social progress stays resilient and capable of withstanding climatic stress and shocks. The complexity of the climate-economy relationship has been made apparent by various studies and the Government of Gujarat recognizes that Climate Change is not only an environmental concern; it has profound implications for economic growth, social advancement, and almost all other aspects of human well-being. Accordingly, the Government of Gujarat initiated a number of processes, involving multiple stakeholders at multiple levels, representative of all sections of society, to cooperate and create a roadmap that leads to the realization of a growing, low-emitting and sustainable economy with a more climate resilient population in Gujarat.

In the year 2008, The Government of India released a National Action Plan on Climate Change (NAPCC) setting eight priority missions-National Missions on Solar Energy, Enhanced Energy Efficiency, Sustainable Habitats, Water, Sustaining the Himalayan Ecosystem, Greening India, Sustainable Agriculture and Strategic Knowledge for Climate Change-outlining a national strategy that aims to promote development objectives while yielding co-benefits for addressing Climate Change effectively and enhancing the ecological sustainability of India's development path. For the realization of these proposed actions at the sub national level, in August 2009, the Hon'ble Prime Minister of India urged each State Government to create its own State level action plan consistent with strategies in the National Plan.

As part of Gujarat's proactive approach, in 2009, the Hon'ble Chief Minister declared an in-principle decision of the Government to form a new Department of Climate Change. The Gujarat Government's Department for Climate Change was set up on 17$^{th}$ September 2009 with a vision to act as a bridge within the Government, and between the Government and society to address Climate Change. Gujarat is the first State in India, the first in Asia and fourth in the world to form an independent Department for Climate Change.

The Government of Gujarat is committed to building a sustainable and climate resilient future for the people of Gujarat, at the highest level of administration. The former Chief Minister of Gujarat and current Hon'ble Prime Minister of India Shri Narendra Modi has

authored “Convenient Action - Gujarat’s Response to Challenges of Climate Change”,a publication outlining policy based answers to adaptation and mitigation.

Gujarat has already demonstrated its leadership through a range of policies and programmes that have the potential to counter some of the challenges of Climate Change while ensuring achievement of sustainable development objectives. Opportunities for energy efficiency and improvements, in the industry, transportation and households/services sectors, are being explored and harnessed by adopting measures like energy efficiency audits, adopting clean fuels and introducing a Bus Rapid Transport System, setting up integrated State-wide gas grids among others. In the arena of renewables, Gujarat has introduced an ambitious Solar Power Policy in 2009 and Wind Power Policy in 2007. In addition a large number of initiatives such as Smart Grid Project; establishment of a Solar Park and developing Gandhinagar as a Solar City; andintroducing fiscal incentives for encouraging private investment in renewables, are underway to tap the immense potential of renewables in Gujarat.

In addition, novel initiatives such as the “Green Credit Scheme”, social afforestation and urban greening programmes, will help in planned expansion of forest and tree cover besides ensuring sustained flow of ecosystem services including carbon sinks. There are also on-going measures supporting sustainable agricultural practices such as agro-meteorological field stations, automatic weather stations and Climate Change research in State agriculture universities.

Numerous path breaking measures for water conservation and management, urban development, disaster management and coastal area development will also help build the adaptive capacity in the State. The inclusion of marginalized communities and women are emphasized in the planning process.

These ongoing initiatives are largely in consonance with the directives of the National Action Plan on Climate Change. To incorporate emerging concerns, in line with the NAPCC,nine thematic groups representing key priorities of the State of Gujarat have been identified.

These include:

1. **Agriculture**
2. **Water**
3. **Health**
4. **Forests and Biodiversity**
5. **Sea-level rise and coastal infrastructure**
6. **Energy Efficiency and Renewable Energy**
7. **Urban Development**
8. **Vulnerable Communities**
9. **Green Jobs**

## 1.2 The State Action Plan on Climate Change

The Government commenced preparation of the State Action Plan on Climate Change (SAPCC) in 2009, with the aim to create a more sustainable and climate resilient future for people in the State. Adhering to the spirit of the NAPCC, the SAPCC intends understanding and comprehending possible Climate Change impacts, and will prepare strategies, with a long term vision, to convert challenges into opportunities.

**Box 1: Vision of the Gujarat State Action Plan on Climate Change**

To build a sustainable and climate resilient future for the people of Gujarat and enabling a low carbon pathway for Gujarat's economic growth that would meet people's aspirations with equity and inclusiveness.

For this purpose, it was proposed that nine thematic groups be formed, under the aegis of Department of Climate Change with technical representatives from other State Government Departments, reputed research institutes, international development organizations and Non-Governmental Organizations (NGOs). These thematic groups have been identified for sector-wise assessment of overall policy and reflect SAPCC priorities, for the next two plan periods. A high powered State Level Steering Committee has also been set-up to oversee and approve the preparation and implementation of the State Action Plan on Climate Change.

The development of the State Action Plan on Climate Change will help to prioritize Climate Change concerns in the State's planning process by means of the following steps:

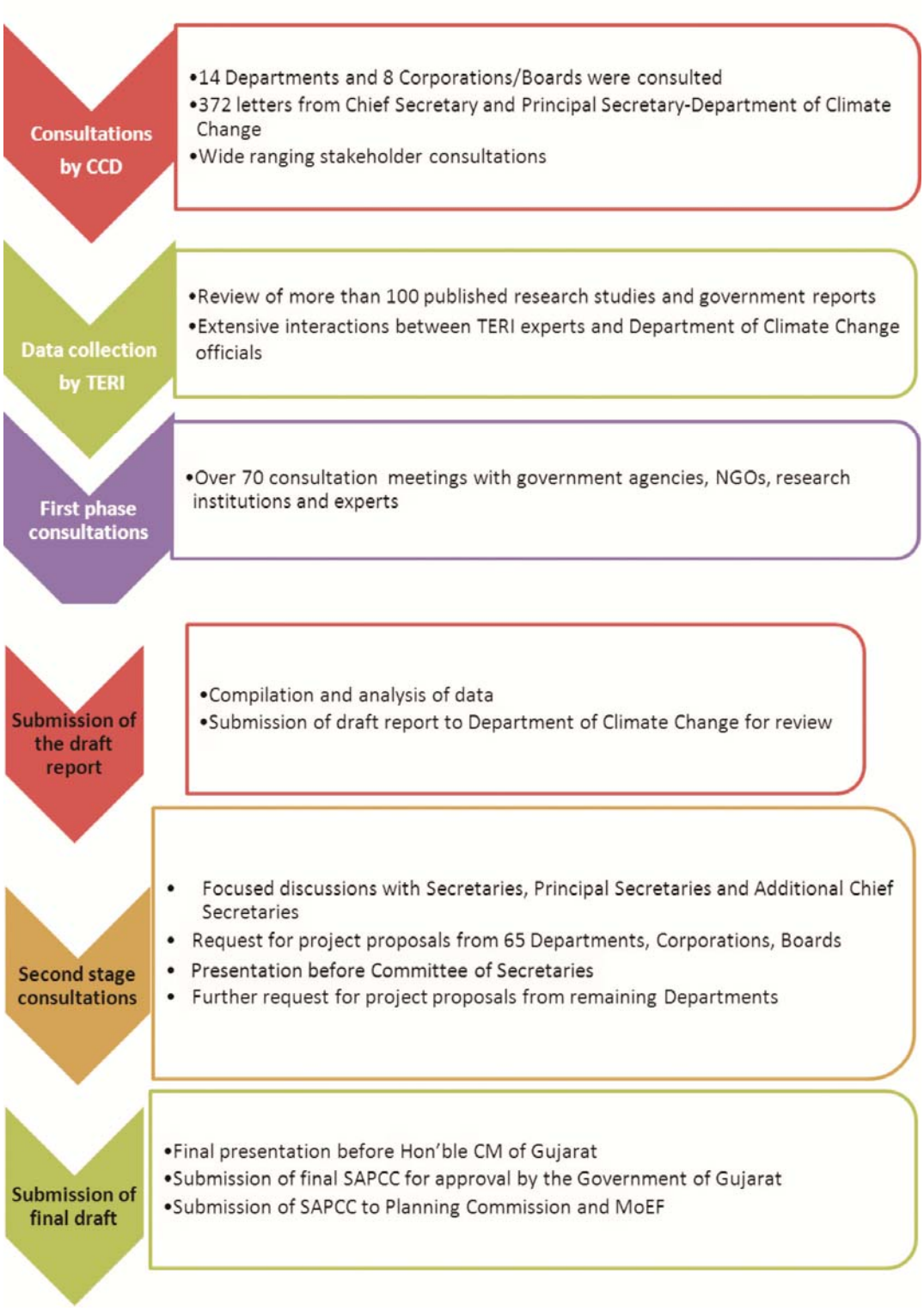
- Mainstreaming action on Climate Change in Government Departments
- Devising innovative and forward looking policies and their means of implementation
- Generating comprehensive Climate Change consciousness among Policy Planners
- Building wide ranging strategic knowledge partnerships
- Ensuring broad based people's participation
- Institutionalizing capacity building at the State level

In 2008, the Government of Gujarat executed a Memorandum of Understanding (MoU) with The Energy and Resources Institute (TERI) for building capacity on Climate Change planning for mitigation and adaptation. Consequently, an "Orientation Programme on Climate Change" for senior ministers and civil servants of Gujarat was organized by TERI.

The drafting of the Gujarat SAPCC has involved extensive consultations with experts, practitioners and policy makers in order to understand expectations and aspirations, and ensure relevance of identified strategies. A high powered State Level Steering Committee has been set-up to oversee and approve the preparation of the State

Action Plan on Climate Change (SAPCC). Figure 1 highlights the steps to the preparation of Gujarat SAPCC.

**Figure 1: Steps to the preparation of Gujarat SAPCC**

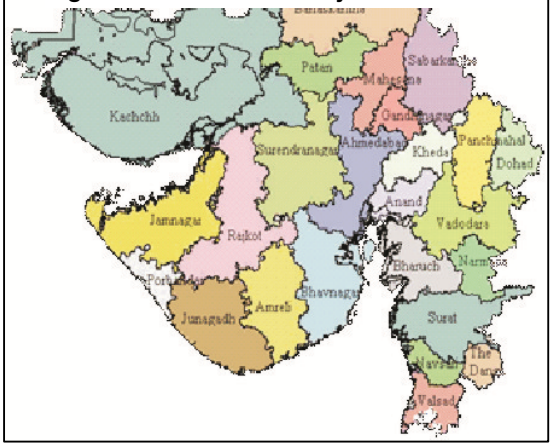


# 2.0 Gujarat – An Overview

## 2.1Physiography and Climate

The State of Gujarat lies on the western coast of India between $20^0$6' N and $24^0$ 42' N and $68^0$ 10' E to $74^0$ 28'E. The length of Gujarat from north to south is approximately 590 km and width from east to west is approximately 500 km The State is spread across an area of 196,024 sq km, which is just six per cent of the total geographical area of India. And it has a longest coastline (1,663 km) among Indian states. The State is bound by Arabian Sea on the west and south-west, Rajasthan in the north and northeast, Maharashtra in the south and south-east and Madhya Pradesh in the east. The State has an international boundary with Pakistan in north-west. The Gulf of Kutch and Gulf of Khambhat are situated on the Arabian Sea. Three perennial rivers - Narmada, Tapi and Mahi are located in South Gujarat. The major non-perennial river, Sabarmati flows through the districts of Sabarkantha, Mehsana and Ahmedabad.

**Figure 2: Districts of Gujarat**




Five types of landforms are found in Gujarat, namely alluvial plains, hilly areas, highlands, desert areas and coastline areas. The alluvial plains extend from Banaskantha in north Gujarat to Valsad in the south and westward to the little Rann and Banni area of Kutch. Hilly tracts form a major divide in the State and most of the rivers originate from the hills in the east and flow towards the south and southwest except the Narmada and Tapi (interstate rivers). The Highland of Kutch (Saurashtra) with an elevation of about 150 to 500 m. comprises of sedimentary and volcanic rocks. Marshy and saline deserts of Rann of Kutch and little Rann of Kutch extend into the saline tracts around the Gulf of Kutch. The coastal areas extend from Rann of Kutch through the little Rann of Kutch and low lying delta region of Bhadar, Bhogavo, Sabarmati, Mahi Dhadar, Narmada and Tapi rivers.

The State has 33 districts and Gandhinagar is the capital city. Ahmedabad, Vadodara, Surat, Rajkot, Bhavnagar and Jamnagar are other key cities. The State falls in the sub-tropical climate zone and experiences sub-humid climate in southern Gujarat (South of River Narmada), moderately humid climate in central Gujarat (between Narmada and Sabarmati rivers), humid and sultry climate in the coastal region (south facing coastal region of Saurashtra), dry climate in regions of central Gujarat (north of Ahmedabad and part of central Saurashtra) and arid and semi-arid climate in north Gujarat and Kutch.

The average temperature varies across the State. The summer temperature varies between $25^0$ C and $45^0$ C while the winter temperature ranges between $15^0$ C and $35^0$C degrees.

The average annual rainfall over the State varies widely from 300 mm in the Western half of Kutch to 2,100 mm in the Southern part of Valsad district and the Dangs. The monsoon usually commences by the middle of June and withdraws by the end of September, with about 95 per cent of the total annual rainfall being received during these months. The monsoon usually commences by the middle of June and withdraws by the end of September, about 95 per cent of the total annual rainfall being received during these months. The total number of rainy days varies from one part of the State to another, ranging from a minimum of 16 days in Kutch to a maximum of 48 days in Surat and the Dangs. Generally, the number increases towards the eastern and the southern parts of the State, and is higher in the months of July and August, as compared to June and September.

## 2.2 Demography

Gujarat has a population of 60.38 million in 2011 (Census, 2011) showing a decadal growth rate of 19.17 per cent as compared to the all India growth rate of 17.64 per cent. The decadal growth rate for 2001-2011 has decreased by 3.49 per cent as compared to the corresponding rate of growth during 1991- 2001. The sex ratio for the State has marginally decreased from 920 in 2001 to 918 in yr 2011. The population density of State has increased from 258 persons per sqkm in 2001 to 308 persons per sqkm in 2011 (Census 2001, 2011). Surat district has recorded a highest density with 1,376 persons per sqkm while Kutch district has the lowest density of 46 persons per sqkm The literacy rate in Gujarat has increased from 69.14 per cent in 2001 to 79.31 per cent 2011. The net increase in literacy is more in the female population (12.93 percentage points) than the male population (7.57 percentage points). Dahod district has recorded a lowest literacy rate (45.15 per cent) while Ahmedabad has recorded the highest (86.65 per cent). The overall literacy rate in the State has shown an upward trend during the period 1951-2011.

**Table 1: Key features of the State**

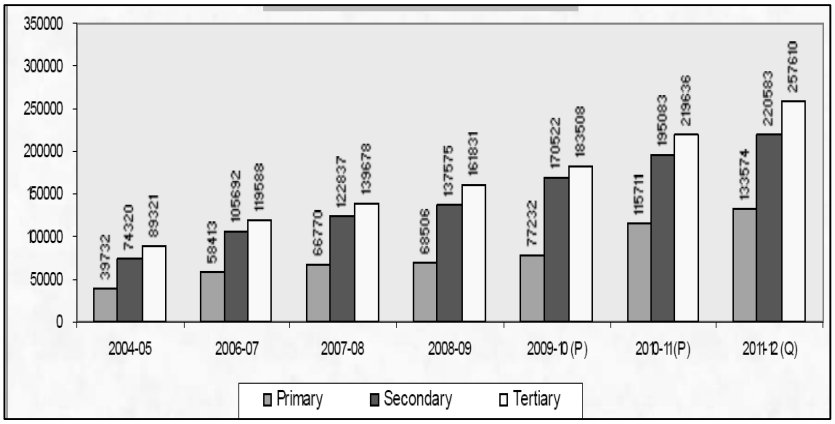
| Parameter | Gujarat |
|---|---|
| Capital | Gandhinagar |
| Districts | 33 |
| Talukas | 248 |
| Towns | 348 |
| Villages | 18,225 |
| Municipal corporations | 8 |
| Municipalities | 159 |
| Population | 60,383,628 |

| Parameter | Gujarat |
|---|---|
| Urban population | 25,712,811 |
| Rural population | 34,670,817 |
| Number of districts | 33 |
| Population density | 308 |
| Sex ratio | 918 |
| Literacy rate ( per cent), Male ( per cent), Female ( per cent) | 79.31, 87.23, 70.73 |
| Birth rates (per '000) | 21.3 |
| Death rates (per '000) | 6.7 |
| Infant mortality rate (per '000) | 41 |

Source: DoES, 2008, Census of India 2011, GoG 2013

## 2.3 Economic Growth and Development

**Figure 3: Components of Gross State Domestic Product**




The Gross State Domestic Product (GSDP) at constant (2004-05) prices, for 2011-12 has been estimated at Rs. 3,98,884 crore as against Rs. 3,67,540 crore in 2010-11, registering a growth of 8.5 percent during the year. Gross State Domestic Product at factor cost at current price in 2011-12 has been estimated at Rs. 6,11,767crore as against Rs. 5,30,430 crore in 2010- 11, registering a growth of 15.3 percent during the year.

The higher growth in the economy during the year 2011-12can be mainly attributed to secondary (manufacturing), and tertiary sectors which have contributed 39.3 and 46.0 per cent growth during the year 2011-12 at constant (2004-05) prices (GoG, 2013).

The Per Capita Income (i.e. Per Capita NSDP) at factor cost at constant (2004-05) prices has been estimated at Rs. 57,508 in 2011-12 as against Rs. 53,789 in 2010-11, registering a growth of 6.9 percent during the year. The Per Capita Income at current prices has been estimated at Rs. 89,668 in 2011-12 as against Rs. 78,802 in 2010-11, showing an increase of 13.8 percent during the year (GoG, 2013)

The State of Gujarat is highly industrialized and one of the most economically developed states in India. Since the inception of the State in 1960, the structure of its economy has changed significantly. Not only have the State's GSDP and per capita

GSDP increased, but it has shown all signs of a developed and urbanized economy and has maintained its high rank in key economic indicators among the Indian states.

Gujarat has excellent infrastructure as compared to the other Indian states. There are 42 ports, 13 domestic airports and one international airport. The State also has an extensive road and rail network. The urban and rural areas have 24 hour power supply. A 2,200 km gas-grid supplies gas to industrial areas. There are 83 product clusters, 202 industrial estates, 59 Special Economic Zones (SEZs) and upcoming infrastructure on the Delhi-Mumbai Dedicated Freight Corridor (GOG, 2010b).

**Table 2: GSDP by broad sectors - sectoral contribution (percentage)**

| S. No. | Industry | At Current Prices | | | |
|---|---|---|---|---|---|
| | | 1999-00 | 2007-08 | 2008-09 | 2011-12 |
| 1 | Primary | 18.62 | 19.85 | 17.76 | 21.8 |
| 1.1 | Agriculture | 14.54 | 15.95 | 14.10 | 18.3 |
| 2 | Secondary | 39.21 | 40.82 | 41.05 | 36.1 |
| 2.1 | Manufacturing | 30.75 | 31.62 | 31.08 | 26.7 |
| 3 | Tertiary | 42.17 | 39.33 | 41.19 | 42.1 |
| | **Total GSDP** | **100.00** | **100.00** | **100.00** | **100.00** |

Source: GOG 2010b, GoG 2013

Robust financial growth and the presence of leading national and international companies belonging to diverse industry sectors, makes it one of the most attractive investment destinations in the country. Accounting for five per cent of the total Indian population, Gujarat contributes 21 per cent to India's exports and around 13per cent to its industrial production. The industrial sector in the State had a 12.5 per cent growth in 2009 (RBI, 2007) According to the study on 'Outlook for corporate investments' conducted by Reserve Bank of India (RBI) in 2007, Gujarat ranks first in private corporate investments in the country. These investments can provide an avenue for promotion of sustainable and green growth in the State.

The visionary approach of the Government of Gujarat has proved to be beneficial for promoting investment and advancement of economic and social development. Important events, such as the Vibrant Gujarat Summit, provide enormous opportunities for the State to display its strengths, progressive stand and initiatives taken to improve governance, among others. The summit was also an opportunity to attract climate friendly investments in the State besides providing excellent networking opportunities through business to business meeting arrangements, network dinners, buyer seller meets, export pavilions and catalogue shows.

**Box 2:**

**Vibrant Gujarat Summit, 2011**

- Participation from 101 Countries, with over 1400 foreign delegates
- About 7,936 memorandums of understanding (MoUs) were signed for Rs. 20, 83,000 Crores ($ 450 billion). 66 MOUs were signed in the energy sector with emphasis on promotion of renewables.
- Around 100 tie-ups with leading institutions from across the globe for exchange of knowledge were forged

**Vibrant Gujarat Summit, 2013**

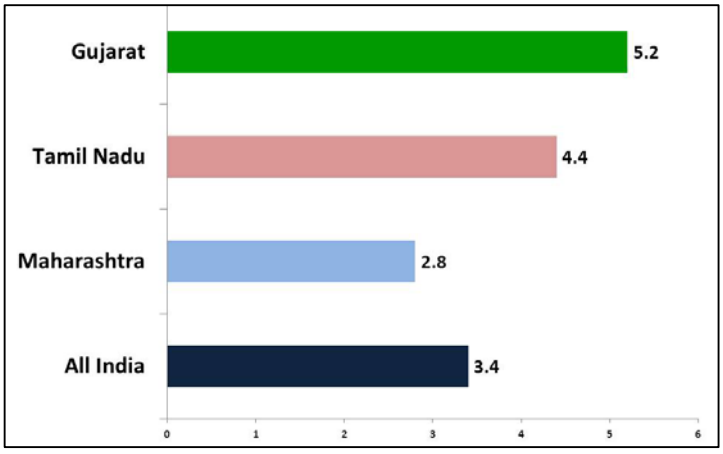
- Participation from 121 Countries, with over 2100 foreign delegates
- 17,719 Investment Intentions were signed and 2,670 Strategic Partnerships were signed in the areas of Technology transfer, R&D, Education, etc. during the summit.

Effective governance enables Gujarat to be in a position to harness economic opportunities, while aiming for a low carbon transition, to build a sustainable and climate resilient future for the people of Gujarat.

### 2.3.1 Rapid urbanization

According to the Development Programme Report 2011-12 (GoG, 2012), urbanization in Gujarat of about 40 per cent, is well above the national average. The heavy influx of investments will generate more jobs, resulting in migration of people from other areas, not only from Gujarat but also from other parts of the country. This could increase demand on the basic infrastructure and basic services available, which presently requires further augmentation and integration.

**Figure 4:Percentage growth of urban population to total population in 2011 over 2001**




Source: GoG, 2011

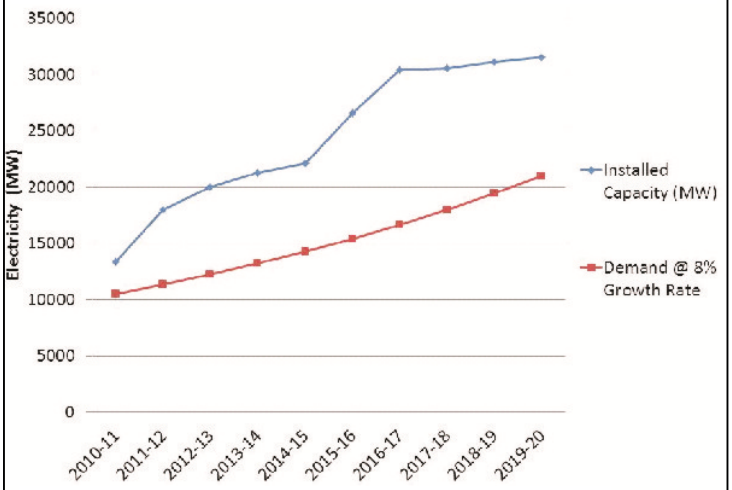
One of the key reasons for Gujarat's accelerated urbanization is the fast growing economy of the State. The Government of Gujarat's outlay on urban development for

2010-11 is 30 billion, which is an approximate tenfold increase in the budget of Urban Development Department in the last five years.

### 2.3.2 Demand for energy services

Policy drivers and planned investment are likely to keep the State on a high economic growth path over the next 10 years. This growth would necessitate an increase in demand for energy. Figure 5 shows the significant increase in demand for electricity and additions to installed capacity projected for the next 10 years.

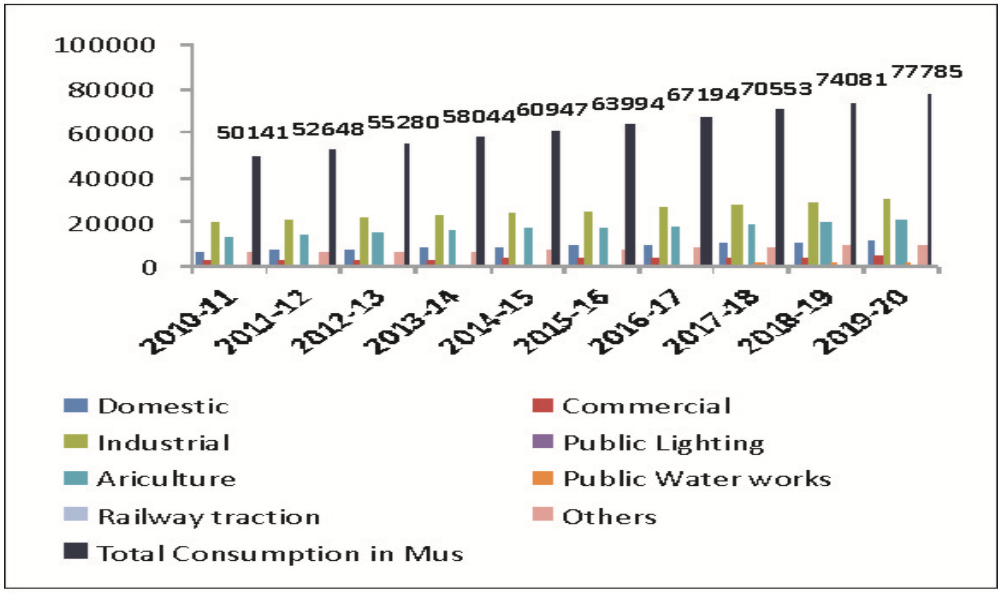
**Figure 5: Demand and supply of electricity in Gujarat**




Source: Gujarat Urja Vikas Nigam Limited

Given the recent growth trends in the State as shown in Figure 6 the demand of energy services is likely to increase rapidly over the coming decade. However, it can be seen that the **State will remain a surplus State in terms of installed capacity.** The State energy policy already has a focus on renewable energy sources and there are ambitious targets for harnessing solar and wind potential.

**Figure 6: Sector wise energy consumption patterns for the next ten years**




Source: Gujarat Urja Vikas Nigam Limited

**Figure 7: Renewable consumption in Million Units (MUs) (included in total consumption -**


Source: Gujarat Urja Vikas Nigam Limited

## 2.4 Policies and Measures

Gujarat has a number of comprehensive and forward looking policies in place along with efficient governance, which is poised to take advantage of a conducive policy framework to undertake measures for addressing Climate Change concerns.

**Figure 8: Policies, programmes and projects of Government of Gujarat which have direct/indirect thrust on GHG mitigation**

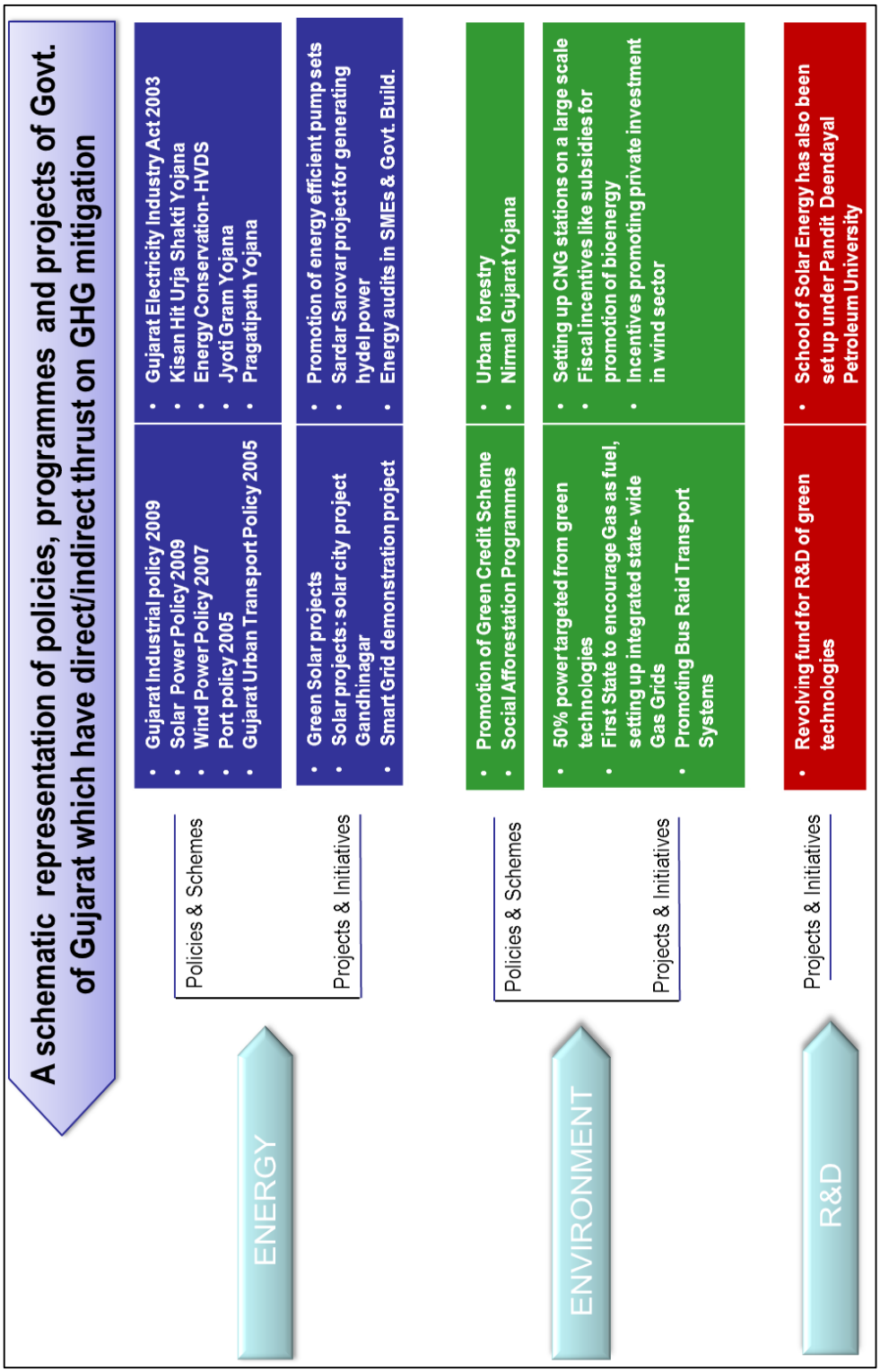
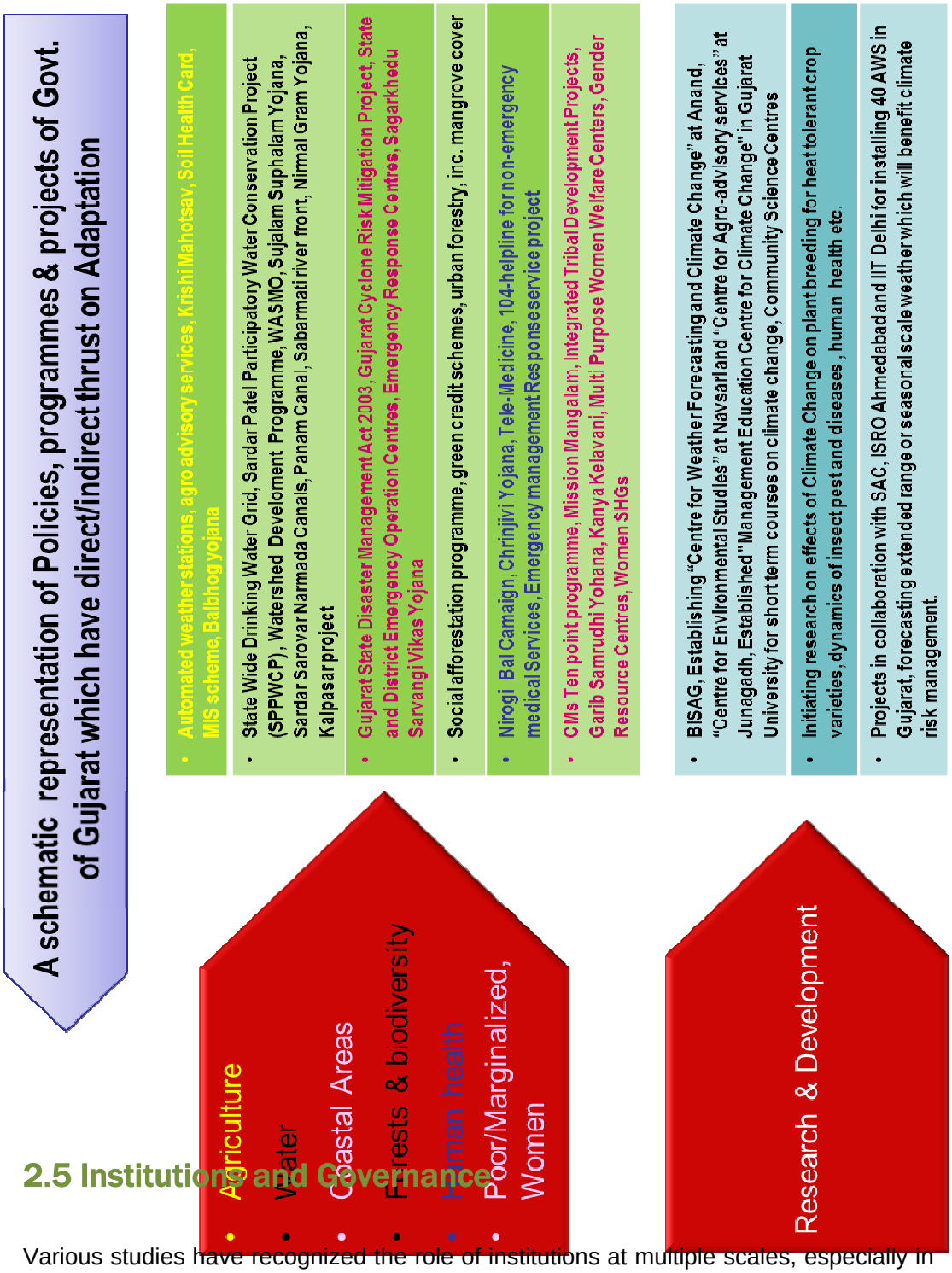


**Figure 9: Policies, programmes and projects of Govt. of Gujarat which have direct/indirect thrust onadaptation**




## 2.5 Institutions and Governance

Various studies have recognized the role of institutions at multiple scales, especially in local contexts, as being the key to adaptation (Thompson et al, 2006; Shepherd et al, 2006). A study commissioned by The World Bank Group, suggests that adaptation to

Climate Change is inevitably local and that institutions influence adaptation and climate vulnerability in three critical ways: a) they structure impacts and vulnerability; b) they mediate between individual and collective responses to climate impacts and thereby shape outcomes of adaptation; and c) they act as the means of delivery of external resources to facilitate adaptation, and thus govern access to such resources. Institutions are also critical leverage points through which to determine the direction and magnitude of flows of resources to different social groups (Agarwal, 2008).

Gujarat has placed considerable emphasis on empowerment of village level institutions through extensive capacity building and proactive facilitation. The creation of Water and Sanitation Management Organization (WASMO) has successfully been able to bring effective citizens' engagement through its innovative governance model, for facilitating the community led water supply programme throughout the State of Gujarat.

Gujarat is also a pioneer State to implement the programme of **Decentralized District Planning** in its true sense. Under this programme, about 20 per cent of the grant of the district level provision is available at the discretion of District Planning Boards to formulate and implement development schemes of local importance (GoG, 2011).Proactive measures by the State for further enhancing capacity, strengthening institutional coordination and improving access to institutions by local communities will help to improve the adaptive capacity to cope with Climate Change stress.

Informing an effective response to Climate Change requires a decentralized and bottom up approach in planning. This not only provides a better understanding of local vulnerability and impacts of Climate Change, but also provides a clear guidance on identifying local needs and priorities to help for designing appropriate interventions for building resilience of local communities.

To encourage decentralization of planning, starting at the finest level of governance, in 2011 the Gujarat Government launched a Rs. 600-crore programme that will involve talukas in the development process and redress people's grievances at the block level. The scheme, 'Apno Taluko Vibrant Taluko (ATVT)', covers all the talukas of the State. Under ATVT, every Taluka in Gujarat is empowered and self-sustaining to provide a local platform for meeting the twin objectives of economic growth and social development. The decentralization of administration upto sub-district (taluka) level is expected to make the governance structure fast, effective, transparent, and citizen centric. Under the scheme, every taluka plans as per its requirements and as per the challenges that it faces, and accordingly carries out more focused implementation of development schemes to reap higher benefits. Such a platform can be ideal for local level adaptation planning by engaging farmers and communities. Another noteworthy initiative of Government of Gujarat, to facilitate participatory and decentralized planning, is a unique programme known as 'Gujarat Pattern of Financial Allocation' which was launched in tribal areas in the 1998. The Gujarat Pattern funds are specially intended for bridging the missing links in interventions and aim at economic development and creation of local infrastructure.

In addition to these, local institutions in the State like Pani Panchayat among others, have huge influence and can be further strengthened to serve as an effective means of steering local communities towards climate sensitive practices.

## 2.6In Summary

The vulnerabilities that climate variability and change create are key issues in the economic and social development of the State. Although, there are studies on climate trends and projections for the Indian region, there are few that are focused on the State. Available observational evidence indicates that regional changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems. There is a need to study systematically the inter-relationship between Climate Change impacts to derive effective adaptation and mitigation measures

# Section 2
# Climate Variability and Change

The earth's climate system is found to be affected by the anthropological activities of increase in greenhouse gases (GHGs) thus leading to Climate Change. Climate Change does not only increase the mean average surface temperature over a region but also imply changes in the type of weather, frequency and intensity of these weather events (IPCC, 2007). Many available observational evidences indicates that regional changes in climate, particularly increases in temperature, have already affected a diverse set of physical and biological systems in many parts of the world (IPCC 2001). The State of Gujarat is a situated on the western end of the Indian region, with vast coastline of approximately 1663 km, which is highly vivid and distinct from others in terms of geomorphology, natural resources and human activities. This makes Gujarat even more sensitive to impacts due to Climate Changes. Covering more than 15 districts extending from Lakhpat in the north to Valsad in the South, the State of Gujarat lies exposed to the likelihood of changes in climatic parameters including changes in temperatures, rainfall variability, sea surface temperatures, rainfall extremes, variation in sea levels, storm surge occurrences and cyclonic activity in the Arabian Sea.

The first step towards preparation of a detailed State Action Plan on Climate Change (SAPCC) is to assess state-specific risks and impacts and prioritize areas for research and policy action in response to current and future vulnerabilities and projected impacts of Climate Change. For this it is essential to analyze the climate variability over the state and assess the risk associated with extreme climatic events, the use of climate models both at the global level and regional level becomes imperative.

At the same time, the potential for the mitigation of green house gasses in the State is substantial and needs to be harnessed.

This section provides information on Climate Trends and Projections, Climate Vulnerability and Impacts and Sources of GHG emissions.

# 3.0 Climate Trends and Projections

## 3.1 Introduction

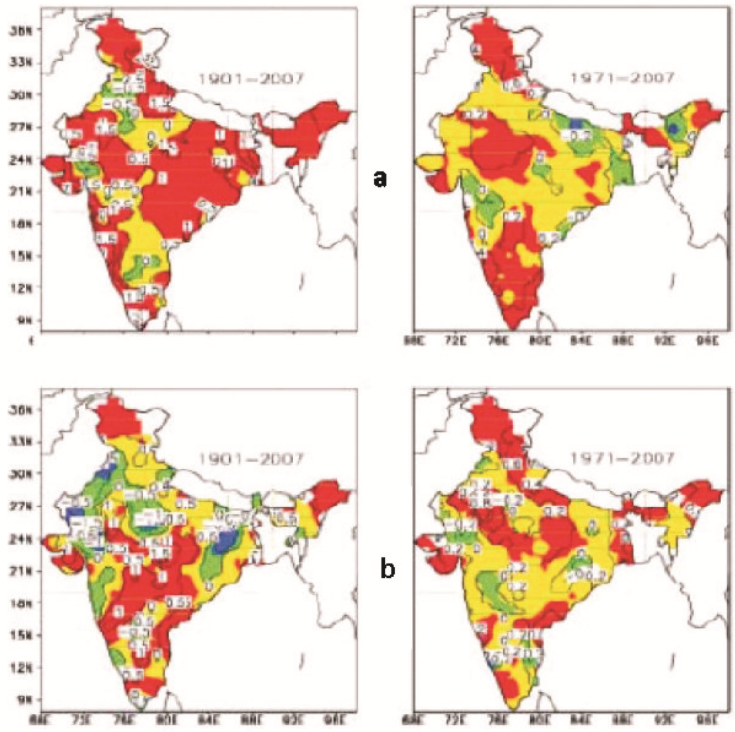
Since the onset of industrial revolution it has been observed that the human induced or anthropogenic activities have influenced the physical as well as chemical composition of the earth's atmosphere. The global atmospheric concentration of carbon dioxide which is a greenhouse gas has increased to a value of 400 ppm in 2014, from 280 ppm in the pre-industrial times. Along with this, the global atmospheric concentration of Methane and Nitrous oxides, other important GHGs, have also increased considerably. The earth's climate system is constantly being affected by increased anthropogenic activities, leading to increased greenhouse gases in the atmosphere, thus resulting in Climate Change. According to the Fourth Assessment Report (AR4), most of the increase in observed global average temperatures since the mid-20$^{th}$ century is very likely linked to the observed increase in anthropogenic greenhouse gas concentrations (IPCC, 2007a). The AR4 concludes that discernible human influences have now extended to other aspects of climate, including ocean warming, continental-average temperatures, temperature extremes and wind patterns. Projected scenarios also indicate rise in global mean temperatures in the range of 1.1 to 6.4$^{o}$C and Sea Level Rise (SLR) in the range of 0.18 to 0.59 m by 2100 (IPCC, 2007). An analysis of instrumental records, globally for over one and a half century, has revealed that the earth has warmed by 0.74$^{o}$ (0.56 to 0.92)$^{o}$C during the last 100 years, with 12 of the last 13 years being the warmest. According to AR4, the rise in temperature by the end of the century with respect to 1980-1999 levels would range from 0.6$^{0}$C to 4.0$^{0}$C and the sea level may rise by 0.18 m to 0.59 m during the same period, globally.

The projections for future climate are obtained by the use of global and regional models. General Circulation Models (GCMs) act as basic tools to simulate earth's climate consisting of physical processes in atmosphere, oceans, ice sheets and land surface. Such models give a projection globally and generally have a resolution of about 1-3° (110-300 km) in latitude and longitude which is too coarse to provide significant assessment over an area. Hence, regional changes are simulated by dynamically downscaling information from GCMs using a Regional Climate Model (RCM). The physical processes are scaled over a higher resolution (25-50 km typical) to arrive at much better assessments over the desired area. Global models, being mathematical manifestations of physical processes, have inherent biases and systematic errors. By downscaling or 'zooming' from them, there is a risk of cascading these inherent biases. Regional climate models also face uncertainty issues due to regions with complex topography, such as mountainous separation between two climatologically different plains. Since, the projections for future GHG emissions depend on assumptions about economic developments; this also forms one of the uncertainty parameters. Hence, for all such models, limitations should be properly understood before carrying out any modeling exercise. Most climate scientists carry out bias correction methods to correct outputs to arrive at better approximations both at global as well as regional scales.

## 3.2 Observed climate trends over Indian region

Indian annual mean temperature for the period 1901-2007 has shown a significant warming trend of 0.51°C per 100 years (Kothawale et al, 2010). Accelerated warming has been observed in the recent period 1971-2007, and has been mainly contributed by the warming in winter and post-monsoon seasons, which have increased by 0.80°C and 0.82°C in the last hundred years respectively. The Indian Network for Climate Change Assessment (INCCA) report indicates an increase in maximum temperatures over Indian region by 0.71°C per 100 years (Figure 10a) (MoEF, 2010). The all India minimum temperature also shows an increase in temperature by 0.27°C per 100 years during the period 1901-2007 (Figure 10b) (MoEF, 2010). In figure 10, red and blue colours indicate a significant warming and cooling trend respectively whereas, yellow and green colours indicate a comparatively lesser warming and cooling trend respectively. Dhorde et al, (2009) have found that some metropolitan cities in India have recorded a significant increase in minimum temperature during winter.

**Figure 10: Spatial patterns of linear trends of (a) maximum and (b) minimum temperature**



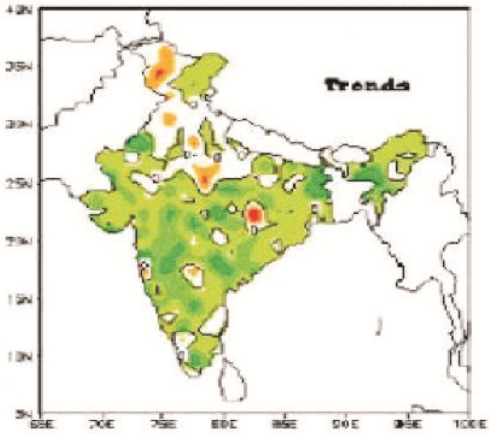

**Key: Red- warming trend at 5 per cent; yellow- warming; Green- cooling trend; Blue- Cooling trend at 5 per cent**

In India, and in particular homogenous regions of the east coast, west coast and the Indian peninsula, a significant increasing trend in frequency of hot days as well as decreasing trends in frequency of cold days, during the pre-monsoon season over the period 1970-2005, has been observed (Kothawale and Rupa Kumar, 2005).

According to Parthasarthy (1984), monsoon rainfall is trend-less during the last four decades, particularly on an all India scale, but Rupa Kumar et al, (1994) brought out regional monsoon rainfall trends in the past century.

Figure 11 shows trend analysis of extreme rainfall for the period 1951-2007 from the INCCA report (MoEF, 2010). The darker shades of green indicates significant increasing trend. Sen, Roy and Balling (2004) also reported overall increase in extreme rainfall events and their intensities during the period 1901-2000.

**Figure 11:Trends in annual extreme rainfall. (Dark green color indicates increasing trends)**




Source: MoEF, 2010

## 3.3 Observed trends over Gujarat State

This chapter brings out climate variability over the State of Gujarat for various climate parameters like temperature, rainfall sea level rise etc. Gujarat has a tropical climate, primarily sub humid, arid and semi-arid spread over different regions over the State. Regions over North Gujarat like Kutch, part of Banaskantha, Mehsana and north western part of Saurashtra have arid climate while the South Gujarat experiences sub humid and in rest of the State, semi-arid climate is witnessed. The general variation of temperature is from 6$^{o}$C to 46$^{o}$C. Annual rainfall varies from 250 mm in the North West and to more than 1,500 mm in South Gujarat.

**Box 3: Data and model projections used**

The high resolution (1$^{o}$ X 1$^{o}$lat/long) IMD gridded data and station data from observatories have been utilized in most of the variability studies over the Indian, as well as the Gujarat region. The all India model projections for future climate stated in this chapter are generated by PRECIS (Providing Regional Climates for Impact Studies, a high-resolution modeling system developed by the Hadley Centre, UK). The runs were made at 50 X 50 km resolution for various IPCC SRES scenarios. High resolution regional climate model (PRECIS) simulations using lateral boundary forcing from three QUMP (Quantifying Uncertainties in Model Projections) runs made at IITM for A1B emission scenario for 2030's indicate an all-round warming over the Indian Subcontinent (Figure 4). The Q1, Q0 and Q14 represent the three ensemble runs carried out using the PRECIS model.

Out of 225 talukas (existing then), 56 talukas are drought prone. The all India assessments in the INCCA report (MoEF, 2010) indicates a warming trend over the Gujarat State for annual mean, maximum and minimum temperatures and also shows a possible increasing trends in extreme rainfall.

Ray et al, (2009) have analyzed various components of temperature and rainfall over the Gujarat using the India Meteorological Department (IMD) thirty year gridded data.

The gridded 30 years moving averages of mean maximum temperature over Gujarat indicate an increase by 0.11$^{o}$C for the past 40 years (1969-2005). The station wise analysis (1969-2008) also indicates the increase in temperatures more over Saurashtra region as compared to other regions of the State. The moving averages of mean minimum temperatures over Gujarat show an increasing trend of 0.107$^{o}$C for the past 40 years (1969-2005). Saurashtra and Kutch also show higher increase in night temperature as compared to other regions using station wise analysis.

An increase of 0.07$^{o}$C in mean temperatures over Gujarat in the past 40 years (1969-2005) with a comparative higher increase over Coastal Saurashtra region (1969-2008) has been observed. Another analysis by Ray et al., (2009) over the cold and heat wave conditions over Gujarat shows a considerable decrease in cold wave conditions for the past decade indicating an increase in night temperature (Table 3) and an increase in heat wave conditions except for Ahmedabad, Bhuj and Okha (Table 4). As compared to 103 cold wave conditions in Saurashtra and Kutch for the period 1969-1978, the period 1999-2008 only recorded 13 cold wave conditions. Heat wave conditions have shown an increase over the southern part of the Gujarat and a decrease over the northern parts. Along the coastal stations of Saurashtra an appreciable rise in heat wave conditions have been observed.

Table 6 gives the frequencies of the occurrence of cold and hot waves in Gujarat, Saurashtra and Kutch for different time periods. In the plains, the most severe cold wave that has occurred included areas over Gujarat, Saurashtra and Kutch during 30 January - 2 February 1929 where a departure of -12$^{o}$C of minimum temperature over Gujarat region and adjoining parts of Saurashtra and Kutch were seen. Saurashtra and Kutch region have also recorded considerably high number of heat spells (Raghavan, 1966). A 30 year moving average of seasonal rainfall from meteorological data from all the stations in Gujarat for the 40 year period (1969-2008) show an increase in normal rainfall for all the stations. Regions of Saurashtra (Bhavnagar, 60 mm) and Southern Gujarat (Surat, 100 mm) show the maximum rise of seasonal rainfall normals. Rainfall extremes have also shown an increasing trend in the past decade for Southern Gujarat region and Saurashtra (Table 3). But the northern Gujarat region and adjoining Kutch hasn't shown any considerable trend both for mean seasonal rainfall and rainfall extremes. An assessment on extreme weather events over India for the last 100 years has been done by De et al., (2005). In July 1927 and July 1941 Gujarat witnessed floods in Sabarmati and Tapi rivers respectively. The severe flooding in Saurashtra and Kutch due to incessant rains over Rajkot in August 1979, flooding of river Narmada in 1970 and river Mahi in 1973 are few of the extreme flooding events that Gujarat have witnessed in the past.

**Table 3: Decadal frequency of cold wave conditions for selected stations**

| Station Period | 1969-1978 | 1979-1988 | 1989-1998 | 1999-2008 |
|---|---|---|---|---|
| Ahmedabad | 20 | 4 | 17 | 13 |
| Baroda | 16 | 12 | 9 | 28 |
| Deesa | 20 | 5 | 10 | 29 |
| Bhuj | 31 | 27 | 42 | 16 |
| Rajkot | 9 | 1 | 14 | 22 |
| Veraval | 53 | 52 | 34 | 72 |
| Naliya | 17 | 35 | 30 | 52 |
| Okha | 5 | 1 | 2 | 1 |
| Surat | 54 | 43 | 25 | 32 |

Source: Ray et al. 2009

**Table 4: Decadal frequency of heat wave conditions for selected stations**

| Station Period | 1969-1978 | 1979-1988 | 1989-1998 | 1999-2008 |
|---|---|---|---|---|
| Ahmedabad | 52 | 72 | 35 | 46 |
| Baroda | 67 | 47 | 22 | 6 |
| Deesa | 60 | 32 | 15 | 47 |
| Bhuj | 146 | 111 | 144 | 10 |
| Rajkot | 95 | 33 | 10 | 21 |
| Veraval | 54 | 43 | 21 | 4 |
| Naliya | 107 | 33 | 19 | 27 |
| Okha | 4 | 3 | 4 | 2 |
| Surat | 48 | 25 | 0 | 62 |
| Bhavnagar | 116 | 50 | 8 | 5 |

**Table 5: Decadal frequency of heavy rainfall events in selected stations**

| Station Period | 1969-1978 | 1979-1988 | 1989-1998 | 1999-2008 |
|---|---|---|---|---|
| Ahmedabad | 42 | 39 | 50 | 50 |
| Baroda | 21 | 14 | 17 | 34 |
| Deesa | 13 | 7 | 21 | 25 |
| Bhuj | 5 | 10 | 12 | 10 |
| Rajkot | 13 | 18 | 15 | 21 |
| Veraval | 21 | 27 | 26 | 33 |
| Naliya | 10 | 13 | 10 | 11 |
| Porbandar | 16 | 25 | 19 | 22 |
| Surat | 92 | 88 | 39 | 101 |
| Bhavnagar | 13 | 10 | 13 | 17 |

**Table 6: Frequencies of occurrence of cold waves and hot waves for different periods**

| Gujarat, Saurashtra and Kutch | | |
|---|---|---|
| Period | Cold waves | Heat waves |
| 1901-10 | 2 | - |
| 1911-67 | 85 | - |
| 1968-77 | 6 | 2 |
| 1978-99 | 6 | - |
| 1901-99 | 99 | 2 |

Source: 1901.10: Annual Summary
1911 .67 : Bedekar FMU
1968 .77 : Disastrous Weather Events Reports . Annual
1978 .99 : WMO Bulletin October 2000, 49, 4, pp. 340 – 348

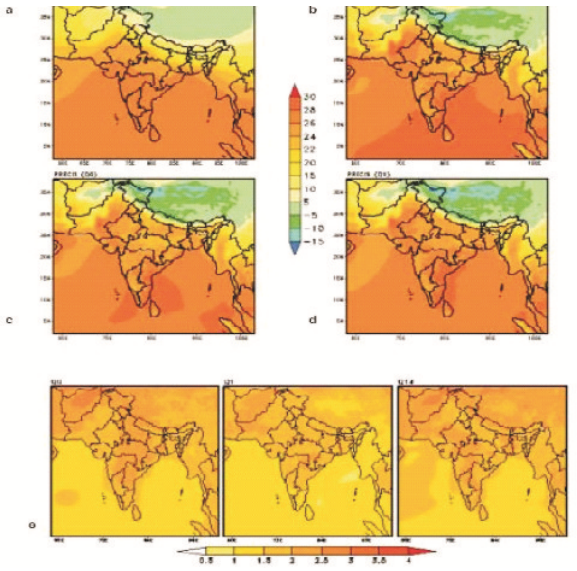
An analysis of tide gauge records from Mumbai, Kochi from west coast and Vishakhapatnam and Diamond Harbour from east coast have depicted a mean sea-level rise along the Indian coast of around 1.3 mm/year. The data from the Kandla and Okha were linearly correlated with Mumbai data in the analysis (Unnikrishnan and Shankar, 2007).

## 3.4 Climate Change Projections

The understanding on climate science and various components of climate system and their interactions have increased to an advanced level nowadays. The main reasons for this increased knowledge are better global data availability and hierarchy of coupled ocean-atmosphere-sea-ice-land-surface models that provide indicators of global response as well as possible regional patterns of Climate Change. The Global ocean atmosphere coupled Climate Models (GCMs) provide satisfactory representations of the planetary scale features but owing to their coarse resolution (100-300 km) their application to regional studies is often limited. For example, to study the influence of realistic topographical features like the Western Ghats along the west coast of India on the monsoon rainfall patterns over India, these global models require to be used at extremely high resolution which is not only computationally expensive but also suffers from uncertainties of representing small scale (high resolution) climate processes on global scale. Hence, State-of-art Regional Climate Models (RCMs) are utilized that dynamically downscale the global model simulations to simulate the regional details of regions of interest.

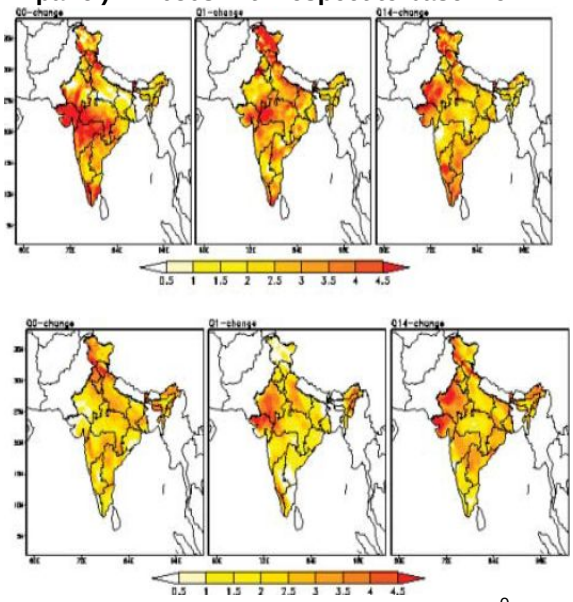
Since the knowledge and understanding of implications of Climate Change at national level was inadequate and fragmentary and to have a sense of future Climate Change over Indian region, Ministry of Environment and Forests published a report “Climate Change and India: A 4X4 Assessment: A sectoral and regional analysis for 2030s”, prepared by the Indian Network for Climate Change Assessment (INCCA) in 2010. This report provides an assessment of impact of Climate Change in 2030s on four key sectors of the Indian economy - agriculture, water, natural ecosystems and biodiversity and health - in four climate sensitive regions of India, namely the Himalayan region, the Western Ghats, the Coastal Area and the North-East Region.

**Figure 12: (a, b, c and d): Mean annual surface air temperature climatology based on observations and simulated by three PRECIS runs compared with the observed climatology for baseline period (1961-1990); (e): Projected changes in the annual surface air temperature in 2030’s with respect to the 1970’s.**



High resolution regional climate model (PRECIS) simulations for 2030's indicate an all-round warming over the Indian Subcontinent (Figure 13). The Q1, Q0 and Q14 represent the three ensemble runs carried out using the PRECIS model. Particularly over the west coast the annual temperatures are set to increase from a minimum of 26.8$^0$C to a maximum of 27.5$^0$C in the 2030's (MoEF, 2010). The rise in temperature with respect to the 1970's (climatology) shows a range between 1.7 - 1.8$^0$C (Figure 12 e). Seasonal temperature from the simulations also projects a rise from 1.5 to 2.2$^0$C, with the monsoon months of June, July, August and September showing maximum rise amongst all the seasons (MoEF, 2010). The State of Gujarat shows a projected rise in the range of 1.5 to 2.5$^0$C for the period of 2030's (in figure 12 e).

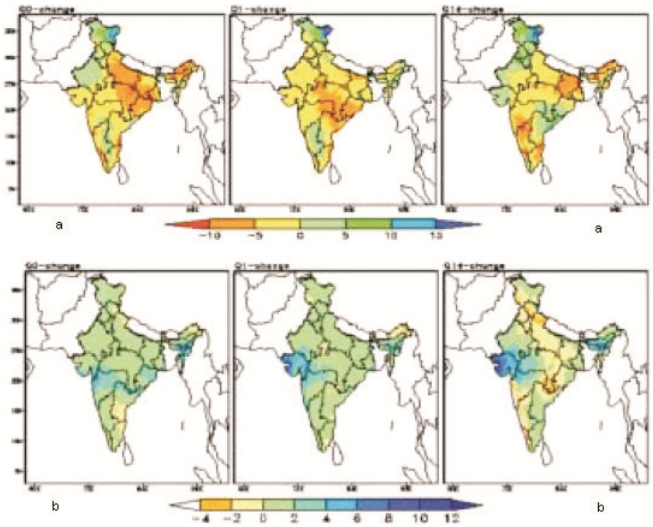
**Figure 13: Changes in the minimum (upper panel) and maximum temperatures (lower panel) in 2030s with respect to baseline.**



The spatial pattern of the change in lowest daily minimum and highest maximum temperature from the three simulations suggests a warming of 1 to 4$^0$C in 2030's for the entire Indian region with Gujarat depicting high positive changes for minimum and maximum temperatures indicating warming under the projected temperature extremes (Figure 13).

The projections of all-India summer monsoon rainfall indicate a 3 to 7 per cent overall increase in the 2030's with respect to the 1970's. Particularly over west coast, the 2030's projections indicate the annual rainfall variations from 935±185.33mm to 1794±247.1mm which amounts to an increase in rainfall by 6 to 8 per cent (MoEF, 2010). The monsoon months (June, July, August and September) show an average increase of 8 mm of rainfall in 2030's with respect to 1970's, however, the months of March, April and May and winter months of January and February show a decrease in the average rainfall with respect to 1970's (MoEF, 2010).

**Figure 14: (a) Change in frequency of rainy days, (b) Change in intensity of rainydays. Both changes are observed in 2030s with respect to 1970s**



Projections of extreme rainfall

events do not show any particular trend for the frequency of rainy days over Gujarat (Figure 14a). However, intensity of rainy days is projected to show an increasing trend over Gujarat region (Figure 14b).

Bengtsson et al., (2006) have modeled the track density and the mean intensity for cyclones occurring globally for 2071-2100 vis a vis baseline 1961-1990. The study shows that under A1B scenario, though the track density (frequency of cyclones) over Indian region does not seem to change much but the track intensity (intensity of cyclones) shows a positive increase for the future time period.

The regional model (PRECIS) simulation of cyclone tracks and intensity show that the cyclonic disturbances over Arabian Sea may be less for the period 2030's with respect to 1970's but the intensity of these systems would be more intense as compared to the present under the global warming scenario A1B.

The INCCA report also suggests that the model-based projections of global average sea-level rise at the end of 21st century indicate a rise from a minimum of 0.18 m to a maximum of 0.59 m. The sea level rise at shorter time scales (few decades) can be attributed to the thermal expansion. For the period 2000-2020, the rate of thermal expansion as projected by an ensemble of Atmospheric Ocean Global Circulation Models (AOGCMs) under the SRES A1B scenario is 1.3±0.7 mm/year which shows no significant difference under the A2 or B1 SRES scenario as well (Meehl et al., 2007). For the north Indian Ocean region the regional variation in sea level has been projected to be less than 0.05 m by 2100 (Meehl et al., 2007). In the absence of availability of regional projections, global projections can be used as a first approximation of sea-level rise along the Indian coasts for the next few decades as well as towards the end of the 21st century (MoEF, 2010).

### 3.4.1 Temperature variation

The historical data (past 30 years) analysis indicates an increase of mean maximum temperature over Gujarat by 0.11$^{o}$C. The station wise analysis (1969-2008) indicates an increase more over Saurashtra as compared to other states. Saurashtra and Kutch regions have recorded high number of heat spells.

The global as well as regional modeling results show a rise in the range of 1.5 to 2.5$^{o}$C for the period of 2030's for A1B scenario and 0.5 to 3.0$^{0}$C for A2 scenario and 0.5 to 2.0$^{0}$C for B2 scenario.

### 3.4.2 Rainfall variation

Historical data for the 40 year period (1969-2008) over Gujarat shows an increase in rainfall over all stations specifically over Saurashtra and Southern Gujarat. The rainfall extremes also show an increase over the same regions.

### 3.4.3 Sea level change

The analysis of tide gauge data shows an increase in mean sea-level rise along the west coast.

Model based projections of global sea level rise show an increasing trend at the end of 21st century. In absence of availability of regional projections, global projections can be used as first approximation of sea-level rise along Indian coast.

### 3.4.4 Cyclone intensity

Cyclones over Indian coastlines are projected to increase in intensity in future though the number of cyclones occurring doesn't show an increase.

**Box 4: Cyclone risk analysis**

There are not many cyclone risk analysis studies associated for Gujarat State. A further in-depth detailed study for cyclone and storm surge hazard risk mapping both with the use of statistical GIS based modeling and dynamic high resolution regional climate modeling is advised. A rigorous parameterization of cyclonic storms especially for the Arabian Sea is also recommended. Detailed ground-truthing has to be undertaken to study the effect of the cyclone at settlement level. Inundation maps for vulnerable sites in terms of sea level rise and storm surge impact should be carefully prepared and studied. The data gaps for the Gujarat coast to validate the surge model outputs should also be addressed.

## 3.5 Gaps to be addressed

While presenting any modeling output study a proper peer review should be carried out and uncertainty in data and model outputs should be reported.

To have an effective response to future Climate Change there is a need for Gujarat specific projections and also there is a need to have the required infrastructural and institutional capacity in the State to make use of such strategic knowledge. It is very important to take into account the existing gaps in this regard.

**Box 5: Special Report on Emissions Scenarios (SRES)**

The A1 scenario family describes a future world of very rapid economic growth, low population growth, and the rapid introduction of new and more efficient technologies.
A1B is a subgroup of A1 scenario. This scenario assumes a balanced mix of technologies and supply sources, with technology improvements and resource assumptions such that no single source of energy is overly dominant.
A2 scenarios are of a more divided and independently operating world having self-reliant nations with continuously increasing population and regionally oriented economic development. A2 is characterized by slower and more fragmented technological changes and improvements to per capita income.
B2 scenarios are of an ecologically friendly divided world with slower rate of increasing population than in A2. Under this scenario the emphasis are on local rather than global solutions to economic, social and environmental stability with intermediate levels of economic development. B2 is characterized by less rapid and more fragmented technological change than in A1 and B1.
Source: IPCC, 2000

# 4.0 Climate Vulnerabilities and Impacts

## 4.1 Introduction

Climate Change is anticipated to have adverse consequences on key aspects of human development and ecosystem sustainability. The projected impacts of Climate Change include increases in temperature and shifts in precipitation patterns, sea level rise and extreme events.

## 4.2 Vulnerability of Gujarat

The IPCC (2001) defines vulnerability as ‘‘the degree to which a system is susceptible to, or unable to cope with adverse effects of Climate Change.’’ Key vulnerability factors for Gujarat include of Gujarat a long coastline and large sections of population dependent upon the natural resource base and climate-sensitive sectors such as agriculture, water and forestry.

Gujarat has over 1,600 km of coastline and settlements, both urban and rural, which could be impacted by sea level rise in terms of inundation of low lying coastal areas, sea water ingress into the coastal groundwater aquifers and loss of ecologically fragile and important mangroves and wet lands. The incidences of storm surges and cyclones could bring heavy economic and structural losses to communities besides making the entire area vulnerable to water resources particularly for drinking and agricultural purposes.

The vulnerability of socio-economic systems and to an extent, ecological systems depend upon economic circumstances and institutional infrastructure. The stronger the economy and institutional capacity, the greater is resilience and adaptability to climate variability.

Development can help reduce vulnerability to Climate Change by reducing the impacts of climate hazard due to less sensitivity and exposure to hazards. It is well admitted that better economic circumstances enhance the capacity situated to cope with Climate Change. Gujarat is one of the progressive States in India with a wide array of policy and programmes in place for the betterment of society and environment. Although if properly implemented these can significantly reduce the vulnerability to many Climate Change impacts, certain studies suggest that in some cases development initiatives may in fact increase the vulnerability to climatic changes. For example, coastal zone development plans which fail to take into account sea level rise will put people, industries and basic infrastructure at risk and prove unsustainable in the long term (OECD, 2009). Therefore in some cases creation of explicit adaptation strategies may be required in addition the on-going development process.

Nine thematic groups have been identified under the aegis of Climate Change for addressing some of the key priority areas for Gujarat. Of these, we review change impacts and vulnerability for the five critical sectors of agriculture; water, health, forests

and biodiversity, sea level rise and coastal infrastructure. Table 7 indicates changes in extreme weather and climate events, based on projections to the mid- to late 21st century.

**Table 7:Possible impacts of Climate Change on Various Sectorsin Asia**

| Observed impacts on Asia attributed to climate change reported in the scientific literature since the AR4 | |
|---|---|
| Snow & Ice, Rivers & Lakes, Floods & Drought | • Permafrost degradation in Siberia, Central Asia, and Tibetan Plateau (high confidence, major contribution from climate change) • Shrinking mountain glaciers across most of Asia (medium confidence, major contribution from climate change) • Changed water availability in many Chinese rivers, beyond changes due to land use (low confidence, minor contribution from climate change) • Increased flow in several rivers due to shrinking glaciers (high confidence, major contribution from climate change) • Earlier timing of maximum spring flood in Russian rivers (medium confidence, major contribution from climate change) • Reduced soil moisture in north-central and northeast China (1950–2006) (medium confidence, major contribution from climate change) • Surface water degradation in parts of Asia, beyond changes due to land use (medium confidence, minor contribution from climate change) [24.3-4, 28.2, Tables 18-5, 18-6, and SM24-4, Box 3-1; WGI AR5 4.3, 10.5] |
| Terrestrial Ecosystems | • Changes in plant phenology and growth in many parts of Asia (earlier greening), particularly in the north and east (medium confidence, major contribution from climate change)<br>• Distribution shifts of many plant and animal species upwards in elevation or polewards, particularly in the north of Asia (medium confidence, major contribution from climate change)<br>• Invasion of Siberian larch forests by pine and spruce during recent decades (low confidence, major contribution from climate change) • Advance of shrubs into the Siberian tundra (high confidence, major contribution from climate change) [4.3, 24.4, 28.2, Table 18-7, Figure 4-4] |
| Coastal Erosion & Marine Ecosystems | • Decline in coral reefs in tropical Asian waters, beyond decline due to human impacts (high confidence, major contribution from climate change) • Northward range extension of corals in the East China Sea and western Pacific, and of a predatory fish in the Sea of Japan (medium confidence, major contribution<br>from climate change) • Shift from sardines to anchovies in the western North Pacific, beyond fluctuations due to fisheries (low confidence, major contribution from climate change) • Increased coastal erosion in Arctic Asia (low confidence, major contribution from climate change) [6.3, 24.4, 30.5, Tables 6-2 and 18-8] |
| Food Production & Livelihoods | • Impacts on livelihoods of indigenous groups in Arctic Russia, beyond economic and sociopolitical changes (low confidence, major contribution from climate change) • Negative impacts on aggregate wheat yields in South Asia, beyond increase due to improved technology (medium confidence, minor contribution from climate change) • Negative impacts on aggregate wheat and maize yields in China, beyond increase due to improved technology (low confidence, minor contribution from climate change) • Increases in a water-borne disease in Israel (low confidence, minor contribution from climate change) [7.2, 13.2, 18.4, 28.2, Tables 18-4 and 18-9, Figure 7-2] |

Source: IPCCAssessment Report 5, 2014

## 4.3 Agriculture

Agriculture is an important sector in the State of Gujarat as it is one of the primary sources of livelihood for more than half (52.0 per cent - 59.84 per cent) of its workforce (Planning Commission, 2002; UNDP, 2004). Around 51per cent of the total geographical area is under cultivation (Department of Agriculture, Gujarat, 2014) and agriculture contributes to about 18.3per cent of the states GDP. Horticulture, animal husbandry and fisheries are important sub-sectors.The output of the agriculture sector grew at an average annual rate of more than 11 per cent in Gujarat (GoG, 2013)

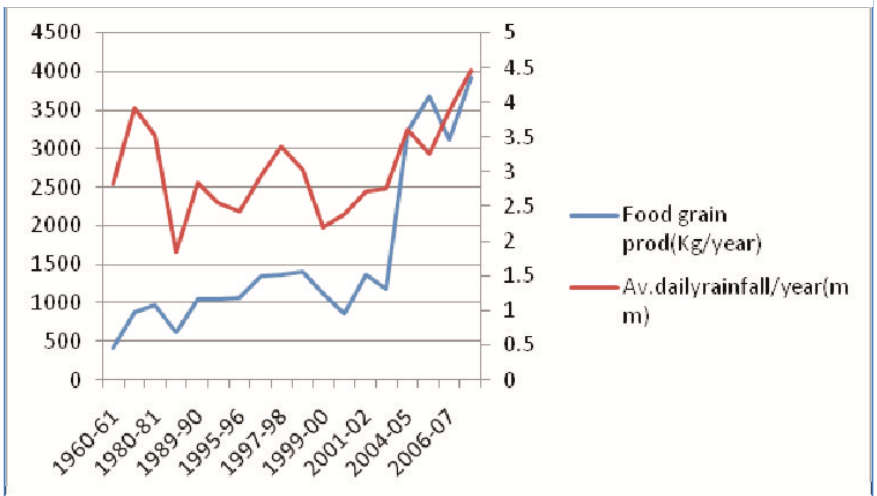
### 4.3.1 Agro-climatic zones

The State is divided into eight agro-climatic zones based on rainfall, soil types and cropping pattern. These are South Gujarat (a heavy rain area, south of River Ambika), South Gujarat (between rivers Ambika and Narmada), Middle Gujarat (between rivers Narmada and Vishwamitri), whole Panchamal, Vadodra, parts of Bharuch, Anand and Kheda districts, North Gujarat (between rivers Vishwamitri and Sabarmati and part of Mehsana, Ahmedabad and Banaskantha districts), Bhal and Coastal Area (around the gulf of Khambhat and Bhal and coastal region in Bharuch, Bhavnagar, Ahmedabad and Surat districts), South Saurashtra (all of Junagadh district, parts of bhavnagar, Amreli and Rajkot districts), North Saurashtra (all of Jamnagar district, part of Rajkot district, part of Surendranagar district and part of Bhavnagar district), and the North West zone (all of Kutch district and part of Rajkot, Surendranagar, Mehsana, Banaskantha and Ahmedabad districts).

### 4.3.2 Vulnerability factors

Agriculture is subject to different kinds of pressures, most of which are dependent on nature and natural resources. Though the Government is taking measures to counteract these, they still remain. In Gujarat, agriculture is partially dependent on rainfall since most of the kharif crops are rainfed. The incidence and distribution of rainfall, particularly in Saurashtra and Kutch regions and in the northern part of Gujarat region, is highly erratic. As a result, these regions

**Figure 15: Food production and average daily rainfall for Gujarat**




Source: Agriculture and Co-operation Department, Government of Gujarat, IMD

are often subject to drought (GoG). Hence non-availability of proper rainfall is a limiting factor for the growth of kharif crops inGujarat.However, it can be inferred from Figure 15 that improvement of irrigation facilities in the State has helped to increase resilience of farming systems to climate variability.

#### 4.3.2.1Salinity

Apart from this, since Gujarat has a long coastline, salinity ingress is a problem. An increase in the ratio of $CL/CO_3$ $HCO_3$ was also noted towards the coast, indicating considerable mixing of seawater with local ground water. In 1971 sea water ingress was observed to a distance between 2.5 and 4.5 km from the coast, and the distance increased between 5.0 and 7.5 km from the coast in 1977. Due to this, there was a decrease in both quality and crop yield (up to 90 per cent) in the coastal belts of Saurashtra and Kutch, known for cultivation of high value cash crops mainly, wheat, , mango, coconut and garden vegetables etc. (GoG 2010).

A study by Coastal Salinity Prevention Cell (CSPC, 2008) on salinity in the coastal areas of Rajkot district shows that farmers growing groundnut and pearl millet (bajra) shifted to cotton and castor. The coconut plantations existing in some villages have been destroyed. The financial requirement of the farming community has increased due to an increasing shift towards cash crops, which demand high input. The survey has recorded that more than 50 per cent of the farmers are seeking loans. This trend has also resulted in people migrating for work. The table given below shows the impact of salinity ingress on agriculture and animal husbandry in the five coastal districts of Gujarat.

**Table 8: Salinity ingress impacts on agriculture and animal husbandry**

| District | Impacts on Agriculture | Impacts on Animal Husbandry |
|---|---|---|
| Porbandar | • Crops like pulses and horticulture crops like coconut, mango, sitafal (custard apple) are declining with increasing salinity in coastal area.<br>• In recent period cotton and castor crop area is increasing due to change towards groundnut crop which is highly sensitive to saline water | • Decline in population of animals and animal rearers due to reduction in grasses from the common property resource as well as from the agriculture. Over the last 20 years |
| Rajkot | • Shift from groundnut and bajra to cotton and castor.<br>• The coconut plantation existing in some villages have been completely destroyed.<br>• The average production of Bajra, Jowar, castor and cotton has halved | • Less impact on animal husbandry since majority of animals are indigenous |
| Junagadh | • The area under horticulture is reducing gradually, no new plantation of mangoes and coconut is carried out by the farmers.<br>• Groundnut cultivation is being replaced | • The number of milch animals per family has reduced from 10-12 animals 20 years back to two- three animals at present. |

| District | Impacts on Agriculture | Impacts on Animal Husbandry |
|---|---|---|
| | by cotton | • Milk production capacity of animals has reduced due to reduction in green fodder from Agriculture<br>• Animals yielding 15-20 liter milk in north Gujarat, produce less than 10 liter milk per day in coastal villages |
| Jamnagar | • Shift in cropping pattern in saline villages from horticulture and ground nut to cotton and fodder crops like jowar.<br>• Crops like chilly and ground nut have reduced.<br>• Change in agriculture season from three crops to one crop. | • Health of animals is deteriorating due to non - availability of fresh drinking water.<br>• Reduction in Groundnut crop area has resulted in shortage of fodder |
| Kutch | • Area under Horticulture is declining<br>• Crop area under pulse cultivation has declined. | • Animal husbandry has declined due to reduction in number of Maldhari families.<br>• Lack of fodder is another problem faced by cattle rearers. |

Source: Costal Salinity Prevention Cell, 2008

The study reveals that in almost all the coastal districts, there is a gradual shift in the cropping pattern, decline in area under horticulture and reduction in yield of crops. However, even with the existing pressure on agriculture sector the State has shown an increasing trend in crop yield, especially from 2001-02. Lack of fodder and health impacts on animals have affected the animal husbandry sector.

### 4.3.3 Climate impacts

According to IPCC 2007, global average temperatures are projected to rise by about 1°C by 2030, while the global mean precipitation and runoff is expected to increase by 1.5 to 3 per cent. These changes will impact global agriculture, differentially, with negative impacts greater in the tropics, than in the temperate areas, thus affecting developing countries. The projected net effect will be a decrease in land suitability for cultivation in arid and semi-arid areas. Reduction in runoff and groundwater recharge will lead to changes in availability of water from rivers and aquifers, and a substantial decrease is projected for India. Climate Change will increase dependence on irrigation while the irrigation capacity will be reduced due to more frequent droughts. Decline in water availability will be greater after 2030, but there could be negative effects on irrigation in the short term (FAO, 2003).

#### 4.3.3.1 Crops

Indian agriculture is facing many challenges, climate variability being one of them. IPCC projects a probability of 10-40 per cent loss in crop production in India by 2080-

2100 due to global warming. India's first National Communication to the UNFCCC suggests that an increase in $CO_2$ to 550 ppm will increase the yield of rice, wheat, legumes and oilseeds by 10-20 per cent. Yields of wheat, soybean, mustard, groundnut, and potato are likely to decline by 3-7 per cent with a one degree rise in temperature. On the west coast, there is a probability of improvements in yields of chickpea, rabi, maize, sorghum, millets and also, coconuts. Due to reduced frost, losses in potato, mustard and vegetables in the north-west India will be less.

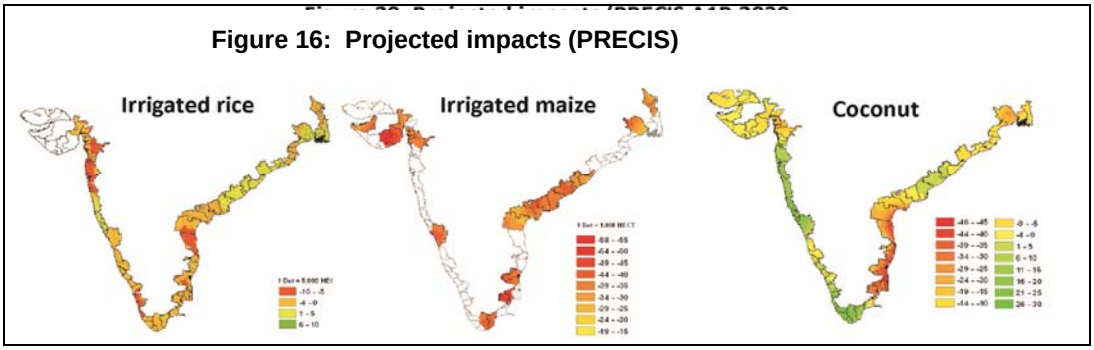
In the case of Gujarat, sufficient studies are not available pertaining to impacts of Climate Change on agriculture. Since most kharif crops are rainfed, while rabi and other summer crops are irrigated, it is important to analyze trends in rainfall and temperature. Analysis of rainfall data shows a decreasing trend of five per cent per 100 years in the western part, including Saurashtra and Kutch and the Gujarat subdivision. Analysis of temperature trends reveal that maximum temperature has increased by 0.2-$0.9^0$ C per decade. The highest rate of increase ($0.9^0$ C) was found in Saurashtra (GoG 2011).

According to GoG 2011, temperature is the main limiting factor to achieve productivity of rabi crops like wheat and mustard. The productivity of wheat declined from 3,013 kg per ha in the year 2007-08 to 2,400 kg per ha during the rabi season due to suddentemperature rise at flowering stage(GoG 2011).

In Gujarat, irrigated rice yields are expected to decline in certain regions by 2030. In the southern regions, including Saurashtra, there will be a decline in irrigated wheatyield. The coast is projected to lose up to 40 per cent of its coconut yield and this can be attributed to existing high summer temperatures which are projected to increase relatively more than in the west coast region (MoEF, 2010).

Some studies suggest that agriculture is likely to be affected in the coastal regions where agriculturally fertile areas are vulnerable to inundation and salinization (Samui and Kamble, 2009). Also, standing crops in these regions are also more likely to be damaged due to cyclonic activity (O'Brien, 2001).

**Figure 16: Projected impacts (PRECIS)**




Source: INCCA, 2010

#### 4.3.3.2 Livestock

Gujarat is one of the foremost contributors to the rapidly growing livestock sector. Livestock contributes five per cent to the total GDP of the State and 22.89 per cent to the agriculture and allied sector. Livestock is also vulnerable to the impacts of Climate

Change, according to IPCC 2007, in many developing countries; and production losses due to greater heat stress, leading to decreased fodder productivity, will negatively impact livestock rearing. According to FAO, effects on livestock will be partly through deterioration of some grassland in developing countries (mostly after 2030). In case of India, heat stress will have effect upon animal reproduction (MoEF, 2010). There will be an increase in water, shelter and energy demand. Impacts on livestock also likely to include, lower yields fromdairy cattle..

#### 4.3.3.2 Fisheries

Since Gujarat has a long coast line, fisheries is an important sector in the State, the sector is vulnerable to Climate Change impacts like sea level rise, higher sea temperatures and changes in ocean currents. According to IPCC, rise of average temperatures over the northern latitude can disrupt ocean currents and fish breeding pattern. Coral bleaching and destruction through higher water temperatures could damage fish breeding grounds in Middle and Southern Latitudes. Sea level rise and increase in temperatures are likely to affect fish breeding, migration and harvests in India.

Possibilites of change in salinity, temperature and ocean currents are anticipated due to global climate change. These factors may influence marine fishiries sector. Till date, marine fisheries sector of the state was mostly focusing on exploiting marine fisheries resource.In the changing scenario, other alternatives like Aquaculture, Cage culture and Artificial Reef programme need to sustain the marine fisheries sector.

The state government is implementing need based programme for the sustainability of marine fisheries sector. Research activites on marine fisheries and allied activites are being carried out by the Central Marine Fisheries Research Institute (CMFRI) under ICAR, National Institute of Oceanography (NIO) under CSIR and Government level by the department of Animal Husbandry, Dairy and Fisheries. The above institutes are working on the issue likely to crop up due to climate change and their effect on marine fisheries.

## 4.4 Water

Surface water is the main source of water in Gujarat. Out of 50,100 million cubic meters of available quota in the State, 38,100 million cubic meters is surface water. There are 185 river basins in the State, but the available water resources are unevenly distributed:North and Central Gujarat, Saurashtra Kutch and South Gujarat have water resources of 10per cent, 17 per cent2 per cent and 71 per cent respectively. Major rivers flowing through the State include Sabarmati, Mahi, Narmada and Tapi. The Sabarmati river basin has an annual per capita water availability of 360 cum/ca/annum. In the Mahi and Tapi basins, it is below 1,000 cum/ca/annum (GoG, Gujarat).

The underground water resources of State are 12,000 million cubic meters. Agricultural activities consume 80 per cent of the available water resource, of which irrigation consumes the major part. Ground water resources are not adequate to meet water demands of the State.

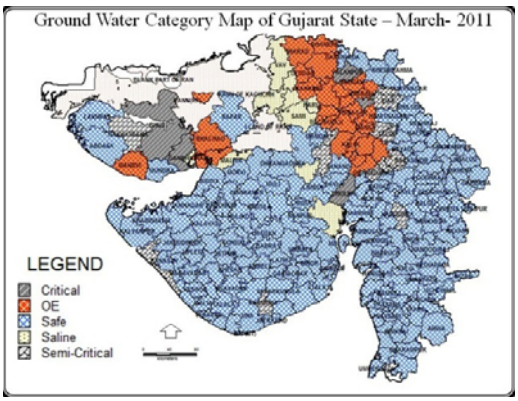
### 4.4.1 Vulnerability factors

Over exploitation of groundwater has resulted in deterioration of quality and quantity. The water table in Ahmedabad could go down at the rate of 4 to 5 m every year (Singh and Kumar, 2010). Water stressed conditionscould be observed mostly in regions of Saurashtra, North Gujarat and Kutch regions. High fluoride concentrations and salinity levels in ground-water, the main source of drinking water supply, were also detected in few of Gujarat's 25 districts in the early 2000s (CGWB, undated).

In the mainland region of Gujarat, water levels could be declining in all the water bearing units in the region. The water level decline in the lower alluvial sub-aquifer, during 1982-1991 was to the extent of 40-60 m, which indicates that this sub-aquifer may be over drawn.

According to the Central Ground Water Board (CGWB) 2014, in Gujarat, out of the 223 assessment units (one taluka for each assessment unit (except Ahmedabad and Dascroi grouped as one unit, Surat city and Chorayashi grouped as one unit) in the State, in terms of ground water, nearly171talukas are safe while 13are semi-critical, 05are critical and 24 talukascould be over exploited. The per capita availability in north Gujarat and Saurashtra Kutch is low (130 $m^3$ to 424 $m^3$), putting pressure on ground water. A maximum fall of 3m per year in ground water level has been observed in the over exploited blocks is around.

**Figure 17: Ground water utilization pattern of Gujarat**




Source: Dynamic Ground Water Sources of Gujarat State, 2014

Climate Change poses uncertainties to the supply and management of water resources. Changes in climate variables like temperature increases affect the hydrologic cycle by directly increasing evaporation of available surface water and vegetation transpiration. Consequently, these changes can influence precipitation amounts, timings and intensity rates, and indirectly impact the flux and storage of water in surface and subsurface reservoirs (i.e., lakes, soil moisture and groundwater). Climate Change affects surface water resources directly through changes in the major long-term climate variables such as air temperature, precipitation, and evapo-transpiration. The relationship between the changing climate variables and groundwater is more complicated. Greater variability in rainfall could result in frequent and prolonged periods of high or low groundwater levels, and saline intrusion in coastal aquifers due to sea level rise and resource reduction (Singh and Kumar, 2010). Thus

groundwater resources are related to Climate Change through the direct interaction with surface water resources, such as lakes and rivers, and indirectly through the recharge process. The direct effect of Climate Change on groundwater resources depends upon the change in the volume and distribution of groundwater recharge.

Scientific assessments show that Climate Change will have a significant impact on Gujarat's fresh water resources. A basin-wise daily grid rainfall data for a period of 1951-2003 was analyzed by IITM using a mathematical model. A falling trend in the annual rainfall of varying magnitude was indicated for Narmada and west coast river basins (MoWR, 2008). According to India's first national communications to UNFCCC, it can be inferred that under the Climate Change scenario, some basins are likely to observe a reduction in the quantity of the available runoff (GoI, 2004). Luni, the west flowing river of Kutch and Saurashtra occupying about one-fourths of the area of Gujarat is likely to experience water scarce conditions (Gosain et al, 2006).The river basins of Mahi, Pennar, Sabarmati and Tapi are also likely to experience water scarcities and shortage. (Gosain etal, 2006)

#### 4.4.1.1 Sea level rise and coastal areas

Gujarat has a coastline of approximately 1,663 km, which is the longest and is approximately 22 per cent of the total coastline of India (GEC, 2008). The coastal region in this State is highly vivid and distinct from others in terms of geomorphology, natural resources and human activities. The long coastline of the State is dotted with 41 ports and has a strong industrial presence. With almost 37 per cent of the total population living along the coast and being an economically active zone, the coastal regions of Gujarat are highly vulnerable to the impacts ofClimate Change.

Coastal regions harbour some of the most diverse and productive ecosystems and act as an active interface between land and water. One of the most visible impacts of Climate Change is that of sea level rise in the coastal regions. Sea Level Rise (SLR) is accounted by an increase in the volume of the ocean with change in mass mainly due to the thermal expansion of ocean water and melting of continental ice (IPCC, 2001). Coastal regions are sensitive to climate-related stimuli owing to their exposure to SLR and tropical cyclones. The Intergovernmental Panel on Climate Change predicts an increased SLR of between 0.18 m and 0.59 m across various emission scenarios over the next 100 years (IPCC, 2007). It also expects, with a high degree of confidence, an increase in the intensity and frequency of extreme weather events including storm surges and cyclonic events. Most coastal regions could be subject to increased levels of flooding, leading to loss of land due to inundation, accelerated erosion, salt-water intrusion and loss of wetlands and mangrove ecosystems. The key climate-related risks associated could be SLR, flooding, storm surges and tropical cyclone occurrences, changes in precipitation, and sea-surface temperatures (IPCC, 2007). The projected biophysical changes due to Climate Change could have adverse socio economic implications for human settlements, health, tourism, fresh water resources, agriculture, fisheries, and so on (IPCC, 2007; McLean et al, 2001; GoI, 2004; Nicholls, 2002). High climate sensitivity and low adaptive capacity of the coastal regions in India makes it a highly vulnerable system. The Delft hydraulics study for the United Nations Environment Programme (UNEP) identified India among the 27 countries with most vulnerable SLR (UNEP, 1989).

A variety of impacts are expected as a consequence of sea level rise with significant implications for coastal population. The primary effects include increased coastal flooding, loss of land due to inundation and erosion of sandy beaches. These could lead to loss of ecosystems such as wetlands, mangroves and corals, degradation of coastal vegetation and habitats, intrusion of salt water into groundwater systems, and loss of cultivable land with huge implications on human systems and settlements relating to health, displacement of population, loss of life and economic losses. All these will increase the exposure and frequency and intensity of storms will increase the sensitivity, leading to an overall increase in vulnerability of the coastal zones.

Studies conducted by Dwiwedi et al (2003) and Chauhan etal (2005) indicate that Gulf of Kutch is vulnerable to sea level changes including sea level rise and of erosion along with shoreline changes.

#### 4.4.1.2 Coastal areas infrastructure

The economy of Gujarat, to a significant level is linked to the coastal region and also depends upon the coastal resources. Sea level rise poses a threat to the coastal infrastructure as it can lead to inundations, flood and storm damages in case of cyclones, erosion, salt water intrusion and wetland loss. Gujarat is also vulnerable to these threats.

## 4.5 Health

The status of health depends on a large number of factors: poverty, food security, food pricing and malnutrition; environmental pollution and degradation; occupational health problems; reproductive health problems; household economy and wages; economic development; represented by per capita income, urbanization and industrialization; social development; especially literacy rates; prices of private health care system and public health care delivery system. Gujarat's performance is better than all India aggregates with regard to all vital statistics (Table 9).

**Table 9: Health indicators for the State of Gujarat**

| Sr. No | Particulars | 1971 | 1991 | 2001 | Current level |
|---|---|---|---|---|---|
| 1. | Crude Birth Rate(CBR) (Per 1000 population) | 40.0 | 27.5 | 24.9 | 21.3 (SRS 2011) |
| 2. | Crude Death Rate (CDR) (Per 1000 population) | 16.4 | 8.5 | 7.8 | 6.7 (SRS 2011) |
| 3. | Total Fertility Rate (TFR) (Per Woman) | 5.6 | 3.1 | 2.9 | 2.5 (SRS 2010) |
| 4. | Maternal Mortality Ratio (MMR) (Per lakh live births) | - | 389 (1992-93) | 202 (SRS-1999-01) | 148 (SRS2007-09) |

| | | | | | |
|---|---|---|---|---|---|
| 5. | Infant Mortality Rate (IMR)<br>(Per '000 live births) | 144 | 69 | 60 | 41<br>(SRS 2011) |
| 6. | Child (0-4) Mortality Rate<br>(Per '000 children) | 57.3 | 31.7 | 18.5 | 12.9<br>(SRS 2010) |
| 7. | Current Contraceptive Use-Any Method (%) | - | 49.3<br>NFHS-I | 59.0<br>NFHS-II | 66.6<br>NFHS-III |
| 8. | Life Expectancy at birth<br>8.1 Male<br>8.2 Female | <br><br>N.A<br>N.A | <br><br>60.9<br>62.7<br>(1991-95) | <br><br>62.9<br>65.2<br>(2002-06) | <br><br>64.9<br>69.0<br>(2006-10) |

Source: GoG, 2013

### 4.5.1 Vulnerability factors

Climatic conditions play an important role in the distribution, degree of endemicity and epidemicity of diseases in an area. Climate Change is expected to adversely impact humanhealth by increasing the risk of exposure to vector, water- and food-borne diseases, aggravating malnutrition and increasing injuries and deaths from extreme rainfall events and thermal stresses. In addition, a number of non-climate factors such as population growth and demographic change, access to clean water, adequate nutrition and sanitation facilities, improvements in health care, and disease prevention and control programs have tremendous influence on either reducing or aggravating these climate induced impacts. Climate Change can have both direct and indirect human health impacts. Indirect impacts arise from changes in temperature patterns, which may disturb natural ecosystems, change the ecology of infectious diseases, harm agriculture and fresh water supplies, exacerbate air pollution levels, and cause large-scale reorganization of plant and animal communities.

Incidences of vector borne diseases (VBDs) malaria could br high in the State. VBDs are probably the most sensitive to changes in climate parameters. Weather conditions determine malaria transmission to a significant extent. Climate Change will modify the dispersal, reproduction, maturation and survival rate of vector species and consequently alter disease transmission. Temperature, humidity, rainfall, soil moisture and the rising sea level are changes in climate that have implications for disease transmission. Heavy rainfall which results in puddles provides good breeding conditions for mosquitoes. In arid areas of western Rajasthan and Gujarat, malaria epidemics have often followed excessive rainfall (GOI, 2004). Malaria, Dengue fever, chickungunya, and Lymphatic Filariasis could be the VBDs in the State. Dengue cases may have increased since 2008. Sporadic cases of chickungunya have also been reported from few districts (SER, 2010-2011).Scabies too,was prevalent in the State however, reporting on scabies has stopped since 1994. Scabies, which is a result of water scarcity, is a communicable disease, spreads rapidly in drought prone regions. As future projections indicate decrease in water availability in the State it could further increase the case of scabies in the State.Coastal districts may face major health

problems due to salinity ingress and non-availability of drinking water. The table below shows the probable health impacts of salinity ingress, district wise.

**Table 10: Probable health impacts of salinity ingress, district wise**

| District | Probable Health Issues |
|---|---|
| Porbandar | • Gastric problems, fluorosis and kidney diseases |
| Rajkot | • Kidney stone, fluorosis, skin and gastric problems |
| Junagadh | • Diseases like kidney stones, fluorosis, skin and gastric problems |
| Jamnagar | • Malaria, kidney stone, fluorosis and gastric problems<br>• Incidences of HIV-AIDS have increased due to migratory population in coastal areas |
| Kutch | • Kidney stones, fluorosis, skin and gastric diseases are common in coastal areas |

Source: CSPC, 2008

### 4.5.2 Climate impacts

Climate Change is expected to adversely impact human health by increasing the risk of exposure to vector, water- and food-borne diseases, aggravating malnutrition and increasing injuries and deaths from extreme rainfall events and thermal stresses. Severity and distribution of livestock diseases and parasites is also decided by climatic factors. (Sirohi etal, 2007)

Preliminary assessments carried out for India's first National Communication to UNFCCC (GoI, 2004) show that under the severity of droughts and intensity of floods in various parts of India is likely to increase. A general reduction in the quantity of available runoff, for period 2041 to 2060, is to be expected which would affect the water availability in many a river basins of the country. River basins like Sabarmati and Luni may experience water scarcity along with basins of Mahi, Pennar and Tapi (Gosain et al, 2006). Further the study brings forth that Luni along with the west-flowing rivers of Kutch and Saurashtra which occupy about one fourth of the area of Gujarat might face water stress conditions. Decline in water availability in the State can affect water resources, agriculture and other dependent sectors which may have serious implications on health outcomes such as water borne and nutrition related diseases amongst others.

Climate Changecould also be expected to reinforce the association between malnutrition and some infectious diseases (Caulfield et al, 2004). While malnutrition can increase susceptibility to infections by inducing alterations in hosts' immune function, infectious diseases adversely affect nutritional status by reducing an individual's capacity for food intake and nutrient absorption (Brown, 2003). Some global studies (Edirisinghe, 1986) show that deficiencies in Vitamin A, zinc, iron and other micronutrients are responsible for a substantial proportion of malaria morbidity and mortality as these nutrients are vital for building natural resistance against malarial

infection. A reciprocal relationship has also been postulated between diarrhea and malnutrition in children, with diarrhea leading to nutrient loss and malnutrition predisposing diarrhea. Other than this, Climate Change may impact quality and quantity of feed and fodder resources such as pastures, forages and grain having significant bearing for the livestock sector.

The projected increase in frequency and intensity of extreme temperatures may also have direct impacts on human health in terms of thermal stresses, such as hypothermia, influenza, cardio-vascular and respiratory diseases, heat exhaustion, heat cramps, dehydration and many others.

Climate Changemay have both direct and indirect impact on animal husbandry sector. The direct impacts include reduced availability of water and food due to reduced crop yield. Increased growth of insects and eco-parasites due to irregularities in seasonal changes and lengthening of hot periods. Examples of such diseases include Leishmaniasis, Babesiosis, Leptospirosis, and blue tongue.

Indirect impacts include resource scarcity due to more dependence of human beings on these resources. Congestion, overcrowding, unhealthy and unnatural feed for the animals are the result of resource scarcity.

Studies conducted for India suggests that milk yield of crossbred cows in India could be negatively correlated with temperature-humidity index. A rise in minimum temperature can reduce the average daily milk yield of the crossbred animals (Sirohi etal, 2007).

## 4.6 Forests and Biodiversity

The forests of Gujarat extend over an area of 21647.44sqkm in the year 2011-2012 and constitute11.04per cent of the total geographical area of the State(GoG,2013). The State has 23 wildlife sanctuaries and four National Parks covering about 8.71 per cent of the total geographical area of the State (GoG, 2011). The forest areas are unevenly distributed, mainly concentrated along the eastern border of the State and the hilly portion of Saurashtra, in the districts of Dangs, Valsad, Surat and Junagadh. On the basis of forest classification by Champion and Seth (1968), the following four forest types are found in Gujarat: Tropical moist Deciduous Forest, Tropical Dry Deciduous Forest, Northern Tropical Thorn Forest, Littoral and Swamp Forest.

**Table 11: Forest cover in Gujarat (2007)**

| (Area in km$^2$) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| State | Geographical Area | Forest Cover | | | | per cent of G.A. | Change * in Forest Cover | Scrub |
| | | Very Dense Forest | Mod. Dense Forest | Open Forest | Total | | | |
| Gujarat | 196022 | 376 | 5249 | 8995 | **14620** | **7.46** | 16 | 1463 |
| India | 3287263 | 83510 | 319012 | 288377 | **690899** | **21.02** | 728 | 41525 |

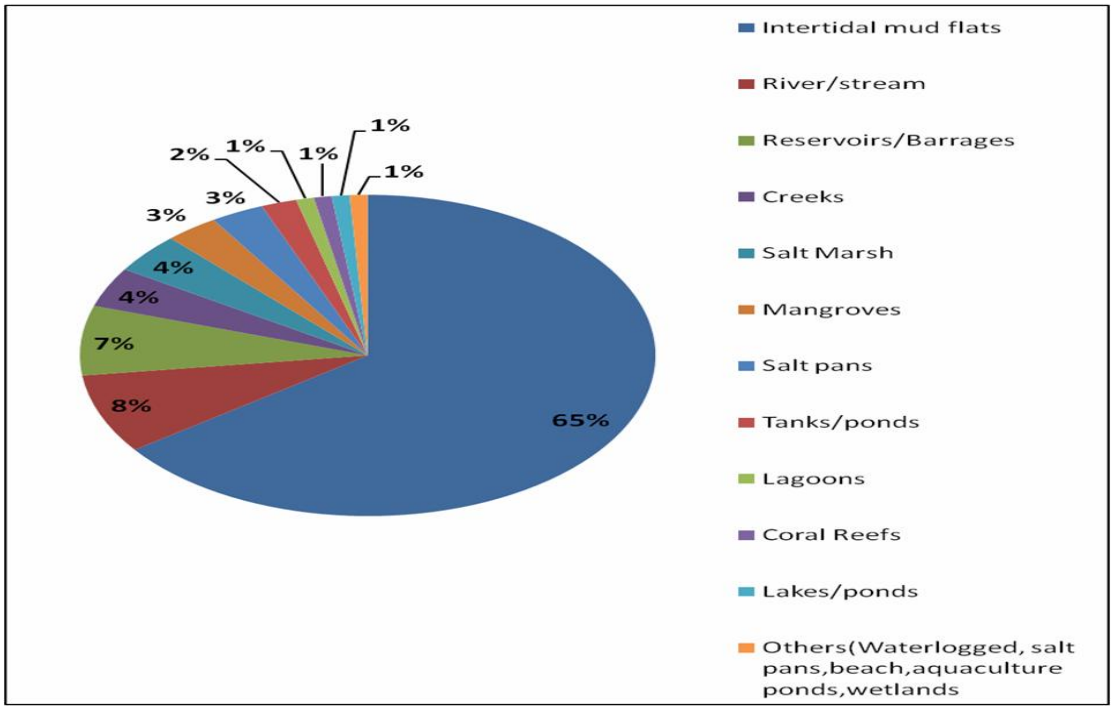
Note:* The change in the above table refers to change in the area with respect to revised assessment for 2005. Source: Indiastat (Ministry of Environment and Forests, GoI), accessed on March 8, 2011

The State has a large number of wetlands, both inland and coastal. They are spread across an area of 2,092 sq. km. and 25,083 sq. km. respectively making a total area of 27,175 sq km constituting 36 per cent of the total wetland share of India. The Gulf of Kutch, the Gulf of Khambhat and the two Ranns cover vast area of coastal wetlands. Main species include wintering waterfowl, lesser and greater Flamingoes. Coral is one of the special coastal wetland ecosystem found only in the district of Jamnagar lying in the Gulf of Kutch. The area occupied by coral is around 33,547 ha, scattered over 50 sites.

Gujarat has the largest area of mangroves (991 sqkm) after West Bengal (FSI, 2009). Mangroves are found in the inter-tidal zone along the Gulf of Kutch, Gulf of Khambhat and Kori creek covering 13 districts of the State with Kutch having 50,197 ha, followed by Jamnagar district with 18,537 ha (ISRO, 2010).

The categories of wetlands and their respective areas are given below.

**Figure 18: Type wise wetland distribution in Gujarat**




Source: ISRO, 2010

## 4.6.2 Climate impacts

Climate is an important determinant of the geographical distribution, composition and productivity of forests, species populations and migration, the occurrence of pests and diseases and of forests regeneration. These changes, in turn, could have profound implications for traditional livelihood, industry, biodiversity, soil and water resources,

and hence, agricultural productivity. Moreover, these Climate Change induced effects would aggravate the existing stresses due to non-climate factors such as land use changes and the unsustainable exploitation of natural resources.

#### 4.6.2.1 Forests

There are few studies addressing the impact of Climate Change on forests (and biodiversity) in India. None of these studies have looked into the impact or plausible impact on the fauna; focusing only on the flora. Most of the earlier studies were based on GCM models and earlier versions of BIOME model that had limited capacity in categorizing plant functional types (Ravindranath et al, 2006). However, these studies revealed critical trends.

More recent studies using BIOME-3 vegetation response model, based on regional climate model projections for India show shifts in forest boundary, changes in species-assemblage or forest types, changes in net primary productivity, possible forest die-back in the transient phase, and potential loss or change in biodiversity (MoEF, 2004). Building upon the above study, Ravindranath et al, (2006) studied the impacts of projected Climate Change on forests of India, using regional climate model (RCM) and more advanced version of BIOME model (BIOME 4). The model results indicate that well over half of the area under forests in India is vulnerable to the projected Climate Change impacts.

Most of the forest biomes in India seem to be highly vulnerable to the projected change in climate. More than 50 per cent of the vegetation in India is likely to find it less than optimally adapted to its existing location, making it more vulnerable to the adverse climatic conditions as well as to the increased biotic stresses. These impacts on forests will have adverse socio-economic implications for the forest-dependent communities and the national economy. The impacts of Climate Change on forest ecosystems are likely to be long-term and irreversible.

#### 4.6.2.2 Wetlands

Wetlands provide a large number of ecosystem services. Inland wetlands are important water resources replenishing groundwater and sub-soil aquifers. Coastal wetlands, including mangroves and coral reefs, often function as natural barriers against salt-water intrusion, protecting coastal land and inland water habitats. Wetlands are also habitat to a large number of animals and micro-organisms.

Sea level rise will have considerable impacts on the wetlands in Gujarat. According to a study by Dwivedi et al, (2005), 0.1 to 0.5m rise in sea level could result in wetland losses between 2,508.3 sq. km. to 12,541.5 sq. km. (Table 12) in Gujarat.

**Table 12: Estimated losses in coastal wetland (km2) in different possible scenarios of sea level rise**

| State | If Sea Level rises by | | | | |
|---|---|---|---|---|---|
| Gujarat | 0.1 (m) | 0.2 (m) | 0.3 (m) | 0.4 (m) | 0.5 (m) |
| | 2508.3 | 5016.6 | 7524.9 | 10033.2 | 12541.5 |

Source: Dwivedi et al, 2005

**Table 13: Losses in coastal wetland if the present trend continues for next 100 years**

| Projected sea level rise (M) | Loss in Wetland Areas ($km^2$) |
|---|---|
| 0.337 | 8452.971 |

Source: Dwivedi et al, 2005

The Great Rann of Kutch has vast areas of seasonal salt lakes that support huge populations of flamingos, and is also the only remaining habitat for the approximately 2000 Indian wild asses. However, the area is highly vulnerable to sea level rise threatening both the Wild Ass Sanctuary and the Kutch Desert Sanctuary (Clark and Duncan, 1992). Submergence of salt marshes and mudflats due to sea level rise could further result in loss of habitat for breeding flamingoes and lesser floricans (Sankaran et al, 1992).

#### 4.6.2.3 Mangroves

Mangroves play a very significant role in maintaining the coastal environment, reducing the impact of wave action and erosion in the coastal areas, preventing salinity and seawater ingress into the inland agricultural areas, and also providing protection to the coastline from the impact of cyclones. Apart from these ecological functions, mangroves play a very significant economic role in the lives of the coastal village communities. Climatic factors like temperature fluctuation, humidity, precipitation, number of rainy days, regular wind flow, radiation and fresh water flow in the region are the most significant factors for development of mangroves. Global warming and sea level rise are likely to case changes in the evapo-transpiration rate across most of the region, resulting in changes to mangrove plantation. While mangroves in the Gulf of Kutch could possibly adapt to low or moderate sea level rise, a rise of more than one-metre relative to the elevation of the mangrove sediment surface in the next century may cause serious losses. SLR could cause a loss of mangroves on the seaward front and cause a landward migration of the mangrove forests (Gilman, 2008). Sea level rise can also change salinity distributions, which can affect mangroves very adversely by reducing their productivity.

Mangroves are also vulnerable to an increase in temperature, which is likely to cause decreased tree height, changes in species composition, changes in phonological patterns, a decrease in leaf size and an overall decrease in productivity. Besides sea level rise and temperature stress, the mangroves in the Gulf towards Jamnagar and the Kutch coasts may also be threatened by drought. Hardy species like Avicennia spcan can tolerate moderate Climate Change and re-colonise but this is not true in the case of the species like Rhizophora, Ceriops, Sonneratia and Aegiceras.Climate Change is also likely to cause a change in ocean circulation patterns, resulting in a change in the community structure of mangroves and could also lead to extreme storm events that would result in a loss of forest cover (Woodroffe and Grime, 1999).

#### 4.6.2.4 Corals

Corals are sensitive to Climate Change impacts such as increased sea surface temperature and ocean acidification. High species diversity and very high rate of biological productivity make coral reefs a very important and unique marine ecosystem. They increase shore stability and protect the coastline from wave action and the impact of natural disasters like cyclones and storm surges. Apart from a significant role as carbon sinks, they also provide a habitat and food for fishes, crabs, prawns and other marine life.

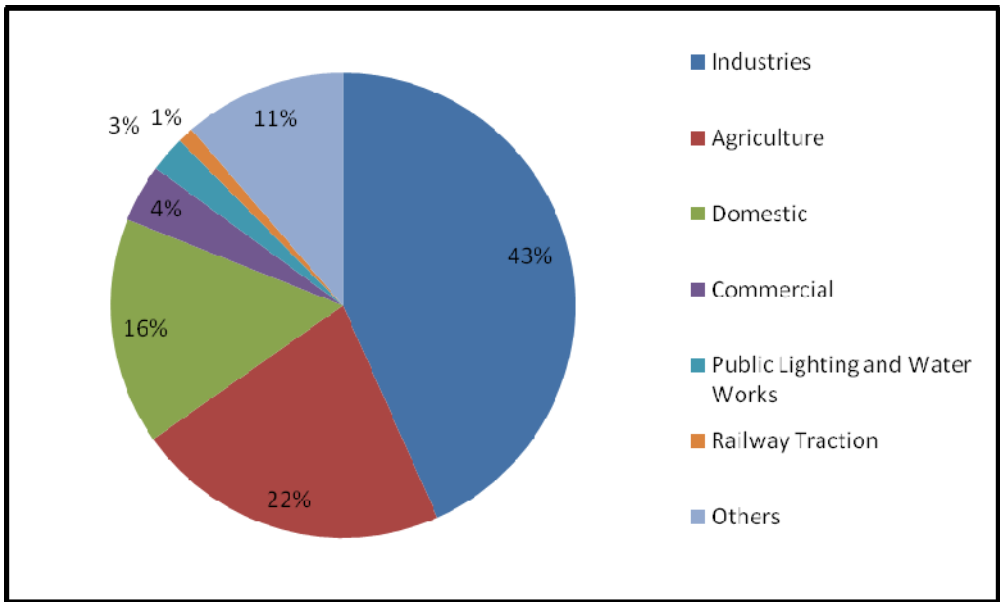
The productivity of corals depends upon their structure, biological recycling and retention of nutrients. Climate Change induced sea-water warming and clear skies (resulting from a higher incidence of solar radiation) damage corals by bleaching them, resulting in high mortality of a number of coral species. Increased ocean acidification could potentially also cause a decrease in the calcification of corals in the region. Impacts of tropical storms may extend further than the direct physical impact of the wind waves they generate. Secondary impacts through changes in coastal runoff that often extend on a scale of 100s of km and cause reduced water quality in near shore areas. Runoff of freshwater and dissolved nutrients from coastal catchments is perhaps the biggest threat to corals in near shore waters. Often these secondary impacts may persist for weeks following a major event, and may extend over a larger area than the physical impact area; they may cause far more damage to reefs than the structural impact (Porter, 1992). IPCC in itsAR4 Report has predicted that up to 88 per cent of all Asia's coral reefs may be lost as a result of warming ocean temperatures.

# 5.0Sources of Green House Gas Emissions

The effectiveness of mitigation efforts over the next two or three decades is reported to have a significant impact on the ability to stabilize atmospheric greenhouse gases at lower levels (IPCC, 2007). IPCC Working Group III (Mitigation) focused on seven sectors, in AR4, that are sources of GHG emissions. These are: energy supply; transportation and its infrastructure; residential and commercial buildings; industry; agriculture; forestry; and waste management.

India has pledged a reduction, though this excludes emissions from agriculture, of between 20 and 25 per cent in GHG emissions intensity per unit of GDP by 2020 from a 2005 baseline (Planning Commission, 2011). An ambitious target of reducing the energy intensity by 20 per cent per unit of GDP by 2016-2017 has been mentioned in the 11th Five Year Plan (2007-2012). The Energy Conservation Act (2001) provides a legislative and regulatory framework for implementation of energy efficiency across nine key energy intensive sectors. India is also finalizing an incentive based market mechanism in the form of trading of energy saving certificates in energy intensive sectors (GOG, 2010). The Green India initiative includes planned expansion of forests for enhancing ecosystem services, including carbon sinks, by afforestation of six million ha to reach the national target of 33 per cent land area under forest and tree cover; and also, supports sustainable agricultural practices. Opportunities for efficiency improvements in industry (both manufacturing and services), transportation, renewables and domestic sectors are simultaneously being explored and harnessed, by adopting measures like standards and labeling for appliances, adhering to performance standards for reducing vehicular emissions, and planned use of incentives such as reduced taxes on energy-efficient appliances etc.

**Figure 19: Sector-wise consumption of electricity (2011-12)**



Source: GoG2013

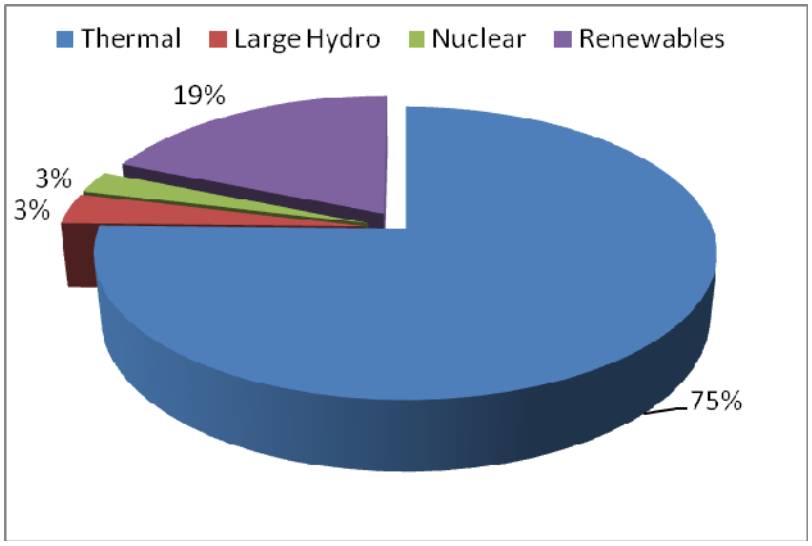
## 5. 1 Energy

Since, Gujarat has recorded significant economic growth over the past decades; the State has a high per capita consumption of electricity. Huge investments that are planned to add to its economic momentum, and the resultant increase in industrialization will lead to increase in urbanization and income levels, that results in substantially higher demand for power.

### 5.1.1 Power generation

Gujarat will need to secure its fuel requirement as most of it is imported. Gujarat also has a large untapped potential for energy generation through renewable sources, which needs to be exploited. The assured availability of power at competitive tariffs can help in positioning Gujarat as a competitive destination for industries, while also providing a good quality of life for its citizens. This will also help revival and development of rural industries and build rural economies, thereby reducing migration from rural areas for employment.As on March 31, 2014, the total installed capacity of the State is over 22,791 MW, of which 4281 MW is from renewable sources of energy.i.e. nearly 19% of share of renewables. This includes energy from wind (3352 MW, 78.4%), solar (891 MW, 20.8%), biomass (31MW, 0.73%) and mini hydro (7MW, 0.16%) There are 23 large power plants in the State which includes nine thermal power plants, nine gas power plants, four large hydro-power plants and one atomic power plant.

**Figure 20: Installed capacity of the State**




Source: Gujarat Energy Development Agency, 2014

In Gujarat, the scenario with respect to ownership distribution is also interesting and has dramatically changed since2009-10. The 7,607 MW of capacity in the private sector (independent power producers) has exceeded the State Government's share of

7,063 MW, not to mention that it has by far surpassed the central share of 3,840 MW by March 2014.

**Table 144: Installed power capacity in western region (MW)**

| Installed Power Capacity in Western Region (MW) | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | As of June 30, 2014 | | | | As of March 31, 2009 | | | |
| | Central | State | Private | Total | Central | State | Private | Total |
| Gujarat | 3631.86 | 7596.70 | 17194.80 | 28423.36 | 2,351 | 5,447 | 3,826 | 11,624 |
| Madhya Pradesh | 4306.81 | 5572.32 | 4585.47 | 14464.60 | 3,451 | 4,583 | 191 | 8,225 |
| Chhattisgarh | 1538.01 | 2952.00 | 5485.00 | 9975.01 | 521 | 2,168 | 1,156 | 3,845 |
| Maharashtra | 6627.34 | 12284.27 | 16255.76 | 35167.37 | 5,169 | 10,818 | 4,467 | 20,453 |
| Goa | 351.97 | 0.05 | 48 | 400.02 | 303 | 0 | 78 | 381 |
| Daman & Diu | 48.29 | 0 | 0 | 48.29 | 28 | 0 | 0 | 28 |
| Dadra & Nagar Haveli | 79.93 | 0 | 0 | 79.93 | 55 | 0 | 0 | 55 |
| Western Region | 18631.60 | 28405.34 | 43569.03 | 90605.97 | 11,878 | 23,016 | 9,717 | 45,987 |
| Note: Grand total includes unallocated power from Central utilities | | | | | | | | |

Source: Central Electricity Authority, Ministry of Power, Government of India (http://www.cea.nic.in, accessed on July 31, 2014)

**Table15: Private capacity in Gujarat (MW)**

| Private Capacity in Gujarat(MW) | | |
|---|---|---|
| | June 2014 | March 2009 |
| **Coal** | 8620 | 640 |
| **Gas** | 4160 | 1,813 |
| **Diesel** | 0.20 | 0 |
| **Hydro** | 0 | 0 |
| **Nuclear** | 0 | 0 |
| **Renewables** | 4414.60 | 1,373 |
| **Total** | 17194.80 | 3,826 |

Source: Central Electricity Authority, Ministry of Power, Government of India (http://www.cea.nic.in, accessed on July 31, 2014)

One of the facts worth highlighting is that from 2001-08, the State's net generation (GWh) has increased by 28.75 per cent and $CO_2$ intensity ($tCO_2$/MWh) has reduced by 4.18 per cent vis-à-vis India's net generation which has increased by 37.34 per cent and $CO_2$ intensity has decreased by 0.93 per cent only. The State Government has undertaken several steps to improve the overall efficiency of the power generating units through adoption of better operation and maintenance (O&M) practices (to reduce station heat rate and auxiliary consumption); renovation and modernization (R&M) of low-performing/old units; and use of better quality - high calorific value coal (washed coal/imported coal). Regular energy audits of power plants are carried out and by implementation of recommendations of audit results, the generating stations have achieved a saving of 13,035.831 MWh of energy per annum. In addition, the State is aggressively promoting gas-based combined cycle power generation plants (219 MW CCTP at Dhuvaran, Anand promoted by GSECL leading to $CO_2$ emission reductions by 2,14,000 $tCO_2$/annum; 375 MW CCTP at Utran, Surat).

The Gujarat State Petroleum Corporation Limited (GSPC) has planned a **'State Wide Gas Grid'** to provide clean fuel to remote areas of the State. A 1,500 km long high pressure gas pipeline passing through 15 districts of the State (to cater to power, fertilizer, chemicals and SME units like glass and ceramic etc.) has been laid and commissioned and an 800 km stretch is under construction. The power generating units of the State are also exploring fuel switching options from naptha to gas (for both captive use and grid supply) to reduce GHG emissions. The State's new Power Generation Policy encourages setting up of super-critical and ultra-super-critical technology based generation projects.

### 5.1.2 Renewable energy

In addition, the State is aggressively promoting renewable energy sources. According to Gujarat Energy Development Agency (GEDA), the State nodal agency working in the field of renewable energy development, investments worth Rs.65,000 crore is expected by 2014. According to the Socio-economic Review of the State Government for 2012-13, the wind power potential in the state is around 10,000 MW of which approx. 3352 MW has already been installedalong with the solar power projects of 891 MW capacity commissionedas on March 2014.Some of the other key energy generation options in the State include biofuel energy, Municipal Solid Waste (MSW) to electricity and geothermal energy.

**Table 15: Renewable energy potential in Gujarat**

| Source | Resource | Energy Generation/saving Potential |
|---|---|---|
| Biomass | 24 Million tones | 900 MW |
| Tidal | Gulf of Kutch, Gulf of Khambhat | 9000MWe |
| Solar | Solar radiation | 5- 6.4 kWh/sq.mt./day |
| Wind | Coastline and hilly regions | 10,000 MW at 50m height |
| Energy Conservation | | 23 per cent |

Source: GEDA, 2014

#### 5.1.2.1 Wind energy

On the wind energy-front, Gujarat has the benefit of the longest coastal belt. The State has the second highest potential (10,645 MW) and third highest installed capacity (3352 MW as on March 2014) in the country with 50 sites across the State having wind generation potential. The State Government has ambitious plan for the coasts of Saurashtra and Kutch. Gujarat's Wind Power Policy (2013) spells out various incentives and exemptions (e.g. feed-in-tariff has been increased from Rs. 3.56/unit to Rs.4.15/unit) to tap over 10,000 MW wind energy potential of the State. The Renewable Energy Power Purchase Obligation (RPOs) for the year 2014-15 has been increased to 6.25per cent to further promote investments in the area. By making use of the wind energy potential of the region, the State can save 4.68 million tonnes of coal per annum and as a result reduce its $CO_2$ emissions by 6.70 million tonnes per annum (GEDA, 2014)

#### 5.1.2.2 Solar energy

In the context of solar energy potential, the State once again, benefits from its geographical position, and has almost 300 days of clear sun and solar insolation of 5.0-6.4kwh per sqmt per day, along with conducive arid condition and minimal sun tracking, making it an ideal place for solar energy power plant. Vast tracts of land in Banaskantha, Kutch and Saurashtra are ideally suited for tapping solar energy both for generation of power and green houses. The State Government's Solar Power Policy (2009) extensively promotes solar power and already 891 MW of solar power has been commissioned in various districts of Gujarat. Under the policy, a slew of incentives are offered to prospective developers in the State. The Government has fixed a tariff of Rs.15/unit for the first 12 years for the sale of energy by those megawatt scale photovoltaic solar projects commissioned before March 31, 2010, and Rs.5/unit for the remaining 13 years For solar thermal power projects, a levelized tariff of Rs. 11.55 has been fixed for 25 years.. According to State Government estimates, by using the solar potential of the State there would coal savings of around 1.00million tonnes per annum thereby leading to reductions in $CO_2$ emissions of 1.43million tonnes per annum. The State agencies are already being harnessed to provide energy inthe tribal and rural regions of the State (Kanzal, Porbandar, Junagadh, etc.). In fact, as a pioneering initiative in the country, the State has already launched a **Smart Grid** for integrated and efficient distribution of solar energy from the solar parks to urban and rural areas.

#### 5.1.2.3 Tidal energy

A large coastline of 1,663 km and a tidal wave altitude reaching nearly six metres at various locations in Gujarat presents the State with yet another energy option - tidal energy. However, the technologies for the efficient use of tidal waves are at the developmental stage, in the State, but undoubtedly could be harnessed. The State Government has completed a feasibility study to set-up the ambitious Kalpasar project which aims to generate 6,000 MW of electricity from tidal waves, during peak hours. The multi-purpose project includes a 33 km long dam-cum-bridge across the Gulf of Khambhat to store a huge reservoir of rain water flowing down the rivers for irrigation purposes.

### 5.1.3Energy efficiency

To address the issue of energy access to all, the State Government has introduced several initiatives to promote use of energy efficient technologies (e.g. power generation) and equipments (e.g. domestic use), and reduction of Transmission and Distribution (T&D) losses. The Jyoti Gram Yojana (JGY) introduced by the State Government supplies three phase power supply for 24 hours to all villages and surrounding hamlets in the State for non-agricultural practices. Besides ensuring regular energy supply to the rural population, this program has to a great degree resulted in creation of better opportunities of local employment in the villages and reduced the migration of people from rural to urban centres. All 18,000 villages and 52,28,660 rural households are beneficiaries of this program with a total expenditure of Rs. 1,290 crores (Rs. 1,110 crores from GoG).

For reducing the T&D losses and improving the power factor, lines with higher transmission voltages have been laid, high voltage sub-stations have been set-up, and capacitor banks have been installed at various sub-stations in the State. As a result T&D loses have drastically decreased over the years. The T&D loss during the year 2000-01 was 35.27 per cent with an installed capacity of 8,588 MW and the generation efficiency i.e. the plant load factor (PLF) of 67.85 per cent. The installed capacity has increased to 9,864 MW by 2008-09 with a PLF of 75.32 per cent and a T&D loss of 21.14 per cent. The maximum power demand catered in the 2000-01 and 2008-09 was 7,289 MW and 9,437 MW respectively. Thus it is evident that there has been a reduction in T&D losses by 14.13 per cent (35.27 – 21.14) and increase in generation efficiency by 7.47 per cent (75.32-67.85) during 2001-2009.

Thus the coming years will witness Gujarat emerging as a hub not only for power generation from conventional sources but also from more environment-friendly renewable sources.

**Box 6: Bal Urja Rakshak Dal**

The State government has introduced several programs and schemes to create awareness about the merits of energy conservation efficiency upgradation. For example, the Bal Urja Rakshak Dal (BURD), initiated in 2004-05, mobilizes children as Urja Rakshaks (energy guardians) to create awareness about responsible, restrained and rational use of energy among communities and schools. Till date a force of 50,000 children and 3,600 school teachers has been engaged in this program

**Box 7: Sardar Sarovar Project**

Amongst the 30 large dams planned for the Narmada, the Sardar Sarovar dam is the largest with a proposed height of 136.5 m (455 feet). According to GoG the multi-purpose Sardar Sarovar Project (SSP) would irrigate more than 1.8 million ha of land, covering 3112 villages of 73 talukas in 15 districts of Gujarat (75 per cent of this area is drought prone). It will also irrigate 75,000 ha of land in the strategic desert districts of Barmer and Jallore in Rajasthan and 37,500 ha in the tribal hilly tracts of Maharashtra. Assured water supply will soon make this area drought proof.

| Year | Electricity Generated (Million KWh) |
|---|---|
| 2004-05 | 263.257 |
| 2005-06 | 1951.782 |
| 2006-07 | 3600.082 |
| 2007-08 | 4435.692 |
| 2008-09 | 2317.673 |
| 2009-10 | 2501.327 |
| 2010-11 | 3588.740 |
| 2011-12 | 4359.296 |
| 2012-13 | 3698.239 |
| 2013-14 | 5877.324 |

There are two power houses - river bed power house and canal head power house with an installed capacity of 1200 MW and 250 MW respectively. With the installed capacity of 1450 MW and commenced since 2004, SSP would generate 856 to 1007 MU per year. The power is shared by three states - Madhya Pradesh (57%), Maharashtra (27%) and Gujarat (16%). This provides a useful peaking power to the western grid of the country which has very limited hydel power production at present. The two powerhouses – River Bed Power House and Canal Head power of SSNNL has generated 32593 MUs of electricity till March- 2014. A series of micro hydel power stations are also planned on the branch canals where convenient falls are available.

An equivalent power generation through thermal sources would require huge amount of coal every year and would release large amount of emissions (after observing all environmental norms and permissible limits of emissions). Moreover, the assured water supply to the region would reduce the pressure on groundwater and in turn reduce the electricity consumption for pumping.

Source: http://www.narmada.org/sardarsarovar.html
http://www.supportnarmadadam.org/sardar-sarovar-benefits.htm

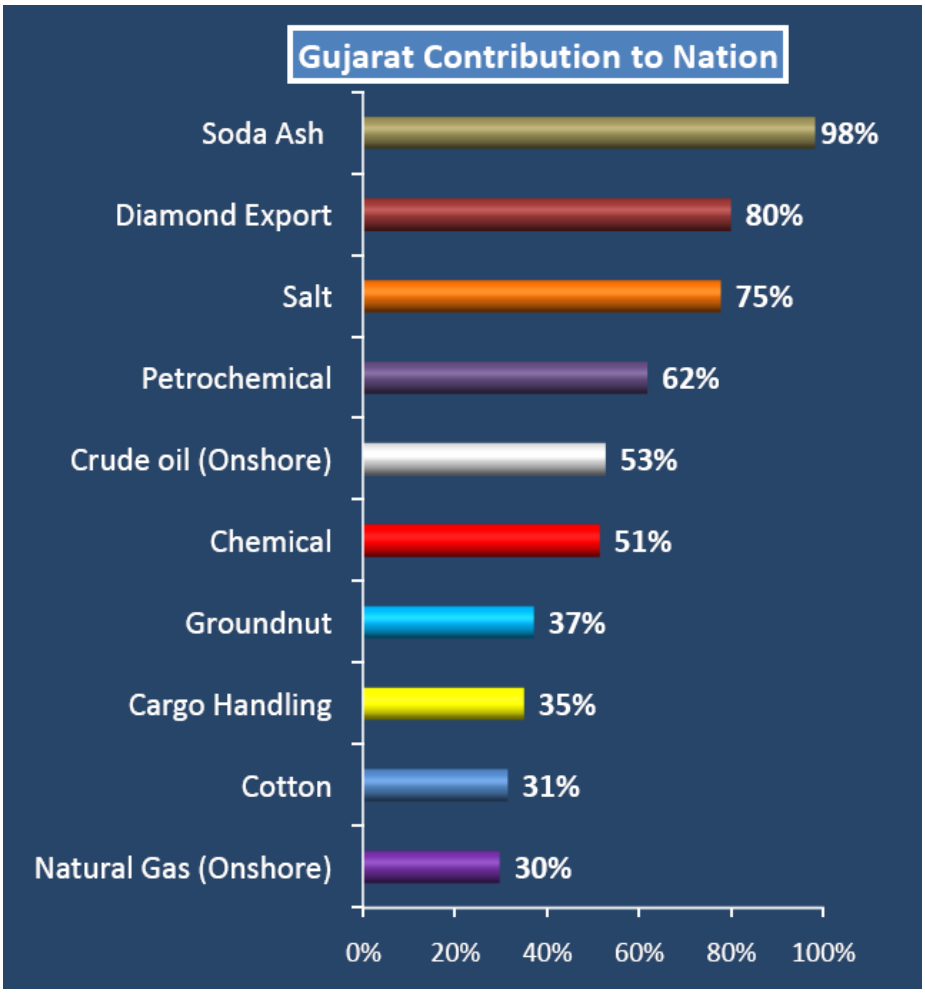
## 5.2 Industry

### 5.2.1 Industrial growth

Gujarat has registered impressive industrial development, since its formation as a separate State in 1960. The industrial sector at present comprises of over 1,200 large industries and over 3,45,000 micro, small and medium industries. As per the results of the Annual Survey of Industry (ASI), 2005-06, carried out by the Central Statistical Organization (CSO), under Ministry of Statistics and Program Implementation, Government of India, Gujarat accounts for 19.69 per cent of fixed capital investment, 16.13 per cent of gross output and 15.35 per cent of net value added in the industrial sector in India. This survey further reinforced the position of Gujarat as the most industrially developed State in India, in respect of first ranking in industrial investment and second, in terms of value of production and value addition in the industrial sector.

Over the years, Gujarat has diversified its industrial base substantially. In 1960-61, textiles and auxiliaries were the major contributor to the industrial economy of the State. In the span of over 49 years, the industrial spectrum has been completely transformed and today 12 major industry groups together account for 86 per cent of factories, 96 per cent of fixed capital investment, 94 per cent of value of output and 95 per cent of value addition in the State's industrial economy. In the recent years, refined petroleum products has emerged as one of the largest industrial groups having 29.25 per cent share, followed by chemicals having 21.21per cent share. Other important groups include food products (3.03per cent), textiles (5.66per cent), basic metals (7.65per cent), machinery and equipment (5.61per cent), non-metallic mineral based products (4.15per cent), fabricated metal products (3.37per cent),(GoG, 2013). The industries in Gujarat produce a wide variety of products. The products which contribute significantly to the Indian economy include - soda ash (98 per cent), salt (75 per cent), processed diamonds (80per cent), petrochemicalproducts (62 per cent),crude oil (53 per cent), chemical (51per cent), groundnut (37 per cent), cotton (31 per cent) and natural gas (30 per cent). Thus a strong manufacturing sector is the edifice of economic activity in Gujarat. The State contributes 17.22 per cent to the total value of output added by manufacturing sector of the country.(GoG,2013)

**Figure 21: Gujarat: Contributing to the nation across sectors**




Source: Government of Gujarat, 2013

Over a period of time, Gujarat has also succeeded in widening its industrial base geographically. At the time of its inception in 1960, industrial development was confined only to four major cities, namely Ahmedabad, Vadodara, Surat and Rajkot and some isolated locations such as Mithapur and Valsad. Today, almost all the districts of the State have witnessed industrial development in varying degrees. Such a massive scale of industrial development has been possible on account of judicious exploitation of natural resources, such as minerals; oil and gas; marine; agriculture; and animal wealth. The discovery of oil and gas in Gujarat in the 60s has played an important role in setting up of petroleum refineries, fertilizer plants and petrochemical complexes. During the same period, the State Government has also established a strong institutional network. Gujarat Industrial Development Corporation (GIDC), established industrial estates by providing developed plots and built-up sheds to industries across the State. Institutions were also set up to provide term finance, assistance for purchase of raw materials, plant and equipment and marketing of products. Later, District Industries Centers (DICs) were set up in all the districts to provide assistance for

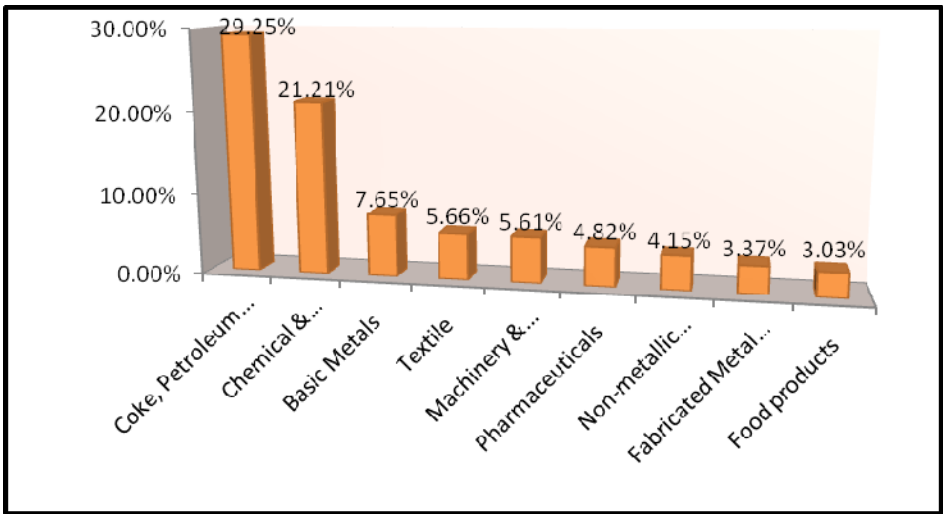
setting up industrial units by providing support services.The State also developedinfrastructure facilities required for industries, such as power, roads, ports, water supply and technical education institutions. The Government also introduced incentive schemes, from time to time, to promote industries mainly in the under-developed areas of the State, to correct regional imbalances. All these initiatives make Gujarat a highly industrialized State.

**Table 16: Key industries in Gujarat**

- Agro & food processing
- Dairy
- Chemicals & petrochemicals
- Textiles & apparels
- Engineering & auto
- Gems & jewellery
- Oil & gas
- Pharmaceuticals & biotechnology
- IT
- Minerals
- Ports and Ship building
- Power
- Tourism

Source: Vibrant Gujarat Summit, 2013

**Figure 22: Share of industry sectors in Gujarat**




Source: Socio-Economic Review 2012-2013. Gujarat State

The filing of the Industrial Entrepreneurs Memorandum (IEM) with Secretariat of Industrial Approvals (SIA), GoI, is considered an important parameter for assessing the degree of industrial development in a State. The details of IEMs filed for Gujarat during 1991-2009 vis-à-vis other key Indian states are as follows:

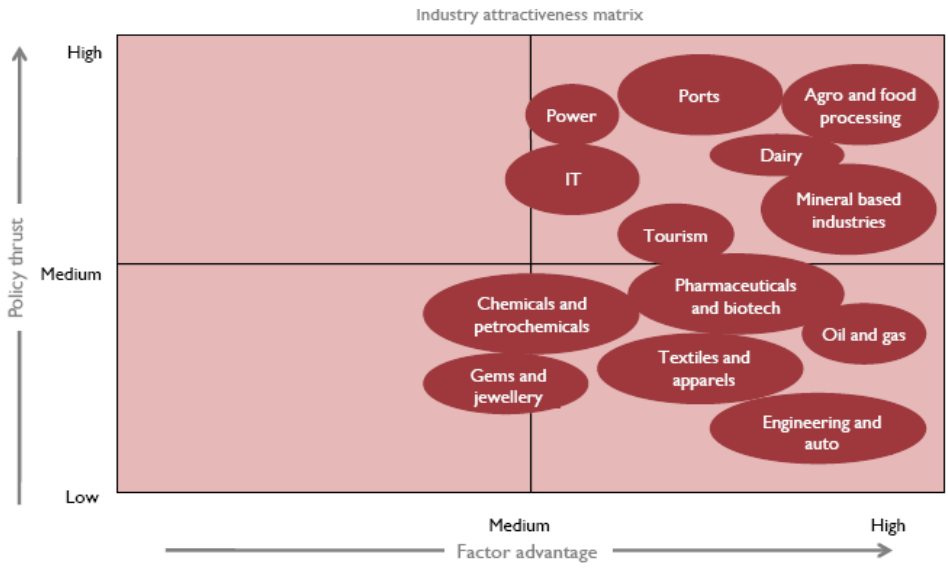
**Table 17: Progress of Industrial Entrepreneurs Memorandum (IEM) - Gujarat and other key states (August 1991 to November 2009)**

| State/UTs | No. of Projects | per cent Share | Proposed Investment (Rs.Cr) | per cent Share |
|---|---|---|---|---|
| Orissa | 1424 | 1.79 | 718542 | 12.83 |
| Chhattisgarh | 2486 | 3.12 | 741766 | 13.24 |
| **Gujarat** | **9324** | **11.72** | **701599** | **12.52** |
| Maharashtra | 14354 | 18.04 | 543939 | 9.71 |
| Andhra Pradesh | 5837 | 7.34 | 476195 | 8.50 |
| Karnataka | 3320 | 4.17 | 425038 | 7.59 |
| Jharkhand | 962 | 1.21 | 385106 | 6.87 |
| Madhya Pradesh | 3149 | 3.96 | 351085 | 6.27 |
| West Bengal | 4521 | 5.68 | 289741 | 5.17 |
| Tamil Nadu | 6783 | 8.53 | 236750 | 4.23 |
| Other States | 27403 | 34.44 | 732058 | 13.07 |
| **All India** | **79563** | **100.00** | **5601819** | **100.00** |

Source: Industries Commissionerate, Government of Gujarat (accessed in February 2011)

As shown in the above table, 9,324 IEMs having an aggregate investment of Rs.7,01,599 crore have been acknowledged for various locations in Gujarat. The State Government has put in place an effective mechanism for monitoring of all industrial approvals, in order to know the status of these approvals and provide effective intervention in the speedy implementation of these projects.

**Figure 23: Key industries with policy thrust and factor advantages in Gujarat**



(*Factor advantages include benefits due to geographical location and availability of factors such as talent pool, natural resources and capital)

Further, over time, Gujarat has registered a sizeable growth in the SME sector. There are over 3,12,000 (September 2006) small scale industries (SSIs) in the State.A total of 140,587MSME enterprises were acknowledged during 1/10/2006 to 31/12/2012. Thus the totalMSME stood at 453,339 on 31/12/2012 providing employment to 25,04,856 people (GoG 2013). SSIs have played an important role in dispersal of industries. Ahmedabad district leads the State with the highest number of SSI units followed by Surat, Rajkot and other districts. Textile including hosiery and garments accounts for the largest number of SSI units, followed by other sectors like machinery and parts, except electrical, metal products, food products, and chemical and chemical products, etc. The development of small and medium enterprises has taken place in the form of different industrial clusters. There are, in all 83 industrial clusters for different industry groups in the State, developed at a number of different locations. The approach of cluster-based development has helped in improving cost competitiveness of the industries by way of creating common facilities; developing market centres and brand names; and promotion of skill. Some of the successful clusters include the ceramics cluster at Morbi, the brass-parts cluster at Jamnagar, the fish-processing cluster at Veravaland the power-looms cluster at Ahmedabad. The State has 202 industrial estates established by the Gujarat Industrial Development Corporation (GIDC) for specific sectors such as chemicals, electronics, gems, apparels and granite.

As of May 2013, the State had 57 approved Special Economic Zones (SEZs), these include multi-product SEZs and sector-specific SEZs covering alternative energy, textiles, pharmaceuticals, engineering, chemicals, ceramics, gems and jewellery and IT/ITES sectors. SEZs are considered as growth engines that can boost manufacturing, augment exports and generate employment. Government of Gujarat has enacted the Gujarat SEZ Act, 2004. Besides this, the SEZ Rules, 2005 and SEZ Regulations are in place. Under the Act, assistance is provided to the developer of SEZ for development of infrastructure facilities and providing services (SEZ policy includes flexible labour laws and exit options for investors, 10-year corporate tax holiday on export profit - 100 per cent for the initial five years and 50 per cent for the next five years).. Gujarat's three functional SEZs prior to SEZ Act are– Kandla SEZ, SUR SEZ, and Surat Apparel Park.

### 5.2.2Environment friendly initiatives

The State Government is undertaking several initiatives to promote clean, energy-efficient, and environment-friendly industrial development, such as using clean fuel (NG/CNG mode) in industrial units; upgradation and improvement of industrial air pollution control systems; and afforestation programs by corporates around their establishments. The new Industrial Policy of the State encourages use of renewable energy sources, water conservation and recycling techniques, reduction of carbon footprints, use of CDM (and other market-based mechanisms) to reduce costs of employment of high-end clean technologies, co-firing of wastes as fuel with coal, use of biotechnological principles and processes to manage wastes and other sustainable waste management practices by industrial units in the State.

#### 5.2.2.1 Energy audits

In order to promote energy efficiency in SMEs in the region, the State Government implements the energy audit schemes carried out by Bureau of Energy Efficiency (BEE) approved consultants. The auditors suggest various measures to SMEs for reduction of energy consumption and over 1,200 SMEs have benefited from this initiative. The GoG subsidizes the cost of energy audit to the extent of 50 per cent or Rs. 20,000 or whichever is lower.

## 5.3 Transport

The transportation system in Gujarat is well developed. The State is extensively covered by rail and road networks and the surface transport network is supplemented by airline routes connecting major cities. The State also has a number of ports.

### 5.3.1 Road network

As of end of 2009-2010, the State had a road network of 77,265km (96.96 per cent of which is surfaced road) including National Highways (3,262 km), State Highways (18,421km), major district roads (20,503 km), other district roads (10,227 km) and village roads (24,852). About 38.2 per cent of the total expressways and National Highways in the State are multi-lane and 87.9 per cent of total roads are asphalt-surfaced. In addition, there is 98.86 per cent rural connectivity through all-weather roads, which is among the highest in India. (GoG, 2013)

'PragatipathYojana', a State Government initiative introduced in 2005, envisages the development of nine high-speed corridors and widening of highways to connect tribal, coastal, industrial and rural areas with mainstream areas.

**Figure 24: Road map of Gujarat**

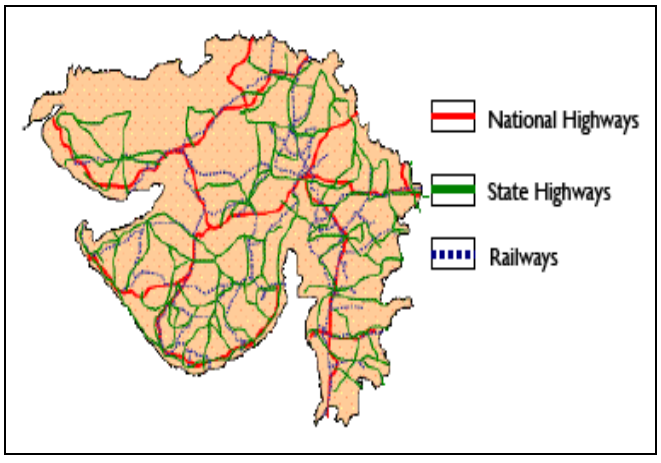



**Table 18: Road network**

| Road Type | Road length (km) |
|---|---|
| National Highways | 3,262 |
| State Highways | 18,421 |
| Major district roads | 20,503 |
| Other district roads | 10,227 |
| Village roads | 24,852 |

Source: Gujarat State Road Development Corporation, GoG 2013

#### 5.3.1.2 Motor vehicle emissions

The number of registered motor vehicles in the State has increased from 129.93 lakh in 2010-2011 to 144.14 lakh in the year 2011-12, showing a growth of 10.93per cent. About 72.86per cent of the total registered vehicles were motor-cycle class vehicles (two wheelers). During the year 2012-13 (April-October-2012), total number of registered vehicles was 151.68 lakhs. The number of registered motor cycles/scooters/mopeds increased to 110.53 lakh from 105.12lakhs showing a rise of 5.14per cent. The number of auto-rickshaws, motor cars (four wheelers including jeeps), goods vehicles (including tempos), trailers and tractors registered an increase of 24,433, 1,06,811, 37,571, 10,945 and 24,284 respectively during the year 2012-13 (April-October-2012).

**Box 8: Reducing Vehicle usage in Ahmedabad**

With the burgeoning population of over 4.5 million in Ahmedabad city, around 8,00,000 passengers are ferried every day through a fleet of over 1,000 Ahmedabad Municipal Transport Service (AMTS) buses and around 1.9 million private vehicles of all kinds. The enormous traffic is a major source of GHG emissions in the city.

To reduce the traffic congestion and thereby address the problem of GHG emissions, the State government has planned and executed the Bus Rapid Transport System (BRTS) at a cost of around Rs.9, 820 million. This would ultimately reduce the movement of 4,00,000 vehicles per day and carry 1,00,000 additional passengers through BRTS buses over and above AMTS buses. As per estimates, there would be a net reduction of 37,000 tonnes of GHG per annum (mainly $CO_2$ and $NO_x$) as a result of this massive project. In addition, more than a dozen flyovers are being executed in the city to facilitate easy transit of around 200,000 vehicles leading to further emissions reductions.

In fact, as a result of the above stated projects and other similar initiatives carried out in the city, Ahmedabad has dropped to the 66th rank from 4$^{th}$ rank in the ranking of leading polluted cities of the country published by the CPCB (2008).

The number of routes operated by the Gujarat State Road Transport Corporation (GSRTC) decreased to14,853, with route km coverage of 11.36 lakh km in 2011-12. The average number of GSRTCvehicles on road during the year 2011-12 was 6,660 as against 6,327 in 2010-11.

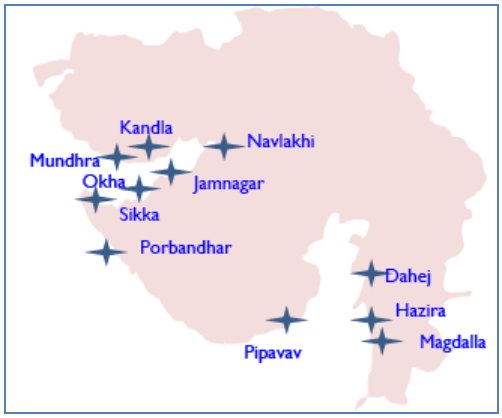
The State authorities are implementing several initiatives to address the problem of air pollution with the increasing pressure on the existing and proposed transport infrastructure in the State. This includes construction of flyovers, ring-roads, by-pass roads etc. to reduce distance travelled between two points (and thereby reduce fuel usage). This effort included construction of 53 bridges by the Surat Municipal Corporation and 14 flyovers that are under construction by the Ahmedabad Municipal Corporation; promotion of mass transport systems (in last three years more than 3,700

buses, including 100 CNG buses, were acquired by the GSRTC and another 1,000 buses will be inducted; and 8 lakhpassengerstravel by Ahmedabad Municipal Transport Services Buses per day) to increase the number of people travelled per litre of fuel; and construction of Bus Rapid Transport System (BRTS), in Ahmedabad, Rajkot, Vadodara and Surat. Conversion of diesel/petrol run vehicles to CNG has been actively encouraged in the State, and till 2009 more than 3.26 lakh auto-rickshaws have switched to CNG. The traffic signals are being run on solar power or LED instead of conventional power in several cities in the State. Urban Local Bodies (ULBs) are being facilitated to adopt the public private partnership model (PPP) for promotion of urban transport run on cleaner fuels to the extent possible, and this has been successful in Surat, Rajkot and Vadodara.

### 5.3.2Ports

The State of Gujarat, located on the west coast of India, has a coastline of about 1,663 km, and one of the strongest port infrastructures in India with 42 ports including one major port at Kandla and 41 minor ports geographically dispersed across South Gujarat (14 ports), Saurashtra (23 ports) and Kachchh region (4 ports). In 2007-08, the State was ranked first in India, with 147 MMT in cargo throughput. The State has five direct berthing commercial ports, seven direct berthing captive port terminals and four lighterage-cargo ports. It handled the largest (79.84 per cent) share of cargo traffic in India's minor and intermediate ports, and 11.5 per cent in India's major ports in 2008-09. The State has two LNG terminals that offer transportation facilities for natural gas, crude oil and petroleum products from the Middle East and Europe. Further, Gujarat plans to have modern mechanized cargo handling systems in all the new ports. Gujarat has formulated a Port Policy and promotes private sector investment in development of ports and related infrastructure. Ten green field port projects identified by Gujarat Maritime Board (GMB) as envisaged in the Port Policy, 2005, are now functional.

**Figure 25: Main ports of Gujarat**




Source: "Ports of Gujarat" –sector profile 2008-09, Gujarat Maritime Board (GMB)

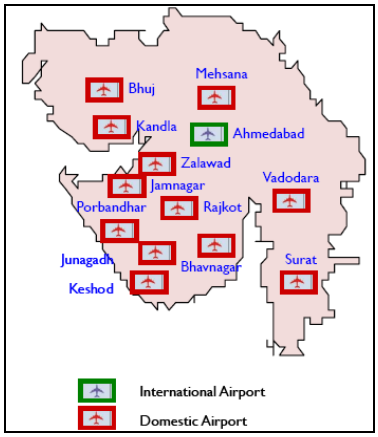
Many upcoming ports are being developed as captive ports to catering to specific company and industry requirements. The State undertakes fast-track clearance in establishment of ports through private participation and there is an increase in connectivity to non-major ports owing to the development of the Delhi-Mumbai

Dedicated Freight Corridor. More than 4,800 ships and 1,000 sailing vessels visit the ports of Gujarat every year.

### 5.3.3 Airports

Gujarat has a fairly extensive network of airports and airfields scattered throughout the State. There are 13 domestic airports (the highest in any State) and one international airport at Ahmedabad. The domestic airports are at Bhavnagar, Bhuj, Jamnagar, Kandla, Keshod, Junagadh, Porbandar, Rajkot, Surat, Vadodara, Zalawadand and Mehsana. Further, a feasibility study for an international airport at Fedrain Dholera (about 130 km away from Ahmedabad) has been completed in January 2010. Once ready, the airport could be useful for both passenger and cargo purposes.

**Figure 26: Airports in Gujarat**

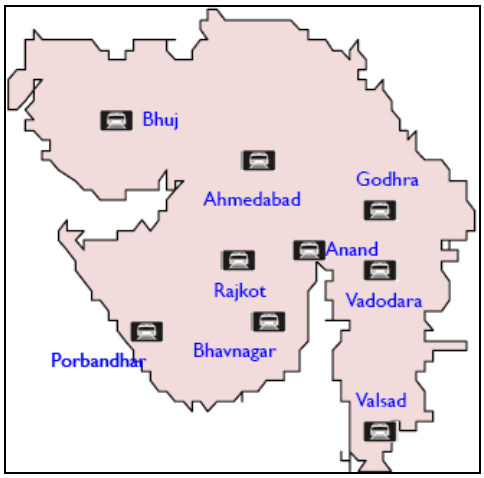



*Source: http://www.ibef.org/states/gujarat.aspx*

### 5.3.4 Rail

The total length of railway lines in the State as on 31st March 2011 was 5,271 route km comprising 3,382 km of broad gauge (BG), 1205 km of metre gauge (MG) and 684 km of narrow gauge (NG) lines. There are 21 major railway stations in Gujarat. The important stations are Ahmedabad, Anand, Bhavnagar, Bhuj, Godhra, Porbandar, Rajkot, Vadodara (Baroda) and Valsad.

**Figure 27: Key railway stations in Gujarat**




*Source: http://www.ibef.org/states/gujarat.aspx*

## 5.4 Agriculture

The agricultural sector, on an average, accounts for about 30 per cent of the total electricity consumption in India and currently Gujarat's agriculture sector is the second largest consumer of electricity in the country. However, it should be noted that the recorded patterns of energy consumption in the State in the yr 2000-2001 showed that agriculture sector consumed the highest share at 45.12 per cent, whereas the industrial sector ranked second with 28.59 per cent consumption. But by the year 2008-09 due to concurrent emphasis of the State Government on initiatives promoting energy efficiency and better irrigation facilities, the sector's electricity consumption drastically reduced to 21.10 per cent leaving scope for enhanced consumption by industries. The sector uses energy directly as fuel or electricity to operate machinery and equipments like tube-wells, tractors etc., to heat or cool buildings for preservation and storage of crops, for lighting on the farm, and indirectly in the fertilizers and chemicals produced off the farm to be used in growing crops. Thus the main drivers of agricultural energy use are agricultural production, the quantity of land used and the penetration of material in use, such as pumping set and agricultural machinery. As shown in the table below, states like Andhra Pradesh, Gujarat, Maharashtra, Karnataka and Uttar Pradesh etc. are some of the leading states in terms of energy consumption in the sector.

The latest data from GHG emissions inventory of 2007 indicates that the agriculture sector contributes 28 per cent of the total GHG emissions from India. The emissions are primarily due to methane emission from rice paddies, enteric fermentation in ruminant animals and nitrous oxides from application of manures and fertilizers to agricultural soils. Indian livestock are responsible for about 54 per cent of total methane emission in India. Indian livestock emit about 10 Tg methane by consuming about 600 million tonnes of feed, consisting largely of crop residues and agro-industrial byproducts (GoI 2011). There exist huge inefficiencies in energy use in the agriculture sector across the country. In fact it has been estimated that the largest population of inefficient pumps and systems is found in this sector. According to BEE, 45-50 per cent of energy savings can be achieved by mere replacement of inefficient pumps and further, there exists a potential of an overall electricity savings of 62.1 billion units annually from over 20 million pumps in the country being used in the sector.[1]The sale of electricity to the sector amounts to no more than 5-10 per cent of the State Electricity Board's revenues in the country and the adoption of a flat rate pricing for agricultural power, which leads to energy wastage, over pumping and inefficient selection of crops. Moreover flat rate pumping masks the true cost of power to farmers. Summing up, the tariff structure and the poor combination of technology and management are responsible for water loss, unsustainable exploitation of ground water and the high energy losses associated with the distribution and end-use of electricity in irrigation water pumping and other agricultural activities. In Gujarat, some of the technical reasons for inefficiency in the agricultural pumping system (APS) in the State include- faulty installation, undersized pipes, high friction foot valves, poor maintenance and

substandard models of pumps. According to GEDA (2006), there is a scope of improving the efficiency of APS in the State by 30-50 per cent by taking corrective measures. As the electricity tariffs for farmers are low, neither the farmer nor the pump dealer have a large incentive to install efficient APS.

Further, studies suggest that Indian states with higher forms of mechanization have higher productivity level. This is especially true for an industrially advanced and economically sound State like Gujarat which has recorded the highest agricultural growth (9.6%) among Indian states between yr 2000-01 and 2007-08. According to International Food Policy Research Institute (IFPRI), the main reasons behind this exemplary performance of the State include massive investment in agricultural infrastructure mainly irrigation, diffusion of new technologies and power reforms by the State agencies.

**Table 19: Net area irrigated by source (Area in '00 ha)**

| Year/ District | Net Area Irrigated by | | | | | Percentage of net area irrigated to net area sown |
|---|---|---|---|---|---|---|
| | Govt. canals (Incl. Panchayat canals) | Tanks | Tubewells & other wells | Other Sources | Total | |
| 1970-71 | 2358 | 372 | 10831 | 147 | 13708 | 14.11 |
| 1980-81 | 3668 | 408 | 15884 | 65 | 20026 | 20.91 |
| 1990-91 | 4731 | 314 | 19301 | 30 | 24376 | 26.07 |
| 2000-01 | 3476 | 153 | 24347 | 84 | 28060 | 29.75 |
| 2001-02 | 3824 | 132 | 25901 | 87 | 29944 | 31.12 |
| 2002-03 | 3804 | 135 | 26373 | 149 | 30461 | 32.32 |
| 2007-08 | 7710 | 454 | 33027 | 1142 | 42333 | 42.48 |

Source-Directorate of Agriculture, Gujarat; Statistical Abstract of Gujarat State (2006), GoG 2013

Another important factor that contributes significantly to the total energy consumption in this sector is the use of chemicals in the form of fertilizers, pesticides etc. The consumption of chemical fertilizers in the State has been steadily increasing over the last few decades.

**Table 20: Consumption of chemical fertilizers in Gujarat**

| Year | Fertilizers (in tonnes) | | | |
|---|---|---|---|---|
| | Nitrogenous (N) | Phosphatic ($P_2O_5$) | Potassic ($K_2O$) | Total (NPK) |
| 1960-61 | 7386 | 3524 | 161 | 11071 |
| 1970-71 | 105711 | 51923 | 6646 | 164280 |
| 1980-81 | 204125 | 117224 | 35519 | 356868 |
| 1985-86 | 286507 | 109296 | 25506 | 421309 |
| 1990-91 | 430746 | 217147 | 58493 | 706386 |
| 1995-96 | 551927 | 160161 | 41410 | 753498 |
| 1996-97 | 596648 | 175619 | 41271 | 813538 |
| 1997-98 | 702771 | 264832 | 60287 | 1027890 |
| 1998-99 | 690728 | 267569 | 61358 | 1019655 |
| 1999-00 | 632133 | 264726 | 68750 | 965609 |
| 2000-01 | 498963 | 195671 | 56006 | 750640 |
| 2001-02 | 605640 | 240232 | 69362 | 915234 |
| 2002-03 | 510793 | 207046 | 71593 | 789432 |
| 2003-04 | 687548 | 255281 | 73497 | 1016326 |
| 2004-05 | 753994 | 296263 | 96223 | 1146480 |
| 2005-06 | 834737 | 328458 | 116729 | 1279924 |
| 2009-10 | 1101600 | 491660 | 206460 | 1799720 |

Source-Directorate of Agriculture, Gujarat; Statistical Abstract of Gujarat State (2006). GoG, 2013

Thus, besides the overall reduction of power savings from the use of efficient heating/cooling and storage etc.

## 5.5 Forestry

Forests play multiple roles in the context of Climate Change. Forests and forest products can play a significant role in mitigation of harmful effects of greenhouse gas

emissions. They act as a “sink” to absorb emissions and store large quantities of carbon for extended periods of time. Forests are also an important component of adaptation strategies needed to address continuing, sometimes dramatic, changes in the natural resource base that sustains livelihoods. However, when forests are destroyed, over-harvested or burnt (deforestation/degradation), they can become a “source” of CO2 emissions. Thus, sustainable forest management should be a critical component of any policy and action programme that seeks to address the growing concern about climate. Afforestation and reforestation programs create opportunities for carbon sequestration.

### 5.5.1 Mitigation

Forests can contribute to Climate Change mitigation (IPCC 2007) by increasing carbon density of existing forests at both stand and landscape scales and reducing emissions from deforestation and degradation. According to IPCC, the mitigation potential of the forest sector is estimated to be in the range of 8.2 to 13.5 per cent of the total mitigation potential, considering all sectors.

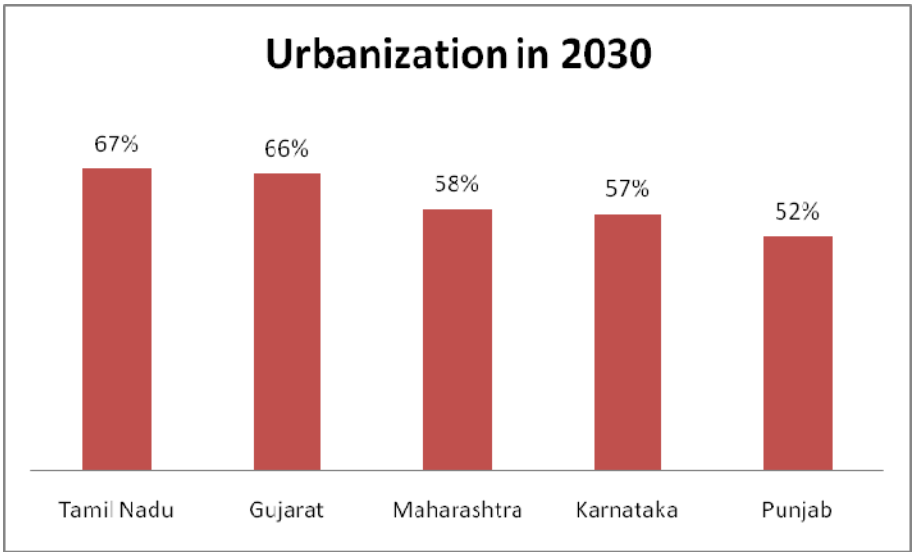
### 5.5.2 Initiatives

Realizing the importance of forests and the role it can play in addressing the challenge of Climate Change, the State Government is undertaking several initiatives to protect the existing cover and also bringing more area under forests and plantations. Some of the strategies being adopted by the State agencies to achieve this goal include social forestry, promotion of multi-cropping in agriculture, mangrove plantation along the 1,663 km coastline etc.

## 5.6 Urban Development

Gujarat is the sixth most urbanized State in India with more than 42 per cent of its population residing in urban centres (Census 2011). This is an approximately a 14 per cent increase over 2001 figures.

**Figure 28: Urbanisation projections**




Source: MHA 2011

Urban planning measures therefore needs to integrate these climate impacts into their planning processes. The State of Gujarat is the first to implement various strategies that directly address climate impacts and the institutional mechanism to implement these is fairly well developed.

The latest National Sample Survey Organisation (NSSO) report, 'Migration in India', which was based on a survey carried out by NSSO across India in 2007 and 2008 has found Gujarat to have the highest rate of urbanization, among all other states in the country. The report brought out that the fast pace of urbanization in Gujarat is mainly due to intra-State migration with large sections of rural people migrating to urban areas, within the State. The report has also found that 6.5 per cent of all urban households in Gujarat are migrants from within the State, which is the highest in the country.

The critical issues that would need to be taken care of with the increasing trend of urbanization include adequate provision of housing facilities (including land use planning), access to energy and water supply, proper sewerage, municipal solid waste management, transport infrastructure, employment generation etc.

However, a fact that needs to be highlighted at this stage is that urbanization leads to a widening gap between demand and supply of essential services and infrastructure. Rapid urbanization fuelled by industrialisation and expansion of service sectors will exert significant pressure on existing urban centres, expanding them to create new urban areas. Hence, there is a need to balance the process of urbanization with the proper and integrated development of its infrastructure. Today more than half of Gujarat's urban population resides in seven large urban centres. Gujarat will need to intervene to ensure that the urban and spatial growth along growth centres/corridors, ports etc are managed well so that urban services can be provided to all.

Commercial and residential buildings are closely associated with emissions from electricity use, space heating and cooling. When combined, the IPCC estimates global emissions from residential and commercial buildings to be eight per cent of global GHG emissions. Commercial and residential buildings are responsible for direct emissions

(onsite combustion of fuels), indirect emissions (from public electricity use from street lighting and other activities and district heat consumption) and emissions associated with embodied energy (e.g. materials used for their construction). Emissions are affected by the need for heating and cooling, and by the behavior of building occupants. The type of fuel used for heating and cooling purposes also determines the amount of GHG emitted (UNHSP 2011)

Use of energy in commercial and residential buildings has a huge potential of reducing emissions. It is expected that, in India, two-thirds of the commercial buildings in 2020 will be built between yr 2005 and 2020. Implementing the Energy Conservation Building

The code to reduce the energy use in new, large commercial buildings, aggressively, should be a priority. This needs effective integration of the ECBC, with the building bye laws implemented by the local governments. Adoption of ECBC could lead to a decline of 30 per cent in the energy intensity of the commercial-buildings sector (GoI 2011)

## 5.6.1 Existing initiatives

### 5.6.1.1 Surat resilience plan

The recommendation of integrating climate risks into urban planning processes offers potential for Gujarat as it already has a pilot city where resilience plan has already been prepared. Surat has been one of the three cities in India which has been a part of Rockefeller Foundation's Asian Cities Climate Change Resilience Network. Under the program Surat city vulnerability to Climate Change impacts was analyzed and a city-wide resilience plan was developed. There is strong potential for replication and scaling up of Surat vulnerability analysis exercise and resilience strategies preparation exercise to other cities in Gujarat. The State has the R&D potential to integrate environmental and sustainability issues in its development planning process through various reputed institutions offering expertise to do so. Although the strategies suggested by the Surat resilience plan do not form part of the Surat CDP, as it was prepared much earlier, they offer potential to do so.

The Surat Resilience Strategy had a multi-sectoral approach, due to which sectoral analyses are available for key urban sectors. For example; five sector studies were conducted which included environment; flood risk and management; health; energy security; and water security to guide the resilience strategy. These studies offered a range of interventions and adaptation options in response to climate risks in the city and to its inhabitants and are available for reference and implementation by the concerned departments.

**Table 21: Broad resilience strategies as propagated through the Surat Resilience Plan**

| Sectors | Resilience Option/Interventions |
|---|---|
| **Natural Disasters** | Climate Watch Group |
| | End-to-End Early Warning System |
| | Multi-Hazard Emergency Response Plan |
| | Hazard Risk Zonation and Zoning Ordinance |
| | Flood reduction infrastructure |

| Sectors | Resilience Option/Interventions |
|---|---|
| Urban Health | • Disease surveillance and epidemiological research<br>• Health GIS<br>• Improved Vector control system<br>• Literacy development on Climate Change and Health Risks |
| Water Resources | • Water resources and supply management plan informed by CVCC. This includes<br>- Water supply monitoring system<br>- CVCC informed resource assessment<br>- Technology options (including reuse and desalination)<br>- Demand side management<br>- Water conservation options<br>- Hardening and design of resilient infrastructure to withstand sea level rise, floods<br>- Emergency supply management<br>- Reduction of leaks programme<br>- Awareness Programme |
| Population | • Skill building Programme (HRD plan)<br>• Certification Programme<br>• Monitoring programme on migration, Need Assessment |
| Environment | • Integrated Public Transport System<br>• Traffic Management Plan |
| Economy | • Loss Minimization Studies<br>• Business Continuity Plan<br>• Development of health support systems for industrial workers<br>• Managed retreat of industries and high value infrastructure (from high risk to low risk zone) |
| Social/equity | • Disaster resilient and energy efficient housing for poor<br>• Awareness generation and social action<br>• Preventive action (to reduce conflicts) |
| Technology | • Energy efficiency improvement programmes<br>• Clean and sunrise industry/service sector |

Source: Surat Resilience Strategy Brief, Rockefeller Foundation

#### 5.6.1.2 Jawaharlal Nehru National Urban Renewal Mission

Under the Jawaharlal Nehru National Urban Renewal Mission (JNNURM), Gujarat is the second highest recipient of projects with 71 approvals after Maharashtra which has 80 projects sanctioned as of 21-3-2014 (MoUD, 2014). Initially, the sanctioned projects for Gujarat include 26 projects worth Rs.2,540 crore for Ahmedabad, 25 projects worth Rs.1.835 crore for Surat, 12 projects worth Rs. 574 crore for Vadodara and 6 projects worth Rs.305 crore for Rajkot. Other projects include BRTS, conservation of heritage structures, drinking water, sewer, over bridges and waste disposal. Initially,under basic services to urban poor (under JNNURM), the State has sanction for 17 projects for

1,01,180 residential units worth Rs. 1,592.12 crore, including three projects worth Rs. 524-crore for Ahmedabad, 9 projects worth Rs. 611 crore for Surat, 3 projects for Vadodara worth Rs. 358 crore and two projects worth Rs. 990 crore for Rajkot(GOG 2010b; Desh Gujarat 2010). As of 08-08-21012, 27 projects have been sanction for 113488dwelling units under basic services to urban poor. By March 2014, Gujarat had already completed 52 projects worth Rs**. 2,77,414.87 lakhs under JNNURM** in the four biggest cities in the State (Ministry Of Housing and Urban Poverty Alleviation, 2014)

#### 5.6.1.3 Green buildings

The design and use of built environment is critical for Climate Change mitigation because the 'Building sector consumes roughly one-third of the final energy used in most countries and absorbs an even more significant share of electricity. A green building design is therefore advocated which reduces the natural resources to the minimum during its construction and operation. The aim of a green building design is to minimize the demand on non-renewable resources, maximize the utilization efficiency of these resources, when in use, and maximize the reuse, recycling, and utilization of renewable resources.

**Box 9: Gandhinagar – The Solar City**

The Gujarat Government has implemented a Gandhinagar Rooftop Programme for electricity generation through solar power under the Gandhinagar Solar City programme. The 5 MW rooftop systems are installed and commissioned out of which 80% are on government building and 20% are on rooftop of private residents. A 1 MW plant has been commissioned within 105 days and at a cost of 15 crore and PDPU, Gandhinagar and a 1 MW plant has been commissioned at the ash dyke of Gandhinagar Thermal Station. Each project generates 15 lakh unit of power per year and reduce the carbon dioxide emission by 1500 T. Solar panels fitted on the rooftops of the houses will generate electricity since seven in the morning till five in the evening. House owners are given two meters - one measures the solar energy generated through solar panels while the other measures the household electricity consumption. The roof-rent agreement has been signed between the Developer and household owner, wherein the Developer pays Rs. 3/- per unit of electricity generation to the owner. Apart from above, other systems such as solar water heating systems at residence & institutes have been installed, energy efficient street lights and tube lights has been installed which have the total annual saving of 149.20 lakhs units of electricity, carbon emission reduction of 14,900 tonswhich is reduction of 10,430 tons of coal.

Source: GEDA, 2014

It maximizes the use of efficient building materials and construction practices; optimizes the use of on-site sources and sinks by bio-climatic architectural practices; uses minimum energy to power itself; uses efficient equipment to meet its lighting, air-conditioning, and other needs; maximizes the use of renewable sources of energy; uses efficient waste and water management practices; and provides comfortable and hygienic indoor working conditions.

### 5.6.2 Urban energy efficiency

The State is implementing the country's largest urban energy efficiency program covering all municipal corporations and municipalities in the State. The program is expected to result in energy savings of nearly 30 per cent thereby contributing significantly in the process of ensuring regular energy supply to all urban centres in the State. To reduce energy consumption and wood usage and thereby restrict GHG emissions, crematoriums in several cities of the State are being converted from electric furnace to CNG furnace leading to electricity savings of over 60 per cent. Burning of one pyre by using firewood requires around 240 kg of wood and emits 160 kg of $CO_2$ in the atmosphere. Replacement of conventional incandescent bulbs with CFLs in commercial and residential buildings and stringent enforcement of the ECBC is being aggressively promoted in the urban areas of the State. Also, decentralized solar energy technologies/equipments like roof-tops for heating and cooking purposes are being encouraged.

## 5.7 Waste

According to the IPCC (2007) report, existing waste management practices can provide effective mitigation of GHG emissions. A wide range of mature, environmentally effective technologies are commercially available to mitigate emissions and provide co-benefits for improved public health and safety, soil protection and pollution prevention, and local energy supply. Waste minimization and recycling provide important indirect mitigation benefits through the conservation of energy and materials. Lack of local capital is a key constraint for waste and wastewater management in developing countries and countries with economies in transition. Lack of expertise on sustainable technology is also an important barrier. In 2007 the waste sector contributed to three per cent of India's total GHG emissions (GoI 2011).

### 5.7.1 Initiatives

To address the issue of municipal solid waste management, construction of regional landfill sites has been proposed for 36 identified clusters, out of which 7 clusters were taken up by the respective municipal corporations. Among them Ahmedabad, Surat and Vadodara has commissioned the landfills, Rajkot Municipal Corporation is developing the landfill, Jamnagar, Bhavnagar and Junagadh are in process to prepare detailed project report (DPR).The rest are being taken care by GUDC. Of which, the construction of nine common/regional landfill sites has been done by GUDC while another nine regional landfill sites is under progress. Ninety three vermi-composting plants have been constructed across the State . The functional vermi-compost plants in the State are eventually expected to generate more than1,000 tonnes of vermi-

compost per day. In addition, to makingthe entire value chain of waste management more effective, elaborate and efficient infrastructure for collection and transportation of wastes from generation sites (e.g. households, etc.) to treatment sites has been developed over the years. (GUDC: http://udd.gujarat.gov.in/projects_SWM.php, accessed on May 5, 2014)

The major cities in the State are implementing several waste-to-energy projects. The Surat Municipal Corporation (SMC) alone is implementing nine sewage treatment

# Section 3
# Strategies for the State Action Plan on Climate Change

plants (STP) with an overall capacity of more than 800 MLD. Another 430 MLD of STP plants are being proposed an extension of existing STPs. To harness the methane generated in the sewage treatment process (and thereby reduce the GHG emissions), SMC has set-up sewage gas based power plants with an overall capacity of 4.75 MW. As per the availability of bio-gas, an average of 3500 units are being generated by one

# 6.0 Strategies for the State Action Plan on Climate Change

The Government of Gujarat, through its State Action Plan on Climate Change, intends to develop an integrated Climate Change response strategy to prepare for and adapt to the impacts of changing climate conditions. State agencies have drawn on the expertise of a broad range of stakeholders to develop strategies for: reducing losses to agriculture and forestry; improving water management and its equitable sharing; protecting livelihoods and human health; safeguarding existing and planned infrastructure and transportation systems; protecting vulnerable species and communities; and promoting environmentally sensitive employment by creation of green jobs.

## 6.1 Gaps in scientific research studies

The vision of a leader can provide impetus and drive action at various levels of administration and governance. Although the political leaders are aware of the challenges associated with global warming, they need detailed information on the Climate Change scenarios, impacts on priority sectors, the possible adaptation measures that can be incorporated in developmental activities and the costs of undertaking these measures. In the absence of definite answers they often find it difficult to channel resources for adaptation actions.

For Gujarat, there may not be enough studies at the district and taluka level on the vulnerability and impacts of Climate Change at a scale that is relevant for anticipatory decision making. Also, the available studies on climate modeling and impacts projections have a degree of uncertainties associated due to factors such as non-linearities, regional scale variations and limited understanding of the climate system. For example, uncertainties are associated with the: magnitude of Climate Change; response of the climate system to these changes at global and local scales; and impact models and the spatial and temporal distributions of impacts. These uncertainties get accumulated at various levels of climate assessments have implications for the development of long term adaptation strategies. These when coupled with limited information base, contribute to the complexity of political decision making for addressing the Climate Change challenge.

Policy-making often involves trade-offs and is a result of fully considered choices. This might create a scenario where action on Climate Change is delayed in anticipation of more reliable scientific evidence. Climate Change requires urgent attention and immediate action. Therefore, it is important to take cognizance of the fact that although there might be uncertainties associated with Climate Change projections, the impacts are imminent, not restricted to administrative boundaries and therefore cannot be overlooked. The development priorities can no longer be viewed in isolation from

Climate Change threats and responding to the challenge demands serious consideration and action at the highest level of administration.

## 6.2 Approach of the action plan

Despite the gaps and limitations in scientific literature and research on Climate Change, Gujarat recognizes the need to harmonize economic growth and industrial development with climate concerns by adopting appropriate adaptation and mitigation strategies. This may involve examining and exploring various approaches and opportunities that are relevant in the local context and mainstreaming those into developmental planning.

### 6.2.1 Creating a knowledge base

The SAPCC implementation process will enable generation and collation of reliable scientific data at the district and block level; strengthening capacity of research institutions in the State to undertake climate impact assessment studies; ensuring the gathering of information on such inter-sectoral impacts; and the analysis of trade-offs and fully informed choices between alternatives after a proper consideration of effects on different sectors. It will include integrated vulnerability assessments of key crops, ecological resources, and socio-economic systems at the community level. The results can be used to promote education, training and public awareness of the potential impacts of Climate Change.

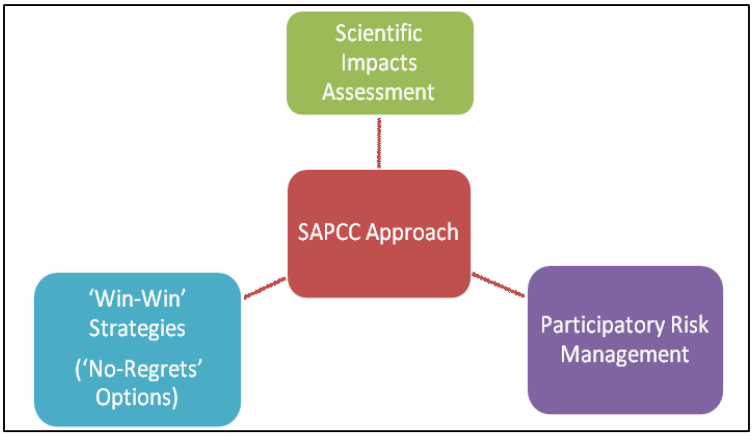



**Figure 29: Approach of the action plan**

### 6.2.2 No-regrets options

The course of the action plan will include adopting 'Win-Win Strategies and 'No-Regrets' Options, that include GHG emissions reduction with negative net costs, because they generate direct or indirect benefits that are large enough to offset the costs of implementation.

### 6.2.3 Participatory risk management

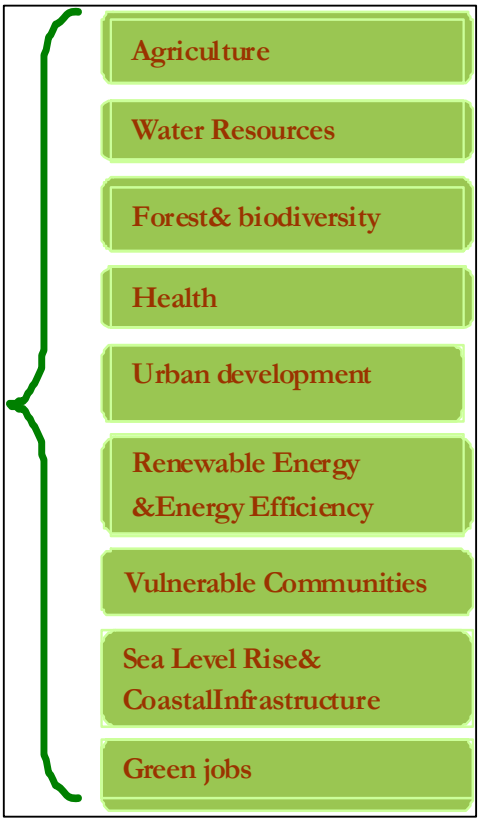
Risk management, by involving all stakeholders, will help overcome existing knowledge and information gaps and issues relating to uncertainties by providing opportunities to merge scientific information with local experience and traditional knowledge. It will also help to strengthen the social and political bases of decisions and policies implemented,

besides greater understanding of the risks and better implementation and management of response strategies.

### 6.2.4 Thematic areas

The SAPCC will focus on nine thematic areas that have been identified under the aegis of the Department of Climate Change, with technical representatives from State Government Departments, reputed research institutes, International Development Organizations and NGOs. **The nine thematic groups are largely in consonance with the National Action Plan on Climate Change and addresses key priorities of the State.** However, the Gujarat SAPCC, in many ways, **goes beyond what has been proposed under the National Missions of the NAPCC, and addresses key issues of health, sea level rise and coastal infrastructure, vulnerable communities and green jobs.**

**Figure 30: Nine thematic groups that addresses key priorities of the State**




For each of the thematic areas identified, this section looks into the initiatives taken by the Government of Gujarat, in line with the objectives of the eight Missions of the National Action Plan of Climate Change, to address the challenges and build upon the opportunities likely to be faced by vulnerable sectors. The key strategies and options have been identified following a multi-track approach, with a focus on:

- Research and development
- Institutional strengthening and infrastructure development/technology development, demonstration, and deployment
- Policy support
- Capacity building

The identified thematic areas can be broadly categorized into:

- Sectoral themes such as water, forest and biodiversity, agriculture, urban development, health and;
- Cross-cutting themes including renewable energy and energy efficiency, vulnerable communities, sea level rise and coastal infrastructure, green jobs.

In addition to the above, there are certain aspects which act as enablers to achieve the mitigation and adaptation targets.

# Sectoral Themes

# 7.0 Agriculture

Since last few years, the agricultural output has increased at an annual rate of 11% in Gujarat, which is a commendablegrowth in this sector. Keeping in mind, the vulnerabilities of this sector it is important to frame strategies that take into account the critical role played by this sector.

## 7.1 Strategies for Sustainable Agriculture

Agriculture is going to play a critical role over the next decade when Gujarat is expected to continue with rapid economic growth. It is a sector that continues to provide sustenance for over half the population in the State. With further growth there could be additional demands on the sector not only in terms of livelihoods but also address concerns relating to food security.

Given the anticipated impacts of future climate variability and change in this critical sector, the SAPCC advocates a holistic approach that would not only address specific vulnerabilities but also meet the wider range of sustainability concerns relating to Agriculture in Gujarat.

It is worth noting that at the National Level the National Mission on Sustainable Agriculture under the NAPCC advocates a similar approach with a focus on four thrust areas:

1. Dry land Agriculture;
2. Biotechnology;
3. Access to Information; and
4. Risk Management.

A large number of initiatives are being taken by the Central governent through the National Initiative on Climate Resilient Agriculture (NICRA).National Initiative on Climate Resilient Agriculture (NICRA) is a network project of the Indian Council of Agricultural Research (ICAR), which, aims at helping the National Mission on Sustainable Agriculture in the domain of climate change adaptation and mitigation measures and increasing crop productivity. NICRA's aim is to augment resilience of Indian agriculture sector to climate change and climate vulnerability through strategic research and technology demonstration. NICRA covers work for crops, fisheries, livestock, and natural resource management (NICRA-ICAR, 2014). District Wise Agricultural

Contingency Plans in Gujarat have been created for each district giving information of strategies for weather related contingencies like drought, floods etc.

**Box 10: National Mission on Sustainable Agriculture**

The vision of National Mission on Sustainable Agriculture (NMSA) is to transform agriculture into a climate resilient production system, ensuring food security and protecting land, water, biodiversity and genetic resources for sustainable production of food. The main objectives of the mission include:

- To enhance agricultural productivity through customized interventions such as use of bio-technology
- To devise strategic plans at the Agro-Climatic Zone level.
- Expanding Automatic Weather Stations (AWS) networks to the Panchayat level and linking them to existing insurance mechanisms including Weather Based Crop insurance Scheme (WBCIS) and National Agriculture Insurance Scheme (NAIS), to facilitate access to information.
- To promote "laboratory to land" research by creating Model Villages and Model Farm Units.
- Introduction of suitable crop varieties and farm practices, livestock and manure management.
- To realize the enormous potential of growth in dry land agriculture through development of drought and pest resistant crop varieties.

## 7.2 State initiatives and achievements

Gujarat has adopted a consistent strategy to cope with Climate Changes in different agro-climatic zones of the State. In each agro-climatic zone, there is one agro-meteorological field unit providing weather based agro-advisory services to the farmers of that zone. Infrastructure such as Automatic Weather Stations (AWS) is being installed at various locations. Agriculture Universities have initiated the creation of a network of observatories in Gujarat, by installing automatic weather stations at different research stations, in order to generate online weather information and create a data bank on climate. Agro-climate based crop planning has been initiated through Soil Health Card Programme, where cropping systems have been suggested based on the soil moisture availability index, and helped farmers adopt more remunerative crops, thereby increasing their incomes.

### 7.2.1 Addressing uncertainties

The Government of Gujarat has established "Centre for Weather Forecasting and Climate Change" at Anand, "Centre for Environmental Studies" at Navsari and "Centre for Agro-advisory services" at Junagadh. These centres are engaged in critical analysis of weather/climate parameters and their likely impacts on agricultural production. Research has already been initiated to study impacts of Climate Change on breeding of heat and photoperiod insensitive crop varieties, erection of poly-houses to create

controlled environments, thereby increasing yield and reducing population dynamics of insect pest and diseases etc.

In addition to above mentioned programs, two projects in collaboration with SAC, ISRO Ahmedabad and IIT Delhi are initiated, under which 40 Automatic Weather Station (AWS) will be installed in Gujarat, forecasting extended range or seasonal scale weather which will benefit climate risk management.

### 7.2.2 Agricultural productivity

The cumulative effect of all these has been drawn of increasing productivity in major crops of the State despite 0.1°C to 0.9°C average increase in temperatures recorded at various locations in the State. Agricultural productivity in Gujarat has been higher than other States, and has been growing at 9.6 per cent per annum. Though there is high volatility in agricultural growth rates for almost all States in India, the performance of Gujarat's agriculture is more than thrice the all India figure. International Food Policy Research Institute in theiryear 2009 document, had specially commended Gujarat's recent growth in cotton, fruits and vegetables and wheat production.

**Figure 31: Performance of Agriculture Sector in Gujarat at constant (2004-05) Prices (Rs. In crore)**

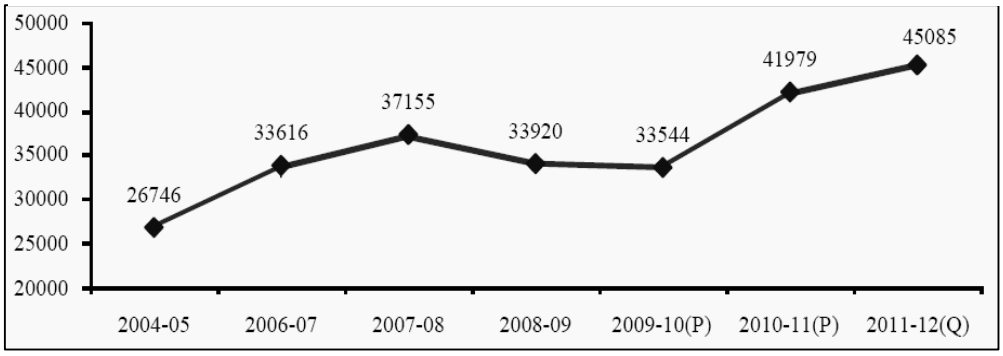
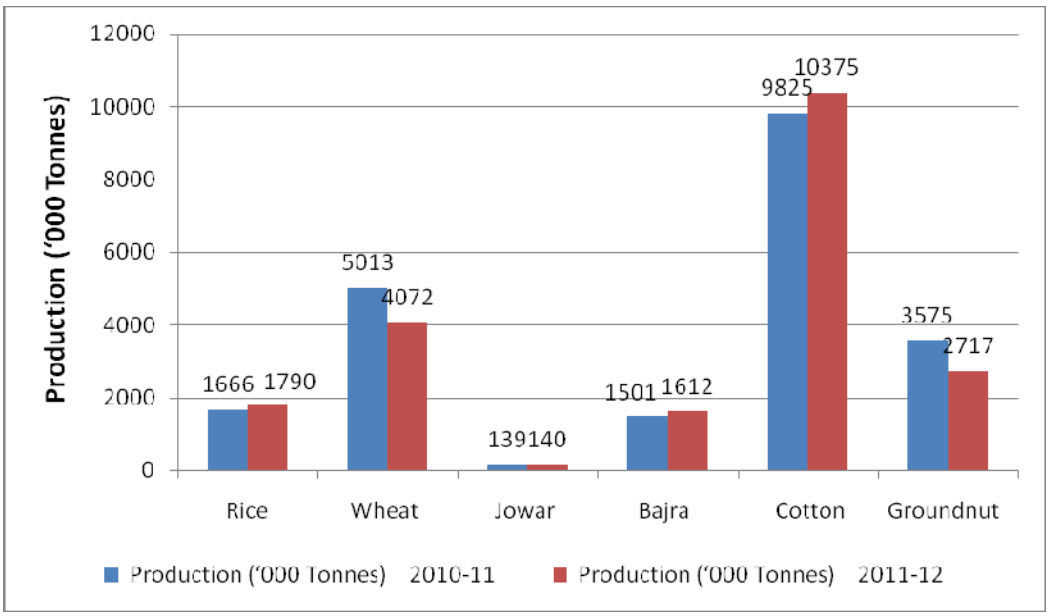



**Figure 32: Change in productivityof crops in Gujarat**




## 7.3 Ongoing initiatives

During the last several years, initiatives have been taken to deal with impacts of global warming by strengthening of schemes and launching of new programmes. There have been efforts to promote thermo-insensitive and drought resistance crops like cotton and castor by providing technological transformation support, training and input subsidy. To reduce the effects of chemical pollution and promote organic farming, an intensified integrated pest management approach is being encouraged in the State.

Events like Eight **Krushi Mahotsavs** have been organized to promote activities like organic farming wherein a common platform is being provided to farmers, researchers and agricultural experts. 42 lakh **Soil Health cards** under Soil Health programme of the Agricultural department have been distributed which has helped farmers take accurate action to increase productivity of their land (GoG, 2013, Vibrant Gujarat, 2013) In addition, twenty six crops have been covered under the crop insurance scheme to provide safeguards against production losses in crops due to natural calamities, diseases, pests etc. and an amount of Rs.4240.49 crores was disbursed toward claims to the farmers in the State, for the year 2011-12. Gujarat ranks first with respect to risk covered, premium income, subsidy paid, farmers covered and claims paid under National Agricultural Insurance scheme among implementing States.**Kisan Credit cards** is another successful initiative taken up by Gujarat. Flood relief is also available to farmers in case of crop/input losses and soil erosion.

### 7.3.1 Animal husbandry and healthcare

The multifaceted programmes of Gujarat Government in animal healthcare and husbandry have created a transformational impact on the milk economy of the State, and energized the livelihoods of millions of villages.

#### 7.3.1.1 Animal hostel

A revolutionary rural empowerment concept envisioned by the formervisionary Chief Minister, Shri Narendra Modi, is the **Animal Hostel**. This project, with its unique model of integration, cooperation and conservation, is a revolutionary step in co-operative cattle management and conservation of natural resources.

Simply put, an Animal Hostel is a large-scale community facility for milch animals of a village. The animals are reared scientifically, and managed on a co-operative basis. Their dung and urine are collected and converted into gobar gas, organic manure and bio-pesticides.

The facilities in the hostel includes: in-house fodder production and storage, electricity generation through bio-gas plants, vermi-compost production, milk collection room, in-house veterinary and breeding services, water harvesting system.

#### 7.3.1.2 Animal health camps (Pashu Aarogya Mela)

Since 2002, the State has embarked upon an intensive, integrated Animal Healthcare drive, to bring about a massive economic resurgence in its rural economy. As a comprehensive, institutional effort towards collective animal healthcare, month-long Animal Health Camps, or Pashu Arogya Mela/s, are conducted every year post-monsoon.

At these camps, specialized animal health care services, breeding facilities and extension activities are offered to rural livestock-owners at their doorsteps. More than 25,000 such health camps have been organized so far, with the active involvement of dairy co-operatives, local bodies and public participation.

**Table 22: Number of villages and activities in Gujarat**

| Activity | 02-03 | 03-04 | 04-05 | 05-06 | 06-07 | 07-08 | 08-09 | 09-10 | 10-11 | 12-13 |
|---|---|---|---|---|---|---|---|---|---|---|
| No of Camps | 2336 | 2665 | 3139 | 3134 | 3088 | 3009 | 2811 | 2891 | 2750 | 5289 |
| Villages covered | 10795 | 8478 | 8965 | 8665 | 7439 | 7038 | 6597 | 6661 | 6067 | 15795 |
| Treatment Lakh | 13.63 | 9.68 | 10.93 | 12.05 | 12.23 | 9.21 | 10.59 | 10.92 | 11.50 | 21.54 |
| Vaccination Lakh | 6.80 | 6.49 | 8.27 | 6.37 | 8.62 | 8.96 | 7.54 | 7.51 | 8.26 | 46.17 |

#### 7.3.1.3 Infrastructure for milk procurement and processing

Gujarat produces about 274.36lakh litres of milk per day with annual increasing rate of 5.07%. Of this, about 40per cent is procured by the organized co-operative institutions, while the remaining marketable surplus goes to unorganized markets.

As a programmatic effort to bring this surplus milk produce under the organized sector, there are two districts milk producer union at Porbandar and Jamnagar. The Government of Gujarat provides assistance to co-operative dairy unions from last four years, in the form of bulk milk coolers and automatic milk collection systems.

These efforts also ensure clean milk production and procurement with creating more trust of producers. The chilling capacity is going to increase. The efforts are made by Government of Gujarat to assist better processing infrastructure in areas like Kutch and Saurashtra where dairy activities are very poor or not well developed..

The multifarious benefits of setting up bulk milk coolers at the society level includes spoilage reduction to near-zero, enhanced quality of milk, and better monetary returns for livestock-owners and Dairy Unions.

#### 7.3.1.4 Gujarat Livestock Development Board

Gujarat is home to indigenous breeds of livestock, such as Gir and Kankrej cows, and Surti, Mehsani, Jafarabadi and Banni buffaloes. These breeds are renowned worldwide for their milk potential, resistant to drought conditions, fodder scarcity and starvation. These breeds are known for their consistent production and regular calving under heat stress and poor nutrition. Through strategic breeding of these animals, this potential is optimally utilized.

**Box 11: Approach to SAPCC Priorities for 2014-2019**

- Impact assessments in the sector at different levels of food system
- Agriculture risk management based on effective surveillance and management
- Strengthening extension services with focus on private sector and community participation
- Building resilience in agro ecosystems through resource efficient technologies and practices

The Gujarat Livestock Development Board (GLDB) is engaged in conservation of domestic breeds of region through selective breeding and selection of elite animal and propagation of genetic material. For that GLDB works as nodal agency for implementation of National project on Cattle and Buffalo Breedingin the State It also works in co-operation with other breeding agencies like National Dairy Development Board (NDDB), co-operative working under Gujarat Cooperative Milk Marketing Federation (GCMMF), Department of Animal Husbandry, some of the Gaushalas and Panjrapol. Through these efforts and co-operation, GLDB harvest best germ plasma available in the field and tries to conserve that germplasm through semen storage and effective breeding strategies.

Under National project on Cattle and Buffalo Breeding, GLDB has initiated **Bull production programme** to get best germplasma in the field and to use bulls for semen production.In that direction, in June 2010, GLDB set up State-of-the-art, certified Frozen Semen Production and Training Institute at Patan.

GLDB is in the process of establishing Embryo Transfer Project at Varudi, Amreli which will be a novel project to harvest and conserve embryos available with best genetic material. GLDB has contributed to establishment of Artificial Insemination infrastructure in remote areas. 632 functional AI Centres have been created with 400 more in the pipeline in remote areas.

GLDB also maintains Cattle breeding farms to conserve indigenous germ plasma. They are also working to establish Bull mother farm for selection of elite animals of indigenous breeds along with establishment of new Frozen Semen station to mitigate the adverse impacts of climate change and disease outbreak.

## 7.4 Key Strategies

Given the vulnerability of this sector, it is important to build on initiatives and opportunities that not only enhance the mitigation options but also tap the adaptation opportunities. T the strategies should also focus on research and development in this sector, including detailed impact studies, infrastructure development through setting up innovative ideas like animal hostels, through policy support and capacity building.

### 7.4.1 Research and development

- Forecasting of impact of global warming on agricultural crops is necessary to taking appropriate action. Farmers can be advised for timely and frequent application of irrigation and use of sprinkler irrigation systems to maintain microclimate near the plant canopy. Aspects of global warming and its effects on crops/agriculture requires thorough study at research institutes and following actions can be initiated as long term strategy on basis of findings:
  - Development and recommendation of new cropping pattern taking into consideration the climatic changes of that area.
  - Development of thermo insensitive and drought resistant varieties of crops.
  - Development and recommendation of new packages of crop practices.
  - Vigilance systems can be developed for monitoring of emerging pests and diseases.
  - Intensifying IPM approach in plant protection in order to decrease cost of plant protection and reduce environment pollution.
- Generic information about weather has to be translated into location-specific land-use advice, based on cropping patterns and water availability. A focused and integrated research and development program for agro-climatology needs to be developed with climate forecasts and cropping system models for improved farm decision-making to produce optimal yields.

- Research on strengthening pest forecasting models could emerge as efficient tool to forecast changes in pest patterns, in advance. Providing site-specific weather data to manage pests and diseases where terrain varies, since elevation, slope, and aspect all strongly affect local temperature, rainfall, and other factors that are used to run predictive pest models. Such site-specific data and model predictions are needed to help farmers to make better decisions on pest management.
- Developing genotypes tolerant to biotic and abiotic stresses such as drought, high temperature, submergence, saline conditions and pest and disease challenges under Climate Change
- A study on the need of change in the cropping pattern by the farmers in the various agro climatic zones, on the basis of the study of the rainfall data of the last ten years, shall be undertaken.

### 7.4.2 Institutional strengthening and infrastructure development

The Government is establishing automatic weather stations and ARG at the sub-district level to facilitate understanding of real time weather and other inputs on production of important commodities at national as well as international level. This can also provide complete technical back up support to the farmers to develop precision farming models, which can be replicated on a large scale.

- Penetration of technologies such as micro-propagation techniques, integrated nutrient, water and pest management, organic farming, immuno-diagnostic techniques for detection of diseases to improve the productivity of horticultural crops.
- Building market information, intelligence and forecasting system for farmers.
- To safeguard the animal population from the impacts of Climate Change, a consolidated and long term strategy can be planned. Animal Husbandry largely depends on agriculture for its survival; hence to safeguard animals, efforts have to be made to address its agricultural parameters simultaneously. The multifaceted efforts could be as follows:
  - Surveillance of disease patterns and monitoring climatic changes could provide valuable time to tackle forthcoming health disasters; and
  - Strengthening the animal disease diagnosis facilities. These concepts are being promoted through setting up Animal Hostels, but they need to be propagated further.
- Developing new generation treatments, vaccines as well as pesticides.
- Providing specific recommendations for nutritional modifications for dairy animals to minimize production loss associated with heat stress.

- Integrating developments in biotechnology into current and future needs of animal husbandry sector with regard to feed, fodder and animal breeding. Developing biotech based fodder that release less methane.

### 7.4.3 Policy support

- Strengthening existing risk cover mechanism under National Agriculture Insurance Scheme. Reducing the unit of 'area insured' to a smaller level for example, the level of village in the case of large villages and to cluster of villages in the case of small villages in order to capture the true variability that exists within large administrative units in terms of the risk and the impact of risks on crop yield. Extending the insurance to cover pre-sowing and post-harvest losses as well. The coverage of Farmers Income Insurance Scheme and Farmers Accident Insurance Scheme should be extended to all districts of the State.
- Encouraging Public-Private Partnership model in agricultural risk management. Increasing Government support to private sector players can promote involvement of private sector in agriculture, increase aggregate insurance coverage and improve viability of the insurance schemes over time.
- Gujarat has a Soil Health Card programme under which a soil health card will be provided to each farmer. This will serve as a means for agri-scientists to reach out to individual farmers and provide expertise for enhancing agriculture productivity. This can also suggest the cropping patterns that should be adopted based on findings of the climate modeling studies.
- Strengthening Surveillance systems for pests and diseases and streamlining the flow of information of pest surveillance and livestock diseases to reduce response time between detection and action to manage and prevent pests and diseases.
- Gujarat has drought prone areas and arid areas cover more than 50 % of State. In addition soil erosion is increasing due to advancement of desert land, deforestation. Participatory Irrigation Management (PIM) by democratically organized water user associations empowered to set and collect water charges, and retain a substantial part of the collectionto help maintain field channels, expand irrigated area, distribute water equitably and provide the tail enders their just share of water. Also increasing the net irrigated area by creating check dams, KhetTalavadis and other major and medium irrigation structures.Gujarat has already brought more than 4,42,000 ha of land under PIM and is expanding further. Watershed management, rainwater harvesting, and ground water recharge can help augment water availability in rainfed areas. Micro-irrigation is also important to improve water use efficiency. Building structures for water management and managing them provides immediate opportunities for employment generation in rural areas.

- Irrigation efficiencies need to be improved by stressing on drip, sprinkler irrigation techniques in place of channel irrigation.
- Wherever micro-irrigation system cannot be used, efforts need to be made for use of pre-fabricated water conveyance system and adoption of ridge & furrow method of irrigation, raised bed method of farming, field bunding and leveling etc.
- Adopting mixed cropping and agro forestry practices help retain soil moisture and help reduce dependency on irrigation.
- Synergizing the existing efforts of various Ministries/Agencies with new ones, to create a data base with advisory for farmers to effectively manage the risks accentuated by Climate Change.
- Implementing region-specific contingency plans based on vulnerability and risk scenarios.
- Establishment of gene-banks for local breeds and ex–situ especially, in-vitro conservation needs to be considered as an important component of a broad-based strategy to conserve critical adaptive genes and genetic traits.
- Establishing AWS & ARG at the sub-district level to facilitate understanding of real time weather and other inputs on production of important commodities at national as well as international level. This can also provide complete technical back up support to the farmers to develop precision farming models, which can be replicated on a large scale.
- Provide incentives to industries to enhance production of bio pesticides to increase their availability.
- Penetration of technologies such as micro-propagation techniques, integrated nutrient, water and pest management, organic farming, immune-diagnostic techniques for detection of diseases to improve the productivity of horticultural crops.
- Building market information, intelligence and forecasting system for farmers.
- Gujarat has Strong Agri Marketing system, Agro based Industries & Co-operatives Strengthening climate resilient post-harvest management, storage and marketing and distribution systems can help increase revenue.
- Introduce certification zoning systems, pesticide-free zones, and organic production zones to facilitate high value exports from the State. The testing laboratories being set-up with Gujarat Agriculture Universities for certification of Organic Product can help in the process.

### 7.3.4 Capacity building

- To overcome uncertainties associated with climate modeling studies, synergizing meteorological seasonal climate forecasts with indigenous knowledge based seasonal forecasts. Climate information needs to be translated into diverse outcomes and comprehensive frameworks needs to be developed to answer some of the 'what if' questions faced by the farmers thereby empowering the farmers for effective decision making.
- Courses on agri-business development and agri-clinics can help graduates generate self-employment opportunities by providing specialized extension services to the farmers. Another area of focus should be on building technical capacity of farmers on use of Information and Communication Technology (ICT) and Resource Conservation Technologies (RCTs).
- Expanding the extension services in the State to build adequate capacity to provide relevant and timely information to farmers to make appropriate choices. Organizing short-term courses for extension workers to help them understand the emerging challenges of Climate Change and ways of effective communication to the farmers.
- Engaging the private sector to supplement public extension services. Privatization of agricultural extension system should not be seen as an alternative to public extension system. Public sector has got a comparative advantage in disseminating location specific, system based and sustainable technologies. The private sector will have a greater success in the technology and commercial aspects, input supply and other technical services.
- Gujarat has a strong telecommunication network and all talukas are connected. Private sector players can be engaged for supplying information on agriculture inputs, issue advisories, suggest good practices etc. to the farmers.
- Organizing group-based informal education approaches that enhance community ownership, sustainability and adaptability of adaptation strategies. Using existing platforms such as the GSWAN network to reach out to the villages for communicating Climate Change risks and adaptation measures.
- Strengthening Integrated Pest Management programmes that effectively integrate community-based field activities, policy, extension and research. Up-scaling field projects and demonstrations, to help farmers gain a practical understanding of pest management practices and application in their own farms, while reducing costs and allow for farmer-to-farmer diffusion.
- Capitalize on the outreach and penetration of Self Help Groups (SHGs) and other Farmers Groups to increase the awareness and acceptance of crop insurance in India. These groups can also play a role for distribution and

post-sales service delivery, developing food and forage banks to manage scarcity during projected increased periods of drought and floods.

- Agriculture Universities in the State and can help organizing distance education programmes and production of farm literature.
- To overcome the lack of expertise with sound technical background in climate science and its implications on the agricultural sector, training centres need to upgraded/established under Department of Agriculture. Regular trainings should be organized for farmers and elected Panchayat members for taking up an advisory role for better management of floods, droughts and varying precipitation patterns.

Based on the strategies that have focused on understanding the detailed impact of climate change on crops, along with the focus on adaptation to changing climate, a brief list of activities have been obtained from relevant Department/s to indicate the focus on implementing these strategies discussed in the previous section. The estimated cost of activities is based on rough estimates.

## Programme of Action for Agriculture

| Sr. No. | Department/ Office Name | Activity | Project Objective | Estimated Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Agriculture & Co-operation Department | To establish Animal Hostels in various districts of Gujarat | To improve production and productivity of the animals and thereby farmers' income by establishing 25 Animal Hostels | 4.15 | 1 | Improved animal husbandry activities through disease monitoring and providing adequate care to animals |
| 2 | | Irrigation development through Micro Irrigation Systems | Efficient use of resources including water/ fertilizer, limiting evaporation, reducing weed growth, and making cultivation possible during and immediately after an irrigation cycle by setting up approx. 900 micro-irrigation units in an area of around 900 acres | 4.5 | 1 | To increase productivity of crops through optimal resource use |

| | | | | | | |
|---|---|---|---|---|---|---|
| 3 | | Climate Change proofing through in situ Soil & water conservation, water harvesting to increase the fertility, productivity and prosperity of Arid & Semi Arid districts of State | Implementing State's and Central's agriculture schemes on watershed basins for in situ soil & moisture conservation as well as to control soil erosion, and to increase ground water tables by adopting technology for harvesting rain water through water harvesting structures etc. in 2.87 lakh hectare area in 14 districts | 575 | 5 | Soil and water conservation, improve depleting ground water tables and increase productivity |
| 4 | | Soil Health Improvement through use of Biofertilizers | To safeguard the soil health and improve the quality of crop products by using natural products like Biofertilizers in a total of 67,150 acre area will be covered across Gujarat. | 0.12 | 1 | Promotion of organic farming |
| 5 | Department of Climate Change | Research on "Climate Change Implications on Crop Growth in Gujarat" | Classify land areas and their suitability for growth of crops based on threshold analysis specifically in the context of warmer temperatures; Quantify the impacts of predicted climate change on agricultural output for the following crops – wheat, groundnut and cotton; | 1.2 | 2 | Holistic understanding of climate change impacts on crops in Gujarat and formulate appropriate policies against adverse impacts |
| | | | Total | **584.97** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

# 8.0 Water Resources

Gujarat state has highly skewed spatial water distribution owing to its physiographic features wherein while, 30% area possess 70% water resources, the other 70% has only 30% water resource. Besides lopsided water distribution, Gujarat faces a threat of rapid declination of the groundwater tables, due to inadequate management of the sources as well. Also, coastal areas of Kutch and Saurashtra, as noted earlier, have widespread saline area making them unsuitable for groundwater development. The state has suffered severe droughts throughout its past. All these factors have often created a situation of water crisis in the state. Consequently, such severe water scarcity situation can lead to substantial loss of income, threatened household food security and forced large-scale migration to other areas. Climate change can exacerbate these conditions, hence water forms a major thematic area in the action plan.

## 8.1 Strategies for management of water resources

The State of Gujarat is traditionally prone to water scarcity situations. Although the Government of Gujarat has taken several progressive measures for ensuring water security in the State, the intensity and return period of major drought, often correlated to the Climate Change impacts, have the potential to undermine these efforts. Groundwater resources and their long-term replenishment are also controlled by long-term climate conditions. Therefore it is essential to consider Climate Change externalities while designing and implementing water conservation and management plans.

In order to enable sustainable management of water, as suggested in National Water Mission, the Government of Gujarat aims to ensure more equitable distribution of water across the State.

**Box 12: National Water Mission**

The focus of National Water Mission is on water conservation and integrated water resources development and management for ensuring its more equitable distribution both across and within States. Main objectives of the mission are –

- Climate Change impact assessment on water resources and provision of water data base in public domain
- Promotion of citizen and state action for water conservation, augmentation and preservation; focused attention to over-exploited areas
- Increasing water use efficiency at least by 20% by 2012
- Promotion of basin level integrated water resources management

## 8.2 States initiatives and achievements

Before 2001, drinking water security had posed serious threat to human and cattle lives in Gujarat State. In 2001, an ambitious strategy was developed for creating a **'Statewide Drinking Water Grid**' for bulk water transmission from sustainable surface

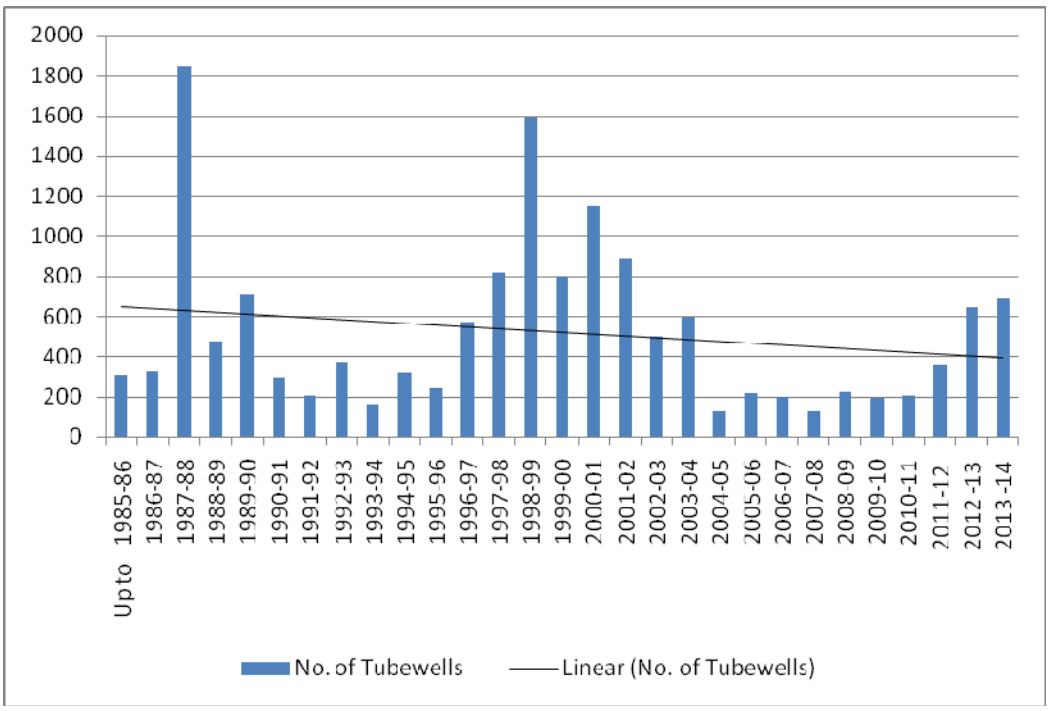
water resources to water scarce and poor water quality habitations. Based on this, large scale infrastructure has been created which includes bulk pipelines, distribution pipelines, hydraulic structures, storage sumps and high ground level reservoirs. Along with this 181water filtration and treatment plants have been promoted with a total capacity of 2900 million liters perday. The backbone of the Grid is the Sardar Sarovar Dam, built on river Narmada. It not only provides fresh surface water for irrigation to several regions of Gujarat but also provides water for drinking purposes.The Sardar Sarovar Canal-based Water Supply scheme has been named as the **largest engineering intervention in India's rural water supply sector**. Gujarat water supply grid constitutes the lengthiest distribution pipeline network for the supply of drinking water the world has ever seen. To date, no other single scheme for drinking water supply in the world covers as vast of an area or reaches as many beneficiaries as the Statewide Water Grid.

The Statewide Water Grid comprises of 387 projects making inter-basin water transfers from sustainable surface or ground water sources to water scarce and quality-affected areas. The network consists of Sardar Sarovar Canal, Sujalam Sufalam Yojana for river inter-linkages and approximately 179 Rural Regional Water Supply Schemes. The Statewide Water Grid aims to connect 75% of Gujarat's population i.e. nearly 47 million people across 15,009 villages and 145 towns, some of them being 700 km away from the command area.

To reach the scorched regions of Saurashtra, Kachchh, Central & North Gujarat, 51 bulk pipeline projects oversee the construction of 3,250 km of bulk water transmission mains and nearly 120,769 km of pipelines and engineering works (distribution network). Out of this, 2,654 km mains have already been built through 37 completed projects (as of December 2013). The piped water from the Grid has supplemented the amount of water drawn from local sources to meet the demands of communities. At the same time as new pipes are added to the system, existing drinking water sources are strengthened in an effort to develop dual supply systems to use water conjunctively and reduce a village's sole reliance on local water sources.

The construction of Grid has not only solved the endemic issue of drinking water availability issues in Gujarat, but has also helped overcome several issues including extensive ground water extraction leading to plummeting ground water tables, water quality issues including high level of fluoride content in the water, drudgery of collection of water from far off sources and increased sustainability and dependability on surface water sources. The grid has had immense impact on education of women and girls in particular, reducing migration of rural population, women empowerment and gender equality and enhanced the quality of life both for rural and urban population.

**Figure 33: Reduction in Number of Tubewells Dug each year in Gujarat**




Annual tanker supply required in 3961 villages in 2002-03 has been brought down to 296 in 2011-12, creating substantial savings. Although in the year 2012-13 and 2013-14, the number of villages requiring tanker water supply increased to 466 and 854 respectively, but this was due to severe drought conditions that existed in the state.

Number of fluoride affected habitations has reduced from 4187 in 2003 to 987 in a recent survey.

- Reduction in tubewell pumping has resulted in an estimated 72.09 million units of electricity being conserved per annum resulting in saving of about 16,076 $tCO_2$ emissions per annum, conservatively estimated. Figure 36 above, depicts the reduction in number of tubewells installed.

- Socio-economic benefits have fallen in place due to availability of water at the doorsteps. Female participation in the labor market has increased as they no longer have to traverse long distances. Women have successfully been involved in microenterprise projects which enable them to obtain extra income for their livelihood.

### 8.2.1 Micro-irrigation in Gujarat

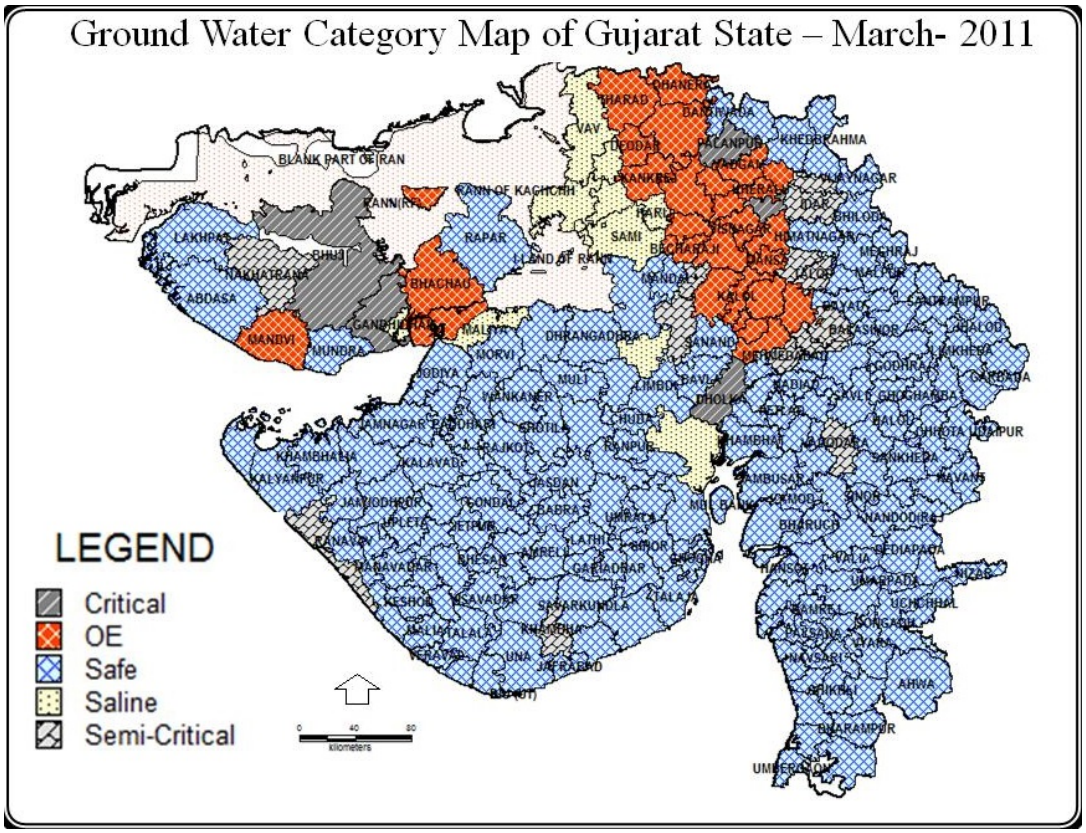
The micro-irrigation system was introduced in the State through Gujarat Green Revolution Company Limited since 2005-06. Total area covered under micro irrigation is 6,00,000ha involving 3,70,964beneficiaries' farmers. Adoption of micro irrigation system not only conserves water, but also conserves energy fertilizers, reduces labour cost leading to reduced cost of cultivation and increase in productivity. Large scale people's participation was involved in creation of massive micro water harvesting

structure network leading to strengthening the adaptive capabilities of millions of people in Gujarat to withstand Climate Shocks. A total of 5,63,000check dams, village ponds / tanks, village talavadi and Boribandh have been created in last few years providing direct benefit to over 13 million people in rural Gujarat.

The unique, **Sardar Patel Participatory Water Conservation Project** (SPPWCP) programme was well recognized in the UNDP Human development report of 2007 as a replicable example of Climate Change adaptation measure. The report states, "Beyond disaster prevention, the development of community-based infrastructure for water harvesting can reduce vulnerability and empower people to cope with Climate risks. Partnerships between communities and local governments in India States such as Andhra Pradesh and Gujarat provide examples of what can be achieved."

The average depletion of water levels in North Gujarat before the launch of this massive programme was around 3 m per year which by now would have cumulatively increased by almost 20-25 meters leading to sharp rise in electric consumption for drawl of ground water. But there has been a reported average, water level rise of about 4 m during last couple of years. Figure 37depicts the ground water development for the state of Gujarat. The entire state is divided into the categories of safe, semi-critical, critical, over exploited (OE) and saline. The category of "safe" indicates that the ground water development was less than or equal to 70% (no falling trends of water level), "semi-critical" indicated 70-90% ground water development showing a falling trend in water table either pre or post monsoon, "critical" indicated 90-100% of ground water development, showing a falling trend both pre and post monsoon, "overexploited" indicated more than 100% ground water development and saline indicated a total dissolved salts (TDS) of more than 2500 parts per million (ppm).

**Figure 34: Ground water Development for the state of Gujarat**




Source: Dynamic Ground Water Sources of Gujarat State, 2014

Various steps have been taken by the Government of Gujarat for improving irrigation efficiency and reducing transmission and evaporation losses in State irrigation network. The Water Resources Department of Government of Gujarat has implemented Participation Irrigation Management (PIM) in command area. Up till now 4,42,000ha area is covered under PIM. The Government is actively considering implementing Pressurized Irrigation Network System (PINS) in the command area for implementing Drip/Sprinkler water saving methods. This methodology when fully implemented will appreciably bring the vast area of canal network under irrigation and also bring down transmission, evaporation and conveyance losses which are found to be appreciable at field level. On a macro level irrigation efficiency has been improved by bringing around 10,42,000ha of land under Participatory Irrigation Management and much more under micro irrigation leading to yield increase along with water, fertilizer, labour and energy savings. It has been estimated that around 74.1 million unit energy has been saved in just one year due to adoption of micro irrigation by Gujarat Green Revolution Company – a body specially created for the purpose.

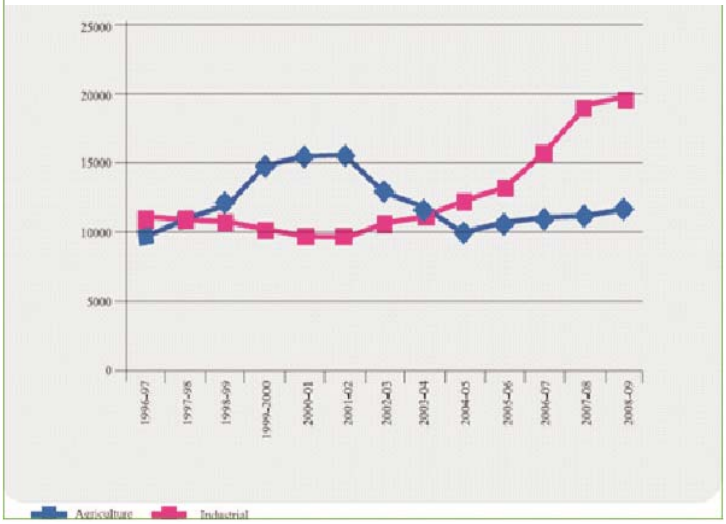
The canal systems which have deteriorated over time were improved by ERM works (Extension, Renovation and Modernization). These works have effectively reduced losses in the system and increased present irrigation area to about 25 per cent.

## 8.3 Innovative climate change projects

### 8.3.1 Sardar Sarovar Project

The Sardar Sarovar Project of Gujarat has been a very vital project for long term water and energy security in the State. Diversion of Narmada waters to main canal of the project, which is **world's largest lined irrigation canal**, was 705 MCM in 2001 and increased to 6,194 MCM in 2004. The command area covers an extent of around 5,00,000 ha which has observed interlinking of many rivers by the interbasin transfer of Narmada water using Sardar Sarovar Canal Network. Narmada water has been released in the dry beds of Heran, Orsang, Karad, Dhadhar, Mahi, Saidak, Mohar, Sabarmati and Saraswati rivers. The ecology and water quality of these rivers have drastically improved. In addition to this, 700 village tanks have also been filled with Narmada water as part of drought management measure. The hydropower generation commenced in Sardar Sarovar Project since August 2004, and has resulted in generation of 32,593 million units of electricity till March 2014. This has led to intangible benefits in terms of virtual savings of around 53,432 million units of electricity that would have been otherwise consumed to draw this amount of water from ground water resources. Thus the electricity consumption for agriculture in the State has drastically reduced from 45.12 to 21.1 per cent of the total consumption in the State (during 2000-01 to 2008-09). The role of Sardar Sarovar Project is impressive in both adaptation and mitigation of Climate Change. Due to this water and energy linkages, 15,459 million $tCO_2$ is saved.

**Figure 35: Consumption pattern of electricity in Gujarat State**



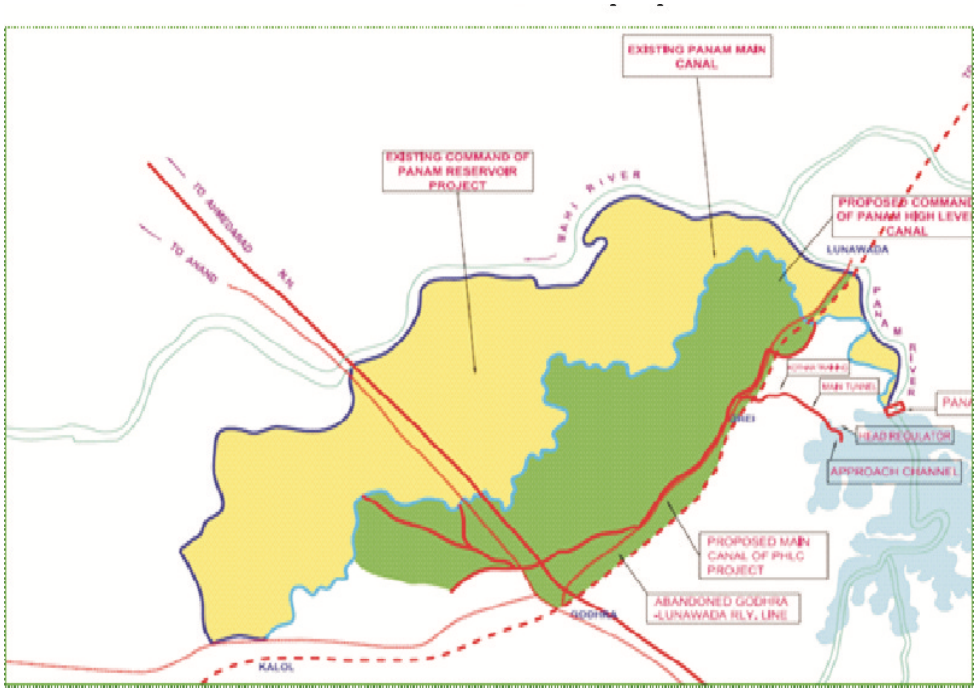

SSNNL has planned and invited EPC tender to develop a Canal Based Small Hydro Power Projects on Narmada Canals (i.e. SBC,MBC, VBC) having total potential of 85.46MW. It has also planned to develop a Canal Based Micro Hydel Power Plant on various Narmada canals having total potential of 13 MW. It is developing a 10 MW canal top solar Power project on Vadodara Branch canal, which is under progress. It has already installed 1 MW canal top power project on Sanand Branch canal. It has installed 10 KW wind Solar Hybrid Power plant for domestic purpose at Kevadia colony for which a grant of Rs. 15.30 crores from MNRE, GoI was awarded to SSNNL. In FY 2013-2014, 1450 MW SSHEP has put forth record generation of green power of 5877 MUs, which is 178% higher than planned generation.

### 8.3.2 Panam canal

Another very interesting example of environment friendly solutions with lesser carbon footprints is the Panam High Level Canal Project. Panam dam was constructed in 1978, to meet the irrigation needs of around 2,00,000 people. But since its inception the project suffered from one major deficiency. Panam main canal, a 100 km long contour canal, served the command area only on its right side while the farmers on the higher grounds of this command area were deprived of irrigation due to difficult and inconvenient topography.

There were two alternative solutions to the problem; one was to dig an open canal (channel) which necessitated acquisition of reserved forest lands, felling of trees and human displacement, besides the consumption of 3.23 million liter fossil fuel (diesel) for excavators and other machinery. The second alternative was lifting of water from the reservoir through pumping by laying down pipelines and constructing pumping stations which would have required 2000 MW power which in turn would have led to additional emission of 3.57 million $tCO_2$ every year.

**Figure 36: Panam dam constructed in 1978**




Considering very high carbon footprints, human displacement and direct loss of forest lands, a third alternative has been put in place. The State constructed its first and foremost irrigation water carrying tunnel, irrigating 18,000 ha of land and benefiting around 1,25,000 people at no extra submergence and no displacement of persons. As an additional advantage, nearby wells, around 60 village tanks and 500 check dams are being interlinked for recharge with the canal work providing irrigation in an

additional area of 2000 ha. This was a conscious choice taken by Gujarat which is a low carbon intensive development alternative.

### 8.3.3 Sabarmati River Front Project

For years, the Sabarmati riverfront in Ahmedabad remained neglected and characterized by unimaginative and unplanned development. It's potential to provide city level social infrastructure and recreation facilities was untapped. Sewage contaminated the storm water out-falls and the dumping of industrial waste posed a major health and environmental hazard. Though the riverbank and bed provided a place to stay and source of livelihood for many poor citizens, the riverbank slums have been disastrously flood prone and lacked basic infrastructure services. The slums located along the riverbed have always been a major impediment to efficient management of monsoon floods in the river.

Sabarmati River was revived by transferring Narmada waters which made the river independent of the vagaries of nature. Once this was made possible, the riverfront is now being converted into a major asset which would improve the quality of environment and life in Ahmedabad, improve the efficiency of its infrastructure, conserve the places of heritage importance, and create an opportunity for recreation/hospitality industry. The ambitious project involves creating embankments on both sides and developing a 10.6 kilometers stretch of river front which will not only provide protection against 5,00,000cusecflood eliminating annual flooding of low lying areas but also prevent evacuation of nearly 10,000 Slum Households, located on Riverbanks as well as the village on downstream of Vasna Barrage and prevent scouring of farm land. This is a unique project with both mitigation and adaptation connotations.

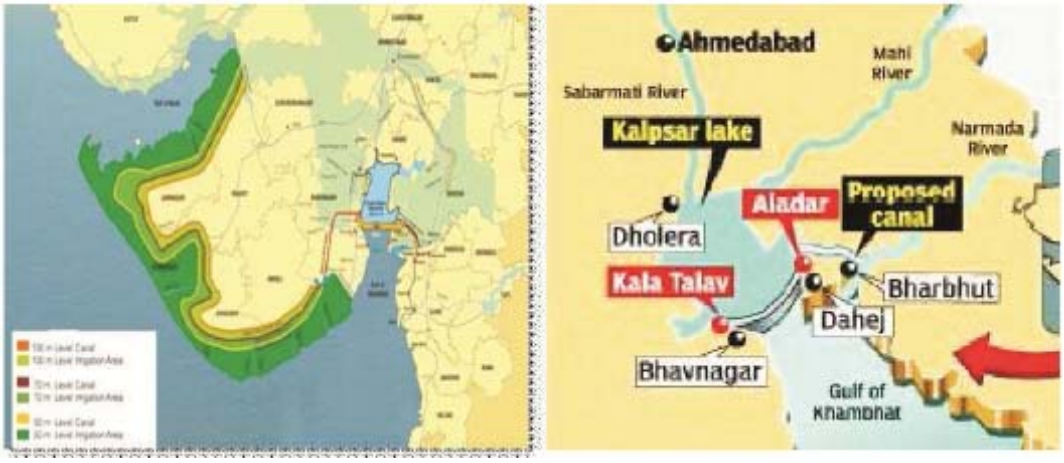
### 8.3.4 Kalpasar project

The Kalpasar Project is proposed to be the World's largest man-made fresh water reservoir. It envisages building a dam across the Gulf of Khambhat for generating tidal power and for establishing a huge reservoir for fresh water for irrigation, drinking and industrial purposes. A 30 km long dam would be constructed for closure of the Gulf of Khambhat. The project will store about 10000 $Mm^3$ of water from the rivers flowing into the Gulf of Khambhat.

Benefits expected from the project are:

- Water supply of about 1400$Mm^3$ for domestic and industrial purpose.
- Reduction in salinity ingress in Saurashtra coastal area
- Improvement in groundwater quality in about 7,00,000 ha catchment area of surrounding six districts
- Irrigation facility to serve about 1 million ha command area of coastal Saurashtra
- Development of fresh water fisheries

**Figure 37: Unique project with both mitigation and adaptationconnotations**




## 8.4 Community participation & empowerment of Panchayat Raj Institutions by WASMO

Gujarat State has taken up reform process and extensive community engagement in a mission mode approach by creating a Special Purpose Vehicle (SPV) in the form of Water and Sanitation Management Organization (WASMO). Water and Sanitation Management Organisation (WASMO) was established by the Government of Gujarat in May 2002, with a mandate to promote decentralization in the rural drinking water and sanitation sector. The rural community is the central focus of WASMO's decentralized approach.The objective of the organization was to bring a paradigm shift in the role of governance from provider to facilitator by empowering village level institutions through extensive capacity building and proactive facilitation.

WASMO has adopted a bottom-up approach in consonance with the spirit of the 73rd amendment of the Indian Constitution. It performs the role of facilitator by empowerment and capacity building of the Panchayati Raj Institutions at the grassroots level. Processes for social mobilization continue to win, build and maintain trust among the people, which is essential to obtain their willingness to join the programme and share the partial cost of work. WASMO's strategy includes development and strengthening of local institutions (Pani Samiti), active involvement and participation of communities.It entrusts the community with powers to plan, design, own and manage their own water supply systems. WASMO has strong faith in the principle that a sense of 'Ownership and Pride' is to be instilled among the community. It undertakes the following activities:

- Creating institutions at the village level and strengthening them through continuous capacity building
- Focus on IEC and software activities before taking up development of infrastructure for water supply
- Putting entire programme in public domain for seeking strong citizens' engagement

- Social process based demand driven programme implementation for achieving stakeholder engagement, gaining public confidence, strong community leadership, accountability and efficient service delivery
- Building strong partnerships based on transparency and trust with community, community institutions and NGOs.

The Pani Samitis work under the overall guidance of Gram Sabha for project formulation, implementation and further operation and maintenance of the intra- villages' infrastructure for service delivery up to house hold level. The Pani Samitis have worked commendably well and the water delivery infrastructure is being maintained with a great ownership feeling and user charges are collected for the maintenance of water supply.

- As on May 2014, as many as 18,185 Pani Samitis have been formed which are the main local institutions for village level water management.
- About 76.84% of people in Gujarat have access to household tap water connections.
- A water quality team has been formed in 16,676 villages and 14,216 more have been equipped with water quality testing kits.

WASMO's innovation has led to scaling up of reform processes to cover entire State. WASMO has also been able to institutionalize the rural water quality monitoring and surveillance programme. WASMO's innovation by Government of Gujarat has emerged as a model for learning and exchange and is now seen as a model in the sector, which is influencing policy initiatives in the water sector at the country level.

Besides WASMO, 'Nirmal Gujarat' is a initiative of Gujarat government for achieving total sanitation facilities in rural and urban areas of Gujarat. It aims at improving sanitation and hygiene so that a clean environment can be created while supporting overall development in the state.

## 8.5 Key initiatives by the Government of Gujarat

Some of the important measures taken by the State Government (GoG, 2011) towards achieving water security and improving the quality of water are listed below:

### 8.5.1 Water resource/watershed development

- Construction of 5,63,000 Water Conservation Structuresacross Gujarat changed the ground water scenario. The average ground water level in May 1998 to 2002 was 2.51 m, there was 4.01 m rise in average ground water level during May 2003 to May 2007. Around 4,42,000 ha.Of land have been covered under Participatory Irrigation Management leading to increase in crop yield and savings in water, fertilizer, labour and energy. It has been estimated that about 74.1 M kwh energy has been saved in just year due to adoption of drip irrigation by Gujarat Green Revolution Company (Shete, 2010).
- Interlinking of Heran, Orsang, Karad, Dhadhar, Mahi, Saidak, Mohar, Shedhi, Watrak, Meshwo, Khari, Sabarmati and Saraswati rivers by interbasin transfer of Narmada waters using the Sardar Sarovar Canal Project has not only improved

the water availability but also led to huge savings in the power consumption in drawing groundwater. The power savings were in the range of 20-25 per cent (Shete 2010).

- The ultimate irrigation potential through the surface water is estimated at 39.40 lakh ha which includes 17.92 lakh ha through Sardar Sarovar (Narmada) Project. Similarly, in respect of ground water resources, it is estimated at about 25.48 lakh ha. Total ultimate irrigation potential through surface & ground water is estimated to be 64.88lakh ha. The total irrigation potential of surface water created upto June 2012 was 32.48 lakh ha whereas maximum utilisation was 23.81 lakh ha.
- A Watershed Development programme is being implemented with the objective of drought proofing, agriculture growth, environment protection and employment generation. DDP, DPAP, IWDP are the major schemes being implemented under the watershed programme as per the agro-climatic condition of the 26 districts in Gujarat. Under these schemes 5590 projects are under execution for the treatment of 27.95 lakh ha in the State. Up to October, 2010, 2900 projects have been completed and 19.65 lakh ha of area have been treated under the programme (GoG, 2011).

## 8.6 Key Strategies

### 8.6.2 Research and development

- Basin-wise studies using hydrological and climate models to study the long term impact of Climate Change on rainfall-runoff processes over river basins
- Climate Change scenarios and impact on catchment and rainfall runoff response in a river basin of different zones of the Gujarat State

### 8.6.3 Institutional strengthening and infrastructure development

- Efforts for increasing effectively irrigated area in the State by extension, renovation and modernization of irrigation schemes and canal systems
- Small reservoirs and natural wetlands form the most practical, instant and cost-effective responses to existing variability and climate-induced water scarcity. Detailed investigations are needed in case of selecting large dams since they pose a high risk of flooding. Integrated watershed development, rainwater harvesting schemes and water conservation is critical.
- Improving water ingress in coastal areas by extending water Grid and undertaking other salinity ingress prevention works
- For ensuring water security in coastal and quality affected areas, setting up plants for desalination of sea water and brackish water
- Balancing the water availability in depleted regions and the areas likely to be affected due to Climate Change by Inter-basin water transfer
- Improved agricultural practices that conserve water through increased infiltration should be promoted. Methods such as organic farming, vermicomposting, choosing water resistant crops, seed conservation should be encouraged. De-silting of ponds, bunding of agricultural fields, construction of anicuts and runoff structures should be given emphasis

- Soil moisture is an important parameter in hydrological cycle and affects infiltration into groundwater aquifers. Farming practices that retain the right amount of soil moisture are an important adaptation strategy. Study on such practices is necessary followed by capacity building of farmers. Improved soil, nutrient and crop management practices should be adopted for increasing the water productivity of the crops.
- Groundwater banking can help recharging of groundwater using rainwater and discharge from dams can form a reliable supply in severe drought conditions. Increasing water productivity is an efficient means of intensifying agricultural production, improving community resilience and reducing environmental degradation that aggravates Climate Change. Technologies enhancing water productivity and wastewater reuse can be solutions.
- To address the increased incidences of fluorosis in remote villages, low-cost and low-maintenance de-fluoridation units should be provided to the households with training on how to use them
- Flood control and storm water measures should be enhanced to solve the problems arising out of water logging

### 8.6.4 Policy support

The Government of Gujarat has been quite efficient in collecting water related data and establishing a data center. Following studies are recommended to further strengthen the program.

- Addressing the data gaps and stressing on its quality
- Analysis of data to obtain trend of past climatic conditions
- Preparation of detailed climate scenarios at micro level, and correlating the past data and future climate projections using sophisticated hydrological and climate models
- Detailed analysis of drought proofing schemes and policy strengthening
- Documenting best practices on community actions at various levels

Human and natural systems, will to some degree adapt automatically. Planned adaptation through policies can supplement them. The adaptation policy should be formulated after detailed research and should:

- Lessen pressure on resources, improve management of environment and increase welfare of the poor
- Focus on development oriented drought mitigation
- Utilize drought relief fund on regular development practice
- Incorporate future climate scenario in drought proofing plans
- The Gujarat State Disaster Management Authority should give emphasis to community-based disaster mitigation along with planning and investment
- Better coordination between Government institutions working in the field of water management

### 8.6.5 Capacity building

- Establishing and institutionalizing bodies comprising of representatives from the community, Government and non-governmental organizations (ex: SETU or Link) through provision of Government development budget. These institutions can be equipped with up-to-date climate related information to enable them to build capacity of local communities on drought preparedness and mitigation
- Institutional strengthening and decentralization of water management and enhancement of water use efficiency and crop productivities.

The Gujarat State Disaster Management Authority should give emphasis to community-based disaster mitigation, particularly flood and drought related, planning and investment.

Based on the identified strategies in key areas of research and development, policy support and institutional strengthening, infrastructure development and capacity building in water sector, a brief of proposed activities were requested from relevant Departments in the State. The list of activities is provided in the table below. The estimated budget for these activities is based on primary and rough estimates.

## Programme of Action for Water Resources

| Sr No. | Department/ Office Name | Activity | Project Objective | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Water Resources Department | Participatory Irrigation Management | Institutional strengthening and decentralization of water management and enhancement of water use efficiency and crop productivity | 300 | 10 | Water resource management and soil conservation |
| 2 | | Extension, Renovation and modernization of schemes | To effectively increase the irrigated area in the state | 1600 | 10 | Increasing irrigation potential of the state |
| 3 | | Water Conservation Scheme through check dams construction | Construction of approx. 4000 checkdams each year in the State | 2000 | 10 | Conservation of Water as a measure towards climate change adaptation |
| 4 | Water Supply Department | Drought proofing measures for scarcity prone areas | Undertaking drought proofing works in the state for approx. 2000 habitations | 5000 | 5 | Assured water availability for drinking and domestic use and efficient service delivery |
| 5 | | Water and Energy Audit to be extended in the entire state | Undertaking extensive audits for water and energy conservation | 800 | 5 | Achieving water and energy use efficiency |

| Sr No. | Department/ Office Name | Activity | Project Objective | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 6 | | Dug well recharge project | Construction of approx. 4,00,000 dug wells to improve ground water recharge | 600 | 4 | Decentralized ground water recharge and improvement in ground water |
| 7 | | Creation of Roof-top rain water harvesting structures | decentralized rainwater harvesting in approx. 40,00,000 Households resulting in additional water availability, reduction of energy footprint due to lesser pumping, groundwater recharge | 1600 | 5 | To achieve water security at household level |
| 8 | Water Supply Department | Setting up water pumps based on renewable sources of energy | Solar pumps-1000; Wind pumps-500 | 65 | 5 | Reduction of consumption of conventional energy for drawing water |
| 9 | | Project for Desalinization of Sea water | Desalination through setting up 4 desalination plants and 500 Brackish Water desalination plants. | 2500 | 5 | To achieve water security in coastal and quality affected areas |
| 10 | | Inter-basin water transfer to water scarce and coastal regions | To balance the water availability in depleted regions and the areas likely to be affected due to climate change. | 3500 | 5 | Interlinking of water bodies to achieve water security |
| 11 | | Save Water and Energy Campaign both at State and village level. | Carrying out community based campaigns for water and energy awareness through carbon footprinting | 50 | 5 | Public awareness for reducing water and carbon footprints. |
| 12 | | Improving water resources near coastal areas by extending water Grid and other salinity ingress prevention works | Extending water Grid and other salinity ingress prevention works | 1000 | 5 | Water security in coastal regions |
| 13 | | Recycling of used water | Waste Water collection, treatment and reuse in 2000 villages | 600 | 5 | Increasing water availability in the State through waste water management |

| Sr No. | Department/ Office Name | Activity | Project Objective | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 14 | M.S.University | Modelling the long term impact of climate change on rainfall-runoff processes over Karjat river basin, Gujarat. | Analysing the impact of climate change, with respect to rainfall and increasing temperature on the water balance and response of catchments. | 0.2 | 1 | Water catchment assessment in Karjat river basin |
| 15 | M.S.University | Climate Change scenarios and impact on catchment and rainfall runoff response in a river basin of different zones of the Gujarat State. | To assess the impact of climate change on rainfall pattern, on catchment hydrology; and developing rainfall-runoff correlation in various zones of South Gujarat, North Gujarat, Central Gujarat, Saurashtra and Kuchchh region of Gujarat state. | 0.33 | 2 | Modelling and projections of water availability in various zones of Gujarat |
| | | | | **19615.53** | | |

* - Figures are based on primary and rough estimates

Apart from the above mentioned activities, an important aspect of working in collaboration both inter-state and intra-state for mutual cooperation and understanding and avoiding duplication of work is also considered worthy. No activity or project could succeed without allocating clear responsibilities to the stakeholders. Therefore cooperation is one of the important ideology to be followed by the Government of Gujarat.

# 9.0 Forests and Biodiversity

Gujarat's forest ecosystems provide both direct and indirect benefits such as watershed protection, food, fibre, medicines, drinking water, air purification and carbon storage. Protecting primary forests and restoring managed or degraded forest ecosystems are vital for reducing anthropogenic emissions and aiding societal adaptation to an unavoidable Climate Change.

## 9.1 Strategies for conservation of forests and biodiversity

The natural ecosystems of Gujarat range from wetlands, grasslands and deciduous forests to deserts. Its coastline shelters diverse coastal ecosystems such as mangroves, coral reefs, estuaries and mudflats. The Government of Gujarat has initiated various programmes for maintaining the environmental balance and restoration of ecosystems by recharging ground water, preventing salinity ingress, conserving biological diversity, soil conservation etc. These are in consonance with the NAPCC and the State Government intends to build on these initiatives through the SAPCC.

**Box 13: National Mission for a Green India**

The Mission acknowledges the role that the forestry sector has in climate mitigation, food security, water security, biodiversity conservation and livelihood security of forest dependent communities. The main objectives of the mission include-

- Doubling the area to be taken up for afforestation /eco-restoration in India in the next 10 years, taking the total area to be afforested or eco-restored to 20 million ha
- Enhancing eco-system services and carbon sinks through afforestation on degraded forest land in line with the national policy of expanding the forest and tree cover to 33% of the total land area of the country
- Increasing the GHG removals by India's forests to 6.35% of India's annual total GHG emissions by the year 2020
- Enhance the resilience of forests/ecosystems by maximizing infiltration, groundwater recharge, stream and spring flows, biodiversity value, provisioning of services (fuel wood, fodder, timber, NTFPs, etc.) to help local communities adapt to climatic variability

## 9.2 States Initiatives and Achievements

### 9.2.1 Forest greening schemes

Forest Department has taken up number of initiative to increase the green cover of the State. There has been a substantial increase in trees in the State. From 2004 to 2009 social afforestation has resulted in an increase of 1.77 crore trees. In the year 2009, there were 16.16 trees per ha which was 14 trees per ha previously. In 7 districts it has been observed that number of trees have increased to 30 trees per ha. Wherein Anand

District tops the list with 68.4 trees per ha followed by Tapi with 64.0 trees per ha, Gandhinagar with 58.3 trees per ha, Mehsana 51.8 trees/ha, Valsad 35.6 trees/ha, Surat 35 trees/ha and Kheda 31 trees/ha.

Social Afforestation Scheme has performed well in the State. In the year 2009 -10, 15601 ha of land were targeted to be planted and 100 per cent was achieved by the Forest department of Gujarat. Under this scheme, afforestation is conducted majorly at roads, river banks, railway tracks, social and institutional places, land near small tanks and ponds and other areas. Other than this, in order to encourage afforestation in private lands, van mahotsav is practiced at a large sale in Gujarat. Under Van mahotsav saplings and seeds are distributed in order to create awareness amongst people of Gujarat and increase the green cover of the State. In the year 2010-11, more than 2000 saplings and seeds were distributed in various districts under this scheme. As of 2013-2014 the cumulative achievementsof Social Forestry works from 1969-70 to 2013-14) are Strip Plantation (1.04 Lakh ha), Village Forests (1.38 Lakh ha), Private Degraded Lands (2.68 Lakh ha), Other lands (0.32 Lakh ha) and 501.10 crore plants have been distributed during Van Mahotsav.(Department of Environment and Forest, 2014)

As per the tree population estimates in 2003 and 2011, number of trees outside forest increased at annual rate of 29 lakh trees (increased from 25.1 crores in 2003 to 26.9 crores in 2011 and 30.1 crores in 2013). As per State of Forest Report (2011 & 2013), tree cover and tree density in Gujarat is second highest among the states of India. Seven districts have tree density over 30 trees/ ha whereas Anand district alone has a tree density of 68.4 trees/ ha. Average tree density in Gujarat is higher than the average of India, although major part of Gujarat is in semi arid and arid zone. Against India's tree cover (TOF) of 2.77% of total geographical area, Gujarat has 4.0% of its geographical area under tree cover outside forest. Timber and wood production from the TOF is very impressive in Gujarat and TOF contributes annually about Rs 4,388 crore of Gross Value Output (GVO) in form of timber. The contribution in terms of NTFP is also tremendous and yet to be monetarily quantified.(Department of Environment and Forest, 2014).

Forest accounting and certification of projects for CDM is being envisaged, as result of Sustainable Forest Management and identification of criteria and indicators has been started in two divisions, i.e. Godhra and Dahod, in the State in association with Indian Institute of Forest Management, Bhopal. A workshop in this regard was organized by Forest Department to explore the opportunities of CDM projects. A State level workshop on designing of Afforestation/Reforestation projects under CDM was organized in Gandhinagar.

Other initiatives taken up by Forest Department of Gujarat are Biogas/Solar cooker distribution. Under this scheme solar/biogas cookers are distributed 50 per cent subsidy. In order to save fuel, Social Afforestation Department has provided improved heater for crematorium in panchayat which has to be maintained by the respective panchayats. In order to create awareness amongst public, initiatives like farmer's nursery, promoting medicinal plants and others are undertaken.

### 9.2.2Urban forestry

Under Urban Forestry, Forest Department has taken up urban plantation works in 139 municipalities in the State and planted up more than 9.43 lakh trees. Urban gardens have also been created in some of these municipalities. 41 Nakshatra Vans, 64 Rashi vans and 81 Pachavati Bans, 90 Smruti Vans, 11 Navagrah Vans, 23 Punit Vans, 8 Dhanvantri Vans and 6 Dampatya Vans were also created. Under Nagar Nandan Van, 5.58 Lakh trees have been planted in urban areas.

"Sanskritik Van" is a concept where the Gujarat Forest Department development a wasteland site as a forest (Van) through public-private partnership. Punit Van, Mangalaya Van, Tirthankar Van, Harihar Van and Bhakti Van are the examples. These are available for public awareness and use. The Sanskriti Vans have been established at 9 different sites up to year 2012.

'Punit van' is plantation of trees in capital city of Gandhinagar. Constellation Plantation is being encouraged under this scheme by Forest Department. A particular plant that is associated with a definite constellation is planted nurtured and worshipped so that the ill effects of that particular constellation could be neutralized and over a period of time get converted into positive influence.

### 9.2.3Enhancing Mangrove cover in Gujarat

Mangroves forests of Gujarat are significantly prominent on the West Coast of the country and also have very high conservation value. Special programs are undertaken in Jamnagar and Kutch districts which have been successful. There has been establishment of mangrove forest in the Gulf of Cambay. During the current year, towards the Golden Goal a target of 12,500 ha has been set for mangrove plantation. As per the report of Forest Survey of India, in Gujarat, the Mangroves forest cover has continuously been improving.

Out of the 33 districts of the State, the State has 16 coastal districts. However as per the FSI 2005 report, the mangrove cover 936 $km^2$ is spread rather unevenly over 10 districts only. About 73.53 per cent (707 $km^2$) of the total mangrove forest is located in the single district of Kutch covering the forests of Kori creek, while 16.02 per cent (150 $km^2$) mangrove forests are distributed in Jamnagar district which covers the mangrove forests of Gulf of Kutch. The remaining 8.44 per cent (79 $km^2$) are distributed in 8 districts hosting the mangrove forests of Gulf of Khambhat. District wise distribution of mangrove cover in the State is given in Table 24.

**Table 23: District wise-mangrove cover (sq km) in Gujarat (FSI, 2005)**

| Sl. No | Region and District | Very Dense Mangrove | Moderately Dense Mangrove | Open Mangrove | Total | Change w.r.t. 2003 assessment |
|---|---|---|---|---|---|---|
| South & Central Gujarat Region | | | | | | |
| 1 | Bharuch | 0 | 22 | 14 | 36 | 3 |

| Sl. No | Region and District | Very Dense Mangrove | Moderately Dense Mangrove | Open Mangrove | Total | Change w.r.t. 2003 assessment |
|---|---|---|---|---|---|---|
| 2 | Navsari | 0 | 0 | 1 | 1 | 0 |
| 3 | Surat | 0 | 7 | 10 | 17 | 4 |
| 4 | Valsad | 0 | 1 | 1 | 2 | 0 |
| 5 | Ahmedabad | 0 | 2 | 4 | 6 | 4 |
| | **Total** | **0** | **32** | **30** | **62** | **11** |
| Saurashtra Region | | | | | | |
| 1 | Bhavnagar | 0 | 6 | 8 | 14 | 0 |
| 2 | Jamnagar (GoK) | 0 | 28 | 122 | 150 | 9 |
| 3 | Porbandar | 0 | 1 | 0 | 1 | 0 |
| 4 | Rajkot | 0 | 1 | 1 | 2 | 0 |
| | **Total** | **0** | **36** | **131** | **167** | **9** |
| Kutch Region | | | | | | |
| 1 | Kutch | 0 | 127 | 580 | 707 | 0 |
| | **Total** | 0 | 127 | 580 | 707 | 0 |
| | **Total Area** | **0** | **195** | **741** | **936** | **20** |

**Figure 38: Location Narara, Gulf of Kachchh, Jamnagar**

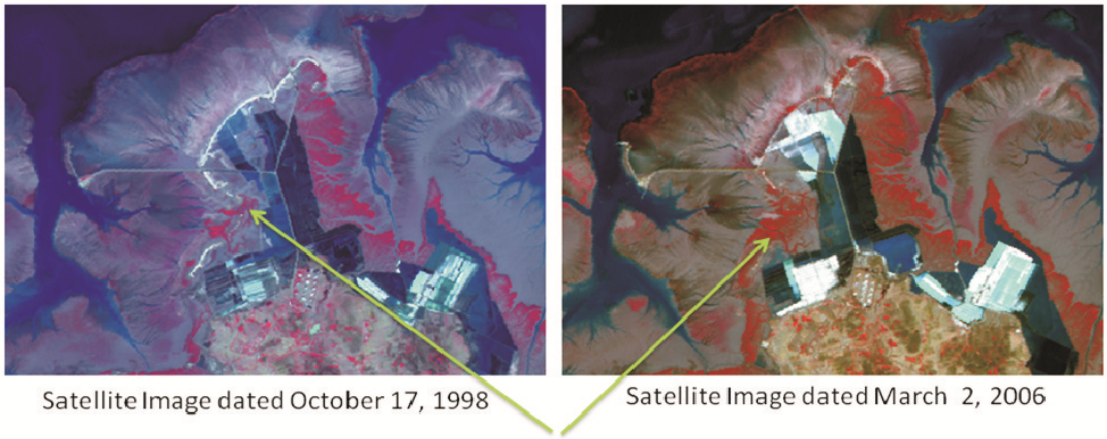
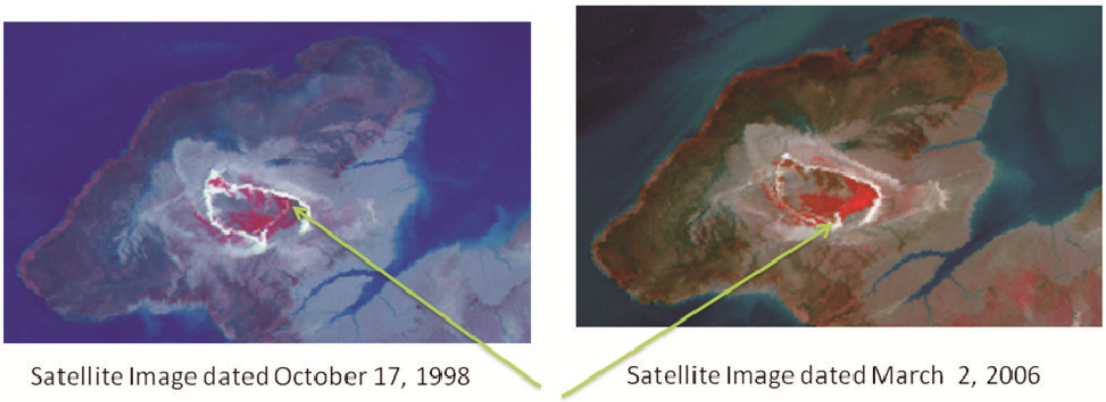


**Figure 39: Location: Pirotan Island, Gulf of Kachchh, Jamnagar**




**Box 14: Approach to SAPCC Priorities for 2014-2019**

- Around 180 MT carbon locked in Gujarat's forests and Trees Outside Forests (TOF): aim is to enhance carbon sequestration potential
- Greening Gujarat: Major focus on social forestry to increase tree density from 16/ha to 22/ha and increase TOF from 27 crores to 35 crores in ten years
- Holistic approach to reducing poverty's carbon-footprint at landscape level

Mangroves play an important role in Gujarat's ecosystem. There is an increase in mangroves in State of Gujarat. In 2009 it was found to be in the area of 1046 sq km Jamnagar and Kutch district along with Gulf of Cambay show increase in mangrove forest. The forest areas of mangroves are second in India after Sunderbans in West Bengal. In the inter tidal zone of Gujarat, 38,873 ha of mangrove plantation have been carried up to the year 2009 -10. Mangrove forests are predominantly distributed over three mangrove zones and as we move north wards on the coastline of Gujarat, these zones are Gulf of Khambhat, Gulf of Kutch and Kori creek.

## 9.3 Key Strategies

The key strategies identify the need for research and development, institutional strengthening and infrastructure development, policy support and capacity building in this sector through various proposed activities.

### 9.3.1 Research and development

#### 9.3.1.1 Understanding change in forest cover

- As noted in past a few State of Forest Reports published by Forest Survey of India, there has been changes in the forest cover of the State. For example, there has been an increase of 86 $km^2$ in the open forest and a decrease of 70 $km^2$ in the moderately dense forest of Gujarat. There is a need to understand the underlying cause of these changes and develop strategies to halt or even reverse the trend.

The opportunities presented by international mechanisms like the CDM could play a role and it's applicability for the State should be assessed. In the same vein, the upcoming mechanism such as REDD-plus (Reducing Emissions from Deforestation and Forest Degradation) should also be explored. The objective of the international debates and discussions around REDD-plus is to create a monetary value for the carbon stored in forests that are under the ever increasing threat of deforestation or degradation (given the direct and underlying causes). Once this forest carbon value can be created and agreed upon, participating developing countries can then be paid for protecting, conserving, sustainably managing their forests rather than cutting them or letting them become degraded. This not only would not only enable more carbon sequestration in the forests, but also be promote forestry-based livelihood, ecosystem based services, biodiversity conservation, among other benefits.

- Studying and addressing linkages between forest degradation and livelihoods of forest dependent communities.
- According to the Wetland Atlas, 2010, the total area under ravines is 2.75 m ha in four states, namely, Uttar Pradesh, Madhya Pradesh, Gujarat and Rajasthan. Ravines eat into farms and villages affecting the poorest and most vulnerable people who become victims of ecological privations in the region. Priority should be to stop further ingress of ravines into the non-ravine farmland.

#### 9.3.1.2 Understanding changes in marine ecosystems

- Studies required for understanding the impact of Climate Change on the marine ecosystems (wetlands, mangroves and coral reef ecosystems) for the State of Gujarat:
  - E
    xtensive studies are required to build a comprehensive database on the current State of the mangrove, wetland and coral reef habitats, and their associated flora and fauna.
  - C
    ollaborations with research institutions is required to strengthen research on the mangrove and coral biodiversity in the State to maximize the effectiveness of resilience-based management.
- Studies required for understanding the long term impacts of Climate Change on the coral reefs in the State of Gujarat
  - Studies on the adaptation and recovery pathways of coral reefs, along with improved monitoring, will help obtain a better understanding to manipulate the direction of events. The non-climatic stresses in the region (e.g. pollution from industries decline, fishing pressure) can be mitigated and managed easier than global Climate Change.
  - There is a need for extensive base-line data (bathymetry, contour maps w/1 m resolution below 25ft, geo-referenced cadastral information, ecosystem status) for the coral reef ecosystems of Gujarat.

- Research is also required for a more in-depth understanding as to the synergistic interactions of Climate Change and ocean acidification, with each other, and with other climate related factors like storm intensity
- Studies are also required on how expected changes in coral reef community structure would affect commercially important fish species in the State of Gujarat, and thereby the local fishing communities that are dependent on the reefs for food and resources, and solutions to improve the situation.
- Vulnerability maps for the corals in the Gulf of Kachchh would contribute considerably to resilience building efforts.

## 9.3.2 Institutional strengthening and infrastructure development

### 9.3.2.1 Improving productivity of forests and plantations

While the State has a good track record of increasing area under 'trees outside forests', improving their productivity is an option to meet the demand for forest products while increasing carbon sequestration. Also, adoption of silvicultural practices and improved planting materials can increase the productivity of forests to 1.35 $m^3$ per ha per year in drier regions, 7.66 $m^3$ per ha per year in moist/wet regions, and 4-5 $m^3$ per ha per year in other parts of the country (MoEF, 1999).

In the case of plantations, productivity can potentially be increased manifold by planting superior planting stock raised through tree improvement programmes as well as through clonal technology and tissue culture. For instance, the annual productivity of a seed-raised eucalyptus plantation is only 4-5 $m^3$ per ha, which can increase to 20-40 $m^3$ per ha with the introduction of genetically improved plants. Tree improvement programmes in the country have not received enough attention and funding in the past. With appropriate funding, research institutes and State agricultural universities can intensify research activities on raising superior planting materials and on silviculture.

### 9.3.2.2 Specific activities:

- **Mapping and data management:** Complete the survey, demarcation and notification of forest areas and update the information on a GIS-platform. This would help in identification of areas that might be available under different scope of activities planned under the State action plan as well as in the process of establishing eligibility of lands to be afforested under CDM. At the same time, individual and community forest rights given would be mapped. Collate, analyze and present the information on forest land diverted for non-forestry purposes in Gujarat. Also assess the status of the afforestation carried out under compensatory afforestation. Understand what worked and what didn't and the reasons thereof.

- **Emissions reduction:** Initiating a pilot project on Reduction of Emissions from Deforestation and Forest Degradation in Gujarat

- **Climate modeling:** Develop dynamic vegetation models for Gujarat to predict more accurately the impact of Climate Change on the flora of the State. This would also require developing regional climate models and initiating more regional and comprehensive research on forest vegetation characteristics, plant physiology, soil and water, etc.

- **Tree improvement:** Develop tree improvement programmes for the predominant species of Gujarat. This would require gearing up the research institutes and State agricultural universities to intensify research activities on raising superior planting materials and carrying out research on the vulnerability of indigenous tree species to Climate Change. At the same time, operationalize new and improved nurseries for the supply of identified, quality planting material.

- **Biomass assessment and carbon modeling:** The State has started to assess the forest biomass and its attendant carbon. The State would model the future carbon flux based on its planned forestry-based/related activities. This would help the State to take informed decision on the uses it puts its forestry resources to. The State would also develop the mechanism of continuous monitoring of the biomass and carbon. Also undertake survey of various forest species and assessing their carbon sequestration potential

- **Urban forestry and agroforestry:** Expand the area of 'trees outside forests' within urban environment and agroforestry systems. Increased area under urban forestry would lead to amelioration of the urban environment in addition to enhanced carbon sequestration. Integrating forestry within the agricultural systems would provide the twin benefit of increased carbon sequestration and increased economic benefit to the farmer. Market linkages would have to be strengthened and a favourable policy environment (e.g., with respect to felling and transit rules etc) created to promote agro-forestry on a large scale.

- **Biodiversity assessment:** Carry out research studies on the threat of Climate Change on the fauna in the State, especially those species in the State that are in the Red Data List. At the same time, put in place mechanism to monitor the biodiversity and changes in the habitat composition, especially in the context of any changes observed in the habitat of the Wild Ass, Lion, the Great Indian Bustard and Flamingo.

- **Afforestation:** Afforestation programme for Coastal Areas of Gujarat with a view to provide shelter and security against natural calamities, high velocity and salty breezes, salinity and effects of Climate Change along the coastal areas of Gujarat and create additional carbon sink

- **Plantations:** Project for raising energy plantations and fodder plantations in the interior forest village areas to reduce the burden over forests and to create a carbon sink. There are about four thousand villages which are situated in and around the forest areas of Gujarat. The demand of fuel and fodder of these villages is met directly or indirectly from the forest areas. To reduce this ever increasing burden fuel wood and fodder resources are required to be created in or in the vicinity of the villages

### 9.3.3 Policy support

- Exploring scope of convergence of developmental programme in areas within forest and fringe forest areas from Rural Development, Tribal and Social Welfare, Health & Education, Power Department for holistic development of forest dependent communities.
- Forests, on their own, cannot sustain the load of unemployment of Forest Dependent Communities; hence, other sectors should be explored to divert the pressure.
- The Green Credit scheme proposes that the Forest Department would identify in advance possible lands and prepare a blue print for their afforestation. They would then sign a Memorandum of Understanding (MOU) with potential user agencies which in turn would provide funds at the disposal of the former for afforestation. Since this afforestation will take place on private lands under the controlled, supervision and monitoring of the Forest Department they then would provide credits (certificates) for this which could later be used by the user agency at the time of making an application under the Forest Conservation Act, 1980 for the use of forest land for non-forest purposes. The Green Credits scheme could be enhanced to focus not just on the area being afforested, but also give weightage to the type of plantations undertaken, its yield in terms of biomass and associated carbon, among other benefits. Planting genetically improved varieties would provide more yields. On the other hand, planting local varieties that are also used by local communities could provide for better livelihood opportunities.

### 9.3.4 Capacity building

- Build capacities at various levels of the State administration and other stakeholders on Climate Change and forestry issues. For example, as envisioned in the Green India Mission, Gram Sabha are expected to play a major role, their capacities have to be strengthened for implementing forestry activities.

  Enhancing the capacity of State Forest Department personnel and other stakeholders to tap the opportunities available under the REDD-plus mechanism. At the heart of REDD-plus would be the monitoring, reporting and verification of carbon. While monitoring of deforestation can be carried out economically by using remote sensing techniques, monitoring degradation would require use of more expensive high resolution satellite imagery. Monitoring could alternatively (and synergistically) be carried out with more extensive ground truthing by engaging local forest-dependent people who can be trained to participate in field surveys and forest inventories (along with the forest department). Not only will this provide the local people with (part time) employment but also mobilize the support of forest-dependent communities for forest protection and management.

## Programme of Action for Forests and Biodiversity

| Sr. No. | Department/ Office Name | Activity | Project Objective | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Forests and Environment Department | Inventorization of Bio-diversity through identification of important species and their interrelation & independence, Bio-physical parameters and understanding impact of Climate Change on Nanikarad Weland as the Pilot Project | Potential of carbon sequestration and threats to such wet lands; its utilization patterns & dependence of local communities; Ecosystem services assessment provided by the wetlands; Public participation in conservation & awareness building | 0.813 | 5 | Understanding Carbon sequestration potential and measuring ecosystem services provided by wetlands |
| 2 | | Afforestation of Coastal Areas of Gujarat with a view to provide shelter and security against natural calamities, high velocity and salty breezes, salinity and effects of climate change and to create additional Carbon Sink. | To afforest chosen intertidal areas with suitable species of mangroves. to reduce the erosion of the shore line; To enrich bio-diversity in shelter belts and mangroves plantation areas; To sequester additional carbon and create carbon sink; To involve local communities in protecting the plantations and seek their participation in protecting the plantations | 61.87 | 5 | Increasing coastal area security through green cover and measuring Carbon sequestration potential |
| 3 | | Project for increasing energy plantation and fodder plantations in the interior forest village areas to reduce the burden over forests and to create a carbon sink. | To create fuel wood and fodder resources in villages situated in and around the forest area; To meet the fuel wood and fodder requirement from such resources instead of meeting the demand from forest areas; To involve people in management of the plantation; To reduce the burden on forests; To create a carbon sink by raising the plantation | 57.8 | 5 | Achieve localized energy security |
| 4 | Forests and Environment Department | To Build Awareness and Communication on Climate Change, Elucidate its Mitigation Measures | To create awareness amongst the people on the effects of climate change; Emphasizing the role of forests in mitigating climate change; To publicize concurrent issues on climate change; To create documentation on the causes and effects of climate | 2.87 | 5 | Increased sensitivity and awareness to climate change issues with regards to forest |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | change | | | |
| 5 | | Developing a Project on Reduction of Emissions from Deforestation and Forest Degradation (REDD+) in Amlipada Area of Fort Songadh Range in Vyara Forest Division to the extent of 3000 ha is identified in Tapi district of the state | REDD plus the potential to earn carbon credits for the state and can bring incentives and monetary benefits to the local people also. | 2.58 | 5 | Carbon sequestration |
| 6 | | Project on survey of various species for carbon sequestration potential, sustainable production and utillization | To study the potential of various forest species to sequester carbon. and give a detailed account of the utilization pattern of various forest species, identify the threats on the species to devise proper conservation plans. It will provide baseline data for the preparation of Forest Working plans | 3.34 | 5 | Identify opportunities of growth of specific species for carbon sequestration |
| | | | | **129.27** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

Apart from various activities listed above, promoting organic farming to build capacity in the production and processing of organic products; to train farmers in organic farming. and environment friendly process of pests and diseases management, soil fertility management, post-harvest handling of crops and marketing of products could be further strengthened.

# 10.0 Health

## 10.1 Strategies for health

Evidence of this relationship between rising temperature and increased mortality and morbidity caused by heat stress can be seen throughout India, and Gujarat is one of the states most affected. Average temperatures are projected to increase and the frequency and duration of heat waves are also projected to intensify, according to both global and regional climate models. This can lead to drought, disease, floods, famine, extreme heat, and humidity causing severe direct and indirect effects on health, such as malnutrition, a rise in climate-sensitive diseases like diarrheal illnesses, dengue fever andchickungunya etc. Increased rates of heat-related mortality and illness after heat waves are particularly pronounced in low-income cities, especially among workers with occupational exposure to extreme heat.

Gujarat has long experienced extreme heat, is among the driest regions in India and houses a large migrant population. Gujarat's rapid economic development adds to environmental health concerns and in recent years, the city has suffered from increasing air, water, and soil pollution from industrial areas, textile, chemical industries and lack of citizen awareness regarding pollution prevention.

Though, the NAPCC does not address climate impacts, on health, specifically, the Government of Gujarat has included this sector in its SAPCC.

## 10.2 Government Initiatives

### 10.2.1 Establishment of heat health early warning system

The State has implemented State Referral lab network plan, 8 medical colleges and 2 priority lab. All districts of the State have been linked with Medical colleges and priority lab for RRT and laboratory conformation outbreaks. The project aims to strengthen the integrated and decentralized surveillance activities of IDSP and also make it compatible to forecast the impacts of Climate Change on health and to strengthen the systems for data collection, reporting, analysis, and feedback using information technology.Heat Action plan for Ahmedabad has already been prepared for the year 2014.

### 10.2.2 Establishment of research cell

In year 2007, Indian Institute of Public Health-Gandhinagar had been established to strengthen the overall health system through education, training, research, advocacy and policy initiatives. The Centre will be staffed by a team of three experts. Each year the cell will take up specific work plan in consultation with health department and Climate Change Department.

### 10.2.3 Vector control measures

Vector borne diseases viz: malaria, dengue, chikungunya are prevalent vector borne disease in Gujarat, for which the Government has taken measures to control the disease. For proactive surveillance 10 Sentinel Surveillance Hospitals with laboratory support have been identified. Other Government proposals include distribution of 12,00,000 long lasting impregnated Net (LLIN) to communities to prevent vector borne diseases. All LLIN will be treated with anti-mosquito drugs regularly in the field by health care workers. During 2012 ,under National Vector Borne Disease ControlProgramme (NVBDCP) 3.60 lakh Long Lasting Insecticide treated Nets (LLINS )were distributed in high risk areas. 9.0 lakh beneficiaries were protected. Moreover 61.83 lakh populations of high risk villages were also covered under regular round of Indoor Residual Spray in 2012 (GoG, 2013). Antenatal mothers, urban slum community, BPL families will be given priority.

A large number of initiatives are being undertaken in the State for the control of vector borne diseases. These include:

- Introduction of larvivorous fish in identified water bodies
- Indoor space Spraying/fogging to protect high risk populations
- Treating community owned mosquito nets and making available more mosquito nets out of various sources
- Intensive surveillance in high risk areas are being carried out as a pre transmission drive in all the districts.
- Deploying additional vector control teams to prevent and control vector borne diseases. These need to be up-scaled by expanding the coverage and reach to the block and village level.

**Box 15: Approach to SAPCC Priorities for 2014-2019**

- Epidemic early warning systems
- Vector control activities
- Climate proofing of health infrastructure

## 10.3 Key Strategies

### 10.3.1 Research and development

Health assessments studies will help to understand linkages between Climate Change parameters and health and will inform the decision makers, health practitioners, planning authorities and civil society organizations with information so public health policies and programmes can be developed, customized and implemented in the light of Climate Change. These include:

- Studies for identifying vulnerable populations and regions need to be carried out for Gujarat. The vulnerability may arise due to a range of factors which interact with various determinants of health outcomes. Vulnerability may arise due to demographic factors such as age and sex of the population or limited access to

health care infrastructure or the existing health status of the individual that may result in increased risk. The study will help identify populations and regions with increased or decreased vulnerability to climate variability and change.

- Studies should be sanctioned for carrying out sensitivity analyses that provide insights on the relationships between weather/climate patterns and health determinants and outcomes. These results can be used for strengthening existing Government policies and programmes.
- Research to understand linkages between Climate Change and respiratory and allergic diseases, urbanization and vector borne disease in relation to Climate Change, Mortality increase due to Climate Change among others.
- Health impact studies should be conducted for the State using high resolution meteorological data (observed and projections) and establish the links with epidemiological parameters.
- To strengthen the systems for data collection, reporting, analysis, and feedback using information technology. The State should develop and maintain a digital health database for mortality and morbidity related to climate sensitive Vector-Borne Diseases, water borne diseases, and those related to higher temperatures and rainfall extremes. The Primary Health Centres, Community Health Centres, District Hospitals and Anganwadi workers can be engaged in the process.
- Spatial analysis using Geographic Information Systems (GIS) can characterize the human and ecological landscape in which disease is transmitted to identify vulnerabilities and possible interventions. Remote Sensing techniques and GIS should be applied to highlight current distribution of vulnerable population and spatial relationship to disease vectors, river basins flooding and other important variables of interest to public health officials.

### 10.3.2 Institutional strengthening and infrastructure development

- Strengthening the disease surveillance systems by having early diagnostic systems for providing immediate treatment.
- Setting up sentinel health facilities- based surveillance systems and conducting periodic household level surveys. Further strengthening the integrated and decentralized surveillance activities of IDSP and also make it compatible to forecast the impacts of Climate Change on health.

- The State has good health infrastructure which has resulted in significant improvement in the health status of the people of the State. As per the Annual Development Report 2011-12, the Death Rate and Infant Mortality Rate has shown a decline. The number of Community Health Centres, Primary Health Centres and Sub-centres functioning in the State has significantly increased .The State has 6 major hospitals with educational institute, 24 district level hospitals and 26 sub-district level hospitals. Strengthening and Expansion of healthcare delivery, infrastructure and services to the sub-district/block level.

- Developing Integrated surveillance systems and Early Warning Systems in collaboration with Indian Meteorological Department to collection of relevant information and its timely dissemination to vulnerable populations. Due to its high

penetration in rural areas, Mobile technology could be a useful mode of communicating risks.

- Development of a research cell to support Government's public health programmes through education, training, research, advocacy and policy initiatives.

### 10.3.3 Policy support

Although there are uncertainties about the rate and magnitude of future Climate Change, policy makers need to understand the potential health impacts of Climate Change, the effectiveness of current adaptation and mitigation policies, and the range of choices available for enhancement of current policies and programmes, or the development of new policies and programmes. Policies and programmes to address the health risks from Climate Change should also explicitly consider ways to avoid large scale health impacts from extreme events.

- Monitoring programmes for assessing malnutrition in vulnerable populations should be introduced. Coverage of programmes such as The Integrated Child Development Services (ICDS) Programme , which provide provides a package of services to the child such as supplementary nutrition, immunization and health check-up, should be enhanced. Existing initiatives taken by Government of Gujarat such as Micronutrient fortified extruded blended – ready to cook take home ration and decentralization: distribution of fruit, milk and breakfast through Matru mandals/Self Help Group should be up-scaled to enhance their coverage and effectiveness.

- Introducing health insurance scheme for the State for providing health insurance to the poor and marginalized. Expanding the coverage of Rashtriya Swasthya Bima Yojana (RSBY) to all districts of the State. This will ensure health security to poor households against the risk of health expenditure aggravating poverty.
- Coordination with other sectors and departments for ensuring success of health programmes. For example coordination with agriculture sector to address the issue of food security and water sector for addressing water issues can help alleviate potential adverse health impacts.
- Introducing Integrated vector management and environmental hygiene programmes

### 10.3.4 Capacity building

- The future health impacts of Climate Change will vary over spatial and temporal scales, and will depend upon changing socio-economic and environmental conditions, with possibilities for diseases to increase in incidence and/or change their geographic range. Therefore capacity needs to be built within public health and healthcare organizations and institutions to prepare for and identify changing risks and to evaluate the effectiveness of current and proposed programmes, both within and outside the health sector.
- Regular training workshops should be conducted for medical and para-medical staff, link workers and multi-purpose workers to understand enhanced risks to human health due to Climate Change and equip them with the knowledge to

recognize and respond to emergency situations. New improved module should be developed which includes IDSP case definitions and reporting

- Effective communication and out-reach activities will empower the individuals and communities with the knowledge to take necessary measures to address the health risks.Educational programmes for communities on risks of and appropriate responses to extreme weather events, identifying and treating water-borne, food-borne and vector borne diseases can be broadcast in the local language on local TV channels and Radio to reach out to the masses
- Upgradation and modernization of Information, Education and Communication and training activities in the State. Alerts in newspapers, pamphlets, posters can be used to spread the message

- Encouraging and spreading awareness about initiatives such as the Tele-medicine whereby the State govt. has decided to provide telemedicine facility at 10 CHCs and 24 PHCs integrated with fourtertiary hospital (attached with medical colleges) and district hospitals and Helpline -104 for non emergencyMedical Services for non emergency cases will help the community to have requiredhealth and medical services including super specialty facilities at the nearest place.

- A network of Civil Society Organizations working on health issues should be formed to leverage on their understanding of ground realities and close ties with the communities. The network would help spread awareness among community groups on coping with health risks.

- Traditional practices including design of houses, cultural practices and dietary habits and clothing are effective means of preventing heat-strokes. These have to be recognized and encouraged.

Based on these strategies and the key vulnerabilites, that have already been stated like increased heat stress and VBD, some activites of immediate importance were identified and have been reflected in the activity section.

## Programme of Action for Health

| Sr No. | Department/Office Name | Activity | Project Objective | Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Health and Family Welfare Department | Vector control measures including distribution of long lasting impregnated | To distribute 12,00,000 LLIN to communities to prevent vector borne diseases to priority stakeholders such as antenatal mothers, urban slum community, BPL families | 99.75 | 5 | Decreased disease burden and frequency of vector borne incidences |

| Sr No. | Department/Office Name | Activity | Project Objective | Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| | | net (LLIN) | | | | |
| 2 | | Heat health early warning system in all districts of the state (linked with Medical colleges and priority lab for Rapid Response team (RRT) and laboratory conformation outbreaks) | To strengthen the integrated and decentralized surveillance activities of IDSP and also make it compatible to forecast the impacts of climate change on health; To strengthen the systems for data collection, reporting, analysis, and feedback using information technology | 19 | 5 | Surveillance of heat stress and climate vulnerability |
| 3 | Health and Family Welfare Department | Activity-Development of a research cell at Indian Institute of public health (IIPH) Gandhinagar | To strengthen the overall health system in the country through education, training, research, advocacy and policy initiatives. | 5 | 5 | Research, advocacy and policy intervention in health and climate change |
| 4 | Health and Family Welfare Department | Heat-stress and health (HSH) impact :Adaption strategies for Gujarat | Planning and management of adaptation solutions to increasing heat wave events focusing on Ahmedabad, Sabarkantha, Surendranagar, Patan, Rajkot and Amreli | 46 | 5 | Capacity building, Parnership, Policy, Advocacy and Implementation for heat stress management |
| 5 | Health and Family Welfare Department | Water quality Surveillance | Water quality monitoring focusing on impacts of water quality on health covering all districts and the state | 55.75 | 5 | Reducing disease burden caused by deteriorating water quality |
| 6 | Climate Change Department | Research on “Assessing climate change impacts on vector-borne diseases in | To assess the impact of climate change on human health, focusing on risks related to specific Vector-Borne Diseases (VBDs) Study the impact of climate variability and change on | 0.25 | 1.5 | Mapping vector borne diseases and their impact on the population |

| Sr No. | Department/Office Name | Activity | Project Objective | Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| | | humans over the Gujarat region" | selective VBDs (malaria and dengue) at selected study sites and evaluate any possible threshold effects; Recommend potential adaptation measures to minimize the additional impacts on population health in the state. | | | |
| | | | | **225.75** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

# 11.0 Urban Development

## 11.1 Strategies for Urban Development

Urban areas are one of the most affected by impacts of Climate Change as people and infrastructure are often concentrated within a limited geographical area and this is particularly true in the case of rapidly developing areas, where these concentrations are increasing. However urban areas have potential advantages in building resilience to Climate Change impacts in terms of the economies of scale and proximity that they present for key protective infrastructure and services and for risk-reducing governance innovations.

The Government of Gujarat aims to address these issues through improvements in energy efficiency in buildings, management of solid waste and provide the infrastructure for the shift to public transport, in accordance with the National Mission

**Box 16: National Mission on Sustainable Habitat**

The main objectives of the mission include promoting energy efficiency in residential and commercial sector, solid waste management and promotion of urban public transport, conservation through appropriate changes in legal and regulatory framework. It also seeks to improve resilience of infrastructure, community based disaster management and measures for improving advance warning systems for extreme weather events.

The main components of the Mission are:

1. Development of National Sustainable Habitat Standards (Legal/Regulatory) measures
2. Incorporation of Principles of Sustainable Habitat in city
3. Complementary action such as support

## 11.2 State Initiatives and Achievements

### 11.2.1 Tackling global warming due to urbanization

With burgeoning population (around 4.5 million) in Ahmedabad city, around eight hundred thousand passenger travel every day through the fleet of over one thousand Ahmedabad Municipal Transport Service (AMTS) buses and around 1.9 million private vehicles of all kinds ply on Ahmedabad roads. Therefore, enormous traffic is a major source of Green House Gas (GHG) emission in Ahmedabad city.

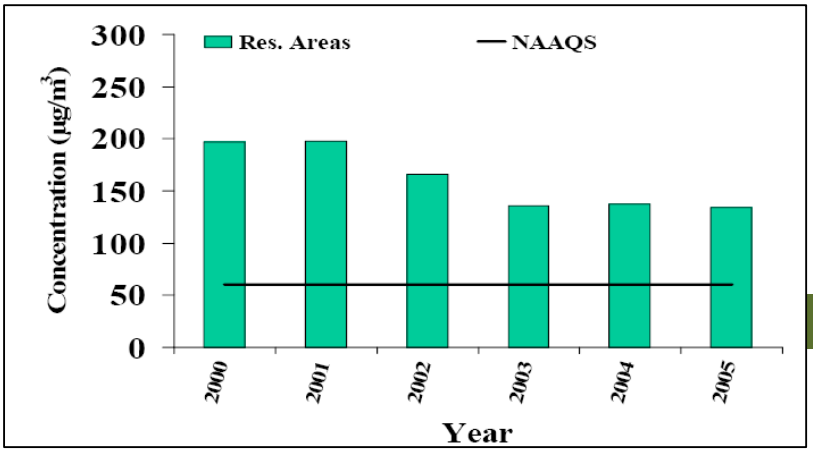
To ease the traffic congestion and simultaneously reduce the GHG emission, the execution of Bus Rapid Transport System (BRTS) was undertaken.The BRTS programme being implemented in the cities of Ahmedabad, Vadodara, Surat and Rajkot, aims to shift 40 per cent of trips from personal transport vehicles to public transport.The objective is to significantly reduce carbon emissions by discouraging use of private vehicles through strengthening of the public transport system. This would ultimately reduce the movement of 400,000 vehicles per day with a net reduction of 37,000 tonnes GHG per annum (mainly $CO_2$ and NOx).

Gujarat has taken up an aggressive programme to convert a large number of public buses as well as auto-rickshaws to CNG for reducing emissions. All pre 1991 auto rickshaws have been completely banned as per the resolution passed by the Regional Transport Authority. In addition to this, more than a dozen flyovers are being executed in Ahmedabad and Surat cities which would facilitate easy transit of vehicles, ultimately leading in pollution and emission reduction.

**Box 17: Respirable Suspended Particulate Matter**

According to the data of Central Pollution Control Board (CPCB), in 2001 the annual average concentration of Respirable Suspended Particulate Matter (RSPM) levels in residential locations of Ahmedabad was 198 µg/$m^3$, which was 4th highest concentration amongst 90 cities of India. As per a 2008 report of the CPCB the annual average of RSPM levels in residential areas of Ahmedabad was 80 µg/$m^3$, improving its rank to 66$^{th}$.

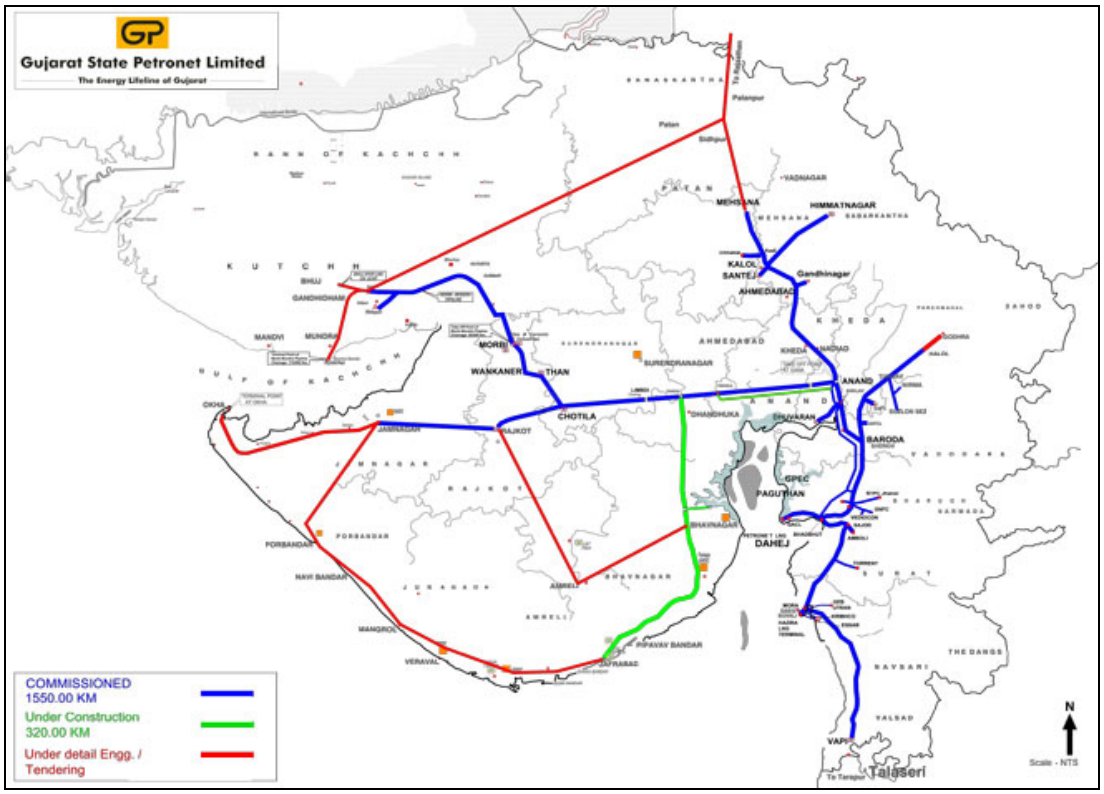
**Figure 39: RSPM Concentration in Ahmedabad**



## 1.2.2 Adopting clean fuels in Gujarat

Climate Change mitigation is an important but not to slow the pace of development, was the core idea when the State went ahead to introduce clean fuel mechanism through the first ever State wide Gas grid of 1550 km covering 15 districts of Gujaratand an additional 350 kilometers is under construction/development. This has led to conversion of thousands of vehicles and industries to natural gas. An ambitious city gas distribution system has led to more than 4,00,000 domestic connections received as a boon in smaller towns of Gujarat. The total gas flow in the three sectors has been around 58.56 Million Metric Cubic Metres per day resulting in reduction of 23 million $tCO_2$.

**Figure 40: Gas grid covering various districts of Gujarat**




**Source: Gujarat State Petronet Ltd. (GSPL), 2014**

In addition, the Gujarat State Petroleum Corporation has established the Pandit Deendayal Petroleum University for training human resources in the energy sector. A School of Solar Energy has also been set up under this University. All public sector undertaking units are taking up Efficiency Gains Programmes through fuel switch and technology change. Largest Urban Energy Efficiency programme in India is under implementation which will cover all Municipal Corporations and Municipalities in the State and lead to energy savings of nearly 30 per cent.

For managing GHG emissions from Municipal Solid Waste, Gujarat Urban Development Corporation (GUDC) is developing compost plants for all Urban Local Bodies work has commenced for93such vermi-compost plants in Gujarat. The project comprises measures to avoid production of methane from municipal solid waste that would otherwise decay anaerobically in land fill sites/dumps. The implementation of Municipal Solid Waste Management (MSWM), as per MSW Rules, 2000 is taken by GUDC. This includes collection, transportation, composting and disposal on scientific basis for all urban local bodies. Gujarat is the leading State in the country in compliance of MSWM rules 2000.They are expected to generate 1000tonnes/day of vermi- compost.

**Box 18: Approach to SAPCC Priorities for 2014-2019**

- Gujarat Development Control Regulations (GDCR) to be revised for promoting Green buildings, regulation for improvement of para-transit in cities
- GHG emissions inventory
- Landfill sites for solid waste management

## 11.3 Key Strategies

### 11.3.1 Disaster preparedness and mitigation plan; early warning systems (IT based)/emergency operation centers

Disaster preparedness and mitigation plan for flood related emergencies at a city level is of critical importance. GSDMA has developed the Hazard Risk and Vulnerability atlas for the State covering six major hazards. Based on this, the hazard risk mapping for areas prone to extreme rainfall should be carried out at the local level for each city/town. For towns prone to flooding, the investment and planning interventions should mandatorily refer to these studies. To enable this further, these cities should have disaster management plans integrated into the development plans. GSDMA could take up preparing city specific guidelines to help cities integrate DRR in planning processes.

Relevant technical capacities should be developed and State-of-art equipment acquired. Apart from this, local authorities should perform constant monitoring of the seasonal rainfall to predict/forecast any disaster like situation.

Inter-departmental coordination strategy- An inter-departmental coordination strategy should be in place for effective implementation of the disaster management plan. This should contain action to be taken by each department i.e. storm water drainage, health, etc in case of floods resulting from extreme rainfall. Each action should be designated to an officer in charge and timelines to be set in the strategy.

Surat city has implemented elaborate monsoon preparation process to mitigate flood risks. The activities under this range from gearing up the administrative system, cleaning up the drainage and sewerage system, preparation of emergency evacuation, emergency drills etc. The level of Ukai Dam is monitored continuously during rainy

season and conveyed to people. Advance warnings are provided by megaphones and SMS system.

The State should encourage, other flood prone cities and towns to develop and enable such mechanisms in their cities. IT enabled early warning systems should be introduced in phased manner in cities. The early warning systems should be linked to evacuation plans and health facilities.

### 11.3.2 Improving community participation

An effort should be made to incorporate communities residing in the flood prone areas in the disaster preparedness and mitigation plan. An IEC (Information Education Communication) campaign in order to educate the communities about the risks of extreme rainfall, and basic good practices to avoid spread of water borne diseases in case of water logging for elongated periods should be undertaken. An evacuation plan should be prepared in consultation with the community and be publicized in the regional language. Maps showing low lying areas and high ground points in an easily readable format should be made available to the communities. Asset bank systems and resource pooling at community level need to be built and where these already exist they need to be improved.

## 11.4 Waste management

Rapid urbanization and changing lifestyles are generating huge amounts of municipal solid waste and sewerage in the urban areas of the State. The State agencies already have several initiatives either in the pilot phase or initial stages to address this problem. Construction of a number of common landfill sites, sewerage treatment plants and composting sites is underway at several locations across the State.

### 11.4.1 Research and development

- There is an urgent need for documentation and database of technology options for processing and disposal of wastes and also the facilities which are in operation in the State. In many cases, facilities /plants work under capacity or have been temporarily or permanently closed. Documentation of the feedback, including actual capital investment, difficulties faced in installation, operation and maintenance of the project facility and its cost, frequency of repair and replacement, and so on is also essential for a holistic assessment of the situation.
- Further, a system for detailed data collection on quantity and composition of municipal and other types of solid waste generated within the municipal area, preferably on a regular basis is required. This data is essential for appropriate and realistic design of a solid waste management system for the city. However, it is acknowledged that reliable data collection regarding solid waste management is very difficult in view of the various uncertainties associated with waste generation, such as season and festive occasions. Therefore, proper data can only evolve if data is collected for at least one full year, which would cover these uncertainties. Regular data collection would provide vital information regarding changing nature and composition of waste with time, which in turn would help in directing R&D efforts, designing waste management systems and strategy for future programmes.

### 11.4.2 Institutional strengthening and infrastructure development

Although statistically speaking, the waste sector is considered a relatively small contributor to greenhouse gas emissions (~3-5% globally) but it has the potential to be a relatively large part of the solution (nearly 20%). Moreover, the sector has far greater relevance in regions witnessing rapid urbanization and industrialization with mature technologies related to recycling, landfilling, and biochemical treatment attaining acceptability and viability in the market. The waste management technologies not only mitigate GHG emissions from post-consumer waste but also provide public health, environmental protection, and sustainable development co-benefits.

- The potential mitigation technologies which can find wide application in the major waste producing centres of the State include landfill gas recovery, improved landfill practices, and engineered wastewater management. In addition, significant GHG generation could be avoided through controlled composting, State-of-the-art incineration, and expanded sanitation coverage. Reduced waste generation and the exploitation of energy from waste (landfill gas, incineration, anaerobic digester biogas) can produce an indirect reduction of GHG emissions through the conservation of raw materials, improved energy and resource efficiency, and fossil fuel avoidance.
- The policy makers/decision makers at each stage of the value chain should ascertain that local technology choices/decisions are influenced by factors such as waste quantity and characteristics, cost and financing issues, infrastructure requirements including available land area, collection and transport considerations, and regulatory constraints and not guided by the best available technology for the purpose alone.
- Waste-to-energy (WTE) projects have dual benefits - they not only solve the problem of waste disposal but also lead to generation of electricity through that waste. However, some of the barriers with regard to such projects like high upfront costs, lack of segregation of wastes (and dangers thereof), lack of awareness about the merits of incineration technology, lack of availability of land for setting up integrated MSW treatment and power generation plant etc. need to be addressed through appropriate policy and financial instruments. Also, there is a need to involve expertise available with the industry sector to develop WTE options for the city (need for local body to work closely with corporate sector).
- Gujarat has pioneered the concept of regional landfills, this needs to be further promoted to not only address the issue of costs involved in the process, but also to ensure regular supply of right quality/quantity of wastes reaching the sites and thereby maximum GHG abatement and recovery of methane to be used as an energy source.

### 11.4.3 Policy support

- The current or the revised policy framework in this regard should ensure implementation of integrated waste management system – linking waste collection and transportation to processing and disposal. Integrated waste management system is required for cities to operate the process more efficiently at lesser cost and making the service sustainable. Integration could be at different levels -

different aspects of sustainability technical, environmental, public health, financial, and so on; integration of different collection, transportation, and treatment options at different habitat levels (household level, neighborhood level, and city level); cooperation, alliance, and socio-economic interaction of different stakeholders either engaged or affected by waste management services (users, Government, formal/informal organizations, and so on);and integration of waste management system with other basic services like storm-water drainage, sanitation, and health and hygiene programmes in the city.

- Performance-based privatization of services especially in the area of waste collection, transportation, and processing should be encouraged to bring in efficiency. However, inviting the private sector for service improvement and better cost recovery would require local bodies to gain expertise in the preparation of contracts and to understand the technical and legal issues related to the requirements regarding processing facilities, landfill sites, and so on. The technical capacity of local bodies needs to be enhanced to cover such aspects as well. The various stakeholders in the value chain should ensure than minimal biodegradable wastes reaches the landfill sites.
- A special task force and a dedicated cell for urban waste management need to be established at the municipal level. The cell would be headed by an environmental engineer or civil engineer as against the public health officer as is normally done to achieve maximum performance. The cell would be guided and advised by a steering committee of eminent technocrats and senior citizens of the city for planning process.
- Replicating the success story of Surat, decentralization of municipal functioning at the zonal level and ward level needs to be aggressively encouraged in all urban centres of the State to bring out the accountability and efficiency improvement. Civil societies could play a critical role in providing decentralized waste management services in peripheral/marginalized areas where municipal service is weak.
- The policy makers should ensure that the provisions of waste management services are in sync with economic/social needs of the region (especially urban poor) like livelihood of urban poor, sanitation and health status for wider acceptability of the proposed system, especially waste segregation, during collection; this would be a key to the success for any waste processing option adopted by a local body. There is a need establish a cost-recovery mechanism for services to make them sustainable.
- The policies should provide incentives for communities to own up local initiatives make the project more sustainable. Further, involvement of waste pickers/community organizations/NGOs ensures successful waste collection and local-level waste management especially in peripheral areas where municipal coverage is generally weak. Or in other cases effective involvement of rag-pickers of the informal system in the door-to-door solid waste collection system would not only make the process more productive but also provide them with livelihood opportunities.

- The policy framework should address the issue of conflicting interests between different agencies responsible for energy generation, compost supply, and waste management. Moreover methane recovery (from various waste sources like landfills, compost plants, etc.) can introduce new actors into the waste segregation/disposal process, potentially disturbing the current balance of economic and political power in the community.
- The privatization efforts (e.g. through PPP) in various local bodies should be able to integrate the informal and formal private sector, and thus make the most from such integration. Such initiatives can be carried out on pilot scale in the first phase and thereby replicated to other areas upon successful implementation.

### 11.4.4 Capacity building

- The State agencies need to undertake capacity building initiatives for all relevant stakeholders to address the knowledge and information gaps with regard to relative costs and effectiveness of alternative technical options, lack of experience with low-cost recently developed processes like anaerobic treatment of wastes or expensive, sophisticated technologies like landfilling.

## 11.5 Water/wastewater management

Providing safe and adequate water to the growing urban population of the State has become a daunting task for the urban authorities. In addition to the insufficient availability of water resources, lack of good infrastructure/techniques for monitoring, treatment facilities, along with poor management of waste water, also contribute towards widespread pollution of surface and groundwater, leading to rapid deterioration of the environment.

### 11.5.1 Research and development

- Any reform initiatives to address the issue of water availability in the urban sector should be preceded with data management. An integrated comprehensive water supply network database is important to get a holistic understanding of the entire network, distribution, and including inlets/outlets etc. This data set will also provide information on coverage, UFW (unaccounted for water), metering, and so on, and ways to manage the system more efficiently and effectively. The data will enable cities to develop its future strategies to improve service delivery and achieve the benchmarks set at the State/country level.
- A regularized system of water audits to provide a comprehensive appraisal of the availability, distribution, utilization, and the extent of losses in the system needs to be introduced. The dataset generated during the water auditing procedure should be used to calculate the various types of leakages at various stages for the entire city to determine the level of leakage within the distribution network and devise the corrective measures.
- The system of water audits also needs to monitor in a transparent manner, the corporate efforts towards conservation of water in the areas surrounding the plant.

### 11.5.2 Institutional strengthening and infrastructure development

- In order to achieve maximum reduction of UFW (unaccounted for water) options like reducing water loss through pressure management, reducing unmetered supplies/improving meter accuracy, reducing UFW through asset management, actively controlling leakage to reduce UFW can be adopted. In fact, all these initiatives toreduce UFWs in the system can be addressed by developing DMAs (district metered areas) - an integrated way of systematically analyzing and addressing the issues in a designated area.
- Rapid industrialization in the State exerts extra stress on the limited water availability of the State owing to erratic and irregular rainfall and receding ground water levels with the changing climate further aggravating the situation. To overcome this and ensure regular availability of water to the industrial activity in the State, the industrial clusters in coordination with the Urban Local Bodies and other local authorities can come together for implementing a compensatory water harvesting initiative. The involved industrial units in consultation with the authorities can fund the initiative to create rain water harvesting and storage and ground water harvesting and storage and associated infrastructure within and around the industry/ies. If scientifically implemented the initiative would not only provide water to the industrial units but also to the nearby residential communities.
- Instead of opting for cost-intensive augmentation measures like long-distance import of surface water or desalination, the ULBs need to aggressively promote non-conventional water sources rainwater harvesting, conservation of catchments/ water bodies from encroachment and restoration of traditional water bodies, complete treatment of wastewater before discharging it into surface water bodies, etc.
- Decentralized sewage collection and treatment should be made mandatory in all towns and cities with inadequate centralized sewage treatment.
- Reuse of grey water for irrigation or flushing should be increased, so as to reduce the total volume of waste-water reaching the city's sewage system; this could be incentivized through financial instruments.
- **Urban Storm Water Drainage Infrastructure Improvement**: Lack of storm water drainage heightens the risks related to water logging and spread of water born diseases during incidents of extreme rainfall. Thus, for addressing these risks, there is a need to improve the storm water drainage infrastructure in the urban centers in the State. This essentially means comprehensively undertaking the following sub strategies:
  - Development of a comprehensive drainage master plan (including background studies, phasing of projects, operation and maintenance arrangement, funding , etc)
  - Construction of roadside and outfall drains in order to carry the storm water
  - Design of the system should be such that the storm water is fed into natural channels or ground water recharging areas

### 11.5.3 Policy support

- The policy framework should essentially focus on strategies/processes involved in establishing and implementing effective water loss management strategies (primarily reduction of UFW) and tariff rationalization.
- State wide rule to incorporating water harvesting in building by-laws: Considering the reduction in average rainfall, and increase in extreme rainfall events there is a need toincorporate regulations on water harvesting, reuse and recycle in the building by laws of urban local bodies. The State Government has passed the orders and made mandatory for the local Government to implement these regulations. An assessment system therefore should be adopted which could help ensuring compliance of the law. TheState should commission preparing manuals on various means of water conservation, water harvesting techniques for different housing types, and ways of reuse and recycle for non-drinking purposes to facilitate the strategy. Some cities like Surat have already introduced rainwater harvesting and the proposed manuals would only facilitate other cities to adopt the system.
- The policy framework should promote initiatives based on public–private partnership models to ensure improved water and sanitation services by using performance-based contracts to manage the water distribution and transmission system. Such models should not only be aimed at enhanced water management of water resources but also an increase in the revenues of the local authorities and a substantial drop in customer complaints. Throughout this process, transparency and effectiveness should be key words. There is, however, a realization that no single model will suit all situations, and PPP must be tailored to meet local infrastructure, affordability, cultural norms, and so on.
- The policies need to curb excessive/uncontrolled groundwater abstraction and subsurface contamination. Non-notified zones should be brought under regulation and strict enforcement in notified areas should be ascertained.
- It should be made compulsory for water-intensive industries within the city limits to recharge groundwater through artificial means like rainwater harvesting. There should be direct regulatory measures as well as economic instruments (financial incentive and sanctions) to achieve this.
- Groundwater abstraction rights should be withdrawn from industrial companies that have not installed water-efficient technologies. Trading treated waste water for groundwater abstraction rights with industrial abstractor in fringe urban areas on a carefully planned basis can be done.
- Before establishing a new plant, water availability needs to be assessed from long-term and ecosystem perspective, keeping in mind present and future (potential) competing water demands in the area.
- Appropriate policies need to be devised to encourage independent provision of water resources, including rainwater harvesting and grey water reuse. Rainwater capture storage should be made mandatory, wherever applicable based on the geological strata and hydrological conditions of the city.

### 11.5.4 Capacity building

- The ULBs are required to be sensitized and encouraged to be responsive to the specific needs of socio-economically vulnerable groups. The main aim of the training should be to motivate and assist the ULBs and generate awareness.
- The ULBs need to be made aware of the full range of low-cost and appropriate water-saving technologies and need to be provided with skills to assist with their selection.
- Different levels of need-based training should be provided to the entire staff of the local bodies on a regular basis to enhance the current skill set of functionaries and to enable them to perform the envisaged tasks more efficiently.
- For effective data management (especially in areas where water management initiatives are being launched for the first time or in the initial phases), staff capacity has to be regularly developed and updated on elements like data collection, screening and logging, data transfer, data checking and validation etc.
- Calculation of water footprint, linking with tax rebates for business owners and individuals: State can encourage large business owners/corporate and individuals to calculate their water footprint. Just like carbon, water footprint can also be calculated by developing a tool using a fixed set of variables for business owners and individuals like water usage in kitchen, bath and gardening etc. This tool can also calculate possible reduction in the water footprint by employing certain basic water conservation principles. Well documented and result-oriented good practices could be made eligible for a tax rebate program.
- It is acknowledged that not all the water boards, utilities and local bodies have similar capacities, resources etc. Therefore, it is not possible to create and develop these capacities within the organization. In such situations, some of the tasks can be outsourced or farmed out to consultancies, research institutes, and so on, who have dedicated manpower and infrastructure for data management including GIS (geographical information service), MIS (management information system), and so on. However, water boards, utilities and local bodies should create adequate capacities to assign, deploy, utilize, oversee, and manage the outsourced assignments.

## 11.6 Urban transport system

### 11.6.1 Research and development

- In order to develop an integrated land use and transportation infrastructure plan for the urban centres of the State, a study needs to be undertaken to help in deciding on an optimal modal mix for the city; assessing public transport demand; identification of routes, nodes, and so on. Authentic data needs to be collected on travel needs, preferences, patterns, trip lengths, modal splits, number and type of vehicles, capacity, ridership, average speeds, age of fleet, and so on.
- Every city needs to have an overall mobility and transport infrastructure plan indicating the present and projected travel demands and patterns; existing modal split and desired modes for the future; and desired framework for overall transport

development and management in the city including intermodal integration. Specific studies in this regard could be carried out to collate the required data/information.

### 11.6.2 Policy support

- For effective transport management, the State polices need to integrate the concerns related to transport planning with land use planning and urban development from the very initial stage of policy making and implementation.
- The current State policies need to be relooked/upgraded to address the growing transportation needs through enhanced implementation of Mass Rapid Transport System (MRTS) especially in all the urban and sub-urban centres of the State. All the major cities of the State could be connected with intercity railway network having good facilities at affordable costs. Rapid-transit-system with city buses could be provided to the satellite towns emerging as growth centers around the main cities of the State. Construction of metro rail for mass passenger transport should be considered for the key business centres of the State.
- PPP models can be implemented for promotion of mass transport system in urban and semi-urban locations. Besides creation of the infrastructure, the PPP scheme could be extended upto the operation and maintenance stage and an appropriate revenue sharing (between the private party and the local authority) scheme can be devised to make the initiative sustainable.
- Generally speaking, public transport today suffers from a poor image—slow, overcrowded, dirty and unsafe. Involvement of the private sector can help in addressing this problem to some extent.
- There exist a number of agencies whose activities are directly or indirectly have a bearing on the transport operations of a city. The local municipal Government provides roads, infrastructure like bus stands, regulates traffic along with the traffic police, controls construction, and so on; the local city development authority discharges town planning functions; the police regulates traffic; the public works department has responsibility for roads and bridges; the development authorities carry out city planning; the pollution control board enforces emission norms; the tax authorities impose and collect different taxes; and so on. Coordination between various agencies is indispensable to achieve an overall quality of transport services in cities.

### 11.6.3 Institutional strengthening and infrastructure development

- Although the State is implementing several initiatives like construction of Bus Rapid Transport System (BRTS), fly-overs, ring-roads and by-pass roads etc. to reduce the number of km travelled between two points (and thereby reduce the fuel consumption) in a couple of cities, but this plan needs to be broadened to cover atleast all the urban centres for far greater results.
- The State authorities need to evaluate opportunities for strengthening infrastructure for promoting non-motorized transport means in cities to reduce GHG emissions and improvement of urban air quality.

- Route planning forms one of the most critical ingredients of a successful public transport improvement strategy. It influences passenger demands, passenger satisfaction, operating costs and perception of non-users. Transportation experts should decide whether a hub and spoke or grid or trunk and feeder systems is suitable for a city. Routes should be planned on a scientific basis, after discussions with all stakeholders.

- Technologies available to enhance public transport performance should be put to use. Some of these technologies include integrated ticketing and fare collection systems (numerous sales outlets, ticketing machines, multiple purchasing options); information systems (telephone lines, web pages, online journey planners, audiovisual equipment at stations); real time GPS (global positioning system) in public transport vehicles to track vehicles, and warn about delays and breakdowns; modern buses with low floors, pneumatic double door, and rear engine; etc.

## 11.7 Land use

### 11.7.1 Institutional strengthening and infrastructure development

- Roadside avenue plantations can be gainfully used to sequester carbon in the key cities of the State in the first phase. Particular road stretches and effective and tolerant species can be identified for specific regions in the demonstration phase and could be replicated throughout the State in the later stages.

- The development of residential/commercial buildings/structures in the cities should be sustainable and environment friendly. The material used for the buildings should be non-polluting, local, and appropriate for the process of future deconstruction. The strategies to achieve this should include reduction in the amount of material consumed, promotion of reuse, use of recycled materials, minimization and management of wastes for reutilization and recycling, and use of materials that reduce the environmental impact. The use of onsite sources and sinks by bio-climatic architectural practices should be optimized; power requirements to the buildings need to be minimized; and use of efficient lighting, air-conditioning; efficient day lighting integration, use of renewable sources of energy, use of efficient waste and water management practices need to be maximized.

### 11.7.2 Policy support

- The master plans or the development plans for the urban centres need to incorporate Climate Change concerns in an objective and scientific manner keeping the short-term, mid-term, and long-term needs and implications into consideration. **Land use planning and enforcement of development rules based on risk**: Land use planning should be based on risk characterization exercise which considers flood prone, water logging prone areas and discourages development here. The drainage pattern of the city is considered while doing the land use plan, but at later stages due to market demands, this consideration takes a back seat. But it should be essential component for areas that are at risk for flooding and so appropriately dealt with.

- For areas prone to pronounced heat waves and to maintain a healthy livable environment, deliberate attempts have to be made to increase the green cover within and outside cities. Leaving of green belts at urban periphery along with extensive plantation plans within cities would reduce incidence of heat island effect besides providing with clean and green cities.
- Urban land use planning should be totally guided by various parameters of urban form like density, land use mix, city shape, street patterns, orientations, traffic growth and its effect on travel demand and trip length. This would enable consideration of geographic and socio-economic constraints while planning for transportation/habitat/industrial growth in urban areas.
- Procurement legislations for energy- and water-saving equipment, appliances, and fixtures should be introduced for all public buildings in at least Class I and Class II cities by the StateGovernment and accordingly each development authority should amend the building bye-laws of municipalities and corporations coming under their respective jurisdiction in a defined time-frame.
- Apart from these minimal mandatory requirements, building certification system (such as GRIHA) should be popularized to recognize high-performance buildings.
- Benchmarking and certification of buildings at the time of rental and sale should be put into place and initially should be made mandatory for all commercial buildings with a built-up area above a certain range. To begin with, the certification system should be simple and just a quantitative assessment of total energy consumption over the year per square metre.
- Mandatory and subsidized audits (energy and water) should be done for already existing public buildings, followed by high-efficiency retrofit to make them role model/ demonstration projects. Mandatory audits could be done for industrial and commercial buildings above a certain built-up area and energy use. Voluntary audits of other private buildings should be incentivized through appropriate measures.

### 11.7.3 Capacity building

- Builders are apprehensive of the incremental cost they bear to build green buildings whose benefits automatically get transferred to the consumers. This could be overcome once there is enough demand in the market for green buildings, which is possible through market transformation and a strong education and public outreach programme.
- Identification of locally available eco-friendly building material and research on production of such resources is required to reduce use of brick and mortar and thereby reduce the carbon content of the buildings.

Taking into considerationthe strategies mentioned above, the Departments proposed a series of programmes/ activities that could be likely undertaken to tap the existing mitigation potential and adaptation opportunities. It is interesting to note that the Urban Local Bodies have also participated in preparation of State Action Plan through

proposing projects that could be done at local level.

## Programme of Action for Urban Development

| Sr No. | Department/Office Name | Project | Project Objective/ Outcomes | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Gujarat Urban Development corporation | Climate change impact on cities of Gujarat | To provide a framework for the development of Climate Resilience Strategies for the cities of Gujarat. | 25 | 5 | Identification of Climate Resilience Strategies for climate proofing cities in the state |
| 2 | | Energy Efficiency in commercial and residential buildings of Gujarat International Finance Tec (GIFT) City | To prepare the Energy Efficiency Building Code (ECBC) for the Commercial and Residential Building Sector of GIFT city. | 30 | 5 | Energy efficiency in GIFT city |
| 3 | Home Department (Gujarat State Police Housing Corporation Ltd.) | Efficient conservation of Rain Water, through rain water harvesting systems for large scale housing and infrastructure projects taken up by Corporations. | To conserve water, reducing ground water depletion/dependence by rain water harvesting systems for large scale housing and infrastructure projects taken up by Corporations. | 13.5 | 10 | Promotion of water conservation |
| 4 | | Energy Efficiency and Renewable Energy options and steps for large scale housing and infrastructure projects taken up by Corporations. | Energy Efficiency and Renewable Energy options and steps for large scale housing and infrastructure projects taken up by Corporations. | 13.5 | 10 | Energy Conservation and use of alternative sources of energy |
| 5 | | Use of alternate energy efficient building materials and construction technologies | Utilization of alternate energy efficient building materials and construction technologies in building complexes, calculation of reduction of Carbon emissions | 13.5 | 10 | Reduction in overall carbon footprint though alternate energy efficient building material and construction technologies. |

| Sr No. | Department/Office Name | Project | Project Objective/ Outcomes | Budget in Crore Rs.* | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 6 | Focus on five Municipal Corporations including Ahmedabad, Vadodara, Surat, Bhavnagar, Rajkot | Sustainable Urban Development activities with focus on sectors such as Health, Water, Waste, Energy efficiency and renewable energy, transport, greening, awareness generation among others | Sustainable and planned development of urban areas contributing to GHG emission reductions | 3252 | 5 | GHG emission reductions and creating carbon neutral cities |
| | | | Total | **3347.5** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

Taking into consideration the strategies mentioned above, the Departments proposed a series of programmes/ activities that could be likely undertaken to tap the existing mitigation potential and adaptation opportunities. It is interesting to note that the Urban Local Bodies have also participated in preparation of State Action Plan through proposing projects that could be done at local level.

# Cross-Sectoral Themes

# 12.0 Renewable Energy and Energy Efficiency

In energy terms, though Gujarat's hydel potential and thermal potential is limited, it has been blessed in renewable energy resources. It get 300 days of sunshine, strong winds along its long coastline, and possesses the scope for energy plantations in its vast wastelands, it also has the ability to generate energy from bio, agro and industrial–waste. Hence, it certainly becomes an imperative for Gujarat to harness it non conventional source of energy.

## 12.1 Strategies for renewable energy and energy efficiency

Energy reduction efforts are of prime importance in Gujarat, where economic growth and development are moving at a rapid pace. The State Government accepts that without significant gains from energy efficiency energy use and greenhouse gas emissions will be growth will untenable. However, the Government estimates energy use could be reduced significantly through advanced technologies, which will restrict the projected increase in emissions, and aims to generate the investments required for the purpose. Support can be assured from the National Solar Mission and National Mission for Enhanced Energy Efficiency.

A large number of initiatives are being taken by the Central government to target energy efficiency and ito promote renewable energy namely the PAT scheme and the REC scheme.

Perform, Achieve and Trade (PAT) schemefalls under the National Mission for Enhanced Energy Efficiency (NMEEE) and was launched by BEE. It is a first of its kind market-based mechanism that targets energy efficiency in developing nations. The scheme aims to incentivize energy efficiency in the large energy-intensive industries wherein certification of energy savings can be traded. Improvements targets in energy efficiency have been currentlyset for nine industrial sectors, namely aluminum, cement, chlor-alkali, fertilizers, iron and steel pulp and paper, railways, textiles and thermal power plants, as Designated Consumers (DCs) under section 14 of the Energy Conservation Act, 2001(BEE, 2014). The program aims to save at least 5% on energy costs, which equates to 9.8 million tons of oil equivalent, or 5,600 MW of avoided capacity addition (Sopher and Mansell, 2012). Gujarat along with Maharashtra, Rajasthan and Tamil Nadu have 48% of DCs so Gujarat can position itself very well in the energy efficiency market (CII, ).

The Renewable energy Certificate (REC) program is a market based trading system whose primary purpose is to promote renewable energy across India independent of the region's renewable power generation capacity. The REC systems contributes significantly to renewable energy generation goals outlined by the NAPCC. (GOI).

Under this program, State Regulatory Commissions (SERCs) set targets for power companies to purchase a certain percentage of their total power from renewable sources called Renewable Purchase Obligations Standards (RPOs). In order to comply with their RPOs or profit from a surplus of RECs, trading of RECs either within or across states is carried out. Gujarat as state that has always been invested in renewable energy has announced that 10% of energy procurement to come from renewable sources, for its obligated entities for the year FY17(Gujarat Electricity Regulatory Commission (GERC), 2014)

The year-wise RPO targets effective April 2014 have been tabulated below:

| Year | Minimum Quantum of purchase (in %) from renewable energy sources (in terms of energy in kWh) | | | |
|---|---|---|---|---|
| | Total | Wind | Solar | Others |
| 2013-14 | 7 | 5.5 | 1 | 0.5 |
| 2014-15 | 8 | 6.25 | 1.25 | 0.5 |
| 2015-16 | 9 | 7 | 1.5 | 0.5 |
| 2016-17 | 10 | 7.75 | 1.75 | 0.5 |

**Box 19: National Solar Mission National Mission for Enhanced Energy Efficiency**

**National Solar Mission**

The National Solar Mission aims at promoting ecologically sustainable growth while addressing India's energy security challenge. It aims to generate **20,000 MW of solar power by 2020** by setting up megawatt scale solar power plants,

The main objectives include-

- Deployment of commercial solar technologies
- Establishing solar research facilities
- Integrating private sector manufacturing capacities for solar materials and equipments,
- Providing funding for these activities,
- Enhancing policy and regulation measures for enhancing and promoting solar technologies.

The mission also aims for local photovoltaic production from integrated facilities at a level of 1000MW/annum. It would also aim to install 1000 MW of concentrating solar power generation capacity.

**National Mission for Enhanced Energy (EE) Efficiency**

The mission aims have **10,000 MW of EE savings by 2020** by accelerating shift to energy efficient appliances, market based mechanisms and fiscal instruments

- Mandating decreases in large energy consuming industries, providing a framework to certify excess energy saving and facilitating trading of the excess savings amongst companies to meet their compliance.
- Providing incentives on tax for promoting energy efficiency. Differential taxation on appliances that have been certified as energy efficient.
- Creation of energy efficiency financing platforms for public-private partnership to capture energy savings by demand side management programs in agriculture, municipal and building sector.

## 12.2 Renewable energy initiatives

In Gujarat, actions addressing Climate Change concerns are concurrent with planning. The State has undertaken a large number of unprecedented initiatives addressing both mitigation and adaptation through its various policies and programmes.

The initiatives taken up by Gujarat are unique for reduction in carbon emission. The actions taken up are reflected in policies of Gujarat as well as small and large projects that are being implemented. Few of the initiatives are described below.

### 12.2.1 Solar energy initiatives in Gujarat

With high solar radiation levels for almost 300 days in a year, Gujarat has vast potential for Solar Power Generation Projects. The State has thus come up with a comprehensive Solar Power Policy in 2009 with the following features:

- Solar Power Generators (SPG) installed and commissioned during the operative period to become eligible for incentives for a period of 25 years from the date of commissioning or for the life span of the SPG whichever is earlier.
- A maximum of 500 Mega Watts SPG to be allowed for installation during the policy period up to 31.3.2014.
- The minimum project capacity of a SPG, in case of Solar Photovoltaic (SPV) and Solar Thermal (ST) to be 5 megawatt each.
- Electricity generated from the SPGs to be exempted from payment of Electricity Duty and also from demand cut to the extent of 50 per cent of installed capacity.
- Purchase price of electricity from Solar Photovoltaic at Rs.13/unit and for Solar Thermal at Rs.10/unit.

The solar projects to be established pursuant to this policy in the State are expected to generate 20,000 million units of electric power annually. These projects are expected to result in reduction of almost 21 million tonnes $CO_2$ emission every year.

### 12.2.2 Gandhinagar as Solar City

City of **Gandhinagar** is being developed into a "**Solar City**" on the basis of the master plan prepared by TERI, where in the major energy demands will be fulfilled through non-conventional sources of energy

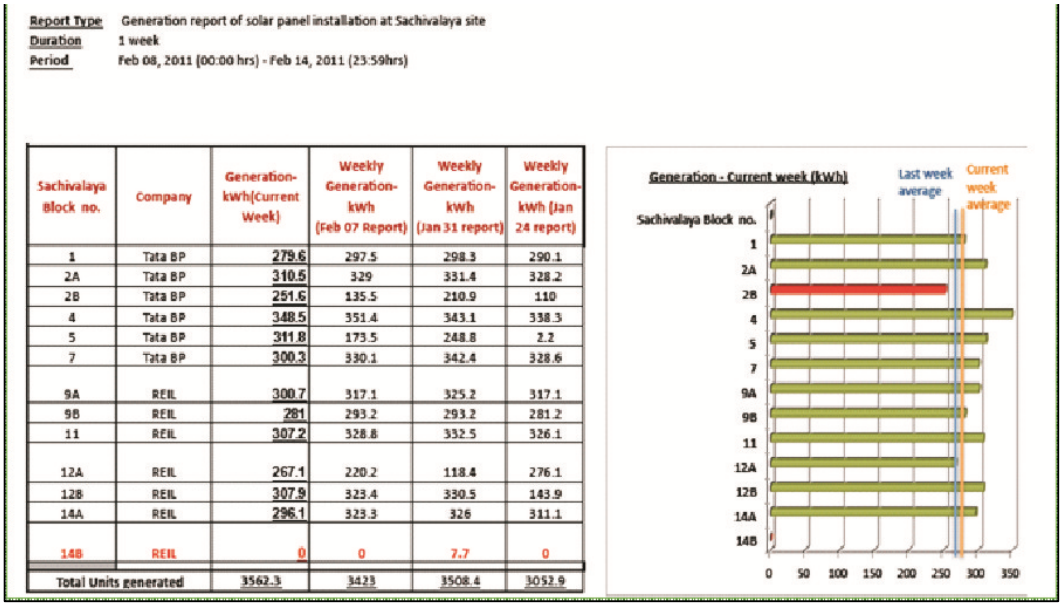
In order to achieve this following initiatives have been taken up in the State Capital.

- 2 MW solar power projects in Gandhinagar
- Grid tied roof top projects for sale to utility for 4,600 kW
- 6 projects of wind solar hybrid for captive use for 60kW
- 127 Nos. Solar stand alone power packs at residences of 1kW each
- 125 solar street lights for roads and parks
- 210 Nos. solar water heaters at residences and 4 Nos. solar water heaters at instituted for 52.5MW and 15 MW respectively
- 30 LED street lights for 2250 kW
- Replacement of 14,000 ordinary lights to energy efficient tube lights (T-5) for 392 kW
- Replacement of 8000 bulbs with CFL for 160 kW
- 15 investment grade energy audits in buildings.

### 12.2.3 Smart grid project

As a **pilot project**, a smart grid for demonstration project has been set-up at **Gandhinagar.**A ***smart grid*** delivers electricity from suppliers to consumer using digital technology to save energy, reduce cost and increase reliability and transparency. Such a modernized electricity network is a method of addressing in dependence including the key aspect of efficient integration of distributed sources of renewable energy, if required. The pilot project consists of monitors stationed at thirteen building of Sachivalaya of 10 KW solar PV Grid connected rooftop systems. This monitors the data of electricity generation, $CO_2$ emission reduction and coal savings of all the systems, individually and collectively, on weekly basis. Gujarat Energy Development Agency (GEDA) will be the Nodal agency for coordination. The output of the Monitor is as shown in Figure 45 and Figure 46.

**Figure 41: Generation report of solar panel installation at Sachivalaya site**

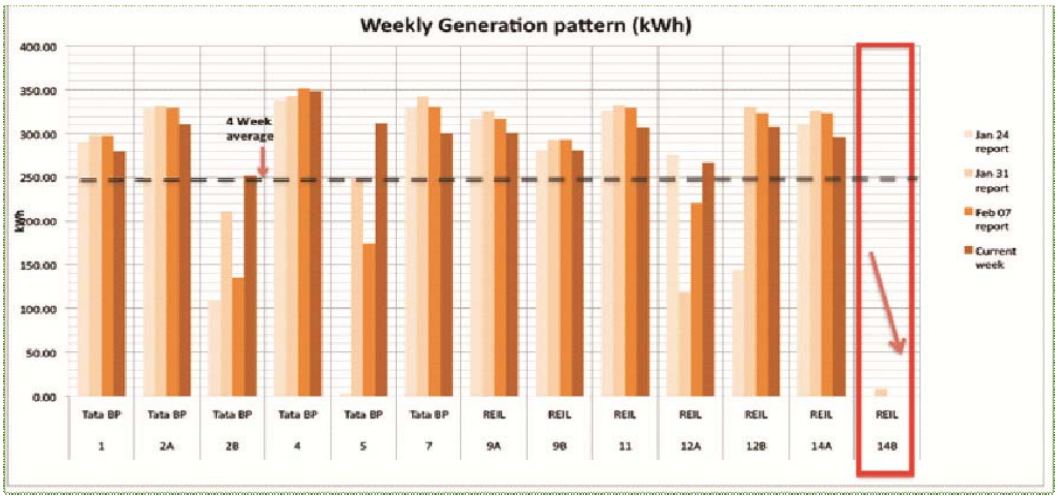


Report Type: Generation report of solar panel installation at Sachivalaya site
Duration: 1 week
Period: Feb 08, 2011 (00:00 hrs) - Feb 14, 2011 (23:59hrs)

| Sachivalaya Block no. | Company | Generation-kWh(Current Week) | Weekly Generation-kWh (Feb 07 Report) | Weekly Generation-kWh (Jan 31 report) | Weekly Generation-kWh (Jan 24 report) |
|---|---|---|---|---|---|
| 1 | Tata BP | 279.6 | 297.5 | 298.3 | 290.1 |
| 2A | Tata BP | 310.5 | 329 | 331.4 | 328.2 |
| 2B | Tata BP | 251.6 | 135.5 | 210.9 | 110 |
| 4 | Tata BP | 348.5 | 351.4 | 343.1 | 338.3 |
| 5 | Tata BP | 311.8 | 173.5 | 248.8 | 2.2 |
| 7 | Tata BP | 300.3 | 330.1 | 342.4 | 328.6 |
| 9A | REIL | 300.7 | 317.1 | 325.2 | 317.1 |
| 9B | REIL | 281 | 293.2 | 293.2 | 281.2 |
| 11 | REIL | 307.2 | 328.8 | 332.5 | 326.1 |
| 12A | REIL | 267.1 | 220.2 | 118.4 | 276.1 |
| 12B | REIL | 307.9 | 323.4 | 330.5 | 143.9 |
| 14A | REIL | 296.1 | 323.3 | 326 | 311.1 |
| 14B | REIL | 0 | 0 | 7.7 | 0 |
| Total Units generated | | 3562.3 | 3423 | 3508.4 | 3052.9 |



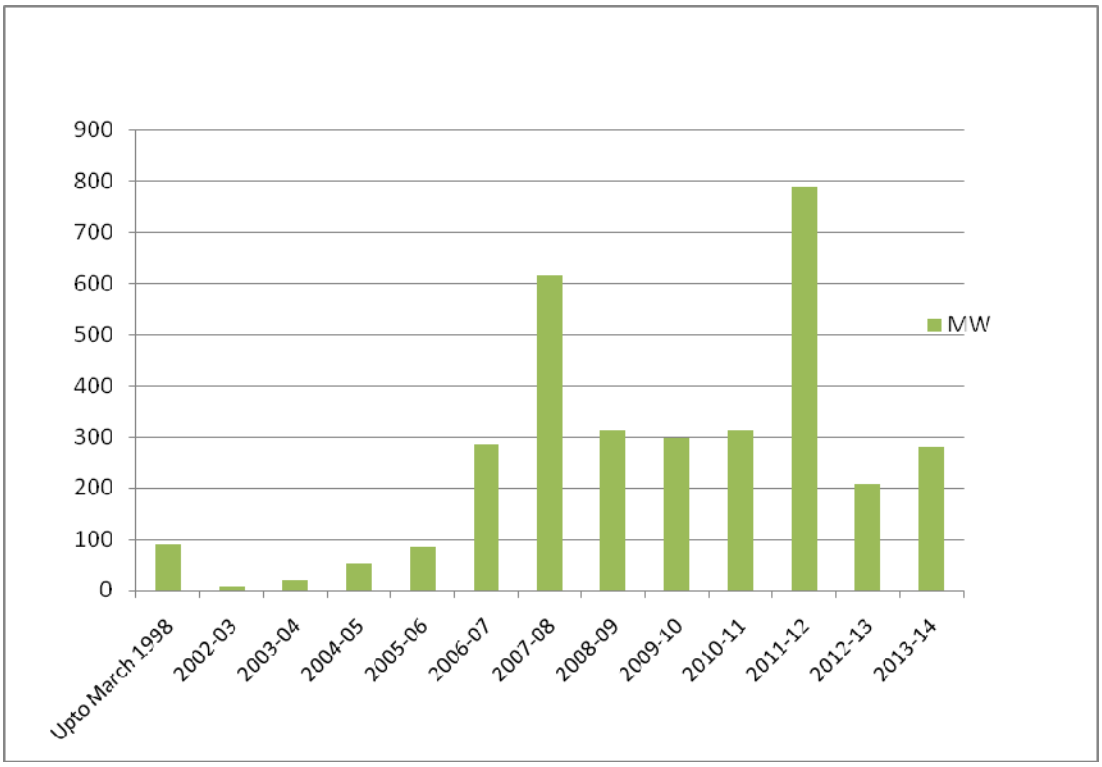
**Figure 42: Sachivalaya smart grid report**




## 12.2.4 Wind energy initiatives

In year 2013, an amendment in the Wind Energy Policy was announced to tap the 10,000 megawatts potential along the coastal areas of the State. The key features of the policy included Power sale tariff increase to Rs.4.15 per unit and Renewable energy power purchase obligation increase from the existing 5.5 to 10 per cent. Today, this policy has undergone major revisions to attract even more investors in the field.

**Figure 43: Wind Power Addition in Gujarat**




**In November 2008, Gujarat notched the first prize and won the Best Wind Developer State Award for maximum capacity additions in wind power generation for the year 2006-08.**

- Gujarat has achieved tremendous growth in the field of wind energy. As depicted in graph in figure 47, Gujarat has total 3352MW of total capacity installed as on March 31, 2014.
- Energy generation potentialper annum is 6,704 MUs, which will help avoiding 6.70 million tons of $CO_2$ emissions and annual saving of 4.68 million tonnes of coal avoided from burning.. Investment made is Rs.20,000 Crores.

### 12.2.5 Vibrant Gujarat 2011 – Promotion of renewables

Vibrant Gujarat has become an important feature of growing Gujarat. With respect to renewable energy, Vibrant Gujarat 2011 has signed 66 MOUs. Table 25, shows the details of MOUs signed.

**Table 24: Summary of MOUs signed during Vibrant Gujarat 2011**

| Sector | No of MOUs | MW | in Crores | Expected Employment |
|---|---|---|---|---|
| Solar Equipment Manufacturing | 36 | 2440 | 22346 | 27500 |
| Wind Power Generation | 28 | 5071 | 33576 | 10142 |
| Tidal Power Generation | 1 | 250 | 5367 | 2440 |
| Electromagnetic energy | 1 | | 1617 | |

| Sector | No of MOUs | MW | in Crores | Expected Employment |
|---|---|---|---|---|
| Total | 66 | 7761 | 61289 | 40082 |

## 12.6 Energy efficiency initiatives

### 12.6.1 Energy efficiency demonstration in the State capital

Gandhinagar, the State capital, has been promoted as a model for energy efficiency demonstration, beginning with the Secretariat complex and other important Government offices. Various measures like replacing conventional lights with T/5 tube lights, Metal Halide fittings to reduce energy consumption; application of sustained Red, Green and Blue Light fittings in Assembly hall to reduce electricity consumption with as increase in illumination level from 350 lumens to 550 lumens; replacement of air conditioners and cooling tower; etc have been undertaken.

### 12.6.2 Energy audits in Small and Medium Enterprises

The Industrial Energy Audit Scheme was launched by Gujarat in 1985-86 to promote energy conservation as well as the concept of energy audit & monitoring in the industrial sector. Over 1200 industries were audited under this scheme. These audits were conducted by qualified energy auditors and the cost of audits was subsidized by the government.

The Government of Gujarat, in year 1990, introduced a Mandatory Energy Audit Scheme for industries having electrical CD of 200 kVA & above. About 8000 industries of Gujarat are covered under this mandate which requires each industry to be energy audited once in 3 years.

GEDA for the first time in the country introduced the Walkthrough Energy Audit Scheme for SME sector in year 2009 with the objective of spreading energy conservation awareness amongst the huge SME sector of the State. Since then walkthrough energy audits in over 2000 SMEs, in selected clusters, have been conducted. Office of the Industries Commissioner, GoG also has various fiscal incentive schemes for promoting energy & water conservation in SMEs.

### 12.6.3 Energy audits in Government buildings

Gujarat Energy Development Agency also does Government and public building audits. Under the mandate given by the Bureau of Energy Efficiency (GoI) GEDA has conducted Investment Grade Energy Audits (IGEA) in 40 Government owned buildings all over the state since year 2009. The buildings included civil hospitals, Municipal Corporation Offices, MS Office Buildings, town halls, government colleges and office buildings of boards & corporations.

### 12.6.4 Action for energy reforms taken up in Gujarat

Energy Sector Reforms pose a daunting challenge for State Governments due to serious political fallouts, since it concerns millions of farmers in addition to dealing with strong unions of workers and other vested interests in gigantic Government Electricity Utilities. Gujarat, however, prepared a careful road map suggesting the framework for

separation of generation, transmission and distribution of electricity in the State to make the power sector more dynamic and sensitive to the needs of changing times. And hence, the Gujarat Electricity Industry (Reorganization and Regulations) Act was enacted in May 2003, before the Central Government enacted a similar legislation. A rationally worked out power transmission and distribution system, which has now ensured adequate access to electricity even in the remotest village of the State. This has also lead to reduced transmission losses from 31 to 22 per cent in the last four years.

The focus was also on power generation efficiency through adoption of better operation and maintenance practices by State Utilities, modernizing of the thermal units, promotion use of washed coal and promotion of gas based power plants. Gujarat State Electricity Corporation Limited (GSECL) has set up a 219 Mega Watts Gas based combined cycle power plant which is estimated to reduce emissions of up to 2,14,000 $tCO_2$ per annum.

**Box 20: Approach to SAPCC Priorities for 2014-2019**

- Promote private investment in renewable sector
- Energy Audits of Power Plants, Renovation and Modernization of low performance power plants
- Promote use of green technologies

## 12.7 Key Strategies

### 12.7.1 Renewable energy

Although currently thermal power generation comprises the lion's share of the energy mix in the State, Gujarat has an aggressive and ambitious plan to exploit renewable sources of energy. However, these policies and action plans need to be further up-scaled and made more ground-breaking to harness the economically exploitable and feasible RE potential the State is endowed with owing to its geographical location. This should apply for 'both - mature and immature technologies. Mature technologies with established markets like wind, solar heating etc., and technologies which are mature but the market support in the country/State is relatively new and immature technologies like - geothermal, landfill gas, municipal solid waste-to-energy, anaerobic digestion, biodiesel, co-firing of biomass, concentrating solar dishes and troughs, solar-assisted air conditioning and tidal energy etc.

The wide gap between actual RE generation and the existing potential in the State indicates that there is a long way to go. Renewable resources need to be exploited by giving them a commercial orientation, encouraging private and foreign direct investment and simplifying procedures, providing of fiscal and financial incentives. It is interesting that the cost of power generation through photovoltaic technology is reducing due to reduction in cost of solar cells and therefore it is essential to promote solar power generation for grid and off-grid connected solar projects.

#### 12.7.1.1 Research and development

- Large scale grid integration of RE power brings in a number of issues pertaining to policy, technical and regulatory in nature especially in case of intermittent sources like wind and solar. Increased share of intermittent power poses difficulty in grid operation. The nature and complexity of these issues would vary depending upon the relative magnitude and spatial distribution of the RE source and grid characteristics. GoG may like to take up a comprehensive study to analyze these aspects up-front to in order to optimally develop the RE resources and ensure their effective operation as part of the grid.
- The State needs to undertake an extensive study to assess the impacts of Climate Change on various potential sources of renewable energy in the State, e.g. changes in rainfall pattern, water availability, wind direction/frequency/intensity; biomass availability in different regions; impacts on sea level and height/frequency of sea waves etc.
- Renewable energy resources and their applications in generating electricity, including their roles in terms of contribution to the total generation mix is most often considered collectively. However, wind, photovoltaic, solar thermal, biomass and geothermal energy, etc options are largely unrelated technologically; each has its own developmental status, readiness, and economic challenges. Thus there is a need for a research study based on modeling, simulation, and future energy scenario analyses to help guide investments in renewable energy and identify the appropriate role of diverse renewable resources
- Further, a study needs to be undertaken to identify the technological status (existing as well as prospective up-gradation) and specific R&D requirements particularly in biomass, solar, tidal and geothermal energy in independent as well as in hybrid mode (in terms of contribution to the State's/region's energy-mix) based on locally available prospective resources.
- The above study also needs to prepare an inventory of best practices adopted elsewhere in the country/globally (under similar conditions of resource endowments and implementation barriers) on renewable energy and energy conservation application in view of the geo-climatic condition of the State.
- The study results should also reflect datasets on feasibility (financial/technical) of installation of windmills and decentralized solar solutions etc, bio-resource assessment of specific areas of the State and load and demand assessment and mapping of current and the targeted energy-mix for the State.
- The research study should also aim at assessing how renewable energy promotion strategies can be used to generate local employment and also address socio-economic concerns of the targeted region.
- R&D initiatives also need to develop solar lighting systems appropriate to the region.
- Technological research needs be to undertaken to develop indigenous and cost effective (local adaptations, considering local limitations and resources) versions of some of the not-so-common technologies like geothermal energy, tidal energy, alternative fuels for surface transportation, biofuel (including second generation), hydrogen energy, fuel cells etc. The developed technologies in the process can be used as prototypes in demonstration projects showcasing RE use.

- In order to implement waste to energy projects on a large scale studies need to be carried out to assess waste generation, composition, calorific content, estimates of emissions from this sector at the State level.
- One of the reasons for limited installation/commissioning of biomass-renewable energy generation is inadequacy of the input material. To overcome this use of alternatives to cattle dung like poultry dropping, agriculture wastes, industry wastes like press mud, wastes from sago industry, bagasse from sugar mills and dairy industry etc. need to be encouraged. However, this needs to be backed by adequate research taking into consideration local conditions and waste specifications.

#### 12.7.1.2 Policy support

Some of the key barriers that put renewable energy sources at an economic, regulatory, and institutional disadvantage relative to conventional forms of energy supply include subsidies for conventional forms of energy, high initial capital costs coupled with lack of fuel-price risk assessment, imperfect capital markets, lack of skills or information, poor market acceptance, technology prejudice, financing risks and uncertainties and high transactions costs etc. Therefore in order to tap its vast RE potential, the State hasdevised anew (and upscale/upgrade existing policies) policy framework to address some of these impediments.

In fact progressive policy-making backed by appropriate technological research has the greatest impact on promotion of renewable energy generation. Markets alone cannot make renewable energy cost-competitive; the State Government will have to accelerate the use of renewable resources through effective policy measures.

- Since, energy conservation measures and renewable energy technologies go hand in hand so far as Climate Change mitigation is concerned; the current practice of treating both in isolation needs to be changed. What is required instead is, to implement energy efficiency measures in processes, equipment, appliances, and devices and then explore the possibility of utilizing renewable energy technologies to meet the balance energy needs. This would also help in accelerating the penetration of renewable energy technologies, considering the fact that the upfront costs of renewable energy devices are on the higher side. This calls for a paradigm shift from supply domination to an integrated approach – a judicious mix of operational efficiency improvement, end use efficiency and renewable energy technologies.
- GoG may like to develop a comprehensive Renewable Energy Vision and Perspective Plan 2020.
- Role of GEDA being central to the proposed action plan, it needs to be strengthened, including developing a long –term plan of capacity building.
- The rural energy programme need to be well integrated with State's other development programmes/schemes such as NREGA, rural development, poverty-alleviation, and social welfare so that rural energy becomes a focal point for income-generation as well.
- Rather than taking up R&D in piece-meal basis, it may be helpful for GEDA to develop a R&D roadmap for the State, keeping in view State-specific needs and

geographical conditions. The roadmap would have clear-cut milestones, quantum and nature of resources (both, financial as well as technical expertise) that are required to reach the predetermined goals. The exercise would comprise, among others, following key elements.

- Chart the growth and need areas based on users demands
- Identify technologies, which need further push in terms of investment in R&D for quality, product utility, wider scale of applications, and improved scale of production etc.
- Identification of gaps in technology and product design.
- Ways for improving the system efficiency and reliability, reducing material intensity, and use of alternate low cost material.
- In case of important technology, chalk out clear requirement in terms of its adaptation and indigenization.
- Exploring ways to reach 'economics of scale' so as to bring down the costs.
- Long term planning (at least 10 years down the line) in terms of technology development as well as commercialization
- Financial implications at each stage.

- Due to its pioneer role in promotion of renewable energy in the country, a significant infrastructure has emerged for the manufacture of different renewable energy systems/components in the State. On the other hand there are institutions in the State that are engaged in developing the specialized human resources. Against this background, and to leverage the expertise that Gujarat has developed in the field over the years, it can establish itself as a 'Renewable Energy Manufacturing Hub' for manufacturing renewable energy systems, devices and their components. Apart from (a) servicing the domestic markets with standard equipment and devices and (b) bringing down the costs of renewable energy systems through economies of scale (and therefore ease of introduction of the latest technologies/processes); this Hub could cater to the growing export markets as well.
- Adequate funds may be earmarked in the annual budget of respective Departments of Government of Gujarat to promote and implement RE and energy conservation programmes. To finance its RE related programmes, the GoG may levy a 'green cess' on conventional electricity and fuels in the lines of National Clean Energy Fund and Maharashtra's Urjankur Nidhi Fund.
- GEDA designs its programmes with certain objectives, which are not merely 'numbers of systems installed'. There is a need to devise a mechanism wherein all the programmes are appraised on continued basis to evaluate the efficacy of the programme vis-à-vis the targets. The field evaluation of the installed systems would form an intrinsic part of such an exercise. Independent organizations may be engaged to carry out this exercise.

#### 12.7.1.3 Technology development, demonstration, and deployment

- Use of solar energy for street lighting, powering advertising boards and traffic lights, etc.Grid and off-grid connected Solar Power Project for Government buildings of the state may be installed to meet 60% electricity requirements
- Photovoltaic pumping systems provide an excellent alternative to fuel burning generators or hand pumps. They provide water precisely when it is needed the most, when the sun shines the brightest. Solar pumps are simple to install and maintain. Advantages of using PV-powered pumps include low maintenance, ease of installation, reliability, and scalability.
- Besides promoting use of Decentralized Distributed Generation (DDG) systems in the urban centres, mass scale deployment of RE generation technologies in the rural areas needs to be aggressively promoted. Cooking, irrigation pumping and lighting are the dominant energy-using activities, accounting for more than 90% of rural energy use. Any energy interventions for these end uses would have a major impact on the quality of life of and GHG emissions from the sector. Installation of improved cook stoves, biogas for cooking, and biomass gasifiers for decentralized power generation, of solar for lighting, cooking and running irrigation pumps etc. need to be encouraged.

#### 12.7.1.4 Capacity building

- The availability of information and expertise is critical to the successful introduction of any new technology and more so with respect to decentralized renewable energy generation. Where customer decision-making is required, as it is for many renewable energy technologies, information must be available in a form that is readily understood and allows comparison with alternatives. For all users, information is necessary on initial and ongoing costs, installation and maintenance requirements, performance, lifetime, and any usage restrictions. This sort of information has not been readily available for renewables in the country as a whole and has made it difficult, even for enthusiastic users to choose renewable options. Gujarat can take the lead and design a short and easy to understand (using common terminologies) manual/handbook for potential consumers listing out all options, costs involved (also vis-à-vis fossil fuels), expertise needed, merits, demerits and future scenarios etc. to enable the consumers to make informed choices.
- Further, besides influencing consumers choices by providing them with information on alternatives and costs; utility disclosure to customers of the fuel mixes used to generate electricity can also act as means of increasing the efficiency of competitive markets (conventional versus renewable). In addition to electricity sources, disclosure of greenhouse emissions and other environmental indices also provides important information in enabling consumer choice.
- In addition, to accelerate market entry, it is necessary to educate the community on the appropriate uses of the various renewable technologies and to counter current misconceptions. Trade and professional training for the manufacture, installation, andmaintenance of renewable energy systems and components should supplement general awareness and education. Lack of trained personnel in the

electricity supply, plumbing, electrical, and housing industries is directly responsible for limiting sales of renewable technologies, as well as for inconsistent performance.

- The rural stakeholders need to be made more aware and educated to be able to assess, adopt, adapt and absorb various RE technologies because a generic information dissemination approach will not make the desired impact.

## 12.7.2 Strategies for energy efficiency

These strategies are designed to assist the transport, buildings, industry, power and agriculture sectors to act on cost effective opportunities for improving energy efficiency, since energy savings are valuable investments to restrict greenhouse gas emissions.

### 12.7.2.1 Transport

#### 12.7.2.1.1 Research and development

- State specific studies and research and development initiatives need to be undertaken to identify and assess the potential of use of low-carbon alternate fuels in the various modes of transport in the State. In addition, opportunities for blending of biofuels with conventional fuels (fossil fuels) also need to be explored and implemented through city-based demonstration initiatives.
- The agencies also need to undertake assessment studies at the State level to evaluate GHG emissions from the transport sector (both in terms of location and mode) and also identify potential for modal shifts and use of low-carbon fuel across the State.
- Specific studies aiming at understanding and evaluation of how societal preferences can be matched with transport options to lower GHG emissions; how much travel or freight movement is expected in the near-term and long-term; what mix of transport modes will be used/needed to provide passenger and freight services; what is the impact of changing technology (fuel economy, fuel type, emission controls) on fuel use and emissions; how can activities be reorganized to reduce transport use; how should infrastructure and vehicle flow be managed to reduce congestion or improve efficiency; and what investments are needed to meet growing demand and improve efficiency needs to be carried out in a phased manner- first targeting the metro cities in the State and then spreading to the other urban locations.

#### 12.7.2.1.2 Policy support

- The policy framework should mandate use of cleaner (low-carbon) fuels like CNG, blended ethanol etc. in atleast all the public transport facilities in all the major cities of the State.
- The policies need to ensure stringent enforcement of traffic/driving rules and fuel efficiency norms across the State. This will not only reduce air pollution caused by the sector but would also minimize problems like traffic congestion and accidents and save on fuel.
- Besides use of regulatory instruments, financial incentives for use of mass transport systems and fiscal incentives and subsides for use of alternative fuels and vehicles etc, can be introduced to accomplish higher fuel and energy efficiency in the sector.

#### 12.7.2.1.3 Technology development, demonstration, and deployment

Many technologies and strategies are at hand to reduce GHG emissions from the transport sector. However, the most promising strategy for the near term is incremental improvements in current vehicle technologies. Advanced technologies that provide great promise include greater use of electric-driven technologies, including hybrid-electric power trains, fuel cells and battery electric vehicles. The use of alternative fuels such as natural gas, biofuels, electricity and hydrogen, in combination with improved conventional and advanced technologies; provide the potential for even larger reductions. In the near-term and mid-term, some of the technologies/strategies that can be adopted by the State include:

- Fuel efficiency improvements for vehicles which primarily comprise changes in vehicle and engine design (e.g. hybrids).
- Use of alternative fuel sources (replacing or reducing the use of fossil fuels) like hydrogen or electricity from renewable power; biomass fuels like CNG and LPG etc.; and fuel cell technology.
- Changes like introduction of traffic and fleet management systems; mass transportation systems and improved land-use planning; and modal shifts could be brought about in the infrastructure and the overall transport management system to achieve higher fuel efficiency.
- Reduction in travel demand can be brought about through land use changes, telecommunications etc.

#### 12.7.2.1.4 Capacity building

- Customized capacity building projects for traffic agencies, urban local bodies and driving training institutes should be undertaken to ensure scrupulous implementation of the set traffic rules and fuel efficiency norms to in turn achieve effective transport management besides saving fuel and minimizing traffic accidents.

### 12.7.2.2 Buildings

Energy efficiency in the buildings sector offers more potential for cost-effective greenhouse gas emissions reductions than any other major abatement category. Building energy performance is directly related to the design of the building envelope (insulation, roofing, windows etc.) and the diverse systems and components within it, such as lighting, appliances and heating, ventilating, and air conditioning (HVAC) systems. Most of the energy-efficient building technologies are widely available today and can reduce carbon emissions at a low or negative net cost in the long-run. Furthermore, in addition to Climate Change benefits, improved energy-efficiency in the sector can advance several development goals (co-benefits often not identified, quantified or monetized) as well as strategic economic targets e.g. reducing mortality and morbidity, poverty alleviation, improving social welfare, employment, and energy security. Also, investments in energy efficient buildings and appliances can help to delay investments in costly new electricity generation technologies.

In terms of building equipment use of energy efficient space and heating (heat pumps, CHP); efficient lighting, air conditioners, refrigerators and motors; efficient cook stoves, household appliances, and electrical equipment and efficient building energy management and maintenance can lead to significant energy savings and in turn GHG emissions reductions.

In fact improved efficiencies in lighting offer the largest low-cost option to reduce carbon emissions and save energy. Switching from incandescent to compact fluorescent light bulbs (CFL) and light-emitting diodes (LED, solid State) improves efficiency by 70-80%. In fact light energy savings also yields air cooling savings (additional savings). Use of CFLs is already quite popular in the residential and commercial buildings in the State with the Government promoting its use through various awareness generation initiatives and policy instruments. LEDs have found limited application in areas like traffic lights but need to popularized (over and above CFLs) in the residential and commercial buildings citing advantages like more controlled (in direction) lighting, can be combined and scaled into customized colors and shapes, have longer lasting fixtures, and unlike CFLs, contain no mercury. Barriers like high costs need to be addressed through policy/financial instruments and use of market-based mechanisms to offset costs.

#### 12.7.2.2.1 Research and development

- A research study to understand the consumption pattern in terms of appliance use, peak consumption, timings, energy wastage sources/trends, potential saving opportunities, least cost options for various levels (economically) of the society etc. is urgently required to design and implement any policy or technology option in this regard.

#### 12.7.2.2. 2 Technology development, demonstration and deployment

- In terms of building thermal integrity use of improved insulation and sealing techniques, energy-efficient windows and proper building orientation would ensure optimal transparency, emissivity and energy/heat exchange between the buildings and the surroundings thereby minimize the energy consumption by the buildings.
- Use of renewable sources of energy like solar, wind, etc. for active and passive heating and cooling adhering to a climate-sensitive design and effective use of natural light (“day lighting”) also goes a long way in minimizing the energy requirements/wastage of buildings.
- A key facet of energy efficiency in buildings is retrofitting, which allows technological advancements to be applied to existing structures.

#### 12.7.2.2. 3 Policy support

- Adoption of energy efficient technologies and equipments in the buildings sector can be promoted through regulatory measures like mandated energy-efficiency performance standards, increasingly stringent over time and mandated appliance efficiency standards and efficiency labeling. The State already has similar policies/initiatives in place, a more broad-based and stringent enforcement of these policies backed by information programs having a thrust on efficiency labeling and demonstration projects can result in considerable energy savings from the sector.

- The regulatory approach should be adequately backed by an incentive approach, for example incentives to consumers for use of new energy-efficient products, incentives for manufacturers for development of energy-efficient products, incentives for industry for voluntary adoption of energy efficiency standards.
- The supporting policy framework should also encourage use of market based mechanisms like CDM, voluntary market etc. to offset the extra investments made in this regard.
- The policies also need to have strong thrust on promotion of energy service companies (ESCOs) in the State to ensure proper monitoring, verification and enforcement of mandated/voluntary energy efficiency standards.
- A minimum energy performance/prescriptive requirement should be made mandatory at least for commercial buildings and for high-rise and big residential buildings with a built-up area greater than some range.

#### 12.7.2.2.4 Capacity building

- Sustainability and energy efficiency in the sector of buildings is a complex concept and involves many stakeholders. It requires the joint efforts of architects, builders, planners, developers, technicians, policy-makers, industrialists and manufacturers. A key role is also played by the end-user, not only through his/her responsibility to use the building efficiently, but also through his/her demand for a sustainable building. Thus, awareness raising and wherever needed capacity enhancement initiatives should be undertaken to not only achieve energy savings but also ensure proper synergy between all the stakeholders involved in the value chain.

### 12.7.2.3Industry

The industrial sector in the State is very diverse and involves a wide range of activities including the extraction of natural resources, conversion into raw materials and manufacture of finished products with manufacturing industry being the core economic activity. The State boasts of some of the most energy intensive manufacturing sectors like chemicals, petroleum refining, and oil and gas sector. Some of the other potential sectors with respect to implementing energy efficiency opportunities include power, textiles, dairy, food processing, and mining.

#### 12.7.2..3.1 Research and development

- The process of GHG emissions reduction mandates a good baseline data/information about current level of emissions. For this purpose GHG inventorization/profiling is the first step. Particular industry sectors/clusters can be selected and the State agencies in association with the R&D/academic institutes of the State can prepare the GHG profile reports in line with the best international practices. Based on this data, a system of GHG auditing can be introduced. The GHG profile reports can also serve as a critical input for the policy making and monitoring performance of large industrial sectors/clusters with respect to carbon efficiency. Large industries can submit GHG accounting as a part of their annual report.
- Gujarat has a large population of energy intensive MSME clusters (using inefficient technologies, thus a huge potential for upgradation). Specific cluster programmes

for MSMEs that are aimed at technology upgradation and improvement of energy efficiency. Such interventions in different MSME sub-sectors would require undertaking detailed diagnostic studies, focusing on technology and needs assessment, designing, developing, and demonstrating energy efficient technologies to suit local conditions, public-private partnerships, providing advisory support to small units for disseminating these technologies.

#### 12.7.2..3.2 Technology development, demonstration and deployment

Broadly speaking, energy conservation in industries can be achieved at three different levels - active or efficient in-house management of energy efficiency through maintenance and housekeeping measures (involves no or minimal investments); replacement of selected equipments (which may require medium-size investments); and modification of entire manufacturing processes and adopting State-of-the-art technologies (which may require large scale investments).

- Efficient in-house energy management (can lead to 5-10% energy savings) can be accomplished through establishment of in-house energy management committees or groups; designation of energy managers; data collection; improved maintenance; and review of operational efficiency. Improvement of energy efficiency by replacement of selected equipments (can lead to 10-15% energy savings) involving medium-size investment costs may be through improved waste heat recovery; better operation of thermal systems; co-generation of electricity and process heat; and improvement of heat exchangers. Major industrial process modifications (can lead to significant energy savings) involving large scale investments include installation or improvements in advanced process controls; installation of waste heat recovery generators; etc.

- In combustion equipment, fuel efficiency can be improved through automatic combustion control systems; efficient burners; and flue gas heat recovery. In heat utilization and heat recovery facilities, energy efficiency can be improved through high efficiency heat exchangers; improvement of heat insulation; heat pattern control; high efficiency steam traps; and heat pumps. The use of co-generation technology and absorption chillers are also important energy efficiency improvement measures in industry.

- Shift in technology and processes by replacing old or inefficient processes with State-of-the-art technologies would help in substantial reduction in specific energy consumption levels but would require huge investments and proper planning.

- Substitution of fossil fuel based energy sources with low- and no-carbon power sources (e.g., natural gas, biomass, wind, solar) or exploring co-firing options (use of coal with biomass or wastes etc.) and adoption of materials efficiency techniques to reduce materials waste or increase materials utilization/recycling can also result in significant energy savings and thereby GHG abatement.

- A large number of MSME units use outdated technologies which are inefficient. Cluster intervention in MSME's would be required to bring about energy efficiency improvements in the MSME sector. Further, appropriate region specific renewable energy must be promoted to reduce the consumption of commercial energy in industrial units.

### 12.7.2..3.3 Policy support

- The State authorities are quite aware of the impacts of the changing climate on the industrial and economic development of the region and the current policies in the sector (like the new Industrial Policy) do reflect some of these concerns (e.g. use of renewable energy sources, water conservation and recycling techniques, reduction of carbon footprints, use of market-based mechanisms etc.). But there is a need for revisiting these policies (and others like the Gujarat SEZ Act, etc.) to not only propose/mandate ways and means on GHG emissions reduction but move a step ahead and develop State level baselines and time-based policy goals with respect to Climate Change mitigation.
- The regulatory approach in this context needs be pertinently complemented with an incentive approach like tax breaks/incentives for energy efficiency, fuel switching, and reduction in GHG emissions or removal of market barriers in the way of implementation of the not-so common technologies/processes. Financial incentives can stimulate investment in energy-efficient technologies by reducing cost and helping to raise awareness. Examples include subsidies, grants, and tax benefits, such as tax reductions, tax exemptions, or accelerated depreciation. Considering energy efficiency investments must compete with projects that are central to a company's product line or mandated by regulation, incentives can tilt a company's investment decision toward energy efficiency.
- The regulatory/policy framework in this regard also need to address the barriers to the development and deployment of energy-efficient industrial technologies and practices. Some of these barriers include conflicting market signals, limited capital availability, inadequate information flow, lack of expertise, inadequate workforce capabilities, performance risks and costs for new technology, insufficient capital allocation for upgrades, and counterproductive policies.
- In order to promote energy efficiency in MSME clusters a PPP model comprising industry, R&D institutions/academia, service providers, technology providers/manufacturers, and Government would have to be devised for desired results.

### 12.7.2.3.4 Capacity building

- Creating awareness and building of capacities on Climate Change issues is of great significance especially in the industry sector. Training programs for on-site/off-site technical staff and all other relevant stakeholders should include educating them and enhancing their familiarity with the intricacies of the plant operations to enable them to evaluate and communicate to management the energy matters specific to their plant. The staff should be made aware of the processes related to annual monitoring and reporting of progress towards energy goals, using reporting mechanisms supported by standardized protocols analogous to GHG reporting registries; benchmarking information, collected through annual monitoring and reporting, etc.

#### 12.7.2.4 Power

##### 12.7.2.4.1 Research and development

- The State needs to undertake an extensive study to study and assess the impacts of Climate Change on energy systems and revisit the planning processes accordingly. The rising atmospheric temperatures might result in significant increases in electricity use and peak demand, or changes in rainfall pattern, water availability etc., and/or may impact the hydro energy potential or biomass availability of the State.
- The distribution utilities in the State need to carry out a load research to understand and assess category-wise demand and consumption data beyond the system level demand i.e. data on contribution of sector or segment or end-use or technology to the total demand and consumption, both, in terms of quantum and timing. In the absence of such data, it is difficult to strategize and plan energy efficiency (EE) and DSM programmes resulting in implementation of ad-hoc or at best demonstration or pilot projects in this regard. Absence of planning data should be perceived as a major constraint for speedy development and implementation of full-fledged State-wide EE and DSM programmes.

##### 12.7.2.4.2 Technology development, demonstration and deployment

- Gujarat is one of the most attractive investment destinations in the country with an active private sector working in close coordination with Government agencies. These factors should enable the State to undertake steps to implement technologies which have only managed to reach demonstration stage or small-scale commercial application in the country but hold huge potential for the nation and the State with regard to energy security. Some of these technologies include - thin-film PV, concentrating PV, tidal energy, biomass gasification and pyrolysis, etc.
- The State has rich resources of lignite and oil and gas reserves and in fact thermal power generation accounts for around 80% of the total power scenario in the region. The State is already promoting measures like adoption of better operation and maintenance (O&M) practices (to reduce station heat rate and auxiliary consumption); renovation and modernization (R&M) of low-performing/old units; use of better quality-high calorific value coal (washed coal/imported coal); fuel switching options (say from coal to gas); and regular energy audits to reduce the net GHG emissions from such units. In addition to further promoting and up-scaling these initiatives, the State needs to identify and create opportunities and supporting framework for employment of more advanced technologies to generate more power from the same amount of fuel. Clean coal technologies can play a critical role in this direction. Some of these technologies include coal beneficiation (pre-combustion coal de-watering, washing and briquetting), efficient use of coal seam methane, use of advanced pulverized coal for supercritical/ultra-supercritical power generation, Fluidized-bed combustion (FBC), Integrated Gasification Combined Cycle (IGCC), and super-advanced technologies like coal-to-liquids (CTL) in combination with carbon sequestration or elimination technologies. In conventional thermal power plants up to two thirds of the primary energy used to generate is lost in the form of heat. Switching from condensing steam turbines to Combined Heat and Power (CHP) (cogeneration) plants not only produces electricity but also captures the

excess heat for use by municipalities for district heating, commercial buildings or industrial processes. With the State witnessing rapid industrialization and urbanization capturing this otherwise waste heat can lead to significant fuel and energy savings. Current CHP designs can boost overall conversion efficiencies to over 80%, leading to cost savings and hence to significant carbon-emissions reductions per kWh generated.

- With its rich gas base, the State can aggressively promote Combined Cycle Gas Turbine (CCGT) because it is not only relatively superior to other fossil-fuel technologies in terms of investment costs, fuel efficiency, operating flexibility, and rapid deployment but also produces less $CO_2$ per unit of energy output than coal or oil technologies (because of higher hydrogen-carbon ratio of methane and the relatively high thermal efficiency of the technology).
- In order to sustain the growth of its economy, above and beyond implementing an accelerated capacity addition, the State needs to operationalize a more efficient transmission and distribution (T&D) system. Technologies like Smart Grid Design (via automation using smart meters and other telecom network infrastructure); High Voltage Direct Current (HVDC); Flexible Alternating Current Transmission Systems (FACTS) (to increase power transfer capability and replace uneconomical generators); underground distribution lines (to reduce 80 per cent of distribution power losses); high temperature superconducting lines, cables, and transformers; energy storage devices, etc. need to be implemented to cut down on the T&D losses in the State. In addition, the State authorities need to upscale implementation of measures which are already underway, like installation of lines with higher transmission voltages and high voltage sub-stations and capacitor banks, etc. to curb the T&D losses.

#### 12.7.2.4.3 Policysupport

- The State needs to develop an Integrated Resource Planning (IRP) process for electric utilities to enable them to evaluate different options for meeting future electricity demands and select the optimal mix of resources that minimizes the cost of electricity supply while meeting reliability needs and other objectives.
- In the traditional utility planning, planners take into consideration the demand to be met, the reliability to be achieved, and applicable Government policies and regulations. The planner then selects the types of fuels, power plants, distribution systems and patterns, and power purchases that will meet these objectives with minimum revenue requirement (the revenue the utility must collect to finance and operate the power system). Options are selected only from the supply side (options to supply more power) as opposed to the demand side (options to reduce electricity demand) of the electricity system. Thus IRP will facilitate evaluation of all potential options, from both the supply and demand sides, in a fair and consistent manner; minimize costs to all stakeholders (and not just costs to the utility); and create a flexible plan that allows for uncertainty and permits adjustment in response to changed circumstances. Furthermore, the inclusion of demand-side options to achieve energy savings presents more possibilities for saving fuel and reducing negative environmental impacts than might be possible if only supply-side options were considered.

- With mass deployment of Smart Grid technologies, the State can introduce the innovative concept of **dynamic pricing**. With dynamic pricing, customers can reduce their electricity bills by shifting consumption from higher-priced hours to lower-priced hours. Shaping consumer behavior through dynamic pricing may reduce the investment that utilities would need to make to increase production and distribution capacity to meet the peak demand. In the Indian context, the concept of dynamic pricing or Time of Day pricing (TOD tariff) has been implemented for large consumers in most of the states. The State can evaluate this approach and explore how this can be implemented for a larger set of stakeholders/consumers. In addition, the State also needs to ensure that the TOD tariff policy in the region has larger focus on DSM measures, which is not the situation currently.
- The State is already pursuing several initiatives to accomplish potential energy savings by adopting energy efficiency measures at the end-use stage (Demand Side Measures). These and other such initiatives need to be more robust and extensive to accomplish the maximum possible energy savings at the consumption stage atleast in all the urban centres. An enabling framework should be created to allow DSM technologies reach their full market potential for utmost results. Further, currently, DSM and GHG emission mitigation measures are implemented quite independently. DSM measures are implemented primarily to assist and improve the operation of electricity systems and any impacts (positive or negative) of DSM measures on Climate Change are only a minor consideration. Efforts to mitigate GHG emissions from electricity production have focused on improving the efficiency at the electricity generation and transmission and distribution stage. There is an immediate need to reconcile these two different approaches so as to identify circumstances in which DSM can contribute to mitigating GHG emissions and emission mitigation measures can achieve benefits for electricity systems. To achieve this some of the measures that the State can undertake include:

    - SERCs should direct all the distribution utilities under their jurisdictions to constitute DSM Cells within their organizations. SERCs should also identify some of their staff for handling the DSM aspects.
    - SERCs may direct all distribution utilities to submit DSM Plans along with petitions for Annual Revenue Requirement (ARR) for the next tariff period.
    - Cost of approved DSM programmes should be assessed and evaluated very objectively and pre-identified sources of fund such as penal interest on late payment of bills and/or load management charges could be earmarked for financing DSM programmes.
    - SERCs could also consider appropriate tariff interventions to support DSM. These could be Time of Day (TOD) tariffs, power factor incentives and penalty/reactive power charges, load management charges, rebate incentives for energy efficient buildings/appliances and differential pricing for agriculture consumers.
    - SERCs could also consider giving a slightly higher return on equity for the investments made towards DSM measures.

- Distribution utilities may be encouraged to create their own energy service companies as unregulated activity.

- The State needs to create necessary infrastructure for implementation, monitoring and verification of DSM programmes. The dedicated DSM Cells operating in all distribution utilities can carry out these functions and other DSM related activities.

#### 12.7.2.4.4 Capacity building

- Recognizing that distribution utilities in the State have limited experience and knowledge in establishment of EE and DSM programme development, financing and implementation infrastructure, the SERCs should provide support and guidance to the distribution utilities in this regard. In fact the SERCs will have to develop their own capacity and also that of the distribution utilities in the areas of load research, integrated resource planning and demand response etc. to implement effective EE and DSM initiatives.

- Training courses should be organized for capacity building (in the area of DSM) of the personnel of the SERCs and the staff of DSM Cells of the utilities. The representatives of the State Government may also be invited to such programmes.

- The State already has several programmes on raising awareness on energy efficiency and DSM measures especially in the urban centres. With the rising living standards (and thereby increasing energy consumption) of the semi-urban and rural populations of the State, these initiatives on energy conservation, especially with regard to use of energy labeled appliances, standards for new buildings, concepts about peak load, etc. need to be spread to these regions for greater results. The relevant authorities from the urban locations (who are already part of such initiatives for some time) can help in building the capacities of the rural authorities to implement such programmes effectively.

### 12.7.2.5 Agriculture

It is worth noting that the bulk of energy consumed in the agriculture sector is attributable to pumping for irrigation and to some extent power for farm machinery such as threshers, tractors, etc. As discussed in the earlier sections, with the region observing erratic and uneven rainfall, and the State Government implementing numerous initiatives to bring more and more land under irrigation, use of agricultural pump sets is fast increasing in the State. And to make the situations worse, the sector has the largest population of inefficient pumps and systems in the country.

The initial high cost of energy efficient motors/pumps, poor pricing regimes, and lack of knowledge about the long-term gains are the major factors responsible for sub-optimum efficiencies.

#### 12.7.2.5.1 Researchand development

- A State specific study needs to be undertaken to identify key energy consuming processes involved in the agriculture sector and the current barriers to adoption of energy efficiency measures including financial, technical behavioral etc. The results of such a study would enable in designing policy measures to promote DSM measures in the sector.

- A further study needs to be carried out to assess the impact of electricity pricing for the sector and the implementation of energy efficiency measures.

#### 12.7.2.5.2 Technology development, demonstration and deployment

BEE has prepared an Agricultural DSM (Ag-DSM) programme in which pump set efficiency upgradation would be carried out by Energy Service Companies (ESCOs) or the distribution company. The Ag-DSM programme has already been initiated by BEE and pilot projects in 5 states including Gujarat (others are Maharashtra, Haryana, Punjab and Rajasthan) would be implemented in the first phase. Options are being explored to understand how CDM can be used to enhance the profitability and viability of this initiative. In addition, efforts are on to pitch in financial institutions to provide loan to the project as well as adequate payment security mechanism to the investors. Utilities can play the important role of monitoring and verification.

Broadly speaking, some of the technological changes/upgradation that the State shall aim at bringing about to achieve energy savings in the sector include:

- Conversion from high-pressure top impact sprinklers to low-pressure systems results in significant energy savings. Low-pressure systems using drop tubes deliver about one per cent more water for every foot of drop tube used because evaporative losses are reduced. The lower the spray package, the more efficient the system becomes. In this regard use of irrigation technologies like micro irrigation systems (MIS) come very handy. The State is already pursuing most of the MIS technologies not only to save energy but also address the issue of water scarcity for the purpose. MIS are modern irrigation systems which include drip irrigation, sprinkler irrigation and sub surface irrigation (porous type). MIS could provide considerable savings in total water and energy demands from agriculture sector. In fact Gujarat is among the leading states in the country in the use of MIS, although the area covered under drip irrigation is 0.18% (Indiastat, 2009) with respect to net irrigated area.
- Minimizing frictional losses in irrigation pipes by using large diameter pipe on the mainline and minimizing turns in the irrigation pipes can lead to substantial energy savings (according to estimates, installation of a 12-inch versus a 10-inch mainline saves 3 horsepower when the flow rate is 1,200 gallons per minute).
- Installation of high- or premium-efficiency pump motor over a standard-efficiency model saves atleast 3-5 per cent energy a month on electric consumption. More efficient motors run cooler and last longer. In fact, motors that run under load at a substantial duty cycle typically use electricity that costs 10 to 20 times their purchase price each year. So investing in premium-efficiency motors can have a very fast payback.
- The pump and motor combination needs to be matched to flow and pressure requirements. Over-sizing makes for inefficiencies that waste energy and cost money. Installing variable speed drives (VSD) on existing motors allows for modulating motor speed to achieve the desired flow. When irrigation requirements change, flow can be adjusted quickly and accurately.
- Replacement of worn nozzles and regulators also allows considerable energy savings. A useful rule of thumb is that nozzle wear of 10% results in a 20%

increase in flow. The average life expectancy of a nozzle and a regulator under optimum conditions is around 8 to 10 years. However, during low-water conditions, irrigation pumps must pull water from lower depths. This pushes more sand and silt through nozzles and regulators, increasing wear. When such sediment is present, life expectancy decreases to 3 to 5 years for nozzles and 5 years for regulators.

#### 12.7.2.5.3 Policysupport

- The issue of higher prices (~20-30% more) of energy efficient pumps needs to be addressed through financial incentives like reductions in sales tax, abolishment of octroi on energy efficient products, and reduction in customs and excise duty on energy efficient equipments must be provided.

- Further, since agricultural tariffs are usually the lowest and also highly subsidized (not specific to Gujarat, at the country level) there is no incentive to the agricultural consumer to improve efficiency of the pump set. Consequently, utilities are not able to recover economic price on every unit of energy sold to these categories of consumers and therefore need to aggressively target these consumers for DSM measures. Some policy means need to be devised by the authorities to address the situation without hurting the interests of the farmers.

Mandating some of the technology initiatives listed in the above section can go a long way in promoting energy efficiency in the agriculture sector in the region, may be in a phased manner and to start with on a pilot scale.

## Programme of Action for Energy Efficiency &Renewable Energy

| Sr No. | Department/Office Name | Activity | Project Objective | Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Gujarat Energy Development Agency | Installation of Solar Photovoltaic Power Pack for Anganwadis. | To install 30,000 nos. of Solar Power Packs in Primary Health Centers of the State of Gujarat each consisting of 1 kwh for meeting their electricity requirement . These Power packs will generate 2,70,00,000 units of electricity. | 450 | 3 | Achieving Energy security in Primary health centres |
| 2 | | Installation of Solar Photovoltaic Power Pack in Primary Health Centers (PHC) in Gujarat. | To install 1,000 Solar Photovoltaic Power Pack in PHCs. Each off-grid Power pack consisting of 1 kWp of SPV modules, module mounting structure, SPV charge controller; Inverter, Battery bank and necessary hardware | 15 | 2 | To utilize the potential of generating solar energy as a major mitigation activity |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | Considering 330 days with proper sunlight, the system installed may annually generate approx. 9,90,000 units electricity, which may save 900 tonnes of CO2 emission and 630 Tonnes of coal annually | | | |
| 3 | | Installation of Solar Pumps for small farmers in Gujarat | Installation of 2,000 Solar Pumps (of 2 HP each) for small farmers in Gujarat with minimum holding of 5 acres of land and maximum 30 m water table. | 90 | 3 | To utilize the potential of generating solar energy for purpose of irrigation |
| 4 | | Installation of Solar Photovoltaic Power Pack for e-Gram at Gram Panchayats in the state | Installation of 725 Solar Photovoltaic Power Pack for e-Gram at Gram Panchayats in the state. Considering 330 days with proper sunlight, the system installed may annually generate approx. 4,78,500 units electricity, which may save 478.5 tons of CO2 emission and 3,34,950 kgs of coal annually | 15 | 1 | To utilize the potential of generating solar energy as a major mitigation activity for e-Gram at Gram Panchayats |
| 5 | | To conduct Solar Photovoltaic Rooftop Programme under Gandhinagar-Solar City Project under Public Private Partnership model | Creation of5MW Solar Photovoltaic Rooftop Programme under Gandhinagar-Solar City Project under Public Private Partnership model | 25 | 3 | To expand the potential of decentralised solar energy through the solar roof-top programme. |
| 6 | | Installation of Solar Photovoltaic Power Plant at Gandhinagar Thermal Power Station under Gandhinagar-Solar City. | Installation of 3 MW Solar Photovoltaic Power Plant at the Ash Dyke of Gandhinagar Thermal Power Station under Gandhinagar-Solar City. | 25 | 1 | Reduce the consumption of conventional energy through setting up solar energy plants. |

| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | | To study to the Carbon Footprint based on lifestyle patterns in Gujarat through Involvement of youth and women | To examine the behaviour, actions and lifestyle patterns of households in terms of their carbon footprint and resource use and to generate a database on consumption patterns of various stakeholders | 26.2 | | Understand sources of carbon emissions and consequently reduce Carbon emission through innovative solutions |
| 8 | Agriculture & Co-operation Department | Replacing conventional light with LED lamps in APMCs spread in Gujarat | Replacing conventional light with LED lamps (3090 in nos.)in 183 APMCs spread in Gujarat, especially in economically weak regions and those situated in tribal belt of the state. | 3.22 | 1 | To reduce carbon content in the atmosphere and create awareness on solar light, by choosing a lighting system which is modern and energy efficient. |
| 9 | | Demonstration of Solar light in APMCs | To reduce carbon content in the atmosphere and create awareness on solar light by saving more than 350 tons of $CO_2$ emissions and saving about Rs. 60.00 lakhs in energy cost per annum. | 11.9 | 1 | Aimed at carbon mitigation through solar lighting. |
| 10 | Energy and Petrochemicals Department (Gujarat Narmada valley Fertilizers limited) | Installation of solar plant on the premises of GNFC | Installation of 5 MW solar plant on the premises of GNFC | 75 | 1 | Green Energy generation and reduction of CO2 emissions |
| | | | Total | **736.32** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

# 13.0 Vulnerable Communities

## 13.1 Strategies for empowerment of vulnerable communities

The IPCC states that "Climate Change impacts will be differently distributed among different regions, generations, age classes, income groups, occupations and genders" (IPCC, 2001). Climate Change can act as an additional stressor for households and communities dependent for a major part of their livelihood on natural resources, whose distribution and productivity are influenced by climate dynamics. Amongst the most vulnerable are communities including tribals and indigenous people, marginal famers, landless, urban poor, migrant workers and women as their livelihoods are intrinsically dependent on natural resources and any stress on these would have a direct or indirect impact on them.

**Box 21: Gujarat's initiatives for vulnerable communities**

The National Action Plan on Climate Change has not incorporated strategies for vulnerable communities. In Gujarat, various initiatives are taken for tribes and coastal communities who can be considered as communities vulnerable to Climate Change. Also several policies and programmes are in place for upliftment of weaker sections of society.

### 13.1.1 Tribal and indigenous communities

Tribal and indigenous communities, due to their dependence upon, and close relationship, with the environment and its resources are amongst the ones to face the direct consequences of Climate Change. They directly depend upon on natural resources for food; wood for timber or fuel; fibre for clothing; and medicinal plants for health care etc. Climate Change may impact the availability and distribution of these resources. Changes in ecosystem dynamics can in turn affect the use, protection and management of wildlife, fisheries, and forests, and the customary uses of culturally and economically important species and resources (IWGIA, 2008).

According to 2011 census, scheduled tribes comprise a population of 89.17 lakhs in Gujarat. Tribal regions in the State comprise 43 tribal talukas, 15 pockets and four clusters. Tribals of Gujarat mostly live along the eastern border of the State. The main resources they depend on include agricultural land, forests and minerals (Gujarat Tribal Development Department). Their main livelihood activities include livestock rearing, farming, fishing, hunting etc. A study conducted by Gujarat Institute of Development Research show that, tribals in Gujarat are facing multiple problems in spite of Government interventions, in 43 tribal dominated districts, shortage of food in tribal households is severe compared to non-tribes. In more than half of the tribal

households (47.9%) distress migration occurs as casual labourers. The forest based livelihoods are of prime importance in the districts.

### 13.1.2 Women and children

It is increasingly recognized that women are more strongly affected by the impacts of Climate Change and variability (Enarson, 2000; Lambrou and Pian, 2005; WEDO, 2007). According to Hemmati and Rohr, (2007), women are particularly vulnerable as a consequence of their social roles, inequalities in the access to and control of resources, and their low participation in decision-making.

Climate Change can compound the vulnerability of households particularly women. This would adversely impact the access to basic needs and natural resources, such as shelter, food, fertile land, water and fuel, becomes hampered, thereby increasing women's workload who are responsible for tasks such as food/water collection and energy supply for the household as well as many care-giving tasks, such as caring for the children, sick, elderly, the home and assets (Enarson, 2000).

### 13.1.3 Coastalcommunities

Since Gujarat has a long coast, it is vulnerable to sea level rise and other impacts of Climate Change. The primary effects include increased coastal flooding, loss of land due to inundation and erosion of sandy beaches. These could lead to loss of ecosystems such as wetlands, mangroves and corals, degradation of coastal vegetation and habitats, intrusion of salt water into groundwater systems, and loss of cultivable land with huge implications on human systems and settlements relating to health, displacement of population, loss of life and economic losses.

In Gujarat, the coastal area, upto 20 km from the shoreline, is 30,022.25 sq.km. consisting of parts of 11 districts and 51 talukas with 59 towns and 2802 villages. Living resources are coral reefs around 34 islands in the Gulf of Kachchh, rich fisheries in the 375 km wide continental shelf, and mangrove vegetation on swampy lands around the coast. Gujarat produces 71 per cent of national production of common salt (GoG, 2009).

Coastal erosion is already being experienced on western boundary of Valsad, Surat, Navsari, Bharuch and Jamnagar districts and on eastern boundary of Bhavnagar, Amreli, Junagadh, Porbandar and Jamnagar districts. The coastal erosion is found in 449 villages, of which the main communities are 'Machhimar'. The erosion is taking place just before monsoon and in monsoon season mostly under the action of strong tidal current accompanied by wave action (Water Resources Department, GoG)

Salinity ingress is also a major threat in the coastal areas, agriculture and animal husbandry production is being negatively impacted due to this.

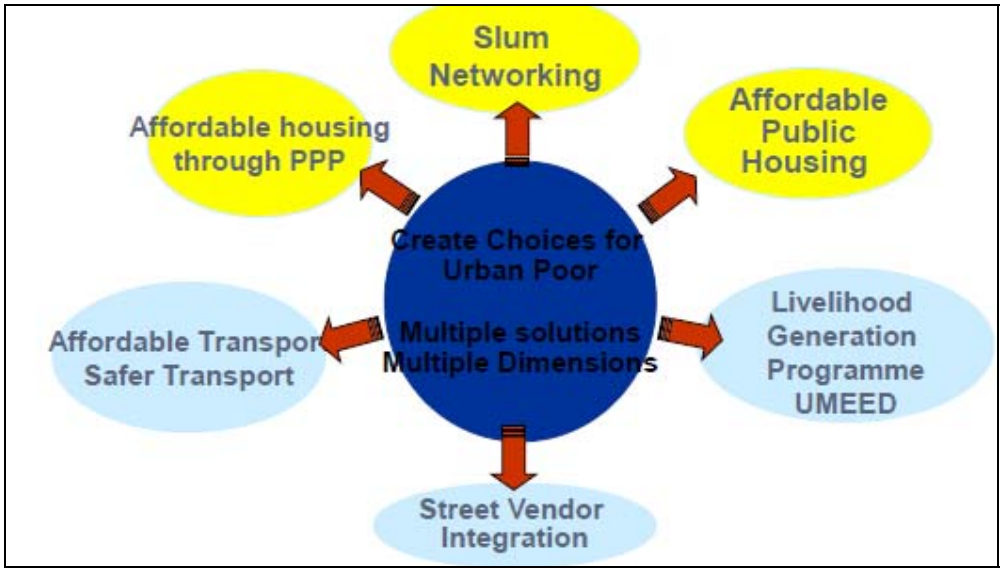
### 13.1.4Urban poor

As per the Planning Commission, the population living below poverty line in Gujarat in 2011-12 was approx. 26.88 lakhs i.e. (10.14%) of the urban population, which is lower

than the national average of 13.7% (GoI, 2013). There is a rise in migrants and already existing population of poor in urban areas, as a result of which the pressure on existing infrastructure and services rise. This exasperates the situation of haphazard growth and adds to their vulnerability to climate change due to improper housing, lack of access to adequate basic services including sanitation, health, education and employment.

The Urban Development and Urban HousingDepartment, (GoG) has devised a multi-pronged approach for mainstreaming urban poor with the overall vision to develop a slum free urban Gujarat and affordable housing for all.

**Figure 44: Multi-pronged approach for mainstreaming urban poor**




Source: The Urban Development and Urban Housing Department, (GoG), 2014

Through a large number of projects identified by various Departments, aspects such as upliftment of urban poor population through provision of housing, sanitation services, skill development through training, self-employment programmes, etc. a number of activities have been planned and implemented to improve the adaptation capacities of the urban poor. Some of the proposed activities have been listed in the subsequent section.The objective is toidentify strategies to integrate climate change dimension into existing state initiatives for in-situ slum redevelopment.

Historically, Gujarat has been an industrialized state and since last few decades the focus on manufacturing sector has been further strengthened in the State. As a result, there has been in-migration from otherneighboring states such as Rajasthan, Madhya Pradesh, Maharashtra as well as from distant states like Bihar, Orissa, Chhatisgarh and Jharkhand as well. On top of that, there is also intra-state migration to centres/areas with higher rate of growth (Hirway and Shah, 2011). This creates a pressure on already existing infrastructure. Since the industrial hubs are major activities of production, it creates an indirect pressure on resources of such areas.

The slum workers vulnerable to financial and social protection, could be supported through developmental aspects along with increasing their adaptability to changing climate.

### 13.1.5Marginal and landless farmers/pastoralists

There are several reasons why landless farmers, laborers, pastoralists arefurther marginalised due to their poverty, lack of access to land or major economic assets, lack of social security net, exclusion from social welfare and benefits due to their nomadic lifestyle, dependency on fragile ecosystem amongst others. Even geography plays an important role in adding another dimension to their vulnerability. For e. g. the Maldhari community of Kachchh are mainly dependent on milk and cattle based livelihoods and are typically nomadic tribes. Added to this situation, since a large number of industries have come up in Kachchh, there has been transformation of common lands into industrial zones. Thereby the dependency on natural resource base economies of such traditional communities has been affected and they are required to alter their profession.

In the long run, the livelihoods of such marginal and disadvantaged communities need to be strengthened and stabilized. Access to resources, creation of assets for sustainable livelihoods, focus on women and children's health and nutrition, investing in human capital, addressing their vulnerabilities will help improve their financial and social status. Through poverty alleviation, these communities can be brought at par with other rural population (UN World Food Program, 2002)

## 13.2 State Initiatives and Achievements

### 13.2.1 Coastal sustainable livelihoods

Gujarat has over 1,600 km coastline with 6 million coastal populations in 38 sub-divisions, which will be more vulnerable to potential sea level rise, flooding, cyclones and damages to infrastructure. Sensing this important fact, Gujarat has devised a new integrated development programme for coastal communities known as **'Sagar Khedu Sarvangi Vikas Yojana'** (Multi-Dimensional Development Packages for coastal Communities). Catering to the needs of the coastal communities for climate resilience and sustainable livelihood promotion the State has promoted a multi-dimensional development package for coastal communities at a cost of INR 110 billion.The programme goes beyond livelihood issues taking into consideration a holistic eco-system approach to coastal areas development. It proposes specific and time bound action plan for improving:

- W age and Self Employment
- C apacityBuilding and Skill up-gradation
- E ducational Facilities
- H ealth infrastructure
- D rinking Water
- H ousing

- S alinity Ingress and Water conservation
- E lectrification
- D evelopment of salt pan workers
- N ational Security

### 13.2.2 Livelihood generation

The Gujarat AnnualDevelopmentPlan (2011-12) accords high priorityforemploymentgeneration through variousState and Centrally Sponsored Schemes. The State has accorded high priority towards industrial development and thereby generating additional employment for youth, both in urban and rural areas.

Emphasis would be laid on self-employment schemes in Agriculture, Animal Husbandry, Dairy Development, Village and Small industries and allied activities. High priority is accorded to maximize employment with special emphasis on agro-based rural industries. In fact, Gujarat has achieved a considerable progress in this sector.

**Table 25: Schemes having potential of employment generation during year 2011-2012**

| No. | Sector of Development | Wage Employment atMan-days (Proposed) (in lakhs) | Self-Employment No. of beneficiaries(Proposed)(in lakhs) |
|---|---|---|---|
| 1 | Fisheries Department | 162.84 | -- |
| 2 | Office of the Principal Chief Conservator of Forest | 298.12 | 2,98,00,000 |
| 3 | (i) Agriculture Soil Conversation | -- | -- |
| | (ii) Animal Husbandry and Dairy Development | 2.12 | 18,000 |
| | (iii) Crop Husbandry (Horticulture) | -- | 2,80,00,000 |
| 4 | SEBC Welfare | -- | 62,00,000 |
| 5 | S.C. Develop. Corporation | -- | 10,000 |
| 6 | Rural Development | 750.00 | 1,20,000 |
| 7 | Development Commissioner | 19.64 | 19,64,000 |
| 8 | Cottage industries | 2.50 | 250,000 |
| 9 | Guj. State Handloom and Handicrafts Development Corporation | 15.05 | 15,051 |
| 10 | Guj. Gopalak Development Corporation | 0.00 | 00 |
| 11 | Guj. Women Eco. Develop. Corp. Ltd. | 4.06 | 1,400 |
| 12 | Guj. Minority Finance and Development. Corp. Ltd. | -- | 1,500 |
| 13 | Guj. Safai Kamdar Development. Board | 0.00 | 00 |
| 14 | Guj. Urban Development Mission | 2.06 | 81,000 |
| 15 | Gujarat Maritime Board | 127.94 | -- |
| 16 | Narmada Water Resources, Water Supply and Kalpsar Department | 348.62 | 89,000 |
| 17 | Sardar Sarovar Narmada Nigam Ltd. | 310.00 | 3,10,00,000 |
| | **Total** | **2,042.95** | **9,75,49,951** |

*(Information from concerned offices)*

### 13.2.3 Implementation of the Twenty Point Programme

The Twenty Point Programme (TPP) was launched by the Government of India in 1975. The Programme was first revised in 1982 and again in 1986. TPP-2006 has Points for the benefit of the rural and urban people. Its thrust is towards programmes for eradicating poverty and improving the quality of life of the poor and the under-privileged people all over the country. The Programme covers various socio economic aspects like poverty, employment, education, housing, health, agriculture, land reforms, irrigation, drinking water, protection and empowerment of weaker sections, consumer protection, environment and e-Governance etc.

Gujarat has been among the front ranking States in the country in implementation of the Twenty Point Programme-1986. Government of India has been implementing the revised Twenty Point Programme–2006 since 1-4-2007. The State has ranked first in the country with 96 per cent achievement during the year 2008-09. The State has achieved 94 per cent in the year 2009-10. The Ministry of Statistics and Programme Implementation of the Government of India has recently published Progress Report ending July-2010 of the year 2010-11, **GujaratState has achieved 1st rank with 100 per cent achievement in the country.**

**Table 26:Achievement under the Twenty Point Programme (TPP) at the end of January-2011 during the year 2010-2011**

| Pt No. | Item Name-Sub Item Name | Unit | Annual Target Year 2010-11 | Target Jan.-11 ending | Achievement Jan.-11 ending | %age |
|---|---|---|---|---|---|---|
| | **Employment generation under the National Rural Employment Guarantee Act (MNREGA)** | | | | | |
| 1 | No. of job cards issued | Number | 0 | 0 | 372965 | - |
| 2 | Employment generated | Number | 0 | 0 | 31024000 | - |
| 3 | Wages given in cash and kind | Lakh.Rs | 0 | 0 | 29051.14 | - |
| | **Swarna jayanti Gram Swarojgar Yojana** | | | | | |
| *1 | Total Swarojgaries Assisted | Number | 6514 | 4993 | 16404 | 329 |
| 2 | SC Swarojgaries Assisted | Number | 0 | 0 | 7891 | - |
| 3 | ST Swarojgaries Assisted | Number | | | | |
| 4 | Women swarojgaries Assisted | Number | 0 | 0 | 5170 | - |
| 5 | Disabled Swarojgaries Assisted | Number | 0 | 0 | 132 | - |
| | **Self Help Groups** | | | | | |
| 1 | Formed under SGSY | Number | 0 | 0 | 5044 | - |
| *2 | To whom income generating activities provided | Number | 3752 | 2876 | 4768 | 166 |

### 13.2.4 Ten point programme

The Government of Gujarat has launched a bold and unprecedented initiative in 2007 - the 'Chief Minister's Ten Point Programme for the Development of Tribal Areas' also commonly known as Vanbandhu Kalyan Yojana. The Ten-Point Programme focuses on the integrated, holistic and inclusive development of tribal communities by touching their lives in core areas It's components are:

- Quality and sustainable employment for 5 lakh tribal families
- Quality of education and higher education
- Economic development
- Health
- Safe drinking water
- Irrigation
- Universal electrification
- All weather road connectivity
- Urban development
- Access to services

Skills imparted lasts for one whole generation so that they do not fall in poverty net again in this generation.A series of technical institutions are being set up in the focus areas to develop the required manpower and to support the major interventions like dairy, Wadi and skill training.

The Ten Point Programme will develop a gender framework to ensure that women are equal partners and accrue benefits from the initiatives. Emphasis will be given to drudgery reduction, access to credit, housing and capacity building while developing the framework.

A large number of initiatives have been undertaken under the Yojana, which comprises of a corpus of Rs. 15,000 crores to be spent (from 2008-09 to 2013-14) for the tribal development and upliftment. Progress has been made in skill development training programmes, income diversification projects, extension of regional water supply schemes and in-situ conservation of water through roof-top rainwater harvesting, infrastructural improvements including deepening of ponds/lakes, building check dams in those areas, improvinghousing stock, etc. The focus is on vulnerable population, who will be supported to help them adapt to changing climate.

### 13.2.5 Engaging with corporate houses/industries for sustainable livelihood generation

Gujarat Livelihood Promotion Company (GLPC) is an implementing agency of the **State of Gujarat for Livelihood Mission**, named as **Mission Mangalam**, under the **National Rural Livelihood Mission** of Ministry of Rural Development, Government of India and works with the primary objective of linking existing Self Help Groups, Producer Groups and other collectives of the poor, strengthening them through mobilization, linkages with the formal banking system, linkages with microfinance and linkages with sustainable livelihoods.

As part of the livelihood interventions, GLPC has launched **Innovative Livelihood Initiatives** under **Mission Mangalam** to bring in corporate houses/ industries to initiate **Social Business Enterprises** with an objective of creating livelihood opportunities for the poor through profitable, sustainable and scalable ventures.

### 13.2.6 Integrated Tribal Development Projects (ITDP)

The Government of Gujarat has identified 12 Integrated TribalDevelopment Project areas viz. (1) Palanpur(2) Khedbrahma (3) Dohad (4) ChhotaUdepur(5) Rajpipla (6) Mandvi (7) Songadh (8)Vansada (9) Dangs (10) Bharuch (11) Valsadand (12) Godhra. These 12 ITDP areasinclude in all 43 talukas of the state. As per 2001 census, the coverage of tribal population under ITDPs is about 61.38 lakh,which accounts for 82.04% of the total tribal population in the State, while 13.43 lakh (17.96%) tribals are in scattered anddispersed area. (GoG, 2013). Focus is on district level “Jilla Adijati Vikas Mandal” which means that 95% of outlay is earmarked for theschemes to be implemented at District level, while the remaining 5% outlay is for State level schemes.

### 13.2.7 Affordable Housing for Urban Poor

Through the Mukhyamantri Awas Samriddhi Yojana (MASY), the aim is to provide affordable housing and infrastructure facilities in partnership with private sector. Through Rajiv Awas Yojana, slum surveys and slum free city plans are under progress for 4 municipal corporations and more than 4 cities of Gujarat Through Integrated Housing and Slum Development Programme (IHSDP), the GoG aims at havingan integrated approach in ameliorating the conditions of the urban slum dwellers who do not possess adequate shelter and reside in dilapidated conditions.

**Box 22: Approach to SAPCC Priorities for 2014-2019**

Creating **Climate Change safeguards** for women, landless labourers, marginal workers, tribal and other vulnerable communities

## 13.3 Key Strategies

- Studies to provide basis for integrating gender concerns in Climate Change policies

in Gujaratand showcase key linkages between Climate Change and gender inequalities

- Promote alternative low cost innovative technologies to reduce women's drudgery.
- Encourage approaches that support women in their well-being, be it health, handling crisis, access to other basic needs etc.

## Programme of Action for Vulnerable Communities

| Sr No. | Department/Office Name | Project | Project Objective | Estimated Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Women and Child Department | Vulnerability assessment of women in context of Climate Change in Gujarat | To showcase key linkages between climate change and gender inequalities. | 0.7 | 1 | Integrating gender concerns in climate change policies in Gujarat |
| 2 | Women and Child Department | Small Grant programme for 100 agencies to implement innovative ideas integrating women with Climate Change in Gujarat | Encouraging women focused and/or women headed initiatives that help in addressing women's concerns in state of Gujarat; Promote alternative low cost innovative technologies to reduce women's drudgery; Encourage approaches that support women in their well being, be it health, handling crisis, access to other basic needs etc; Document innovative ideas/approaches in this regard and publish the same for wider use; promote the local traditional knowledge and remedies in addressing women's concerns. | 3.5 | 5 | Promotion of women empowerment and women participation in climate change management |

| Sr No. | Department/Office Name | Project | Project Objective | Estimated Budget in Crore Rs. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 3 | Labour and Employment Department | Research and Development project to understand the impact of climate change on migrant workers | Mapping the lifestyle of migrant workers, identifying the impacts of climate change and planning adaptation solutions for migrant population. | | | Vulnerability assessment of migrants |
| | | | Total | **4.2** | | |
| | | | | | | |
| * - Figures are based on primary and rough estimates | | | | | | |

# 14.0Sea Level Rise and Coastal Infrastructure

Gujarat has a coastline of approximately 1,663 km, which is the longest and is approximately 22 per cent of the total coastline of India (GEC, 2008). The long coastline of the State serves as a major industrial hub and strategic location. Coastal Gujarat harbours almost 37 per cent of the total population. Also, data clearly suggest that there may be a mean sea-level rise along the Indian coast of around 1.3 mm/year. A summation of all these facts makes it important that importance is given to coastal infrastructure to safeguard this strategic location and therefore special impetus has been given to this thematic area.

## 14.1 Strategies for Sea Level Rise and Coastal Infrastructure

**Box 24: Addressing Sea Level Rise**

The NAPCC recognizes the threat of Sea Level Rise, but specific strategies are missing for coastal infrastructure. Also missing is a comprehensive policy for coastal shipping at the national level

### 14.1.1 Current initiatives and goals

**Box 23: Approach to SAPCC Priorities for 2014-2019**

- Expansion of coastal shipping
- Sea Level Rise studies
- Costal infrastructure: risk assessment and protection
- Renewable energy applications in ports and shipyards

Over 25,000 ha of Mangrove Forest have been added in the coastal areas of Gujarat which will be working as strong Carbon Sink absorbing 50 tons of Carbon per ha.

- Taking a series of preventive pollution measures, through user industries and companies and develop an Environmental Infrastructure Plan for 10 years in light of Vibrant Gujarat offers.

### 14.1.2 Research and development

- Anticipatoryplanning to encounter sea level rise along Gujarat coast
- Studies are required to evaluate the interactions between climatic and non-climatic stressors on vital processes (e,g. productivity, connectivity, calcification) of mangroves and corals, and reports produced that would be the basis for modifying management policies and targets
- Studies are required on the threshold levels/critical limits of mangrove and coral species, and processes beyond which impacts of Climate Change (temperature, SLR) cause irreversible damage
- Studies required for a better understanding of the impacts Climate Change on the Gujarat Mangrove and wetland ecosystems would include;
- Detailed digital elevation models of mangrove, salt marsh, salt flats and coastal plains
- Fine scale classification of the coast into typological units based on geomorphological characteristics
- Informed linkages between geomorphological classifications and ecological and physical processes
- An understanding of sedimentation rates in mangroves and wetlands on the State, variations from past sedimentation rates and the role of sedimentation to wetland stability.
- A better understanding of the changes in the response of fauna to changes in the intertidal wetland plant species composition, changes in extent and connectivity of habitats and changes in productivity.

- A quantitative understanding of the impacts of cyclones on intertidal wetlands, rates of recovery and interactions with other factors (eg sea level rise).

### 14.1.3 Institutional strengthening and infrastructure development

- A "No regrets" mitigation action is required to reduce the non-climate stresses (e.g run off from the industries) on mangroves and wetlands in the State of Gujarat. This would help reduce mangrove vulnerability and enhance mangrove resilience to climate stress (Adger et al, 2007).
- M anagement processes would have to evolve so as to a) create buffers around wetlands to increase resilience, and b) assist in relinquishing lands to accommodate landward migration of intertidal habitats.
- W hile coral reefs located in the Gulf of Kachch Marine National Park are protected (corals are also protected under the Wildlife Protection Act, 1972), there is a need to design and maintain networks of protected areas to increase resilience of the entire reef system.
- A n integrated management and planning framework should be developed for a cost-effective response and adaptation to the impacts of global Climate Change. Also, a long term monitoring program that will help illustrate the impacts of Climate Change on coral reefs needs to be established
- I nitiatives could be taken to explore the efficiency of technologies to reduce the impacts of Climate Change (shade structures, restoration technologies) for small areas of high natural and/or (tourism) value like in the case of the Pirotan Islands

### 14.1.4 Capacity building

The Climate Changeeducational curricula should include information on the value of wetlands conservation and on the important services that mangroves provide. Public awareness about mangrove and wetland resources would help local communities make well-informed decisions about mangrove use, and is likely to result in grassroots support and increased political will for measures pertaining to the conservation and sustainable management of mangroves.

Due to the presence of multiple ports a l3arge number of proposed projects have been aimed at securing these coastal regions, as they are the lifeline for trade and commerce.

# Programme of Action for Sea Level Rise and Coastal Infrastructure

| Sr No. | Department/Office Name | Activity | Objective | Budget in Crore Rs*. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Ports and Transport Department (Gujarat Maritime Board) | Anticipatory Planning for Sea level rise to protect Ports and port led development and other coastal resources along the coast of Gujarat extending in 1600km X 10km area | To protect ports and port-led development and other coastal resources along the coast of Gujarat | 100 | 3 | Coastal infrastructure protection to SLR through adaptation options |
| 2 | Ports and Transport Department (Gujarat Maritime Board) | To cater clean power to the GMB Ports as a part of the Climate Change Defense Mechanism of the State | Installation of Solar Power Stations in 9 identified GMB Ports viz Magdalla, Dahej, Bhavnagar, Veraval, Porbandar, Okha, Bedi Group of Ports, Navalakhi and Mandvi and a Ship Recycling Yard at Alang | 17 | | Creating balanced energy mix in ports. |
| 3 | Department of Climate Change | Proposal for undertaking research on “Assessment of Climate Change Impact on Sea Level Rise (SLR) over the Gujarat Coast” | Assessing vulnerability due to climate change and its impact on Sea Level Rise using the state-of-the-art coupled models and dynamical downscaling of these climate change projections over the Gujarat region using a regional climate model; To recommend site-specific adaptation measures to reduce coastal | 1.07 | 0.5 | Vulnerability and impact assessment of coastal areas to SLR and formulation of adaptation solutions |

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | vulnerability to SLR | | | |
| | | | Total | 118.07 | | |
| * - Figures are based on primary and rough estimates | | | | | | |

# 15.0 Green Jobs

## 15.1 Strategies for Creation of Green Jobs

The terms low carbon jobs, green jobs, clean energy jobs etc., are often used interchangeably. According to ILO (2007) "Jobs are green when they help reduce negative environmental impact ultimately leading to environmentally, economically and socially sustainable enterprises and economies". More precisely green jobs are decent jobs that:

- L imit GHG emissions
- M inimize waste and pollution
- R estore and protect ecosystems
- R educe energy and raw material consumption

In the United States, green jobs are often defined solely as those in renewable energy and energy efficiency. White et al, (2008) on the other hand, refer to employment in sectors that 'make up the clean energy economy', including energy efficiency, renewables, alternative transport and fuels as low carbon jobs. According to UNEP, "work in agricultural, manufacturing, research and development (R&D), administrative, and service activities that contribute substantially to preserving or restoring environmental quality". Low carbon jobs are classified into three categories, jobs related to environment protection; jobs related to renewable energy (RE); and jobs related to energy efficiency (EE) and clean technology by the UNEP and SEF Alliance study.

Green jobs can be created in both in rural and urban settings, all sectors and types of enterprises, and in countries at all levels of economic development. They play an important role in reducing the environmental footprint of an economic activity.

According to UNEP report, green jobs will impact the economy in four ways-

- I n some cases, additional jobs will be created, for example in the manufacturing sector
- T here will be substitution of employment in some cases, for example to the recycling sector.
- E limination of some jobs without replacement.

- Some jobs will be transformed and redefined.
- According to UNEP, Green jobs exist in both developed and developing countries in six sectors which contribute to economy of a nation.
- Energy Supply- More than 2.3 million jobs have been created in renewable energy sector. The solar PV sector employs an estimated 170,000 people, wind power about 300,000 people, and the solar thermal industry more than 600,000. Bio-energy has high potential to create employment.
- Energy Efficiency in building and construction- Buildings are responsible for 30-40 per cent of all energy use, waste generation and greenhouse gas emissions. The sector which includes construction and renovation of buildings has a high potential of GHGmitigation and job creation. New jobs will be defined in terms of skills, training and certification requirements.
- Transportation- Public transport systems offer lower emissions and green jobs than in private vehicles. There are about 5 million jobs in the railways in India, China and the European Union alone. Railways have a high potential of employment generation in manufacture of locomotives and rolling stock. Green employment opportunities exist in retrofitting diesel buses to reduce air pollutants and in introducing vehicles running on Compressed Natural Gas (CNG).
- Agriculture- Agriculture sector is vulnerable to Climate Change impacts and also a major contributor to GHG emissions. Agriculture sector also contributes to land and water pollution, drives deforestation and hence leads to biodiversity loss. Potential for green jobs in this sector exists in creating organic farms and practicing organic farming.
- Encouraging small farms, using crop rotation, manuring and other sustainable methods can prove to be a source of green jobs generation. Employing rural dwellers for terracing or contouring land, conservation of water, building irrigation structures, and other related activities will therefore provide employment.
- Forests- It is difficult to decide how much proportion of jobs is green in the forest sector. Considering their role as potential carbon sinks, providers of raw material and other ecosystem functioning, sustainable forest management can offer large number of jobs.
- Recycling and basic industries- Basic industries include iron and steel, aluminium, cement, pulp and paper. These industries consume a large amount of raw materials and energy and hence account for large amount of GHG emissions. It is difficult to create direct green jobs in these sectors, but inclusion of recycling can prove as a possible solution. For example, steel production, based on recycled scrap can be seen as a proxy for green production since it requires 40–75 per cent less energy than primary production.

The Green Jobs initiative, a joint initiative by the ILO, the United Nations Environment Programme, the International Organization of Employers and the International Trade Union Confederation is being started in India. The initiative supports effort by governments, employers, and trade unions to promote environmentally sustainable decent jobs in a climate-challenged world. In India, inclusion of poverty reduction strategies in growth following sustainable development path is of importance. The green jobs initiative tries to address these issues. Demonstration initiative has been started in the dairy sector of Madhya Pradesh.

The State of Gujarat also can generate green employment largely in the agriculture sector and other industries. Such an initiative will have the benefits of GHG mitigation and job creation.

**Box 25: Approach to SAPCC Priorities for 2014-2019**

- Promotion and R&D of Green Technologies so they become new economic drivers for creation of employment opportunities

## Programme of Action for Green Jobs

| S. No | Department/Office Name | Activity | Objective | Budget in Crore Rs*. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| 1 | Panchayats and Rural Housing Development (Gujarat Livelihood Promotion Company) | Irrigation development through micro irrigation systems | To provide water to large area from a small water source through micro-irrigation systems and creating workforce for setting up infrastructure | 4.5 | 1 | Achieve water security and increase employment by creating jobs in setting up irrigation infrastructure |
| 2 | | Setting up bio Briquetiing Plant to utilize the bio/agri wastes generated and convert it into biofuel. | To provide at least 250-300 days of employment to farm laborers who otherwise will be rendered jobless during off-season or non-agriculture season and to enable price realization of agri waste to farmer. | 2.51 | 5 | Employment generation in bio-fuel sector |
| 3 | | Planned expansion of tree cover under the urban greening | To consider plantation/Landscaping / Green Cover in all the large housing and infrastructure projects undertaken by the Corporation as a | 4.5 | 10 | Job generation and increasing urban green cover |

| S. No | Department/Office Name | Activity | Objective | Budget in Crore Rs*. | Project duration | Outcomes |
|---|---|---|---|---|---|---|
| | | programs. | potential way to produce carbon sinks. | | | |
| 4 | Home Department (Gujarat State Police Housing Corporation Ltd.) | Installation of Solar pumps for the salt miners, also known as Angariyas | To eliminate diesel pump use by the miners by providing more than 300 solar pumps thereby freeing them from the clutches of moneylenders/ traders giving credit to run the diesel pumps. | 0.46 | 5 | Reduction of Carbon emission and increasing salt miners income |
| | | | **TOTAL** | **11.97** | | |
| * - Figures are based on primary and rough estimates | | | | | | |

Besides these activities other activities like promoting organic farming,up scaling training for solar energy technicians, Promoting ecotourism in the state and Promoting of construction of green building through regulation can also serve as areas to increase green jobs.

# 16.0 Enablers

Along with the sectoral and cross-sectoral themes mentioned in the previous sections, there are certain strategies which will provide enabling environment in planning, execution, and evaluation of such activities. These have been mentioned in the section below.

## 16.1Generating knowledge, building capacity and public awareness

Environmental education in Gujarat has become increasingly important due to its policy of sustainable development and the State Government's awareness strategy includes incorporating education that includes climate concerns, specifically, at the tertiary level. Generating awareness on climate vulnerabilities and impacts requires people from different disciplines, age groups and areas to work together, and disseminate factual information that is made available to them. It requires methods to bridge the knowledge gap and address the lack of understanding on various climate issues. This will require capacities to be built; research to be coordinated; dissemination of best practices; and innovative actions on the ground. The aim is to effectively incorporate communication and education through a participatory process that will ensure two-way communication with contribution and awareness from people in the State, who will be able to accept ownership and guide corrective processes themselves.

Both education and awareness require sustained support by research on the climate system and the identification of options for mitigation and adaptation, in addition to

research on energy, transport, industry, agriculture, water and forestry, as these sectors influence and are influenced by economic growth.

The Government of Gujarat will add to or strengthen programmes for outreach activities, capacity building and expansion of the knowledge network, in a structured manner under the aegis of the SAPCC, in both urban and rural areas. These programmes will cover a broad range of climate issues that will address inadequate planning, poor quality and limited outreach actions. The Government also aims to strengthen research capacity by enhancing institutional capacities; and assess technical, institutional and regulatory barriers.

The SAPCC will enable access to appropriate and meaningful information, raise awareness and encourage discussion within the State, across all target audiences and lifestyles, through a series of campaigns that include the media, awareness products, and inventories of initiatives and best practices. Detailed implementation schedules, including work-plans and indicator selection will be developed in participatory work-planning sessions with all stakeholder and State institutions.

### 16.1.1 Climate Change Education and Awareness

Limited awareness about Climate Change at all levels of society exists, but these are scattered and insufficient. Therefore, there is a need to establish a common understanding and influence individual and collective behavior to adopt low carbon development agendas, thus mitigating climate impacts likely to affect the State. The Government of Gujarat aims to educate, empower and engage all stakeholders on issues relating to Climate Change. Since, improving awareness and understanding of Climate Change, and creating solutions to facilitate access to information, on a changing climate are a key to address the challenge.

### 16.1.2 Climate inclusive education

The primary purpose of including climate concerns into formal tertiary education is to build capacities and increase resilience to cope with vulnerabilities and deal with impacts. It is expected that this will lead to innovative and viable responses to the climate challenge that the State will face, considering its rapid economic growth agenda. In **2011,** Gujarat University, in a decision that is first of its kind taken by any university in India, has made: **Environmental Science a compulsory subject** at the undergraduate level; and the book written by Gujarat's Chief Minister "Convenient Action- Gujarat's Response to Challenges of Climate" a part of the syllabus. Climate Change has also been integrated into the school curriculum. Gujarat has established the "**Management Education Centre for Climate Change**" in Gujarat University for building capacity through introduction of short term and long term courses on Climate Change. A "School of Solar Energy" has also been established at Pandit Deendayal Petroleum University. Gujarat University has already started a M.Sc. in Climate Change Impact Management which aims at developing expertise in the essential multi-disciplinary fields that comprise the core of this new science.

### 16.1.3 Enhancing climate focused research

In dealing with Climate Changes and challenges, the importance of research cannot be overstated and the Government of Gujarat is on a strategic course to create and strengthen interdisciplinary research institutions that address environmental and societal concerns. CEPT University in Ahmedabad has a “Faculty of Sustainable Environment and Climate Change” to strengthen multidisciplinary expertise among professionals. The faculty offers academic programmes on Climate Change and sustainable human settlements; conducts training and capacity building exercises; undertakes research and publishing; and carries out networking and institutional cooperation. A specialized Centre for Climate Change Studies is also being established under the Faculty.

### 16.1.4 Gujarat Institute of Research in Climate Change

The Government of Gujarat has proposed setting up of the **Gujarat Institute of Research in Climate Change (GIRCC).** The thrust of the “GIRCC” would be Climate Change capacity building in various departments of the Government so as to integrate the Climate Change perspective in long term planning, creation of mechanism for promotion of clean technologies and generation of widespread consciousness on Climate Change amongst people at large so as to achieve desirable lifestyle changes.

GIRCC will offer a post graduate degree programme in Climate Change and doctoral research programmes and will provide research support to various departments of the State Government in the area of Climate Change. It will work as a think-tank for various State Government departments to fulfill the objectives of the State Action Plan on ClimateChange (SAPCC) in consonance with the National Action Plan on Climate Change (NAPCC).

GIRCC will also provide education in the area of Climate Change, participatory planning, information dissemination, capacity building of different stakeholders, advisory services and monitoring and evaluation works.

## 16.2 Strategies for the transfer of knowledge

To understand and comprehend the possible impacts of Climate Change for the State of Gujarat and prepare strategies with a long term vision in a way that the challenges are converted into opportunities, it is imperative for all the stakeholders including the decision/policy makers to take cognizance of Climate Change concerns. When stakeholders are involved and have ownership of the strategy development process, more effective decision-making is made possible.

### 16.2.1 Increasing capacities through trainings

Knowledge is the foundation of capacity and greater investments need to be made in continued learning. Therefore, it is felt that the level of knowledge and awareness on Climate Change issues among many of the officials in decision making capacities need to be built. In this context an “Orientation Workshop on Climate Change”, for senior officials and policy planners of Gujarat, was organized at TERI in 2008.

Regular training programmes will be organized for officials of key Government departments and these will provide essential information on: climate science and

modeling; impacts and vulnerability assessments; mainstreaming Climate Change into development planning and prioritizing strategies that can help build adaptive capacity. This will ensure that the Department of Climate Change will have in-house scientific and technical expertise. Besides regular sensitization of Government officials, from the State to the Block level of administration, will allow effective mainstreaming and implementation of climate actions. The Climate Change department has already taken initiative and is conducting multiple trainings for teachers, college professors and bureaucrats in the state of Gujarat.

### 16.2.2 Nurturing strategic knowledge linkages

The Department of Climate Change has been involved in extensive consultation processes with various Government Departments, Civil Society Organization and different institutes. Strategic Knowledge Partnerships have been established with various organizations, like The Energy and Resources Institute (TERI). Gujarat has signed the R20 Charter to identify a plan of action to identify energy efficiency and renewable energy projects in the framework of a low carbon development strategy in Gujarat State. The Department of Climate Change, Government of Gujarat, has entered into partnership with J-PAL South Asia, a centre within the Economic Department of Massachusetts Institute of Technology (MIT), to conduct detailed energy audits and to identify Small and Medium Enterprises (SMEs) suitable for CDM projects.

The Department of Climate Change will build strategic partnerships with institutes of excellence and think-tanks within the State, in India and overseas. The objective would be for enhanced cooperation for technological and technical skill transfer; and access to financial resources to implement adaptation and mitigation measures in the State.

## Programme of Action for Education and Learning

| S. No. | Department/Office Name | Proposal Details | Objective | Scale and Coverage | Amount Rs. in Crore* | Project Duration |
|---|---|---|---|---|---|---|
| 1 | Gujarat University | Proposal for supporting M.Sc.in Climate Change Impacts Management by Gujarat University | M. Sc. Climate Change Impacts Management study comprises of acquire/possess expertise in the essential multi-disciplinary fields that comprise the core of this new science. Quality research and education in Climate Change Impacts Management are vital not only to meet the existing challenges but also to set and accomplish new goals in Environmental and Earth Sciences. | Gujarat University, Ahmedabad | 1.36 | 1 |
| 2 | Department of Climate Change | Gujarat Institute of Research in Climate Change | To work as think-tank for various State Govt. Dept. to fulfill the objectives of State Action Plan on Climate Change (SAPCC) in consonance with National Action Plan of Climate Change (NAPCC) | Gandhinagar, Gujarat | - | - |
| | | | | **TOTAL** | **1.36** | |

| S. No. | Department/Office Name | Proposal Details | Objective | Scale and Coverage | Amount Rs. in Crore* | Project Duration |
|---|---|---|---|---|---|---|

* - Figures are based on primary and rough estimates

## 16.3 Initiatives for communication and change

As Climate Change is a global problem with wide-ranging impacts, it is essential that the Climate Change messages are communicated successfully to suit different stakeholder requirements. The communication and outreach strategy provides a framework for delivering key messages on Climate Change issues to target audiences. This strategy discusses the actions recommended to raise awareness of Climate Change and its impacts, and the communication of these actions.

Three ongoing projects in the State focusing on awareness generation and behavioral change are discussed below.

### 16.3.1 Women as agents of change for addressing Climate Change

The Gender Resource Centre (GRC) promoted by the State Government's Department of Women and Child Development, in the districts of Gandhinagar and Ahmedabad, is aimed at building a cadre of women who are energy savers. A demonstration project was undertaken to highlight the role of women in promoting sustainable and climate-friendly technologies that address Climate Change concerns as well as create awareness among the community on these technologies. IEC material was prepared and used for generating awareness for Training of Trainers and mass distribution.

### 16.3.2 CarbonFootprint calculation analysis in Gandhinagar city

The State of Gujarat, with its fast growing urban population, has been witnessing a change in lifestyle patterns, with the increasing purchasing power of the growing middle and upper class section. While the application of the lifestyle concept to environmental and sustainability is at a nascent stage, there is the need for a Gujarat specific study, of lifestyle patterns and associated carbon footprint, which should disseminated to sensitize the people of Gujarat.

Youth will be mobilized to examine lifestyle attributes, energy consumption and resource consumption pattern in an average Gujarati household and calculate its carbon footprint. This will also help in building awareness among civil society, especially women, on the issue of global warming and Climate Change.

The study is expected to develop an elaborate database of carbon footprints based on local lifestyle patterns, linked to several socio-economic factors. The major outcome of the study would be creating platforms for students and young women to learn, engage, and have a voice on environmental sustainability issues that affect various communities in the State.

### 16.3.3 Bal Urja RakshakDal (BURD) programme

A Statewide School Energy Education-intervention was initiated in 2003 that led to the Bal Urja Rakshak Dal (BURD), a programme initiated in 2004-05, that mobilizes children

as Urja Rakshaks (energy guardians) and teachers (Urja Agevans) to create awareness about responsible, restrained and rational use of energy among communities and schools. The programme creates awareness on best practices in energy conservation through participatory activities in homes, schools and the community. Till date a force of 50,000 children and 3,600 school teachers have been engaged in this programme.

In yr 2008-09, Energy Audits in 5,000 homes and 1,600 schools in Gujarat were also conducted. In year 2009-10, a need was felt to further educate the school children on how architecture, climatic conditions, building orientation, ventilation and vegetation can help reduce electricity consumption in their homes. The objective was to spread awareness through the participatory process about energy consumption of the traditional vis-à-vis contemporary dwellings and commercial establishments.

### 16.3.4 Online literacy

To spread digital literacy and strengthen Information Communication and Training (ICT) –a module has been prepared and an online teachers training has been conducted through GUJCET – the Online Connectivity Network in Gujarat. An Energy Knowledge Portal has been specially designed to spread knowledge and to upload children's work on the digital platform and also generate secondary data.

### 16.3.5 Specialized Resource Centre on Climate Change (SRCCC)

With the growing economy and growing concerns for the Climate Change related issues; there is arising need for a dedicated information and resource centre that can disseminate information to all parts of society. This underscores the need for sharing of information and knowledge resources, and services on a continued basis in a structured manner to enable easy access to information. The Specialized Resource Center on Climate Change (SRCCC) will therefore, aim to provide access to information services and promoting resource sharing and networking amongst individuals and institutions working on Climate Change in Gujarat and elsewhere.

The objectives of the dedicated Resource Centre on Climate Change are to:

- Function as a resource centre to collect, compile and disseminate information on Climate Change;
- Develop and provide access to information products and online databases; and
- Promote resource sharing and networking by establishing links with different libraries and information centers on Climate Change

## 16.4 People'sparticipation

Lack of awareness and limited understanding of Climate Change issues is an impediment for initiating climate actions. Broad based peoples' participation is essential to build adaptive capacity of society and make them resilient to emerging Climate Change threats. This will also increase public participation for addressing Climate Change impacts and devising adequate response measures

A community that is well informed will be able to make responsible choices. The challenge, therefore, will be to include women and youth in Climate Change deliberations, and also empower them to take requisite actions at the local level.

A series of activities will be planned to maximize knowledge sharing at the local level, initiating field based projects, and delivering key messages to raise awareness on State specific issues, among target audiences. The Climate Change Department will play a significant role for (i) forging partnerships with NGOs, knowledge organizations, community associations working on Climate Change issues in India and elsewhere, and (ii) Ensure that participation is at multiple levels and inclusive of all sections of society.Thepurpose is to generate State-wide public awareness by building consciousness and capacity among women and youth, communication agents, and NGO and mobilizing them to function as 'Climate Change Guardians' of Gujarat.

### 16.4.1 Enabling women to address climate concerns

In many contexts, women are more vulnerable to the effects of Climate Change as their dependence on natural resources is threatened more by Climate Change impacts. Women who have the responsibility of securing water, food and fuel face the greatest challenges. In addition, unequal access to resources, and to decision-making processes make them more vulnerable. However, women can also at the same time, be active participants for both mitigation and adaptation. The knowledge and expertise of women can be used in Climate Change mitigation, disaster reduction and adaptation strategies. If social, political and economic barriers on women are removed, they can significantly contribute to effective climate actions (UN Women Watch 2009).

Village level consultations with women should be held to tap indigenous knowledge about Climate Change. The dependence of women on natural resource and their role in procuring these resources for their household needs has to be identified; this would help in assessing the role that women can play in Climate Change adaptation, in relation to livelihood. This can be undertaken by local NGO's or the Gender Resource Centres (GRC).

Promotion of green jobs for rural women will be done by the Government. Activities can include setting up technology centres which can train women in installing solar home systems and improved cooking stoves. Trained engineers can disseminate information through workshops, demonstrations and door to door visits. Women Self-help groups and Sakhi Mandals can be trained to make these initiatives more successful.

A program for empowering women, through micro-credit, can be introduced. Poor women can be organized into groups, at the grassroots, and volunteers can be selected and given designations such as infrastructure volunteer, health volunteer, financial volunteer and environmental volunteer. Through these groups, training programmes, community health care programmes and environmental sanitation programmes can be organized. Climate Change and environmental issues can be made focus areas in these groups. Awareness about Climate Change can be provided and training can include climate resilient activities like improved methods of farming, steps to be taken to make the livestock sector resilient to Climate Change, processing units and other cottage industries for women etc.

### 16.4.2 Inculcating climate resilient attitudes amongst youth

Young people need to be well-informed about Climate Change and mitigation options and to be made aware of the consequences of their consumption behavior so that they can play a strong role in combating Climate Change and promoting changes in attitudes and behaviours. Education and training in Climate Change can also prepare young people to take advantage of new employment opportunities arising from the shift to greener technologies.

Creating awareness in schools can be done by introducing a course on Climate Change, and by organizing role plays and dramas. Special training programs can be organized for school teachers for mainstreaming Climate Change education in the school curriculum. Events like science exhibitions can have Climate Change as their main theme, wherein students can showcase models on Climate Change impacts and practical models created by using improved and innovative technologies.

Concepts similar to the Environmental Protection Agency's (EPA's) emission calculator kit (available online) should be introduced in schools so that students can learn to estimate GHG emissions of their respective schools and conceptualize mitigation actions. Such kinds of activities should be introduced in all schools and those who perform the best should be rewarded. Schools can be given star ratings based on the efforts they take to reduce their carbon footprint.

Apart from this, competitions like poster making and slogan writing on Climate Change should be organized in schools.

In colleges, youth can organize events like a climate walkathon and street plays to spread awareness about Climate Change. Various competitions like documentary film making and a quiz can also be organized. Youth should be encouraged to take up initiatives, like greening of their campus and measures to reduce their carbon footprint.

Youth can organize a Climate Change festival wherein there can be a photography exhibition featuring GIS images of threats faced by Climate Change like glacier melt, floods, droughts and desertification etc so that people get to know about the direct impacts of Climate Change. The fest can also include a pledge on protecting the environment.

### 16.4.3 Facilitating community leaders to initiate change

Community leaders like the 'Sarpanch' or the head of the Panchayat and village elders can help spread awareness about Climate Change impacts especially on local livelihoods. They can organize awareness drives by involving local NGOs and facilitate regular trainings by extension workers to build the adaptive capacity of the local communities. They can also motivate community members to adopt a climate resilient lifestyle. A State level competition can be organized for innovative and successful application of climate resilient technologies and the best village can be awarded for its efforts.

A concept of 'climate friendly communities' can be introduced, wherein a leader or a climate champion can be elected for this activity. The emission scenario of an area can be assessed by involving different stakeholders, at the local scale. Taking cognizance of

local-level resilience and the strategies that local people and institutions use to cope and adapt to climate variability, the communities can devise local level action plans and work towards attaining it. These require coordinated and concerted efforts of the local administration and State and district level sector authorities.Government should provide funds for such activities if they are taken up. Success of such initiatives should be celebrated giving communities and local administration due credit

## 16.5 Proactive role for NGOand Private Sector

Grass root level organizations play a major role in mobilizing people and creating awareness among them. NGO's must take up activities like public talks on Climate Change to spread awareness. Also, the private sector can also invest to help increase climate resilience of the state.

### 16.5.1 Awareness and outreach

NGO's can develop content for radio programs on Climate Change which can be aired on local radio stations. They can also organize screening of documentaries and movies related to Climate Change and its impacts. Mobilizing people to take Climate Change mitigation action like improving their energy efficiency, more use of public transport, greening their surroundings etc can be done. NGO's can help communities map and identify their local biodiversity resources, make them aware of its importance and methods to conserve them. Documenting existing coping strategies of communities can be done. This will help in designing adaptation strategies, later.

### 16.5.2 Training and capacity building

NGO's can act as facilitators in Climate Change Schools, wherein farmers and communities will be enabled to gather technical data including rainfall, soil moisture, runoff and soil qualities. They can be made aware of improved and resilient methods of farming. Health camps wherein people can be educated about climate sensitive diseases and methods of preventing them can be initiated by NGO's. Campaigns like 'Know your carbon footprint' can teach youth and school children, to calculate their carbon footprint and methods to reduce it.

### 16.5.3 Grassroots actions and pilot projects

- NGO's can take up activities like planting mangroves involving communities and making them aware of the importance of these initiatives. They can encourage people to maintain these plantations.
- Pilot projects on using solar lanterns and demonstrating them to people should be initiated.
- Integrated climate adaptation strategies including regenerating the watersheds; adopting sustainable agricultural and livestock practices; and undertaking water balance studies etc can be taken up.
- Demonstrations on how to live a 'Low Carbon Life' can be taken up by the NGO's wherein methods to reduce individual carbon footprint can be shown to people.

### 16.5.4 Climate Change Ambassadors

Climate Change ambassadors can be eminent personalities and local celebrities, celebrities who can spread Climate Change awareness by activities like public talks,

and motivate people. They can also be involved in activities like distribution of solar lanterns and kick start the greening initiative taken up by the Government.

### 16.5.5 Private Sector participation

Gujarat is a highly industrialized state in the country with planned capacities, and long-term goals include a realistic annual growth of 10.5% by 2020 (GEDA). Given this scenario it becomes important for industries to play a pro-active role in climate change mitigation and adaptation process. Under the PAT scheme as discussed earlier Gujarat is one of the forerunning states to set standards for the DCs.Besides this, Gujarat can also be involved in other activities like CSR with climate perspective. Adaptation activities may be aimed at increasing resilience of business operations, or the provision of technologies or services that assist in the adaptation of local communities.Activities may include developing new water-treatment technologies for drought-prone areas, distributing solar lamps and cookers providing drought resistant seeds, helping communities building climate proof housing in flood prone regions or creating early warning systems for the local communities. The activities can also be in the form of soft adaptation options like providing capacity building training or having awareness campaign

## 16.6 Innovating Grassroots level Action

Innovation and grassroots action are two requisites for sustainable development. Grassroots activities are potential sites for innovative activity and the Government of Gujarat intends exploiting the opportunities available through grassroots innovations, as its strategy to address climate challenges is through sustainable production and consumption which separates economic growth from environmental degradation. Pursuant to this policy a series of innovative grassroots initiatives are ongoing, and more are planned, through panchayats, gram sabhas, schools, colleges, universities, research institutes, NGOs, community organizations and Government departments.

### 16.6.1 Green Forts

'Swarnim Nirmal Gujarat' drive was organized by the Gujarat Government's Urban Development Department between16 and 23 December, 2011 across the seven Municipal Corporation and 159 minor-middle level towns in Gujarat. The unique concept of Green belt inside the city and green forts around the city has been taken up. Green guard volunteers will be encouraged to plant 'Tulsi' at their homes and celebrities will be asked to promote the campaign to motivate public participation. The Government will develop 'Oxygen parks' and a 'green belt' inside the city. Every city and roads connecting to it will get green fort cover.

### 16.6.2 ApnoTaluko Vibrant Taluko (ATVT)

Apno Taluko, Vibrant Taluko (ATVT) is aimed to empower people to guide the growth process, locally. Taluka Sarkar[3] was launched so as that every Taluka in Gujarat will be empowered to perform better. Administration will be decentralized up to sub-district

[3]TalukaSarkar is a sub district citizen-centric approach where governance and development is activated at the grass root level

(taluka) level to make it speedier, effective, transparent and citizen centric. Applications for assistance under various schemes would now be collected and processed at the taluka level itself. The Government has made a provision to allocate Rs.27 billion over the next four years for this.

Functions of the Taluka Seva Sadan will include-

- Effective, transparent and citizen-centric administration.
- E-Governance to fasten the system
- All the services of different departments will be available at one place.

### 16.6.3 Rurban lungs

Rurban infrastructure is an ongoing initiative to provide infrastructure facilities like water, sewage and roads to rural areas. Initially it is proposed to cover villages with a population of 10,000 or above, except in those which are Taluka head quarter, where the population may be lower; and 7,000 in the tribal area, even below 10, 000 in villages. The initiatives will include-

- Providing all basic infrastructures like water, roads, electricity, educational infrastructures and sewerage to villages.
- To modify or strengthen existing infrastructures.
- To provide non-conventional energy to villagers.

An outlay of Rs.18,500 lakhs is proposed for the year 2010-2011. The main objective of this initiative is to stop the migration of rural people to urban areas. The project will be implemented in three phases.

On similar lines, the concept of 'Rurban lungs' can be implemented which would include greening of the rural areas. This is similar to green forts initiative but with focus on rural areas. The villagers can take up the responsibility of maintaining the green cover. Women and youth can be mobilized to undertake plantation activities with the help of forest department. This would not only help maintaining flow of ecosystem services but also meet subsistence needs of local communities.

### 16.6.4 One Billion tree campaign

This initiative works in tandem with the green forts concept. Trees producing Non-Timber Forest Products (NTFP) can be planted on Government lands and the responsibility of maintaining these can be given to the local people who are permitted to benefit financially. - Trees can be planted within school campuses and colleges and each class could take up the responsibility of taking care of a plant. The class who performs the best should be rewarded. Since Gujarat has areas suitable for the growth of Mangroves, coastal communities should be encouraged to plant more mangrove species and given incentives for protecting the plantations. Trees can be planted on roadsides and strict rules should be implemented to protect them. Each Taluka can be

asked to green their area and the best Taluka can be rewarded for maintaining this green cover.

### 16.6.5 Save Water, Save Energy Campaign

The Save Water, Save Energy Campaign aims to generate public awareness for reducing water and carbon footprints by carrying out an extensive Information, Education and Communication (IEC) campaign at the State as well as village level.

Save water campaign can include:

- A public talk at each village by experts or celebrities on the importance of water as a scarce resource and the current situation of the State.
- Free screening of documentaries or movies on water issues to create awareness among people.
- Small scale projects like rainwater harvesting systems can be piloted by NGO's and can be asked to replicate by the people.
- In schools and colleges, recycling of water should be mandated. And students should celebrate a week as 'Water Week' wherein various competitions like slogan writing and debates can be organized. Children should also be asked to educate and inform their parents about the importance of saving water.
- Separate taps for supplying recycled water to households can be established.
- Save energy campaigns can be started in several sectors and institutions.
- The importance of saving energy should be conveyed to people through mass media's like newspapers, Radio and Television.
- In offices, a guide for energy efficiency can be circulated and workers should be asked to follow the guide strictly. Apart from this, stickers written 'Save energy' can be circulated among workers to be pasted on their desktops.
- NGO's can demonstrate small solar energy pilot projects involving people and make them aware of its benefits
- In a large scale, CFL's can be distributed in each household in exchange of normal bulbs and while doing this, a brochure with benefits of using CFL's should be circulated.
- At village levels, small scale renewable energy projects can be established and people should be incentivized for maintaining these.
- Women should be trained in methods of energy conservation at household level.

# Section 4
# The Way Forward

The State aims to create core competencies for addressing the challenge of Climate Change. Some of the focus areas include generating strategic knowledge for informed decision making, creating public awareness and education and empowering communities for participatory and decentralized action on Climate Change.

This will require capacities to be built; research to be coordinated; dissemination of best practices; and innovative actions on the ground. The aim is to effectively incorporate communication and education through a participatory process that will ensure two-way communication with contribution and awareness from people in the State, who will be able to accept ownership and guide corrective processes themselves.

The Government of Gujarat will add to or strengthen programmes for outreach activities, capacity building and expansion of the knowledge network, in a structured manner, in both urban and rural areas. These programmes will cover a broad range of climate issues that will ensure adequate planning, improved quality and extensive outreach actions. The Government also aims to strengthen research capacity by enhancing the institutional capacities.

# 17.0 Further Course of Action

## 17.1Institutionalarrangement

The Department of Climate Change will be the nodal agency for coordinating and implementing the SAPCC. The State Level Steering Committee will provide recommendations for the preparation and implementation of the SAPCC in accordance with State priorities and in alignment with the NAPCC guidelines. The Steering Committee will also recommend budgetary provision for the SAPCC and allocate resources to various departments and implementing agencies based on transparent criteria for adaptation and State-relevant actions.

### 17.1.1Department of Climate Change

On 17th September 2009, the Hon'ble Chief Minister of Gujarat declared an in-principle decision of the Government to form a new department to address Climate Change concerns in the State. It is the first department of its kind in India and so far only six countries in the world have a Department on Climate Change.

The Department was formed with the objective of coordinating and collaborating efforts of different departments and providing them with necessary support, advice and direction within a comprehensive Climate Change Framework

**Box 26: Functions of the Department of Climate Change**

The Department of Climate Change will function to act as a bridge between the Government and society with the following mandate:

- Preparation of a comprehensive multidimensional Climate Change Policy of Gujarat State;
- Coordination with all other departments with respect to Climate Change;
- Gujarat has a 1,663 km coast line. The department would undertake detailed and extensive research and survey on impacts of Climate Change in coastal areas. This would cover the possible impacts on the Gujarat coast due to sea level rise, changes in agricultural productivity, new challenges to health and infrastructural facilities in the coastal areas and measures that would be required to deal with them;
- The department would prepare a pro-active policy to convert the challenge of Climate Change into an opportunity. This department would become a nodal agency for turning Green Technology into a new economic driver by creation of extensive employment opportunities; and maximum usage of Green Technology and investments thereof would be promoted.
- Creating a Revolving Fund for R&D in Green Technology and promotion of its usage would also be established;
- Preparation of an integrated strategy for environment in its dimensions like land, air and water;
- Intensive efforts will be undertaken for earning maximum Carbon Credits;
- Educational curricula on Climate Change will be prepared and introduced;
- Universities will undertake research and development on Climate Change along with introduction of new courses and teachers training modules on Climate Change;
- For reducing GHG emission in industries like cement, alkalis, chemical fertilizers, textiles and chemicals etc. new technologies will be developed along with creation of appropriate regulatory and financial mechanisms;
- Public participation and public awareness will be developed in an extensive way; and
- Cooperation with national and international agencies will be undertaken. Constant interactions and consultations will be undertaken with National Clean Development Authority and international agencies working in this sector, especially those under the United Nations.

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### 17.1.2 Formation of State Level Steering Committee on Climate Change

The Government of Gujarat has constituted a State Level Steering Committee to oversee and approve the preparation and implementation of the State Action Plan on ClimateChange.

**Box 27: Members of the Steering Committee on Climate Change**

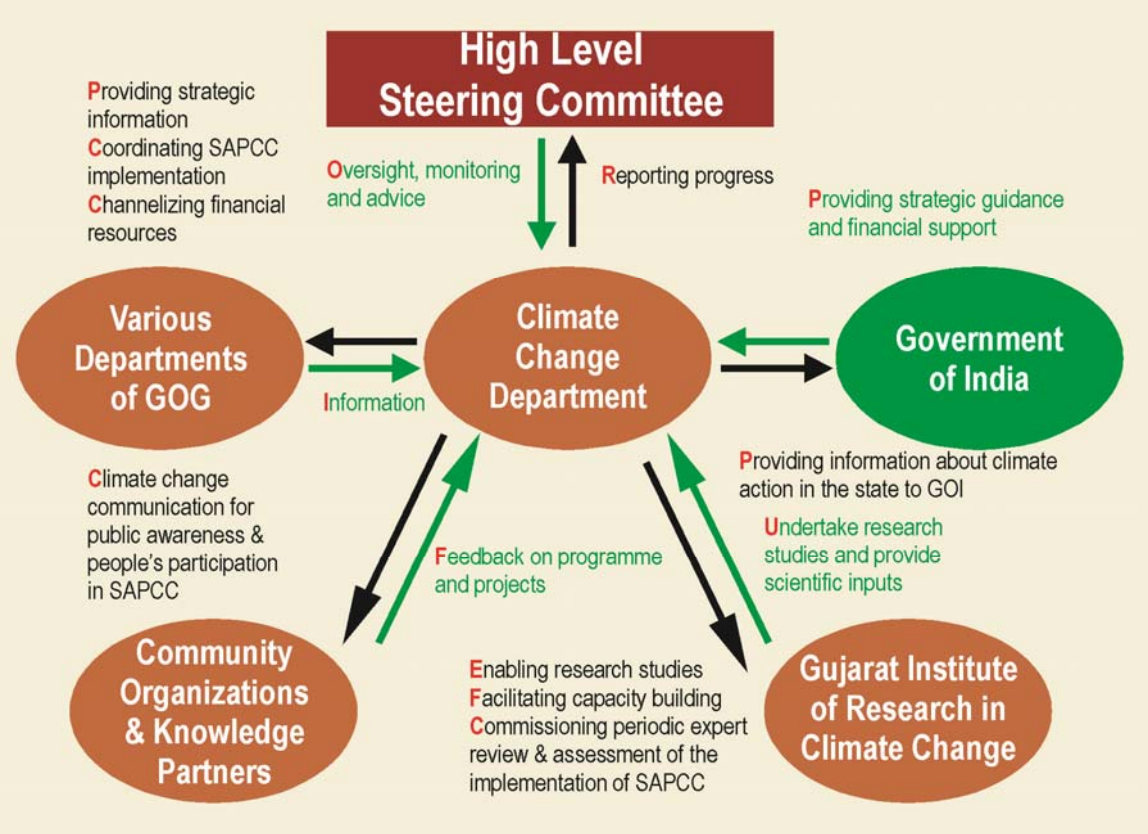
| | |
|---|---|
| Chief Secretary of Gujarat | Chairman |
| Additional Chief Secretary (planning) GAD | Member |
| Additional Chief Secretary/Port & Transport | Member |
| Additional Chief Secretary/Urban development & Urban Housing – Additional Charge | Member |
| Principal Secretary/Agriculture & Co-operation | Member |
| Principal Secretary/Forest & Environment | Member |
| Principal Secretary/Health & Family Welfare | Member |
| Principal Secretary/Industries & Mines | Member |
| Principal Secretary (Water Supply) N.W.R. & KalpsarDepartment | Member |
| Principal Secretary Narmada, Water Resources/Water Supply & Kalpsar Department | Member |
| Commissioner Rural Development & Principal Secretary/Rural Development & Housing | Member |
| Principal Secretary/Energy & Petro-Chemicals | Member |
| Principal Secretary/Tribal Development | Member |
| Secretary/Department of Climate Change | Member Secretary |
| Secretary (Narmada) N.W.R. &Kalpsar Department | Member |
| Secretary/(Kalpsar) N.W.R. &Kalpsar Department | Member |
| Secretary/Women & Child Development | Member |
| Chief Executive Officer/GSDMA | Member |

The Steering Committee will provide valuable suggestions from different departments to be incorporated in the State Action Plan on Climate Change, which would finally be sent to Government of India for their approval. The Committee will also oversee the implementation of the State Action Plan in accordance with the suggestions and directions of Government of India.

## 17.2Implementation Plan

The Implementation of the State Action Plan on Climate Change will be overseen by the State Steering Committee under the chairmanship of the Chief Secretary. The Department of Climate Change, Government of Gujarat will be the nodal point for coordination and implementation of the State Action Plan on Climate Change (SAPCC). The Department of Climate Change will work in close association with the various Government departments by providing strategic information and channelizing financial resources for the implementation of the SAPCC. It will also work closely with community organizations and knowledge partners to spread awareness among communities and encourage grassroots action while deriving important lessons from the field. To fill in the scientific research gaps various studies on Climate Change will be commissioned to the proposed 'Gujarat Institute of Research in Climate Change' which will generate specialized scientific knowledge Climate Change.

**Figure 45: Coordination Mechanism for State Action Plan on Climate Change**




### 17.2.1 Financial provisions

Financial provisions have been made for the Department of Climate Change for undertaking various activities. For the year 2014-15, a provision of Rs. 110 crorehas been made under Climate Change Department. It includes a provision of Rs. 28 crore as assistance for special project to develop Gandhinagar as a Solar City and Carbon

Neutral City and a provision of Rs. 23 crore for promotion of technology for development of energy efficient instruments, to motivate people to adopt such technology and thereby creating awareness.

Climate Budgeting has been proposed to be introduced in State budgetary process whereby every Department will have specific component for mitigation and adaptation in next planning process.

Several proposals have been submitted to the Government of India to seek support for implementing climate actions in the State. In addition efforts are made to attract private investments in the State and funding from bi-lateral and multi-lateral agencies.

### 17.2.2. Monitoring and Evaluation

The steering committee will oversee the implementation of the State Action Plan in accordance with the suggestions and directions of Government of India

The proposed Gujarat Institute of Research in Climate Change will also be commissioned to carry out periodic expert review and assessments of the implementation of various activities under the SAPCC.

Another major focus of the action plan is monitoring the progress of activities that have been previously listed in the programme of action and establishing key milestones in their achievements. For the same a Monitoring and Evaluation framework has been created wherein indicators for each activity have been generated. Along with their indicators the key departments that can be responsible for overseeing O&M activity and feedback have also been listed.

**Gujarat Monitoring and Evaluation framework**

| Thematic Area | Monitoring indicators | Activity No. | Key Department for monitoring |
|---|---|---|---|
| **Agriculture** | Milk productivity | Activity 1 | **Agriculture and Co-operation** |
| | Crop productivity | Activity 2,3,4,5 | |
| | Extent of micro-irrigation network | Activity 2 | |
| | Area under biofertilizers | Activity 4 | |
| **Water resources** | Waste water recycled/reused (Volume) | Activity 13 | **Water supply** |
| | % H/H connected to water supply | Activity 12 | |
| | Reduction in electricity units due to use of non-conventional energy based Water pumps | Activity 5,8 | |
| | No. of harvesting structures built | Activity 3, 4, 6,7 | |
| | No. of water and energy audit conducted | Activity 5 | |
| | No. of desalination plant | Activity 9 | |
| **Forest and** | Increase in Tree cover % | Activity 2, 5 | **Forest and** |

| | | | |
|---|---|---|---|
| **biodiversity** | Afforestation rates | Activity 2, 5 | **Environment** |
| | Mangrove extent | Activity 1, 2 | |
| | Reduction of $CO_2$Emission | Activity 2, 5 | |
| | Increase in fodder plantation | Activity 3 | |
| **Health** | Incidence of Vector borne disease | Activity 1, 6 | **Health and Family welfare** |
| | Incidence of heat stress | Activity 2,4 | |
| | Incidence of water borne diseases | Activity 5 | |
| **Urban development** | No. of water meters installed | Activity 6 | **Urban Housing and Urban Development and ULBs** |
| | Waste collection rates | Activity 6 | |
| | No. of energy efficient street light installed | Activity 6 | |
| | Average energy efficiency in buildings | Activity 2,4,5,6 | |
| | No. of cities mapped for climate resilience | Activity 1 | |
| | Kilometers of low carbon roads | Activity 6 | |
| | Energy efficient building rating | Activity 2, 5, 6 | |
| **Energy efficiency and Renewable Energy** | Installation no. of solar power units | Activity 1, 2, 3, 4, 5, 6, 10 | **Gujarat Energy Development Agency** |
| | $CO_2$ Emissions Reductions | Activity 1,2,3,4,5,6,8,9, 10 | |
| | Energy saved from solar power | Activity 1,2,3,4,5,6,9,10 | |
| | Energy saved due to energy efficiency | Activity 8 | |
| **Sea Level Rise and Coastal Infrastructure** | Installation of solar power plants | Activity 2 | **Gujarat maritime board (GMB) and Coastal Salinity Prevention cell (CSPC)** |
| | Infrastructure targets to provide protection measures | Activity 1 | |
| | Investment programs to protect ecologically sensitive and economically important areas | Activity 1, 2 | |
| | Sea level rise measurement | Activity 3 | |
| **Vulnerable Communities** | Gender participation % | Activity 1,2 | **Women and Child and Tribal Development** |
| | Daily wage earnings | Activity 1,2 | |
| **Green Jobs** | Employment generation % in environmental sector | Activity 1,2,3,4 | **Labour and Employment** |
| | Growth rate of green activity | Activity 1,2,3,4 | |
| | Income generation | Activity 2, 4 | |
| | Poverty ratio | Activity 4 | |
| | **Diversification of livelihood** | **Activity 1,2,3,4** | |

# The Way Forward

The State Action Plan on Climate Change outlines broad and ambitious strategies for addressing Climate Change concerns and articulatesa clear programme of action that will help carve a climate resilient future for the people of Gujarat, while the State continues on its accelerated economic growth pathway.

The SAPCC will draw on state-of-the-art knowledge of Climate Change, to combine new innovations with traditional best practices to navigate through the uncertainties associated with the phenomenon, while actively contributing to the development of communities, and at the same time reducing their carbon footprint. It will stay abreast with the developments in international negotiations on Climate Changeand India's position, in order to re-assess and fine-tune its own progressive policy framework to ensure adequate, timely and effective action on Climate Change in the State. The SAPCC will also regularly seek expert inputs and stakeholder feedback to make necessary amendments in its approach as required.

Delivering the State Action Plan on Climate Change demands coordinated effort by all key government departments to align their policies and activities to build climate resilience by means of mandates, procedures and capacity to meet such accountabilities. For this, specialized training programmes will be organized for key department personnel to build core competencies on climate science and policy. This will allow effective mainstreaming and informed decision making for engaging with Climate Change concerns in Gujarat.

Ensuring adequate public participation is central to the design and implementation of Gujarat SAPCC. The Government of Gujarat will build upon the existing and launch large scale awareness campaigns engaging community leaders, youth, women and the elderly and among other stakeholders to ensure that Climate Change actions also have local roots. In addition, integration of Climate Change into formal educational curriculum will lay the foundation for Climate Change consciousness to be ingrained within Gujarat's social structure.

Implementing this ambitious plan requires resources, both technical and financial, for achieving envisaged outcomes within the desired time-frame. The State has several exemplaryinitiatives in place to address Climate Change, and the SAPCC would leverage these to continue do much more in the future as well. For building technical expertise, knowledge partnerships will be forged with various institutes of excellence working on Climate Change issues in India and overseas. To support the more ambitious plans, additional financial support would be sought from the Government of India. In all, a total of **24,775 crore** worth of projects have been proposed by various Departments to be undertaken with the help of Central Government funds which will leverage the action on climate change front.In addition multilateral and bilateral

channels and market based mechanisms will be explored for supporting action for Climate Change adaptation and mitigation.

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# Abbreviations

| | |
|---|---|
| Ag-DSM | Agricultural Demand Side Management |
| AMTS | Ahmedabad Municipal Transport Service |
| AOGCM | Atmospheric Ocean Global Circulation Models |
| APS | Agricultural Pumping System |
| AR4 | Fourth Assessment Report |
| ARR | Annual Revenue Requirement |
| ASI | Annual Survey of Industry |
| ATVT | ApnoTaluko Vibrant Taluko |
| AWS | Automatic Weather Stations |
| BEE | Bureau of Energy Efficiency |
| BG | broad gauge |
| BRTS | Bus Rapid Transport System |
| BURD | Bal Urja Rakshak Dal |
| CBO | Community-based organization |
| CBR | Crude Birth Rate |
| CCGT | Combined Cycle Gas Turbine |
| CDM | Clean Development Mechanism |
| CDR | Crude Death Rate |
| CFL | Compact Fluorescent Light |
| CHP | Combined Heat and Power |
| CGWB | Central Ground Water Board |
| CNG | Compressed Natural Gas |
| CSO | Central Statistical Organization |
| CSPC | Coastal Salinity Prevention Cell |
| CTL | Coal-to-liquids |
| DDG | Decentralized Distributed Generation |
| DSM | Demand Side Management |
| DIC | District Industries Centre |
| DMA | District Metered Areas |
| EE | Energy Efficiency |
| EEBC | Energy Efficiency Building Code |
| EPA | Environmental Protection Agency |
| ERM | Extension, Renovation and Modernization |
| ESCO | Energy Service Company |
| FACTS | Flexible Alternating Current Transmission Systems |

| | |
|---|---|
| FBC | Fluidized-bed combustion |
| GCM | General Circulation Model |
| GEDA | Gujarat Energy Development Agency |
| GHG | Green House Gases |
| GIDC | Gujarat Industrial Development Corporation |
| GIRCC | Gujarat Institute of Research in Climate Change (GIRCC) |
| GIS | Geographic Information Systems |
| GLPC | Gujarat Livelihood Promotion Company |
| GMB | Gujarat Maritime Board |
| GPS | Global Positioning System |
| GRC | Gender Resource Centre |
| GRIHA | Green Rating for Integrated Habitat Assessment, |
| GSDP | Gross State Domestic Product |
| GSECL | Gujarat State Electricity Corporation Limited |
| GSPC | Gujarat State Petroleum Corporation Limited |
| GSRTC | Gujarat State Road Transport Corporation |
| GUDC | Gujarat Urban Development Corporation |
| HVAC | Heating, Ventilating and Air conditioning |
| HVDC | High Voltage Direct Current |
| IRP | Integrated Resource Planning |
| IEC | Information, Education and Communication |
| ICDS | Integrated Child Development Services |
| ICT | Information Communication and Training |
| IEM | Industrial Entrepreneurs Memorandum |
| IFPRI | International Food Policy Research Institute |
| IGCC | Integrated Gasification Combined Cycle |
| IMR | Infant Mortality Rate (IMR) |
| INCCA | Indian Network for Climate Change Assessment |
| IPCC | Intergovernmental Panel on Climate Change |
| JGY | The Jyoti Gram Yojana |
| JNNURM | Jawaharlal Nehru National Urban Renewal Mission |
| LED | Light-emitting Diode |
| LLIN | Long Lasting Impregnated Net |
| LPS | Lighting Power Density |
| MG | Metre Guage |
| MIS | Micro Irrigation Systems |
| MIT | Massachusetts Institute of Technology |
| MMR | Maternal Mortality Ratio |

| | |
|---|---|
| MoEF | Ministry of Environment and Forests |
| MoU | Memorandum of Understanding |
| MRTS | Mass Rapid Transport System |
| NAPCC | National Action Plan on Climate Change |
| NG | Narrow guage |
| NGO | Non-Governmental Organizations |
| NSSO | National Sample Survey Organisation |
| NTFP | Non-Timber Forest Product |
| PHC | Primary Health Centre |
| PIM | Participatory Irrigation Management |
| PINS | Pressurized Irrigation Network System |
| PLF | Plant Load Factor |
| PPA | Purchase Power Agreement |
| PPP | Public Private Partnership |
| RBI | Reserve Bank of India |
| RCM | Regional Climate Model |
| RCT | Resource Conservation Technology |
| RE | Renewable Energy |
| REDD | Reducing Emissions from Deforestation and Forest Degradation |
| RPO | Renewable Energy Power Purchase Obligation |
| RSBY | Rastriya Swasthya Bima Yojana |
| SAPCC | State Action Plan on Climate Change |
| SEZ | Special Economic Zone |
| SHG | Self Help Group |
| SIA | Secretariat of Industrial Approval |
| SLR | Sea Level Rise |
| SMC | Surat Municipal Corporation |
| SME | Small and Medium Enterprise |
| SPG | Solar Power Generator |
| SPPWCP | Sardar Patel Participatory Water Conservation Project |
| SPV | Solar Photovoltaic |
| SRCCC | Specialized Resource Centre on Climate Change |
| SSI | Small Scale Industries |
| ST | Solar Thermal |
| T&D | Transmission and Distribution |
| TERI | The Energy and Resources Institute |
| TFR | Total Fertility Rate |
| TOD | Time of Day |

| | |
|---|---|
| TTP | Twenty Point Programme |
| UFW | Unaccounted For Water |
| ULB | Urban Local Body |
| UNEP | United Nations Environment Programme |
| UNFCCC | United Nations Framework Convention on Climate Change |
| VBD | Vector Borne Disease |
| VSD | Variable Speed Drive |
| WASMO | Water and Sanitation Management Organization |
| WTE | Waste-to-Energy |

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