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WHITE PAPER ON

CLIMATE ACTION UNDER 5 TRILLION-DOLLAR ECONOMY IN INDIA

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List of Abbreviations

FY	Financial Year
GDP	Gross Domestic Product
GSDP	Gross State Domestic Product
USD	United States Dollar
UP	Uttar Pradesh
TN	Tamil Nadu
MH	Maharashtra
KA	Karnataka
GJ	Gujarat
FDI	Foreign Direct Investment
PMKVY	Pradhan Mantri Kaushal Vikas Yojana
ITeS	Information Technology Enabled Services
CAGR	Compound Annual Growth Rate
INR	Indian Rupees
GoG	Government of Gujarat
kW/ha	Kilowatt per Hectare
APMC	Agricultural Produce & Livestock Market Committee
NAM	National Agriculture Market
ICT	Information and Communications Technology
MT/ Mt	Metric Tonne
Y-o-Y	Year over Year
GIDC	Gujarat Industrial Development Corporation
SEZ	Special Economic Zone
EV	Electric Vehicle
GSVA	Gross State Value Added
GVA	Gross Value Added
AI	Artificial Intelligence
GIFT	Gujarat International Finance Tec-City
IFSC	International Financial Services Centre
PPP	Public-Private Partnership
MICE	Meetings, Incentives, Conferences and Exhibitions
ESG	Environmental, Social, and Governance
BFSI	Banking, Financial Services and Insurance
Mn	Million
LPG	Liquefied Petroleum Gas
GW	Gigawatt
KM	Kilometer
EXIM	Export-Import
DGCA	Directorate General of Civil Aviation
MU	Million Unit
MW	Megawatt
RE	Renewable Energy
GoI	Government of India

RPO	Renewable Purchase Obligation
GSRTC	Gujarat State Road Transport Corporation
CNG	Compressed Natural Gas
CO2e	Carbon Di-Oxide Equivalent
GEDA	Gujarat Energy Development Agency
NAPCC	National Action Plan for Climate Change
SAPCC	State Action Plan for Climate Change
MOEFCC	Ministry of Environment, Forest and Climate Change of India
NDCs	Nationally Determined Contributions
GSDMA	Gujarat State Disaster Management Authority
GHG	Greenhouse Gas
CDM	Clean Development Mechanism
UJALA	Unnat Jyoti by Affordable LEDs for All
MSMEs	Micro, Small and Medium Enterprises
ISO	International Organization for Standardization
OEM	Original Equipment Manufacturer
DMIC	Delhi Mumbai Industrial Corridor
CUF	Capacity Utilisation Factor
PM KUSUM	Pradhan Mantri Kisan Urja Suraksha Evem Utthan Mahabhiyan
SERC	State Electricity Regulatory Commission
PAT	Perform, Achieve and Trade
IoT	Internet of Things
SDGs	Sustainable Development Goals
UDAY	Ujwal DISCOM Assurance Yojana.
DISCOM/ discom	Distribution Company
GUVNL	Gujarat Urja Vikas Nigam Limited
EESL	Energy Efficiency Services Limited
BEE	Bureau of Energy Efficiency
GIS	Geographic information system
ULBs	Urban Local Bodies
SKY	Surya shakti Kisan Yojana
RTO	Regional Transport Office/ Road Transport Office
FAME	Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles
IEC	Information, Education and Communication

Executive summary

India's ambitious pursuit of attaining a 5 trillion USD economy by FY 26-27 symbolizes not only economic fortitude but a commitment to global eminence. This vision is intricately woven into the economic fabric of key states, with Gujarat standing out as an indispensable player. As India's fifth-largest economy, the nation has demonstrated robust growth, boasting a current GDP of 4 trillion USD with a commendable expansion of 6.9% for FY 22-23. Gujarat, contributing 8.36% to India's GDP in 2021, is not merely a participant but a linchpin in this economic tapestry, notably within the manufacturing sector, constituting a formidable 30% of the Gross State Domestic Product (GSDP).

The economic landscape of Gujarat is anchored on three principal pillars—Agriculture, Manufacturing, and Services. In this strategic tapestry, enablers such as Transport Infrastructure & Logistics, Energy, and Education, Skilling, and Start-up ecosystem development serve as crucial catalysts. This economic blueprint positions Gujarat as a key player in steering the nation towards its lofty economic aspirations.

However, Gujarat faces an intricate tapestry of climate challenges. The specter of temperature extremes, precipitation variations, and the imminent threat of sea-level rise looms large. These climate adversities pose multifaceted risks to agriculture, economic sectors, infrastructure, and coastal communities. The agricultural sector, employing half of the workforce and contributing significantly to the GSDP, confronts productivity threats from erratic rainfall, groundwater depletion, and heat stress in livestock. The extensive coastline, home to 9.9 million people, faces vulnerabilities to sea-level rise, cyclonic events, and salinity ingress.

Recognizing the intricate interplay between economic development and climate resilience, there exists an imperative for seamless integration of climate action—both mitigation and adaptation—into Gujarat's growth strategy. The confluence of these two trajectories is not merely a strategic choice but an indispensable necessity to ensure sustained economic growth amid the uncertainties of a changing climate.

Within the realm of sectoral growth strategies, discernible entry points for climate action emerge. In agriculture, advocating for low-carbon, climate-smart farm mechanization techniques and the adoption of conservation tillage methods, coupled with renewable energy-based irrigation, stands as imperative. These measures not only bolster productivity but also contribute to water conservation and soil carbon sequestration.

The manufacturing sector, a linchpin in Gujarat's economic mosaic, demands a nuanced approach. Encouraging electrification, decarbonizing energy sources, and enhancing energy efficiency in manufacturing processes are pivotal. Moreover, the cultivation of a circular economy within key industries like textiles, automobiles, electronics, and energy storage promises substantial contributions to environmental sustainability.

In the services sector, the integration of climate action unfolds across multifaceted dimensions. Prioritizing energy efficiency in buildings, strategic decarbonization of transportation, and the introduction of innovative financial products tailored for climate action projects exemplify transformative potential. By championing eco-tourism and embracing sustainable tourism practices, the services sector can emerge as a beacon of responsible environmental stewardship.

To ensure the seamless integration of climate action into broader economic growth strategies, a meticulous and systematic approach is essential. Embedding dedicated sections on sector-specific climate actions in the strategy document is not just advisable but imperative. This not only solidifies the commitment to sustainability but ensures a comprehensive and effective approach that transcends mere rhetoric.

While Gujarat's climate change mitigation and adaptation plans are meticulously outlined in the Gujarat SAPCC document, a systematic arrangement is imperative to align these plans seamlessly with the economic growth strategy. The current strategy document lacks a discernible linkage between Gujarat's

economic growth and climate action plans, underscoring the need for a coherent and integrated approach that harmonizes the state's economic ambitions with its climate resilience imperatives.

The report also provides the sector-wise climate change interventions that may be adopted and alignment of Gujarat's strategy paper with the climate change plans. The suggested interventions are categorized in short, medium and long term based on the timeline for their implementation. The potential responsible departments/ agencies for sector-wise implementation of the interventions are also mentioned as the entry point for implementation of the interventions.

In conclusion, as Gujarat charts its course towards significantly contributing to India's 5 trillion USD economy, the intertwining of economic ambitions with climate action is not merely a strategic imperative but a moral responsibility. The state's journey to prosperity must be underpinned by climate-resilient strategies that not only mitigate risks but drive innovation, efficiency, and responsible growth. Through meticulous integration, Gujarat has the potential to emerge not just as an economic powerhouse but as a beacon of environmental stewardship, setting a paradigm for a resilient and sustainable future that harmonizes economic vibrancy with ecological prudence.

This report broadly covers three chapters including India's USD 5 Trillion economy ambition and alignment of Gujarat's economic pursuits as the Introductory Chapter 1, highlighting India's USD 5 Trillion Economy Plan, Gujarat's USD 500 Billion Economic Growth Ambition and alignment and contribution of economic growth of Gujarat to India's ambition of a USD 5 Trillion Economy.

Chapter 2 covers analysis of economic growth sectors in Gujarat including economic growth sectors in Gujarat contributing to Gujarat's ambition of a USD 500 billion economy, climate change impacts of the economic activities in Gujarat, climate actions covered in Gujarat SAPCC, climate action gaps/ challenges in the successful implementation of SAPCC and potential measures to better implement plans and strategies in the SAPCC.

Lastly, Chapter 3 covers implementation roadmap for sectoral climate change interventions. Interventions have been disaggregated into sectors and timeframes.

1. Introduction - India's USD 5 Trillion economy ambition and alignment of Gujarat's economic pursuits

1.1. India's USD 5 Trillion Economy Plan

India's ambitious goal of achieving a United States Dollar (USD) 5 trillion economy by Financial Year 26-27 represents a significant milestone in the nation's economic trajectory. This vision highlights India's dedication to nurturing economic progress and establishing itself as a global economic powerhouse. India, currently ranking as the world's fifth-largest economy, stands as the fastest-growing among major economies with current Gross Domestic Product (GDP) of USD 4 trillion with an expansion of 6.9% for the FY 22-23.[1] The ambition is intricately linked to the growth and contributions of its key states. The chart below shows the projected growth of Gross State Domestic Product (GSDP) in state economies in nominal terms. India intends to achieve the target GDP of USD 5 trillion by FY 26-27 in nominal terms.

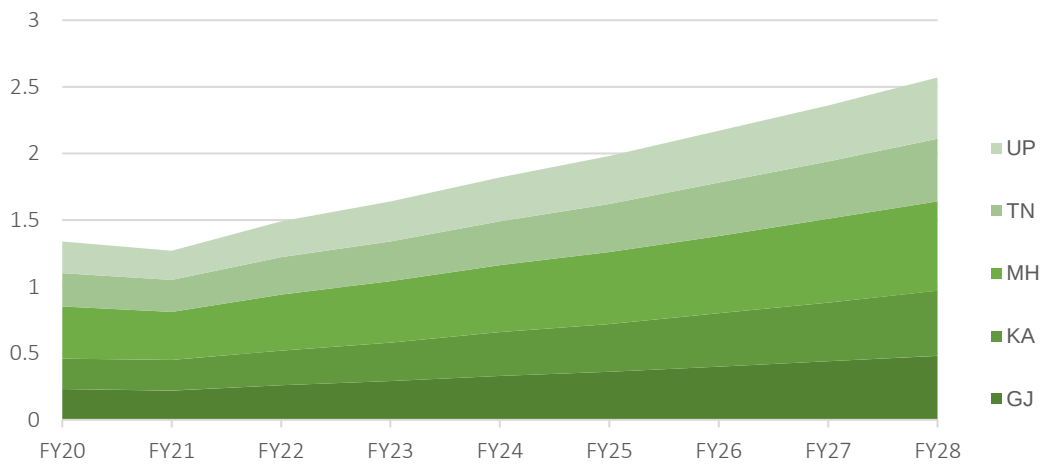

Figure 1: Size of top five state economies (nominal magnitudes, in USD trillion)

The Government of India (GoI) roadmap for achieving a USD 5 trillion economy comprises sectoral targets, comprehensive strategy, policy reforms, budget allocation, long-term perspective, and diversity of initiatives from technology-driven development to climate action like focusing on inclusive growth, promoting digital economy, fintech, technology-enabled development and energy transition.[2] These initiatives collectively aim to propel India towards its ambitious economic milestone.

Agriculture, Industries, and Services are the three major sectors that constitute the Indian economy. In 2021, the industries (mainly the Manufacturing sector) contributed 14% to the economy.[3] These sectors drive job creation and enable service exports. The Agricultural sector, with 43.96% of the workforce, with the highest employment rate, followed by services (30.7%) and industry (25.34%).[4] Industries enhance exports, bolstering national income and reserves. India's exports of goods and services are projected to touch USD 900 billion in the FY 23-24. Merchandise exports could expand to between USD 495 billion and USD 500 billion, while services exports could touch USD 400 billion in the year ending.[5] In agriculture, the governments focus shifts from production to income orientation. The 2018 Industrial Policy aims for a globally competitive, modern, sustainable, and inclusive Indian industry. In the services sector, an Action Plan for Champion Sectors is formulated, which is focused on a few sectors which will accelerate the expansion of services sector.[6]

[1] The World Bank (2022). India Overview
[2] Livemint (2023). Focusing on roadmap to make India a $5 trillion economy: Govt
[3] Statista. India: manufacturing as a share of GDP
[4] Statista (2018). India - Distribution of the workforce across economic sectors 2018
[5] Kumar, M. (2023) India's exports likely to touch $900 billion in 2023-2024, exporters say, Reuters.
[6] Centre formulates 'Action Plan for Champion Sectors in Services' to give focused attention to 12 identified Champion Services Sectors, Ministry of Commerce & Industry

1.2. Gujarat's USD 500 Billion Economic Growth Ambition

Gujarat is a key driver of India's GDP, contributing 8.36% in 2021. It has been recognized as a growth engine for the country, with manufacturing as its primary growth sector, constituting 30% of the GSDP, the highest in India. Gujarat seeks to maximize its economic output and contribute significantly to India's journey to a USD 5 trillion economy. The below figure explains about the economic growth strategy framework, which builds on the economic pillars of Gujarat economy i.e., Agriculture, Manufacturing and Services sector. It aims to pinpoint growth opportunities within these sectors, focusing on specific areas and sub-sectors. To facilitate this growth, identified enablers encompass Transport Infrastructure & Logistics, Energy, and Education, Skilling, and Start-up eco-system development.

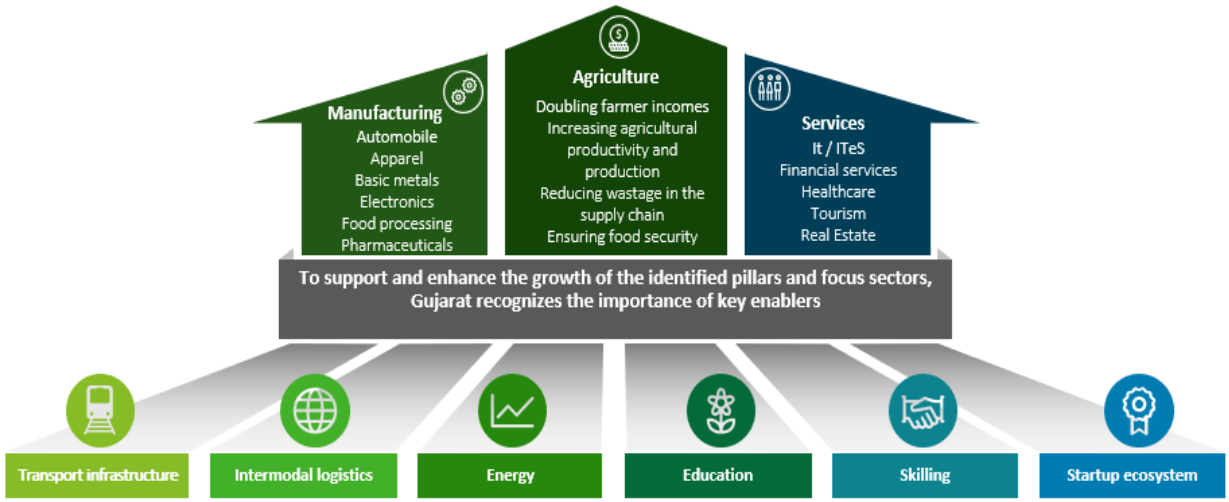

Figure 2: Economic growth sectors of Gujarat

To become a USD 500 billion economy by FY 26-27 in nominal terms, Gujarat is focusing on higher growth in Industry and services sector. Achieving higher growth in the agriculture sector until FY 26-27 (Nominal) in terms of percentage may pose a challenge, given the substantial productivity gains witnessed in recent years, which imply an assumed lower growth rate which can be supported by focusing on export promotion. The graph below explains the required growth rate to achieve USD 500 billion by FY 26-27 in each sector.

In order to achieve success in each pillar and its sub-sectors, strategic interventions encompassing investments and targets, policy initiatives, infrastructure development and institutional changes have been proposed. These interventions help tackle challenges, stimulate, and sustain higher and lead to sustainable economic growth in Gujarat.[7]

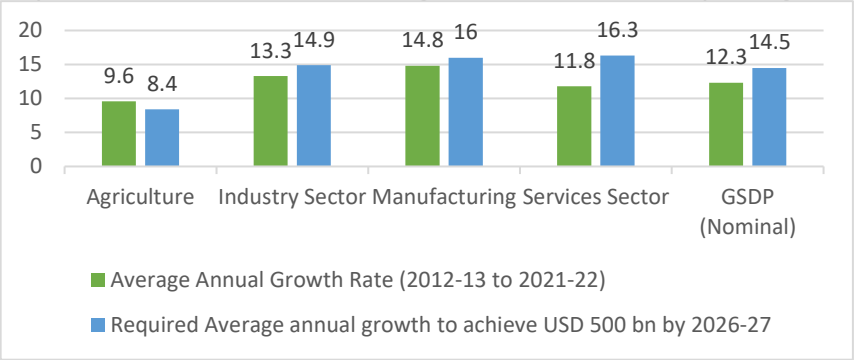

Figure 3: Sector wise growth requirement until FY 26-27 (Nominal), in percentage

1.3. Alignment and contribution of economic growth of Gujarat to India's ambition of a USD 5 Trillion Economy

Gujarat's strategic advantages align seamlessly with India's goal of achieving a USD 5 trillion economy. Its key strengths include strategic ports, a robust industrial base, investor-friendly policies, and extensive infrastructure. Additionally, Gujarat's focus on renewable energy, innovation hubs, agriculture, agro-processing, and financial services positions it as a critical driver of India's economic growth. This synergy emphasizes the need for ongoing collaboration between Gujarat and the national economic agenda.

In pursuit of this goal, Gujarat plans substantial investments across sectors like agriculture, manufacturing, Information Technology/ Information Technology Enabled Services (IT/ ITeS), tourism, and energy, poised to catalyze significant economic growth within the state. The state's commitment to sustainability is evident in ambitious targets for electric vehicle adoption and energy consumption. This concerted effort amplifies Gujarat's contribution to India's economic aspirations. The accompanying table illustrates how Gujarat's sector-wise projections and required investments will play a pivotal role in achieving national and state-level objectives.

Table 1: Gujarat's sector-wise projections and required investments to achieve USD 500 billion economy

Sector	Details
Agriculture	Growth rate Needed: 8.4% CAGR from FY 22 to FY 27, reaching INR 381.14 thousand crore by FY 27.
Manufacturing	Investment Needed: INR 6.45 lakh crore for 16% Gross State Value Added (GSVA) growth (FY 22 to FY 27).
	Land Requirement: 54,000 acres, with 42,000 acres for focus industrial infrastructure
	Expected Employment: 10,000 direct, 60,000 indirect jobs in sectoral parks.
	Export Growth: Expected to double from USD 101 billion (FY 22) to USD 199 billion (FY 27).
IT/ ITeS	Projected Revenue: USD 350 billion by FY 26 (as per National Association of Software and Service Companies (NASSCOM).
Energy	GSDP Contribution: Needs to grow at a CAGR of 11.7% to achieve INR 1 lakh crore by FY 27.
Transport	Electric Vehicles (EVs): Aims to add 2 lakh EVs by FY 25, requiring a 97% CAGR in adoption.

[7] Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy

2. Analysis of economic growth sectors in Gujarat, climate impacts and potential measures to better implement climate strategies

2.1. Economic growth sectors in Gujarat contributing to Gujarat's ambition of a USD 500 billion economy

The study report "Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy"[8] focuses on revamping the growth strategy of Gujarat for the period of five years (FY 22-23 to FY 26-27). The report suggests a sector-wise number of strategies and sub-strategies in order to achieve this reorientation. The three identified major driver sectors of the economy in Gujarat are Agriculture and Allied Services, Manufacturing and Services supported by Enabling Sectors which are Transport Infrastructure & Logistics, Energy and Education, Skilling & Startup Ecosystem which are discussed in the following sections. The sector wise strategic interventions mentioned in the strategy are discussed in the following sections.

2.1.1 Agriculture and Allied Activities Sector

The agriculture and allied sector have four constituents: crops, livestock, forestry & logging, and fishing & aquaculture. During FY 12-19, the contribution of livestock, forestry & logging and fishing & aquaculture increased while that of crops decreased which shows the potential of allied sectors to contribute to the state's GDSP. GoG may adopt the five thematic areas for the overall improvement and growth of the agricultural and allied sectors which are discussed below with the proposed strategic interventions for each of these thematic areas till FY 26-27.

Incremental growth to efficient growth

- **Seed (Timely use of high-quality seed planting material and improving the seed replacement ratio):** One of the most critical factors for enhancing agricultural production is quality seed. It is estimated that the direct contribution of quality seed alone to the total production is about 15-20%, depending upon the crop. The following interventions are highlighted in the strategy:
  - Formulate and notify an Agriculture Seed Policy.
  - Increase production of certified seed.
  - Augment the centralized procurement by Gujarat State Seeds Corporation Ltd. (GURBANI).
  - Improve the genetic potential of the various crops especially ones with high industry demand.
  - Strengthen the seed distribution system through the establishment of agriculture business centres and Krishi clinics.
- **Irrigation (Increasing net irrigated area - Har khet ko pani):** The State has about 47% net irrigated area which is almost at par with the national average of 49% out of the net sown area. However, it is significantly less than the best-performing state Madhya Pradesh. To increase crop productivity and bring in more fallow land under cultivation, the State should put more focus on increasing the net irrigated area to decrease the climate dependency of farmers. The following interventions are highlighted in the strategy:
  - Completion of the ongoing activities for the creation of several minor, medium and long-term irrigation projects.
  - Increase the irrigation acreage in rainfed areas through the development of micro-level water resources.
  - Increase area under micro irrigation through effective implementation of Pradhan Mantri Krishi Sinchai Yojana (PMKSY).
  - Support the construction of rainwater harvesting structures.

[8] Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy: https://www.gidb.org/usd-5-trillion-economy-task-force-report

- **Farm Mechanization**: Improving farm mechanization level is important for improving efficiency in crop production, crop harvesting and post-harvest handling practices, and reducing human drudgery. The average farm power availability in Gujarat is 2.56 kW/ha which is higher than the national average of 1.73 kW/ha. However, there is huge potential for farm mechanization in Gujarat. The following interventions are highlighted in the strategy:
  - Establishment of small agriculture equipment bank at panchayat level and large agriculture equipment bank at Block level.
  - Continuation of distribution of equipment on a subsidized rate.
- **Improving Crop Intensity:** Gujarat state has a cropping intensity of about 1.39 against the national average of about 1.44. The following interventions are highlighted in the strategy:
  - Introduction of intercropping and sequence cropping pattern.
  - Growing of low water-guzzling crop.
  - Increase in irrigation potential to provide water at critical stages of irrigation.
  - Selection of short-duration crop variety for Kharif as well as Rabi season.
  - Conversion of fallow land into cultivable land.

Innovation and Creative Disruptions

- **Adoption of crop-specific precision agriculture practices:** Around 4.69 lakh hectares (5% of the net sown area as of 2019) will be brought under phase-wise Precision Agriculture within 5 years (FY 2022-23 to FY 2026-27). The following interventions are highlighted in the strategy:
  - Training of extension officers and farmers in Precision Agriculture.
  - Provision of high-quality seeds and other agricultural input.
  - Frequent agriculture extension services to the farmer.
- **Integrated Nutrient Management (INM) and Integrated Pest Management Techniques (IPM):** Crop management techniques should be sustainable and aim at providing the best practices without negatively affecting the environment. In such scenario, there should be increased focus on crop specific INM and IPM.

Market Orientation and Processing

- **Promote weekly markets during the harvest season at locations distant from regulated agriculture markets, e-NAM integration and e-commerce platforms to increase farmers' access:** Out of the 224 APMCs in the state, only 122 APMC Mandis are on e-NAM portal. In addition, farmers do not get full benefit of e-NAM due to a lack of collection points at the village level, leading to the farmers carrying their produce to the market.
- **Farmer Produce Organizations (FPOs):** GoG should aim at creating crop specific FPOs with specific focus towards its market linkage.
- **Develop integrated storage (dry and cold) network across Gujarat with common ICT based information platform:** Integrated storage network through ICT so that information about location-wise space availability is visible to potential users of cold storage facilities.
- **Develop Integrated Cold Chain Network:** Gujarat currently has about 38.22 lakh metric tonnes (MT) of cold storage capacity and is ranked second in the country. Gujarat state can further increase the total capacity and develop an integrated cold chain network involving pre-cooling units, cold storages, pack houses, refrigerated trucks, ripening units, etc.

- **Develop Agro & Food processing clusters and establish integrated food processing parks:** This will increase food processing in the state. The raw materials produced from farms can directly be sent to these centers for processing helping in wastage reduction, ensuring the assured market for farmers and value addition of produce.

Shift towards diversification

- **Horticulture:** Horticulture crops cover only 14% share of the area, but it contributes to about 40% share of the overall farm income. There is good export potential for horticulture crops from the state. The following interventions are highlighted in the strategy:
  - Promote premium fruit crops of the state through area expansion programme and establishment of crop clusters.
  - Crop diversification from field crops to Potato, Onion, Mango, Dragon fruit and Strawberry.
  - Increase in share of Export of horticultural produce from Gujarat.
  - Reduction in post-harvest losses of horticulture produce by building on-farm storage structure.
  - Collaboration with producer groups, research institutes, processing industries and management institutes.
- **Fisheries:** The fisheries sector in Gujarat is characterized by both Marine and Inland fishery resources. There are 121 fish landing centers and more than 65,300 families together in marine fisheries, reflecting the importance of fisheries in the State. The growth rate of the inland and marine fisheries sector of the state is less than that of the respective sectors at the national level, reflecting the need to augment the growth of the sector with dedicated efforts. The following interventions are highlighted in the strategy:
  - Phase-wise increase in production of Fisheries (~5% Y-o-Y during FY 19-20 to FY 26-27).
  - Creation and modernization of infrastructure for capture and culture fisheries.
  - Promotion of inland fisheries through government schemes.
  - Establishment of fish brood tanks in States for quality fish seed production.
  - Increase in export of fish products from Gujarat.
  - Establishment of fishing harbors.
- **Animal Husbandry-Dairying**: It plays a vital role in the GSDP of the state by contributing about 5.08% share to it. Moreover, the state has a huge livestock population of 26.9 million. Gujarat's contribution to the export of milk from India (19% in FY 19-20) and that of Maharashtra (28%), the leading exporter from India, reflects the untapped potential of the dairy sector in Gujarat. The following interventions are highlighted in the strategy:
  - Phase-wise increase in the share of export of Dairy Products from Gujarat to 25% of India's Projected Export of Dairy Products in FY 26-27.
  - Promote project under the Rashtriya Gokul Mission scheme to facilitate the establishment of Breed Multiplication Farms.
  - Setting up of a network of Satellite Dairy Farms to augment milk production.
  - Strengthening the infrastructure facilities at the veterinary and epidemiology units.
  - Improving the availability of good quality feed and fodder in the state.
- **Poultry:** In comparison to the national average, Gujarat is only having 27 eggs per annum whereas the national average is 86 eggs per capita per annum in FY 19-20. Per capita meat availability in Gujarat is 491 gram per year against the national average of 6450 gram per year. Thus, there is a scope to promote backyard poultry farms in the light of incentives available under GoI scheme and commercial poultry production to fill the existing gap in egg and meat production. The following interventions are highlighted in the strategy:
  - Phase-wise increase in production of egg and poultry meat from Gujarat: Promotion of Backyard Poultry among rural households; Promotion of commercial broiler and layer farms by incentivizing the primate players; Promotion of improved breeds of layer and broiler; Improved veterinary services, feed management, etc.
  - A policy should be devised for promotion of backyard and commercial poultry cooperative in Gujarat in collaboration with National Cooperative Development Corporation.
  - Infrastructure facilities at the veterinary and epidemiology units for poultry.
  - Ensure availability of quality concentrated poultry feed free of toxin.

Agribusiness Extension Bureau

Industrial Extension Bureau Agribusiness (iNDEXTa): A separate department/ division would be important for the promotion/ resolution of issues for the agribusiness and food processing sectors and

act as a common portal for all the stakeholders in agriculture and allied sectors. It will also facilitate farmers or individual beneficiaries as a one stop shop to avail subsidies or assistances under different government schemes.

2.1.2. Manufacturing Sector

The traditional manufacturing sectors of Gujarat have saturated, and Gujarat is planning into newer areas of smart manufacturing and green manufacturing to leverage their multiplier effects. Major manufacturing sectors were selected based on parameters like sectoral contribution (3-year average share in Gujarat's output), sectoral growth (3-year average CAGR growth of manufacturing output), evaluation and identification of sectors that have high growth potential from a national and international perspective. Based on these frameworks, a total of 9 manufacturing sectors have been identified as "Winners" to help the manufacturing sector growth in Gujarat till FY 26-27 and in the future: Automobile, Apparel, Basic Metals, Electronics, Electrical machinery & equipment, Food processing, Gems & Jewellery, Pharmaceuticals and Textiles.

The sub-sector industries/opportunities have been identified in the above-mentioned 9 broad sectors based on the framework of two key parameters: Global demand and Global imports; Investment intentions in Gujarat. The 10 sub-sector opportunities that have been identified within the 9 broad focus sectors are highlighted below.

- **Automobile -** Motor vehicles (including electric vehicles, alternate fuel vehicles)
- **Apparel -** Wearing apparel (including knitted & crocheted fabrics)
- **Basic Metals -** Basic Iron and Steel (including green & specialty steel); Basic precious and other non-ferrous metals
- **Electronics -** Electronic components (including semi-conductor and fab manufacturing)
- **Electrical machinery & equipment -** Batteries and accumulators (including Li / Hydrogen batteries); Domestic Appliances
- **Food processing -** Processing and preserving of fruit and vegetables
- **Pharmaceuticals -** Pharmaceutical, medicinal chemical & botanical products
- **Textiles -** Spinning, weaving and finishing of textiles (including technical textiles)

The growth strategy and interventions for attracting new investments, developing industrial infrastructure, and providing policy incentives to enable manufacturing competitiveness, skill availability and plan to enable export growth are discussed in the following sections.

Attracting investments in the manufacturing sector: To achieve the growth ambition of 16% manufacturing GSVA growth in the next five years (FY 22 to FY 27), it is envisaged that a total of INR 6.45 lakh crore of investments shall be required by the manufacturing sector during the same time period. Of this, 77% (~INR 4.95 lakh crore) shall be required by the 9 focus sectors identified. The state has already received investment intentions to the tune of ~INR 5.5 lakh crore in 2022 for the overall manufacturing sector.

Development of industrial infrastructure: It is estimated that around 54,000 acres of developed industrial land shall be required to cater to demand from new manufacturing investments till FY 26-27. Of this, around 42,000 acres of industrial land will be required by focus sectors. Around 35,000 acre is already available in the state offered by the government and private industrial parks. It is estimated that there is a deficit of ~19,000 acres. The districts Vadodara, Surat, Jamnagar, Mehsana, Valsad and Rajkot currently have less land supply than demand and can be prioritized by Gujarat Industrial Corporation (GIDC)/ GoG for the development of new industrial estates. The following interventions are highlighted in the strategy:

- Development of new industrial estates in the following districts on priority under Phase-I: Vadodara, Surat, Jamnagar, Mehsana, Valsad, Rajkot.
- Development of new industrial estates in remaining districts under Phase II: Bharuch, Kheda, Banaskantha, Gandhinagar, Panchmahal and Surendranagar.

- Development of export infrastructure such as SEZs, testing & certification facilities, etc.
- Expedite development of sectoral parks in Gujarat: - PM MITRA Park, Bulk Drug Park, Ceramics Park, Toy Park, Biotech Park, Dholera SIR and Mandal-Becharaji SIR
- Consider/ evaluate development of new sectoral industrial parks: Special Economic Zones (Export oriented), Electronic Manufacturing clusters, Future of mobility parks (Auto, EV, Batteries), High tech engineering park (Machinery, Electrical machinery, other equipment's), Mega food processing parks, Chemical clusters, Green Hydrogen Park, Metal clusters, etc.

Export development and promotion: On average, Gujarat's manufacturing exports contributed to around 34% of the manufacturing output during FY 15 to FY 19. It has been proposed to target increasing this share to 38% by FY 27 by achieving around 17% CAGR during FY 22 to FY 27. The state needs to have a two-tier institutional structure at district as well as state level to provide institutionalized export promotion assistance and contribute to the accelerated export targets.

Opening new markets through tariff negotiation: Support from the Government of India shall be required to negotiate tariffs with target nations where India does not have a favorable tariff structure and open new markets for Gujarat's exporters and accordingly boost exports from the State.

Enhancing manufacturing competitiveness through policy initiative: Incentivize new investments into focus sectors through providing Policy/ Scheme incentives to improve competitiveness i.e., reducing the cost of doing business in Gujarat.

Skill availability: Interventions to strengthen the core skill and work towards shortening gaps in skill deficits shall be taken up through skill development and related interventions.

2.1.3. Services Sector

Gujarat's Service sector GSVA has grown at a rate higher than India's, at a CAGR of 10.5% from FY 16 to FY 21. However, in terms of the contribution of state service GVA to National services GSVA in FY 20, Gujarat at 5.2% ranks 7th, and thus Gujarat needs to make a higher contribution to play a greater and integral part in India's USD 5 trillion growth story. For Gujarat to achieve the vision of a USD 500 billion economy by FY 27, it is estimated that the Services sector nominal GSVA needs to grow at a CAGR of 16.3% from FY 22 to FY 27.

The focus sectors based on criteria like Historical Trends, Future Outlook and Champion Services were identified within the Services sector which are IT/ ITeS, Financial Services including Fintech, Healthcare including medical value travel, Tourism and Real Estate. Gujarat need to invest high capital on providing quality infrastructure for all these sectors, for example, international connectivity from four or five major airports is crucial to attract investment in the services sector. The planned strategic interventions for each of the identified focus sectors to achieve the growth story and contribute to Gujarat's economic ambition of USD 500 billion till FY 27 are discussed below.

Information Technology/ Information Technology Enabled Services (IT/ ITeS): The share of Gujarat's IT exports was 0.62% of the total state exports in FY 18-19. thus, Gujarat has a huge potential to increase the share of IT-ITeS exports. Gujarat's IT-ITeS sector has huge growth opportunities especially after the announcement of state IT-ITeS policy FY 22-27 which provides attractive financial incentives and support for organizations. Presently, the total number of IT offices of major IT companies in Gujarat is low compared to other states. Most of these tech giants do not have a footprint in Gujarat. The following interventions are highlighted in the strategy:

- **IT-ITeS Policy:** Implementation of the new IT/ITeS policy of Gujarat covering several fiscal incentives for IT companies like CAPEX and OPEX, Enhanced Incentive component, etc.
- **Emerging economies:** Organizing summits for IT companies in Gujarat to showcase their capabilities and tap into the emerging economy markets of Africa, Southeast Asia and Latin America.
- **Social infrastructure:** Enhance social infrastructure in terms of number of hotel rooms, tourist attractions, malls, etc. to attract and retain young IT workforce.

- **Centers of Excellence (CoE):** Fast tracking the setting up of 7 CoEs in universities, notified in January 2022, in addition to the AI School/ CoE.
- **Increase number of Science and Technology programs**: Create more colleges with information and communications technology (ICT), technical, engineering and scientific programs.
- **English language:** Introducing English earlier in non-English medium schools, setting up of more English medium schools, teacher training courses and dual language textbooks.
- **Expanding benefits to Tier 2 and 3 cities:** Providing infrastructure, financial support and incentives to companies to shift to Tier 2 and Tier 3 cities.
- **Direct international flights:** Increasing number of direct flights to tech hubs of the developed economies like San Francisco, Singapore, etc. and to new markets in emerging economies like Africa.

Financial Services: This sector may be segmented into three verticals – Banking, Insurance and Capital Markets, with the FinTech sector cutting across all three verticals. Gujarat's Banking and Insurance sector's contribution to GSVA has been growing fast at ~11% between FY 16 and FY 20, however the state is ranked 4th in terms of contribution to National Banking and Insurance GSVA. The following interventions are highlighted in the strategy:

- **Promoting Global In-House Centre (GIC) at GIFT IFSC:** GoG should promote GIFT City as a hub for GIC activities.
- **International Arbitration centre and separate court:** A state-of-the-art International Arbitration Centre and Separate Courts needs to be established in GIFT IFSC.
- **Developing International Fintech Institute:** GIFT City to develop International Fintech Institute jointly with the Asian Development Bank.
- **Developing tri-city connectivity:** Ahmedabad, Gandhinagar and GIFT City may be positioned together to leverage existing infrastructure and ecosystem.

Healthcare: The rising purchasing power and aging population are the key demand drivers of the Healthcare Sector. The healthcare sector has seven key segments including hospitals and infrastructure, health insurance, pharmaceuticals and biotechnology, medical devices, medical tourism, home healthcare as well as telemedicine and other technology-related health services. The following interventions are highlighted in the strategy:

- **Increase public expenditure on health:** Increase healthcare expenditure as a portion of state budget by 50% (from the current 5% of budget to 7.5% of budget) in Gujarat.
- **Graded fiscal incentives:** Promote a good quality healthcare ecosystem in Tier 2 and 3 cities by providing graded fiscal incentives for setting up healthcare infrastructure.
- **Health insurance coverage**: Increase the health insurance coverage to 90% of the Gujarat population.
- **Encourage Private investment in medical education:** To enhance the number of physicians, nurses and midwives. Creation of brownfield medical colleges in PPP model may be allowed.
- **PPP Model:** To Increase the number of hospital beds from the current 0.9 to 2 per 1000 population and to boost the number of specialty and super specialty hospitals in Tier 2 or 3 cities.
- **Improve air connectivity**: Specific focus should be on more direct international flights to countries having Gujarati diaspora like Nairobi, Kenya, etc. especially for medical tourists.

Tourism: Gujarat was one of the top 10 performing states in Domestic Tourist Visits in 2020, while it stood 12th in terms of foreign tourist footfall. Gujarat ranked 9th in domestic tourists' footfall when compared with high-tourism states. GoG has undertaken multiple initiatives by introducing policies like Gujarat Tourism Policy 2021-25, Gujarat Heritage Tourism Policy 2020-25 and Gujarat Homestay Policy. To cater to the varied tourist expectations, as well as to increase competitiveness compared to other leading states, the following interventions are highlighted in the strategy:

- **Develop Statue of Unity (SoU) as Iconic Tourist Village:** Develop Kevadia as an iconic tourism village in a phased & planned manner through master planning and vision planning for 20 years.

- **Developing Tourism Circuits to extend length of stay**
  - **Promotion of Buddhist circuit:** (Junagadh-Gir-Somnath-Bharuch-Kutch-Bhavnagar-Rajkot-Mehsana) including historical caves is instrumental in attracting international tourists. Development of multiple attractions, activities on cave themes, selective marketing (including international), onboarding of tour operators, wayside amenities along the route, etc. will be crucial for the success of the circuit
  - **Developing Statue of Unity Circuit:** Developing tourist circuit with State of Unity and Kevadia as the Anchor site connected with Ahmedabad, Vadodara and Panchmahal will help in extending the length of the stay of tourists. Improving connectivity of Ahmedabad Airport with International Destinations such as US, Europe and developing quality wayside amenities would be impactful for the circuit.
  - **Developing Saurashtra Tourism Circuit:** Somnath and Dwarka are the two most popular pilgrimage sites for domestic tourists. Gir National Park and Junagadh are other popular sites near Somnath. Interventions such as development of multiple attractions, activities and supporting infrastructure in destinations, improving airport connectivity and developing international standard facilities in Saurashtra region airports would help in success of the circuit.
- **Promoting Adventure Sports along the coast:** Beach tourism in Gujarat has been relatively nascent and should be given special focus to achieve its potential through short-term activation and focused marketing and events. In medium to long term, capacity building for trained resources, development of adventure institute and comprehensive infrastructure development at key beaches can be undertaken.
- **Sea cruise service:** It can be considered from Surat/Dwarka/ Porbandar to Mumbai/ Goa to cater to the growing demand for leisure activities. Creation of a dedicated cruise terminal at the ports of Surat/ Dwarka/ Porbandar will be helpful in success of the intervention.
- **Improve international connectivity:** Connectivity of Ahmedabad airport with countries where the Gujarati Diaspora exists like the USA, UK, Australia, Canada should be improved. Intervention for expansion and broadening of the existing runways to land larger international & domestic aircrafts should also be considered.
- **Improved connectivity in key tourism destinations:** The state can prioritize developing/ improving connectivity (road, rail and airport) to at least five key tourism destinations in Gujarat.

Real Estate: The real estate sector comprises of four sub-sectors – housing, retail, hospitality and commercial. Currently, the residential sector contributes to approximately 80% of the real estate sector. Currently, Gujarat's organized real estate activity is currently limited to GIFT city at Gandhinagar and few developments at Ahmedabad, Surat and Rajkot. However, Gujarat has significant potential to unlock in this segment as 2 of the top 10 growing cities in India viz. Rajkot and Surat are in the State. The following interventions are highlighted in the strategy:

- **Special tourism/ development zone**
  - Narmada riverfront at Statue of Unity
  - Vision plan for 20 years (adopting a phase wise approach for unlocking land)
  - Provision of way side amenities in the form of small restaurants, restrooms, support retail, etc.
  - Development of iconic tourism village with a private sector participation (premium restaurants, cultural tour, reading zone, viewing zone, alfresco dining)
  - MICE destination - Trade exhibitions, cultural fares, shopping festivals, host world and national conventions
- **Incentives for ESG compliance:** To reduce carbon footprint & promote sustainability, State can gain a first mover advantage via incentivizing developers to adopt ESG compliant building practices. Pilot project of such intervention is Dholera SIR, GIFT City.
- **Potential Asset classes:** High end commercial (IT & BFSI parks), Food & Beverage hub, river facing premium residential, hospitality, etc.
- **Good utilization of waterfront and area:** Boating jetting, water sports, etc. run by private operators with rental revenue to the Government.

2.1.4. Transport and Logistics Sector

Gujarat is a port-led economy as it accounts for ~40% of all cargo handled at the Indian ports. The State has managed to secure top ranking in LEADS (Logistics ease across different States) for the third consecutive year in 2021. Gujarat is one of the first Indian states to formulate 'Gujarat integrated logistics and logistics park policy 2021'. Private sector participation, governmental interventions, and PPP models must be leveraged. The following interventions are highlighted in the strategy as discussed below.

Port

- **Greenfield and brownfield expansions of ports:** Gujarat is a port-led economy as it accounts for ~40% of all cargo handled at the Indian ports. In FY 19, the port capacity utilization of non-Major ports in Gujarat was 542 Mn MT and it is anticipated that the port traffic will reach above ~750 Mn MT by FY 27 creating the opportunity for significant port capacity augmentation. The following interventions are highlighted in the strategy:
  - Greenfield construction and brownfield expansion of multipurpose ports across Gujarat.
  - Development of greenfield liquid terminals/ berths to cater South and Central Gujarat Chemical manufacturing and trading.
  - Development of greenfield terminals to cater to increasing LPG imports along with blending facilities.
- **Development of smaller existing ports as satellite ports:** This would support coastal shipping and reduce road congestion owing to traffic growth.
- **Development of port for offshore wind power project**: Mithi Virdi, in South of Bhavnagar can be a potential location for the development of a dedicated port to service 20 GW offshore power plant in gulf of khambat for logistics requirements of wind power project.

Road

- **Construction of elevated freight corridor:** Ahmedabad and Surat are witnessing high growth in urbanization and are also key industrial and commercial hubs. Developing elevated freight corridors in to ease road congestion will assist in improving the overall flow of the traffic through major industrial/ business hubs.
- **Improving the road connectivity for some of the non-major ports:** With the increase in Gujarat's manufacturing and consumption economy, growth in port traffic is also envisaged. Port connecting road infrastructure is expected to act as a bottleneck to cargo movement while industries access the port terminals. Port connectivity roads of a few non-major ports such as Navlakhi, Bhavnagar and Jamnagar require capacity augmentation.
- **Enhancing road capacity to reduce traffic congestion across major industrial and commercial centers:** The following interventions are highlighted in the strategy to enhance road capacity:
  - The 6-lane highway of 200 KM connecting Rajkot and Ahmedabad.
  - ~100 railway over bridge projects across Gujarat with budget of ~INR 5000 crore.
  - Upgradation and development of missing links along the coastal road of Gujarat starting from Umargam in South Gujarat to Narayan Sarovar in Kutch.

Rail

- **Expediting rail connectivity and capacity augmentation projects for already identified projects as part of Gujarat Railway Masterplan:** In alignment with the Gujarat railway master plan developed in 2018, Gujarat Rail Infrastructure Development Limited (G-RIDE) is implementing projects to reduce overall connectivity and capacity for cargo movement across Gujarat. These are critical projects and have a direct impact on the key commercial and industrial hubs of Gujarat such as Ahmedabad, Mehsana, Surat and Jamnagar districts.
- **Doubling the existing rail at key industrial areas and ports:** With rail lines already operating at optimum capacity especially connecting the ports and key industrial areas (Okha-Kalanus,

Viramgam-Mehsana, Rajkot-Veraval), there is a need to increase the capacity by doubling the existing rail line.

- **Development of semi high speed rail connectivity between Ahmedabad and Rajkot:** The proposed semi-high speed rail project is expected to reduce 60% of the travel time between Rajkot and Ahmedabad. G-RIDE has already conducted detailed technical and financial feasibilities studies and project viability is established.
- **Rail connectivity in Special Investment Regions (SIRs):** The cargo movement is currently planned to be majorly moved via roads in these SIRs. Rail connectivity and terminals can be developed at key SIRs in Ahmedabad (Dholera SIR), Vadodara (Halol Savli SIR) and Bharuch (Dahej PCPIR) as per the 'Gati Shakti Cargo Terminal (GCT) Policy' of Indian Railways.
- **Rail Freight Terminals:** Planning to develop rail freight terminals at Morbi in Ahmedabad district and at Bedi port in Jamnagar district under GCT policy to cater the growing EXIM and domestic freight traffic in the region.

Air

- **Development of air freight hub in Surat:** Gujarat's air freight traffic is approximately half of that handled by Maharashtra. Gujarat cargo owners prefer Mumbai airport both for domestic and EXIM air freight movement on account of better connectivity options and competitive freight rates. Development of air freight hub with specialized parking bays and hangers to accommodate large air freighters, cargo storage is required.
- **Upgradation of Regional Airports:** To improve passenger operations to enhance overall experience and achieve cost efficiency for attracting more passenger traffic.
- **Modernization of available cargo facilities at regional airports:** Cold storages, packaging facilities, truck docking stations, etc.
- **Increase international air connectivity:** There is inadequate direct international connectivity at Ahmedabad airport from key tourist countries which include USA, Europe, Australia and Canada. GoG needs to co-ordinate DGCA to increase international connectivity between Ahmedabad and USA and Europe.

2.1.5. Energy Sector

Gujarat was the first state to introduce solar policy in 2008, which initiated the transformation towards clean energy. It was also the first state to introduce solar wind hybrid policy in 2018. Gujarat power utilities sold about 108,073 MU to consumers in FY 22, which reflected CAGR of 5.2% over a period of the last five years. Considering the accelerated economic growth leading to a USD 500 billion economy by FY 27, the expected growth of consumption by agriculture, industrial, commercial and residential sectors would be steeper as compared to their historical growth. As a result, reliable power supply needs to be ensured for consumption growth at CAGR of 5.9%. The state has to go in a big way in promoting renewables, micro grids and electric mobility.

Renewable energy capacity addition: GoG has already decided not to add any conventional power plant in Gujarat and to achieve economic growth in a sustainable manner, the incremental demand served only by RE would require ~21 GW of RE capacity addition by FY 27. Over the five years from FY 22 to FY 27, this will increase the share of RE from 27% to 56% in terms of capacity (MW).

- **Distributed RE:** Rooftop Solar (5.8 GW); PM-KUSUM (7.8 GW); Small-scale/wasteland RE (3.5 GW)
- **Large Scale RE:** Solar & Wind hybrid RE parks (3 GW)
- **Minor & Emerging RE:** Floating solar (0.5 GW); Biomass (60 MW); Small Hydro (90 MW); Off-shore wind (0.5 GW)

Gujarat has a capacity addition plan of around 30,268 MW of RE capacity by FY 27, of which 10,400 MW is planned under the large-scale wind and solar projects category, 18,215 MW under the distributed RE projects category (rooftop solar, PM-KUSUM, small-scale/ wasteland PV) and 1,653 MW under

emerging technologies projects (offshore wind, floating solar, biomass, waste-to-energy and small hydro).

Grid stability: Integration of an additional 21 GW of variable and intermittent RE capacity into the grid will have a significant impact on the net electricity demand. For grid stability, necessary balancing measures (such as ancillary services, energy storage, etc.) need to be planned and implemented in a time-bound manner.

Investment target for RE addition: Investment of INR 1.2 lakh crore in power generation and storage segments and INR 0.5 lakh crore in Transmission & Distribution segments for new RE capacity procurement of ~21 GW by power utilities is required.

Increase in RE procurement obligations: GoI's 'Panchamrita' concoction for COP26 climate commitment requires 50% of electricity consumption to come from RE sources by FY 30. Based on which, the RPO for FY 27 in Gujarat would be about 36%, which equates to 20,959 MW of RE capacity by FY 27.

Land requirement for RE Projects: Gujarat Power Corporation Limited (GPCL) has acquired 35,800 hectares of land area for 7,500 MW of RE projects in Gujarat. Additional land for planned capacity will be identified in phase wise manner. The identified land area for 7,500 MW is as follows:

- Solar: Dholera Ultra Mega Solar Park (700 MW, 1400 hectare)
- Solar Wind Hybrid: RE Park at Khavda, Kutch (5700 MW, 11,400 hectare)
- Wind: RE Park at Khavda, Kutch (1100 MW, 23,000 hectare)

Green Hydrogen Parks: Hydrogen demand in India is estimated at around 6.9 mn tonnes per year of which 53% is consumed in petroleum refineries and 44% in fertilizer plants. It is estimated that 2.03 mn tonnes of hydrogen per year is consumed in the refineries and fertilizers sector of Gujarat. At least 1.5 mn tonnes of green hydrogen production will be required in Gujarat by FY 30. Given ESG/ Net Zero commitments/ and regulations in the export markets, several sectors including steel are transitioning to green steel production, which will further add to the state's demand for green hydrogen. All these will translate to at least 1 mn tonnes of green hydrogen production per year by FY 27 in Gujarat, which will need around 13 GW of RE capacity.

RE-powered Electric Mobility: Gujarat's EV policy in 2021 aims to add 2 lakh electric vehicles by FY 25. From about 26,000 EVs in March'22, it would require CAGR of 97% in EV adoption over the next three years. Electricity for charging would increase from 15 MU to 400 MU per year by FY 27. GoG's diesel/ CNG fueled vehicles operating on lease should be replaced with e-mobility. With around 20% of the existing fleet being over-aged, GSRTC has an opportunity to transition to electric buses for intra-state transport and a roadmap for transition to e-mobility for public transport buses should be developed.

2.1.6 Education, Skilling, and Startup eco-system Development Sector

As in the latest report, Gujarat ranked 4th at School Education Quality Index. The state government through its various policies such as Scheme for assistance for Startups/ Innovation-Gujarat Industrial Policy 2020, Student startup and Innovation policy by the Education Department, Incubators and Startups under the Electronics & IT/ ITeS Startup Policy and Student Startup and Innovation Policy (SSIP 2.0) is providing support to various elements of the startup ecosystem at grass-root level. Gujarat will need to provide a push to education and skilling in the state for which it may undertake the following interventions.

Primary and Secondary Education: English education curriculum to be promoted across primary and secondary education and introduce ESG compliance related course curriculum.

Higher Technical Education: Courses on Disruptive Technologies through collaboration: Skill-based courses such as courses to build capacity of the manpower with requisite skills.

Promote Startups

- Encourage, support and promote startups in the domain of healthcare, agriculture, education, natural language processing, retail, transport and logistics, manufacturing and fintech in the state to support the sectoral growth targets for the next 5 years.
- Implementation of Student Startup policy and encouraging Student Startups.
- Dedicated Institutional mechanism shall be developed for deep technology-based startups.

Promoting skill development

- Identifying Re-skilling and Up-skilling requirements and providing adequate platform for the same.
- Development of certification and accreditation mechanism for skills across the sectors.
- Identify skill gaps and take up skill programs that are demand based.
- Organize Short, Medium and Long term programs that focus on the skill gaps of the future needs training to students and bridge the industry academia gap.

2.2 Climate change impacts of the economic activities in Gujarat

The main climate change risks Gujarat faces are temperature extreme, precipitation extreme and sea-level rise. These impact agriculture, various economic sectors, infrastructure, and population groups in different ways. Agriculture is a major sector that employs 50% of the working population and contributes 9.5% to the GSDP. Higher projected rainfall variations threaten productivity, with 54% of the cultivated land dependent on rain-fed agriculture and more than 60% of the total land area lying in drought-prone zones. The agriculture sector is also threatened by a decline in the availability and quality of groundwater. The livestock and animal husbandry sector could suffer productivity losses due to heat stress and grassland deterioration and a significant population is dependent on access to forests for daily needs. Gujarat has India's longest coastline with 9.9 million people living in 40 coastal talukas (Census, 2011). This makes Gujarat vulnerable to the impacts of sea-level rise, cyclonic events, salinity ingress and shifts in fish breeding patterns.

Urban areas that account for 43% of the population are highly vulnerable to detrimental impacts of climate change, especially temperature extremes, urban flooding, and pressure on urban lands. About 4-5 urban flooding events happen each year in Gujarat over the last decade. The 2010 Ahmedabad heatwave caused about 1,344 excess deaths. Surat has experienced 23 floods in the last century, including highly destructive ones in 2006 and 2013. Heatwaves are frequent in Kachchh, Saurashtra and North Gujarat.[9]

Emissions in Gujarat increased at a CAGR of 5.75% from 138.82 Mt CO2e in 2005 to 286.98 Mt CO2e in 2018. The Energy sector was the major contributor to Gujarat's total emissions from 2005 to 2018 with 79% share of economy-wide emissions. The share of emissions of different sectors in Gujarat's total emissions from 2005 to 2018 is highlighted in the figure.

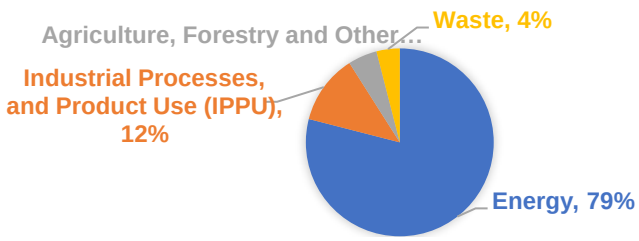

Figure 4: Sector wise GHG emissions in Gujarat (2005 to 2018)

[9] https://ccd.gujarat.gov.in/Images/Gujarat-State-Action-Plan-on-Climate-Change.pdf

Emissions from Energy Sector

Emissions from Energy sector increased at a CAGR of 6.81% from 2005 to 2018, and ~99% of the Energy emissions of Gujarat were due to Fuel Combustion activities. The Energy sector emissions comprise of emissions from Fuel Combustion and Fugitive Emissions. Fuel Combustion includes emissions from Public Electricity Generation, Transport, Captive Power Plants, Industries, Agriculture, Commercial and Residential categories while Fugitive Emissions are due to Fuel Production. Within the Energy sector, category wise share of emissions in the total Energy sector emissions are highlighted in the figure.[10]

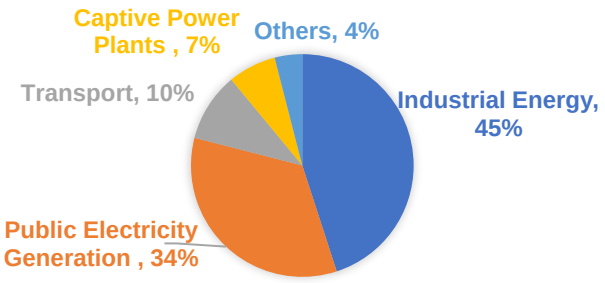

Figure 5: Category wise contribution to Energy sector GHG Emissions in Gujarat (2005 to 2018)

As of September 2023, the Renewable Energy (RE) Installations in Gujarat are: Total Solar Power (10.4 GW) out of which Ground Mounted Solar (6.9 GW), Rooftop Solar (2.9 GW), Solar Component in Hybrid (0.6 GW) and Off Grid Solar (0.1 GW); On-shore Wind (11.09 GW). Gujarat Energy Development Agency (GEDA) released the draft Gujarat Renewable Energy Policy 2023. The policy aims to facilitate the development of 100 GW of cumulative Renewable Energy capacity by 2030 with investments of around INR 5 lakh crores by utilizing approximately 4 lakh acres of land.[11]

GoG has already decided not to add any conventional power plant in Gujarat and to achieve economic growth in a sustainable manner, the incremental demand served by only RE would require ~21 GW of RE capacity addition by FY 27 as the strategic intervention in USD 500 billion economic growth of Gujarat by FY 27. Additionally, grid stability for integration of an additional 21 GW of RE will require necessary balancing measures (such as ancillary services, energy storage, etc.), large land area of RE projects, development of Green Hydrogen to the scale of 1 Mn tonnes production per year by FY 27 will have climate impact because of infrastructure development.

GoG is also planning for multiple strategic interventions in the Transport & Logistics sector to achieve the growth story of the sector in economic ambition of Gujarat till FY 27 which are discussed in the previous section, some of which are greenfield construction and brownfield expansion of multipurpose ports across Gujarat, development of port for offshore wind power project, improving the road connectivity for some of the non-major ports, 6-lane highway of 200 KM connecting Rajkot and Ahmedabad, ~100 railway over bridge projects, doubling the existing rail at key industrial areas and ports, development of semi high speed rail connectivity between Ahmedabad and Rajkot, development of air freight hub in Surat, etc. which may attract large emissions in the development and operating phases.

Emissions from the Industrial Processes and Product Use (IPPU) sector

The overall IPPU emissions increased at a CAGR of 4.65% from 2005 to 2018. Emissions from the IPPU sector are largely driven by Chemical, Metal and Mineral Industries. Chemical Industry and Mineral Industry sub-sectors were the key drivers of Gujarat's IPPU emissions, with shares of 62% and

[10] https://www.ghgplatform-india.org/wp-content/uploads/2022/09/GHGPI_Trend-Analysis_2005-to-2018_Gujarat_Sep22.pdf
[11] http://www.vasudha-foundation.org/wp-content/uploads/Indias-Energy-Overview_September-2023.pdf

38% respectively. Cement Production and Ammonia Production were the key drivers of emissions of IPPU sector, with average shares of ~30% and ~ 28%, respectively from 2005 to 2018.

A total of 9 manufacturing sectors have been identified as "Winners" to help the manufacturing sector growth in Gujarat till FY 26-27 and in the future. The growth strategy and interventions for attracting new investments, developing industrial infrastructure and providing policy incentives to enable manufacturing competitiveness, skill availability and plan to enable export growth are discussed in the previous section, some of which are development of new industrial estates in Phase 1 and Phase II, development of export infrastructure, expedition in development sectoral parks in Gujarat, etc., which would attract emissions from the project developments and processes.

Emissions from Agriculture, Forestry and Other Land Use (AFOLU) Sector

The net emissions from the AFOLU sector grew at a CAGR of 0.47% from 2005 to 2018. Emissions from AFOLU sector arise from three main sub-sectors: Livestock, Land and Aggregate Sources and Non-CO_2 Emissions Sources on Land. The Livestock sub-sector was the major contributor to the gross AFOLU emissions (excluding Land subsector) in Gujarat in 2018. Within the Livestock sub-sector, Enteric Fermentation category was the major contributor to gross AFOLU emissions from 2005 to 2018. Within the Aggregate Sources sub-sector, the categories of Agriculture Soils and Rice Cultivation were major contributors to gross AFOLU emissions.[12]

The agriculture and allied sector in the growth strategy of Gujarat till FY 26-27 is divided into constituents: crops, livestock, forestry & logging, and fishing & aquaculture and GoG may adopt multiple interventions in the five thematic areas for the overall improvement and growth of the agricultural and allied sectors which are discussed in the previous section, some of which are increasing net irrigated area by completion of the ongoing activities for the creation of several minor, medium and long-term irrigation projects, increase in the irrigation acreage in rainfed areas, support the construction of rainwater harvesting structures, improving farm mechanization, development of Integrated Cold Chain Network, etc. The implementation of these strategic interventions may attract emissions in the infrastructure development and operation phase.

Emissions from Waste Sector

GHG emissions from the Waste sector grew at a CAGR of 0.73% from 2005 to 2018. Solid Waste Disposal, Domestic Wastewater and Industrial Wastewater are the key sources of GHG emissions in the Waste sector. Domestic Wastewater, Industrial Wastewater and Solid Waste Disposal had a share of 34%, 61% and 5% respectively in the total Waste sector emissions of Gujarat in 2018. Pulp and Paper Industry had a major share of ~78% of the emissions in Industrial Wastewater emissions in 2018, followed by Fertilizers Industry (16%) and Dairy Industry (~3%).[13]

2.3. Climate actions covered in Gujarat SAPCC

2.3.1. Institutional and Governance Arrangements of Climate Change in Gujarat

GoG has established Climate Change Department in September 2009 and the department is the nodal entity for the subject of climate change in Gujarat and coordinates all actions that are directly or indirectly linked with climate change. Gujarat is the first and only State in India, the first in Asia and fourth in the world to form an independent department for Climate Change. Gujarat Energy Development Agency (GEDA) works under the aegis of the Climate Change Department to provide advice and guidance on research and project development in the context of Climate Change.[14]

The core objectives of this department are related to creating core competencies in the Government and facilitates capacity building of various Government Departments to integrate Climate Change perspectives in their planning, generating strategic knowledge for informed decision making for

[12] https://www.ghgplatform-india.org/wp-content/uploads/2022/09/GHGPI_Trend-Analysis_2005-to-2018_Gujarat_Sep22.pdf
[13] https://www.ghgplatform-india.org/wp-content/uploads/2022/09/GHGPI_Trend-Analysis_2005-to-2018_Gujarat_Sep22.pdf
[14] https://ccd.gujarat.gov.in/index.htm

sustainable and climate resilient future of Gujarat, enabling a low carbon pathway for Gujarat's economic growth with equity and inclusiveness, mitigation of Green House Gases emissions, empowering communities for participatory and decentralized action on Climate Change, and creating public awareness, education and capacity building on Climate Change.

After the formulation of the NAPCC, the Government of India directed state governments and union territories in 2009 to prepare their own respective action plans on climate change. The State Action Plan o Climate Change (SAPCC) for Gujarat was developed in 2014 on the lines of the NAPCC. The aim of SAPCC is to create core competencies in the State for addressing the challenge of Climate Change. MOEFCC addressed the States and Union Territories in January 2018 for revising of SAPCC considering India's commitments under the NDCs.[15] Climate Change Department has played a vital role in planning and implementation of the initial SAPCC in 2014 and the revision of the SAPCC in 2021.

A State Level Steering Committee was constituted by GoG to oversee and approve the planning and implementation of the 1st SAPCC and will continue to play its guiding role in the formulation/ approval and implementation of revised SAPCC published in 2021. The committee is composed of the total of 18 members who are representatives of various line departments of the state including Chief Secretary of Gujarat (Chairman), Additional Chief Secretary (planning) GAD (Member), Additional Chief Secretary/ Port & Transport (Member), Principal Secretary/ Agriculture & Co-operation (Member), Principal Secretary/ Industries & Mines (Member), Principal Secretary/ Energy & Petro-Chemicals (Member), Secretary/ Department of Climate Change (Member Secretary), Chief Executive Officer/ GSDMA (Member), etc.[16]

2.3.2. Climate Change Regulations and Policies in Gujarat

Environmental law is important and describes a network of regulations and customary laws that address the effects of human activity on the natural environment. Environmental law works to protect land, air, water, and soil. Without these laws, there would be no regulations concerning pollution, contamination, hunting, or even response to disasters.[17] The Environment (Protection) Act in India was enacted in 1986 with the objective of providing for the protection and improvement of the environment. It empowers the Central Government to establish authorities charged with the mandate of preventing environmental pollution in all its forms and to tackle specific environmental problems that are peculiar to different parts of the country.[18]

It can be viewed as an important factor that the Environment law/ rule/ regulation to exist at a state level as it is a possible approach to environmental management, but presently, Gujarat state does not have any Environment law/ rule/ regulation in place to tackle environment concerns at state level. GoG may consider drafting and implementing of the Environment law/ rule/ regulation aligned with the National level Environment Act.

GoG has implemented more than 110 policies across 27 departments (including many national policies) that have direct and indirect reduction in GHG emissions from Gujarat state since 2005. These include promotion of solar power, wind power, other renewables, reduction in power transmission and distribution losses, installation of super critical power plants, UJALA scheme, Street Lighting National Programme (SLNP), Perform Achieve and Trade (PAT) scheme, drip irrigation, CDM projects, ethanol blending, bioenergy promotion, Bus Rapid Transit System (BRTS), 30 GW hybrid renewable energy park at Kachchh, and many others. Multiple policies have been assessed and estimated high potential of emissions reductions or mitigation up to 2030 are in the implementation of key policies that are Solar Power Policy, Wind Power Policy, Super Critical Power Generation, CDM Projects and UJALA Scheme.[19]

[15] https://ccd.gujarat.gov.in/state-action-plan.htm
[16] https://ccd.gujarat.gov.in/Images/Gujarat-State-Action-Plan-on-Climate-Change.pdf
[17] https://unity.edu/environmental-careers/what-is-the-importance-of-environmental-law/
[18] https://cpcb.nic.in/env-protection-act/
[19] https://ccd.gujarat.gov.in/Images/Gujarat-State-Action-Plan-on-Climate-Change.pdf

2.3.3. Gujarat State Climate Change Mitigation Initiatives and Measures

Gujarat SAPCC has identified 128 number of state's key policies and programmes which have direct impact on climate change mitigation, adaptation and vulnerability. Sector wise key policies for Mitigation and Adaptation plans are discussed in the below sections. Climate Change Mitigation plans have been described at the sectoral level with detailed programmes developed in the Gujarat SAPCC. The brief of the sector wise planned Climate Change Mitigation plans of Gujarat are discussed below.[20]

2.3.3.1. Agriculture and Allied Activities Sector

Solar Cold Storage and Solar Powered Tractors: Gujarat's embrace solar-powered technologies in agriculture represents a promising step toward addressing climate change challenges in the sector. Solar cold storage, with the capacity to preserve perishable goods, holds the potential to reduce food waste and bolster farmers' incomes. The introduction of solar-powered tractors offers the prospect of significantly decreasing diesel consumption and associated greenhouse gas (GHG) emissions, contributing to a cleaner and more sustainable agricultural landscape. However, it is important to acknowledge that the adoption of these technologies may present barriers for small-scale farmers. The initial cost, as well as the ongoing maintenance, could be prohibitive for some. Ensuring affordability, access, and providing technical support to farmers will be crucial for the widespread success of these initiatives.

Irrigation Efficiency: Enhancing irrigation efficiency through micro-irrigation systems and participatory management is a laudable approach. This strategy conserves water resources, reduces energy consumption, and improves crop yields, thereby increasing overall agricultural sustainability. Nonetheless, it's essential to recognize that the implementation of micro-irrigation systems may pose challenges, particularly for smaller farmers who may lack the necessary resources and technical expertise. Ensuring equitable access and providing support to these farmers is paramount to maximize the benefits of these efficiency-improving measures.

SAUNI Yojana (Saurashtra Narmada Avataran Irrigation Project): The SAUNI project delivers substantial advantages by addressing water scarcity, ensuring a dependable water supply for agricultural, industrial, and domestic purposes. This initiative also diminishes reliance on groundwater, leading to improved livelihoods for farmers. Moreover, the availability of dependable water resources fosters regional economic growth and enhances overall social well-being. However, there are challenges, including environmental impacts like redirecting floodwaters which can have environmental consequences[21], affecting local ecosystems, wildlife and vegetation, improper maintenance and functioning, water quality, and social considerations which might affect various local communities. Careful assessment, stakeholder coordination, monitoring and evaluation and environmental assessments are vital to mitigate these issues. Incorporating climate-resilient design is also essential for long-term success.

Social Forestry Programme: The social forestry program has successfully raised green cover contributing to overall environmental conservation and climate resilience. However, challenges arise during the implementation, including maintaining high survival rates, water availability, vandalism and theft, and pest infections.[22] To improve program efficiency, it is essential to prioritize proper maintenance and care, engage stakeholders and employ diverse planting strategies. Additionally, implementing water conservation and management techniques, like drip irrigation or rainwater harvesting, can help ensure an adequate water supply for newly planted trees.

Mangrove Conservation: Gujarat has taken many initiatives to increase the mangrove cover along the state's coastline. But there are certain barriers in mangrove conservation that include reclamation for development, shore protection works like sea walls, changes to freshwater and tidal flows and drainage

[20] https://ccd.gujarat.gov.in/Images/Gujarat-State-Action-Plan-on-Climate-Change.pdf
[21] Akhmetshin, Elvir & Kovalenko, Kseniya. (2019). Construction of large dams: problems and development trends. MATEC Web of Conferences. 265. 07015. 10.1051/matecconf/201926507015.
[22] Sarmah, D. (2018). FORESTRY IN KARNATAKA -A JOURNEY OF 150 YEARS. [online] Available at: aranya.gov.in

for land reclamation, uncontrolled stock access to saltmarshes, off-road vehicles and pedestrian traffic, pressure by nearby communities for mosquito control. Buffer zones can protect these including fencing along the intertidal zone, removing barriers to restore natural tidal flows, disposing of rubbish and chemicals responsibly, removing weeds and avoiding stormwater discharges into coastal habitats. The most successful restoration can be achieved by creating the right conditions for water flows to enable natural regeneration or recolonization.[23]

State Bamboo Mission: Bamboo plantation is a great initiative by the Gujarat state to enhance climate change resilience, supplement farm income and this initiative aims to address demand for high-quality raw materials in various industries, which can be met through the sustainable cultivation of bamboo. It is important to acknowledge the potential challenges in this undertaken, including the need to educate and train farmers and landowners in bamboo cultivation techniques, maintenance practices and the potential benefits. Additionally, efficient progress monitoring tracking and ensuring a steady and sustainable supply of resources can be a logistical challenge that needs proper attention.

Urban Forestry: This initiative by the Forest Department of Gujarat reflects a commendable effort to enhance green spaces and foster ecological balance in urban areas. Urban forests offer crucial ecosystem services like improved human health and reduced environmental exposure. With most of the global population residing in cities, these benefits are of increasing significance, especially in the face of climate change, however urban trees face threats from a changing climate, rapid urbanization, and emerging pests and diseases. To preserve the services provided by urban forests, it is imperative to develop effective tree maintenance and management practices that mitigate the risk of widespread tree mortality.[24]

2.3.3.2. Manufacturing Sector

Promoting of Micro, Small and Medium Enterprises: Cluster based development is great initiative by the Gujarat state, significantly enhancing the cost competitiveness of industries adopting to this approach. Despite the MSME sector contributing significantly to the economy, yet it continues to face several challenges. The significant challenges include lack of resources (finance, technology, skilled labor, market access and market information), lack of networks that can contribute to a lack of information, and experience of domestic and international markets, physical infrastructure bottlenecks, absence of formalization, inertia to technology adoption, backward and forward linkages, lack of access to credit and risk capital, and the perennial problem of delayed payments.[25] Some of the potential actions that may be implemented are: [26]

- Improving the Credit Flow and addressing delayed Payments.
- Diversifying Channels of financing like development of credit guarantee schemes.
- Development of specialized private banks for financing.
- Development of hometown investment trust funds for risky businesses.
- Development of Database and Credit Risk Analysis of businesses.
- R&D Tax Incentives, Collaboration, and Innovation.

Start Ups - Innovation Scheme: Gujarat's new Industrial Policy and support for Start-Ups/ Innovation provides a valuable assistance to entrepreneurs fostering an innovative mindset and also emphasizes technological advancements. Startups face several critical challenges in their early stages. Access to supporting infrastructure like incubators, science and technology parks, and business development centers is crucial for their success. Without such resources, the risk of failure increases significantly.

[23] Department of Climate Change, Energy, the Environment and Water (2022). Coastal wetlands - Mangroves and saltmarshes – DCCEW.
[24] Paquette, A., Sousa-Silva, R., Maure, F., Cameron, E., Belluau, M. and Messier, C. (2021). Praise for diversity: A functional approach to reduce risks in urban forests. Urban Forestry & Urban Greening, 62, p.127157. doI
[25] Das, S. (2020). Micro, Small and Medium Enterprises: Challenges and Way Forward. 15th ASSOCHAM Annual Banking Summit: Reserve Bank of India.
[26] Yoshino, N. and Taghizadeh-Hesary, F. (2016). Major Challenges Facing Small and Medium-sized Enterprises in Asia and Solutions for Mitigating Them Asian Development Bank Institute

Additionally, securing sufficient financial resources is a perennial issue, as startups often struggle to obtain the necessary funding. Furthermore, creating awareness in the markets is essential for startup growth, and neglecting to address market limitations can lead to eventual failure. Overcoming these hurdles requires strategic planning and a comprehensive support system for startups to thrive and contribute to the economy effectively.[27]

Petroleum, Chemicals and Petrochemicals Investment Region (PCPIR): PCPIR in Dahej, South Gujarat, stands as India's pioneering investment region and the convergence of underscores the promising future. However, the challenges experiences by the petrochemical industries are volatility in raw materials, shortfall in petrochemical intermediate capacity and impact of environment[28], which includes environmental degradation, air pollution, greenhouse emissions, resource depletion, habitat disruption and health risks. The PCPIR needs careful planning for balances economic growth and environmental sustainability. The main important factors include coordination among stakeholders is vital for successful project implementation, addressing environmental impacts and maintaining regulatory compliance. Additionally, the major challenge lies in skilled labor to meet the industry standards and demands. A crucial goal for manufacturing of the petroleum products, chemicals and petrochemicals should drive towards circular economy and prioritize sustainability.[29]

Dholera Special Investment Region (D-SIR): The successful implementation of the DSIR is contingent upon addressing several critical challenges, securing adequate funding and encouraging private investment are paramount to kickstarting the development process, secondly, securing adequate funding and encouraging private investment are paramount to kickstarting the development process and the complex task of land acquisition and pooling necessities, land acquisition, and pooling to ensure smooth progress. Additionally, the governance structure is crucial for transparency and effective decision-making within the region likewise the DSIR projects need long-term cautious planning and execution, local community engagement and trust, resource utilization and sustainability (balancing industrial growth with environmental protection is a key challenge), operation and maintenance. By addressing these challenges, DSIR can emerge as a thriving hub of innovation and economic growth.[30] Potential measures that may be implemented for success of D-SIR are as follows:

- Implementing efficient governance and expediting services and approvals is crucial.
- It is essential for all stakeholders and state governments to collaborate to enhance the cities with robust infrastructure, effective governance, and strong institutions.
- Prioritizing the adoption of sustainable practices and compliance with environmental regulations is of utmost importance for industries in the region.

Mandal Becharaji Special Investment Region (MBSIR): MNSIR is great initiative that brings forth numerous advantages for both investors and the local economy. But the automobile and auto component manufacturing industries face several critical challenges that include low investments in R&D, poor infrastructure for supply chain and exports, lack of system integration, limited domestic market for various components inhibiting capacity creations.[31] Additionally, the industry faces increasing pressure to reduce its environmental impact, leading to the development of more sustainable manufacturing practices and the use of eco-friendly materials. Addressing these challenges is crucial for the sustained growth and competitiveness of these industries.

Diamond Research and Mercantile (DREAM) City: DREAM city is remarkable initiative offering substantial benefits for the promotion and growth of the diamond industry in the region. The aim to promote diamond trading presents several potential challenges particularly attracting diamond traders

[27] Roshan, S., Patel and Barfiwala, S. (2019). GAP iNTERDISCIPLINARITIES- SPECIAL ISSUE ON STARTUP AND INNOVATION STARTUP INDIA -OPPORTUNITIES AND CHALLENGES.
[28] Ranjan, N. (n.d.). Petrochemicals Scenario Challenges Faced by Petrochemical Industry in India.
[29] Harnessing the Potential of Sustainable Manufacturing and Circular Economy in the Indian Chemical Industry. (2023).
[30] Sharma, A. and Tomar, A.S. (2020). Opportunities and Challenges for the Development of Industrial Cities proposed in Industrial Corridors. A Case-DMIC Corridor, Phase 1. International Research Journal of Engineering and Technology (IRJET).
[31] Borgave, Sachin. (2010). Indian Auto Component Industry: Challenges Ahead.

and businesses, as well as ensuring safety and security which encompasses tax fraud and money laundering.[32] This necessitates the implementation of advanced security systems and the establishment of emergency response protocols. Additionally securing a skilled and experienced workforce is vital for the success of the Dream city. Offering training programs and educational opportunities for diamond workers can help maintain a high level of expertise in the industry.

Zero Defect in Manufacturing and Zero Effect to Environment (ZED): Initiated with a vision of World's Manufacturing Hub, the ZED program is a commendable effort aimed at elevating quality of manufacturing goods and empowering the MSMEs to excel in global supply chain, contributing to economic growth and competitiveness which will drive and build Make in India initiative. The 'Zero defect, Zero Effect' concept intends to lower the impact of manufacturing and service initiatives on environment and society.[33] Some challenges with Zero Defect in Manufacturing include integrating big data, innovative technology and methods, ZDM-modelling, near real-time computing/ data analysis.[34] Some challenges with Zero Effect to environment include air pollution, solid waste, liquid discharge, zero wastage of natural resources, energy sources depletion and plastic waste.[35]

The significance and methodology of ZED in manufacturing and design operations can enhance economic standing through targeted efforts on the following:

- For a unified approach to certification, standards adoption, international rule making, infrastructure development and private sector coordination, integrating the national regulatory body with vertical organizations such as ZED QCI, NPC, and BIS.
- Adopting international standards and conducting a conformity assessment in accordance with the National Conformity Assessment policy, all within a predetermined timeframe from the industry's start.
- Improving vendor-managed inventories and accelerate time-to-market, making use of efficient management and quality solutions including supply chain management, project management software, and ERP for management information.
- Creating a Services Working Group to accelerate the services industry's integration process.
- Put into effect quality controls and procedures that are in line with ZED culture.

Assistance for Environment Protection Measures-MSME unit: The initiative intends set a commendable support to MSMEs in environmental management which promotes green practices and facilities environmental audits for MSMEs, helping foster in sustainability and reducing environmental impacts. However, MSMEs face more challenges in pursuing green growth compared to larger firms despite being more flexible in adapting to market changes. These include lack of awareness, limited access to technology, strict regulations, shortage of qualified personnel and limited access to finance and markets. To implement the right measures to improve green growth among MSMEs, it is necessary to be able to measure their current level and potential progress. Measures may undertake for successful implementation of Green, Sustainable and Innovative MSMEs: [36]

- Adoption of waste-reducing practices.
- Implementation of resource-efficient methods.
- Production of goods or services that enhance user firm resource efficiency.
- Attainment of business certifications, like ISO 14000, for effective environmental management.
- Imposition of environmental taxes on activities causing harm, e.g., CO_2 emissions.
- Participation in environmental projects and collaboration with knowledge-based institutions.

[32] Tagliablue, J. (2015). An Industry Struggles to Keep Its Luster. The New York Times. 5 Nov.
[33] Emerald Publishing. (2019). Issues and challenges in implementing 'Zero Defect- Zero Effect' for the manufacturing and service industry in a developing country.
[34] Lindström, J., Petter Kyösti, Lejon, E., Birk, W., Andersson, Å.E., Borg, M., Juntti, M., Anna-Maria Suupf, Germain, M., Hermanson, A. and Gunnarson, B. (2020). Zero Defect Manufacturing in an Industry 4.0 Context: A Case Study of Requirements for Change and Desired Effects. Social Science Research Network.
[35] Khatabook (n.d.). Know About Zero Defect Zero Effect Scheme.
[36] Cheok, D. and Singh, S.K. (2018). Identifying Green, Sustainable and Innovative MSMEs in APEC. APEC Policy Support Unit POLICY BRIEF No.19.

- Development of "green" jobs or skills, including R&D and climate change-related skills.

Carbon Capture and Storage (CCS): The investment in the CCS projects will reduce CO_2 emissions and thus help in mitigating climate change but to implement carbon capture storage and utilization may face challenges like lack of financing, research and development, concerns about land acquirement, groundwater pollution, transportation and CO_2 leakage**.** The recommendations for Indian refiners that may address these challenges are: [37]

- For economic feasibility, install CO_2 capture close to the refinery. For recovery, store released CO_2 in a possible oil field.
- Modifying regulations to draw in foreign capital for the funding of workable projects including the capture, storage and use of carbon.
- Providing tax breaks to regional investors that finance pertinent initiatives involving the capture, storage and use of carbon.
- Making sure that transportation infrastructure (pipelines, terminals) is positioned advantageously to reduce the cost of transporting CO_2 for businesses that use CO_2 based goods.

2.3.3.3. Services Sector

Gujarat IT Policy (2022-2027): Gujarat's ambitious IT industry aspirations demand a multifaceted strategy to be achieved. Crucial issues include building exceptional data centers and infrastructure, developing a highly qualified IT staff and drawing sizable investments for large-scale initiatives. There are challenges to achieve the objectives of creating over a lakh new IT/ ITeS employment, growing IT exports at an exponential rate and taking the lead in developing technology. A coordinated approach including government programs, educational changes, business partnerships and a nurturing environment that promotes innovation and entrepreneurship is necessary to overcome challenges which would help in success of the IT Policy objectives and targets.

Gujarat Tourism Policy (2021-2025): Taking a crucial step, this initiative provides financial incentives for certifications in green building global sustainable tourism. Beyond monetary gains, it promotes "ease of doing business" via digital interventions, creating an environment favorable to green and sustainable practices. However, there are specific challenges that are important for successful implementation, which include low community involvement and low societal knowledge of tourism, a lack of appropriate community organizations, a lack of benefit-sharing mechanisms, a lack of infrastructure development and poor coordination among stakeholders.[38]

Gujarat International Financial Tech (GIFT) City: The development of GIFT City is an important initiative attracting global companies and financial institutions to evolve as a world-class fintech hub, marking a significant leap forward for the financial services sector. Technology is crucial in streamlining operations, safeguarding sensitive information, and providing seamless customer service. However, as beneficial as these advancements are, they also bring their own challenges, including cyber security, data management, system downtime, legacy systems, and talent shortage. The successful development of GIFT City as a global financial and IT services hub will require careful planning, strategic foresight, and effective execution to overcome these challenges and create a thriving international business environment.[39]

2.3.3.4. Transport & Logistics Sector

Gujarat Electric Vehicle Policy 2021: The ambitious move of EVs positions Gujarat as the manufacturing hub for electric vehicles and also encourages start-ups and investments, fostering innovation in the field of electric mobility by enhancing the quality of the environment. However, The EV industry is new and faces typical challenges which include durability of EVs, the limited battery life

[37] Dalei, N.N. and Joshi, J. (2022). Potential matching of carbon capture storage and utilization (CCSU) as enhanced oil recovery in perspective to Indian oil refineries. Clean Technologies and Environmental Policy.
[38]Teshome, E., Dereje, M. and Asfaw, Y. (2022). Potentials, challenges, and economic contributions of tourism resources in the South Achefer district, Ethiopia. Cogent Social Sciences, 8(1).
[39] www.auratechnology.com. (2023). Top 5 IT Challenges in the Finance Sector | Aura Technology.

necessities periodic replacement, incurring additional capital expenditure every 4-5 years with limited financing options. Moreover, the resale value of both the battery and the vehicle without it remains uncertain, as a recycling market for batteries is yet to be established.[40] Overall, while the project's goals are laudable, addressing these challenges will require coordinated efforts from various stakeholders including government bodies, private sector partners, research institutions and the public for the future growth. Some of the measures that may be taken for successful implementation are as follows:

- Creating low-cost funds with risk-sharing arrangements.
- Classifying commercial electric vehicle loans as priority sector financing.
- Creating a framework for performance certification and safety requirements for batteries.
- Decoupling the battery from the vehicle.
- Offering tax breaks and subsidies.

It is essential to tackle financing barriers to attract a larger pool of buyers to this emerging segment. This requires government, financial institutions, OEMs and various industry players to collaborate to realize the target.[41]

Electric vehicle charging infrastructure: There are certain challenges in adoption of EV charging infrastructure which includes inadequate power grid, power shortage can discourage EV adoption by reducing prospective EV owners' confidence about being able to reliably charge their vehicles, additionally retail stores, small business owners and RWAs are concerned about the significant capital these stations require, lack awareness about the potential benefits these stations could yield for their businesses. Moreover, India's diverse geography requires varied EV charging considerations. These challenges require innovative solutions, which could include everything from using renewable energy sources to developing fast charging technology.[42] Measures that may be taken for effective electric charging infrastructure in Gujarat are as follows:

- Increasing Public Charging Infrastructure.
- Integrating Renewable Energy.
- Developing Fast-Charging Technology.
- Incentivizing Private Sector Investment.

Gujarat Integrated Logistics Policy 2021: The initiatives taken in this policy aims reduce logistics costs but also foster efficiency by enabling multi modal transportation, promoting private investments, and contributing to adoption of green energy and sustainable practices but to implement the projects successfully the potential challenges of these projects should address which include implementation of green energy large scale projects like DMIC. Western corridor may face challenges due to availability, affordability and integration of renewable energy sources. Additionally Constructing a 110-kilometer long six-lane expressway, rail connectivity and port development may encounter challenges in terms of land acquisition, environmental clearances and engineering complexities. Moreover, sustaining the adoption of green energy and sustainable practices throughout the projects' lifecycle may require ongoing commitment, monitoring and adaptation to changing technologies and policies.

Bus Rapid Transit System (BRTS): The 88 KM network highlights the positive impacts of urban mobility and underscores the potential benefits for the other cities like Surat and Rajkot, extensive networks are planned to enhance connectivity and sustainable urban development. However, Indian public transport sector faces significant challenges attributed to the following key areas which has led to higher adoption of private vehicles over public transport that include poor customer experience including lack of seamless connections between different modes of transport, overcrowding, poor safety and low convenience, particularly for women and differently abled individuals, and the absence of integrated ticketing. A crucial factor in encouraging the use of public transport is the ease of getting to

[40]DRIVING AFFORDABLE FINANCING FOR ELECTRIC VEHICLES IN INDIA. (2022). NITI Aayog
[41] DRIVING AFFORDABLE FINANCING FOR ELECTRIC VEHICLES IN INDIA. (2022). NITI Aayog
[42] Bolt Earth. (n.d.). EV Infrastructure in India: What to Expect By 2030

and from the main transport hubs. Also, the last mile connectivity remains a significant challenge. Based on the key challenges there is a need to prioritize the optimal utilization of existing resources over other efforts (like huge investments) and create an ecosystem that can sustain itself financially. Some of the recommendations maybe taken for successful execution include: [43]

- Ensuring seamless connectivity by integrating different modes of transport across various operators and locations which requires interventions at Institutional level and grass-root level
- A single organization or body that oversees all modes of transportation can therefore be more effective
- improving quality of available infrastructure by Route Rationalization, introducing exclusive bus lanes
- Improving the quality of vehicles and adding work-friendly features
- Embracing technology in public transport like common mobility ticketing through cards or apps to enhance the travel experience can be instrumental in this direction.

Ahmedabad Metro: Ahmedabad Metro Rail Project Phase-I is about 40.03 KM long and is poised to transform the city's transportation landscape. However, the metro rail projects possess various barriers, including securing sufficient funding for the construction and operations, land acquisition, integration with existing infrastructure, compliance with environmental regulations, and minimizing their impact on local ecosystems. This can include issues related to noise pollution, air quality, and wildlife habitats. Ensuring the financial viability and environmental sustainability of the metro system over its lifespan is a long-term challenge that needs to be addressed for a successful metro project.

CNG Sahbhagi Yojana: The "CNG Sahbhagi Yojana" success in Gujarat hinges on overcoming several key challenges. Firstly, there is a pressing need for a consistent and reliable supply of high-quality Natural Gas in locations easily accessible to vehicles. Additionally, the absence of local gas distribution pipelines presents a significant hurdle. Gas supply pricing is crucial; it must be notably more affordable than petrol and diesel to incentivize adoption. The limited availability of suitable land in strategic areas within the targeted regions further impedes network expansion. Moreover, ensuring enough skilled professionals to oversee planning, construction, operation, and maintenance is essential. Lastly, there is a need to address the gaps in market awareness, training and education for the program to thrive.[44]

2.3.3.5. Energy Sector

Gujarat Renewable Energy Policy 2023: The policy lays out an ambitious plan with a major focus on increasing the capacity for renewable energy by 2030. This aim is in line with the country's objective of obtaining 50% of its total electricity generation from non-fossil fuel-based projects. But achieving this aim will not be easy, there are several obstacles to overcome including high upfront costs, intermittent grid integration which includes emerging issues including escalating fluctuations in hourly demand, heightened ramping needs, short-term frequency fluctuations, localized voltage challenges, inadequate grid infrastructure, land purchase and environmental concerns[45].The policy's successful driving of a significant increase in renewable energy capacity and alignment with the larger national purpose are made possible by the incorporation of the mentioned problems which promote transparency and accountability. Some recommendations that may be used to overcome challenges are as follows:

[43] shaikh, rehman (2023). Policy Review: Sustainable Urban Transport for India's Rapidly Growing Economy.
[44] GUMBER, A. (n.d.). CHALLENGES IN DEVELOPMENT OF CNG INFRASTRUCTURE - INDIIA'S EXPERIENCE. NEW DELHI, INDIA: GAIL (INDIA) LIMITED.
[45] pv magazine India. (2023). Driving renewable energy adoption: Challenges and opportunities.

- Intermittency can be handled in several ways, most promising are pairing RE generation with gas-based power plants, pumped-hydro storage where possible, using RE electricity in peak hours and generating hydroelectricity when needed and use of grid-scale battery storage.
- Restoring the financial health of the discoms should clearly have the highest priority for policy. Privatization is often recommended as the best way of solving the problem.
- Although the major burden of setting up RE generation capacity will fall on the private sector, the government/public sector will also have to play a major role in creation of transmission infrastructure.
- The introduction of carbon taxation will internalize the social costs of CO_2 emissions from burning coal and raise the price of coal-based electricity. This will create a market-based incentive for discoms to shift to RE.

Gujarat Solar Power Policy 2021: Gujarat Solar Power Policy 2021 holds great potential to propel Gujarat's solar energy capability and make a substantial contribution to India's larger renewable energy targets. It improves the state's energy security and complies with Sustainable Development Goals (SDGs) by reducing dependency on fossil fuels. Solar projects encounter challenges to fulfil demand for solar panels, equipment and inverters, it is necessary to invest in research and development, sophisticated development facilities and manufacturing infrastructure. Solar systems have longer payback times and need a large initial investment. Administrative problems that impact the installation of solar power plants and cause delays in development include those related to government permissions, ease of acquiring land, constraints on the supply of materials, overall setup warranty provided by the implementation partner, etc.[46] Successfully addressing these challenges is pivotal for the effective implementation and attainment of the objective.

Gujarat Surya Urja Rooftop Yojana 2019

The Rooftop yojana promotes sustainable energy practices but also empowers citizens by providing clean and cost-effective solar energy solutions by environmental conservation, reducing carbon emissions and fosters energy independence aligning to combat climate change. However, the adoption of solar rooftop technology faces various challenges including the high initial cost, limited awareness among the public about benefits and government schemes, issues related to tariff structures and limited rooftop space pose significant challenges for solar adoption. Additionally, subsidized electricity and the shortfall in achieving the set targets contribute to the slow progress and setting up a solar rooftop system requires a substantial initial investment, which discourages many potential adopters.[47] Limited land availability, technological efficiency and cooperative ownership in residential societies are also key considerations. To overcome these obstacles, facilitating financing options and adapting policies based on consumer preferences are essential steps towards achieving the ambitious solar rooftop targets.[48] Successfully addressing these challenges is pivotal for the effective implementation and attainment of the objective.

Gujarat Wind-Solar Hybrid Power Policy 2018: The hybrid policy brings numerous benefits which includes enhances energy production efficiency, reduced environmental impact and increased resilience to fluctuation in the energy generation and the integration of wind and solar strives to create more sustainable energy. However, there are several challenges developers in this market are grappling with certain issues such as lower tariffs, policy uncertainty and technical challenges. Key issues and challenges include:

- Land Constraints: It might be difficult to achieve CUF criteria in bids when there is a lack of sufficient land with strong wind potential and grid connectivity.

[46] Enphase (2022). India's solar energy sector: Challenges, opportunities, and the way forward.
[47] Warrier, S.G. (2022). Rooftop solar extends deadline for target which is not a promising sign say experts. [online] Mongabay-India.
[48] Gujarat's Residential Solar Rooftop Targets: Challenges and Way Forward. (n.d.). The Times of India.

- Integration Challenges: Lack of a metering framework creates technical obstacles to wind and solar energy integration with the grid, particularly on the DC side.
- Lack of Experience: The implementation of hybrid plants is being hampered by a lack of qualified personnel, which presents a problem for developers.
- System Sizing: Choosing the right generating and storage capacity is essential since it depends on the wind and solar energy potential at each location and guarantees effective storage utilization during times when renewable energy output is at its peak.[49]

Effectively tackling these challenges is crucial for the successful implementation and achievement of the goal.

Gujarat Wind Repowering Policy 2018: The wind Repowering policy promotes the utilization of wind energy for sustainable power generation, increasing the efficiency of the existing wind projects and fostering technological advancements. However, transitioning to wind power projects in India faces some challenges, including coordinating stakeholders becomes more complicated when dealing with shared infrastructure and multiple owners, especially when various landowners are involved. Additionally, there may be resistance from distribution companies or hesitant developers when evacuating surplus energy. Enhancing efficiency through repowering projects often involves negotiating with ownership structures across patches, which can be time-consuming. Furthermore, obtaining Power Purchase Agreements (PPAs) that satisfy both Discoms and wind developers for the power generated after repowering can be a process. Lastly, the complexity of the transition process is further increased by the need to obtain approval from distribution companies before selling surplus power through access. Tackling these challenges would help in the success of achieving objectives of wind power target.[50]

Gujarat Waste to Energy Policy 2022: Gujarat has 170 Urban Local Bodies (ULBs) comprising of 8 Municipal Corporations and 162 Municipalities and solid waste generated in these urban areas can support WTE Plants of around 100 MW capacity. Waste to energy (WTE) projects face many challenges which includes developers and stakeholders have limited control over factors such as the availability, type, size, density, moisture content, mineral content and calorific value of waste. These factors significantly impact the effectiveness of waste to energy plants. Additionally, the heterogeneous nature of waste leads to variations in value and moisture content. This variability makes it difficult to accurately predict the amount of energy that can be generated from waste to energy plants. Consequently, there may be discrepancies, between the scheduled energy generation and the actual energy generation achieved.[51] Tackling these challenges would help in the success of achieving objectives of waste to energy target.

Gujarat Small Hydel Policy 2016: GoG anticipates participation from investors in setting up Micro Hydel Projects of up to 100 KW station capacity, Mini Hydel Projects ranging from 101 KW to 2000 KW (unit size of up to 1 MW) and Small Hydel Projects of 2 MW to 25 MW (unit size of up to 5 MW). Hydro projects helps in minimizing the ecosystem's negative impact and provide sustainable energy solutions but to obtain financial support the major constrains are the inherent complexities of hydropower infrastructure, including the need for financial instruments best suited to the revenue profile and life of investments; the proportion of local versus foreign currency components; and the project's risks (for example, risk guarantees, insurance against hydrological variability and funds to support improved project preparation). Other constraints include inadequate planning and project prioritization leading to increased costs and risks in project preparation; need more attention to project budgets, additional appropriate expertise, and capacity building at all levels of the industry (government, services, and

[49] Wind-Solar Hybrid: India's Next Wave of Renewable Energy Growth. (2020).
[50] Kumar, M. (2022). After little success in past, India revisits plan to repower its ageing wind turbines. [online] Mongabay-India.
[51] Petition seeking implementation of CERC DSM regulation. (2022). abelloncleanenergy.com.

developers) and limited hydrological data, analysis and modeling. Potential recommendations that may be adopted for efficient implementation of small hydel projects are: [52]

- Increasing adaptability and opportunities for adaptive management by refining project design and water regulation.
- Integrating hydropower into low-carbon growth and climate change strategies.
- Strengthening hydrological assessments concerning climate-induced variations and changes, applying these assessments to both new and existing facilities.
- Emphasizing the collaborative potential between hydropower and other technologies, particularly those with less reliable supply sources like wind and solar.
- Strengthening research on linkages between water management and the economic impacts of climate change.

Surya shakti Kisan Yojana (SKY): The SKY scheme empowers the farmers to generate solar power for their agricultural needs, reducing electricity bills and contributing to sustainable energy practices. However, the initiative may face challenges in convincing farmers to participate in the absence of sufficient incentives. Additionally, farmers are locked into a cropping system that must always remain compatible with the Agri voltaic structure, likely resulting in conflicts. Agricultural production may lose priority if revenues from power generation are significantly higher. This could potentially create food security concerns.[53] Thus, it necessitates to address careful considerations and strategic solutions for its long-term success.

Kisan Urjas Suraksha evam Uhaan Mahaabhiyan (KUSUM) Scheme: The Kusum Scheme brings numerous advantages, including widespread access to solar energy for farmers, reducing the dependency on traditional methods of power sources, fostering sustainable agricultural practices and cleaner environment, but the implementation of this schemes has several barriers, low awareness and financial affordability, poor maintenance support, lack of economically viable business models and poor market environment. Strategic planning and continuous monitoring are very much crucial for the successful execution. Few potential recommendations that may be adopted for effective and successful implementation are generating demand and enhancing supply chains involve conducting technology demonstrations, awareness campaigns and capacity-building sessions for stakeholders throughout the entire value chain. This encompasses farmers, government officials, financial institutions, technicians, private companies and pump operators.[54]

Renewable Energy Certificates (RECs) and Renewable Purchase Obligations (RPOs): This initiative includes fostering renewable energy adoption, creating sustainable and environmentally friendly energy ecosystem, and contributing to carbon emissions. However, there are certain challenges, underscoring the need for further strategies. The annual monitoring of Renewable Purchase Obligation (RPO) compliance is evident in market dynamics. Anticipating the issuance of over a million Renewable Energy Certificates (RECs) in a single month in the future, strict enforcement of RPO compliance is crucial to maintain supply-demand equilibrium and improving Stakeholder Capabilities. It is important to address the problem of establishing considerable stakeholder capacity. Few potential suggestions may be adopted for successful implementation are as follows:

- Tightening up on RPO compliance and increasing the frequency of compliance checks are essential.
- Arranging seminars to inform stakeholders, including SERCs, State Agencies, and project developers, on the REC scheme's technical and regulatory elements and promote the RPO rules.[55]

Solar Banking and Power Storage: Solar banking and Power storage in Gujarat brings a significant boost in clean energy production and reduction in greenhouse gas emissions. The adoption of

[52] DIRECTIONS IN HYDROPOWER: SCALING UP FOR DEVELOPMENT, Water Working Notes. (2009). IFC.
[53] Agrivoltaics in India Challenges and opportunities for scale up IISD REPORT. (n.d.).
[54] www.greenpolicyplatform.org. Green Policy Platform.
[55] Soonee, S., Agrawal, V., Mani, A., Garg, M. and Prakash, S. (n.d.). Analysis of Indian Renewable Energy Certificate (REC) Market.

innovative solutions such as solar banking and power storage enhances the viability of solar energy. However, it includes several challenges such as, to meet the Net Zero Scenario, grid-scale battery storage must expand dramatically. Due to market disruptions and competition from electric car producers, the cost of key minerals used in battery production, notably lithium has increased even though battery costs have decreased significantly in recent years due to the scaling up of electric vehicle production. It is becoming clear that additional cost savings depend not only on technological advancement but also on the cost of battery minerals. Few suggestions that may be adopted for successful implementation are as follows:

- Commercializing second life batteries.
- Targeting policies to start encouraging battery recycling.
- Evaluating storage in long-term energy planning and encourage its deployment if needed
- Updating the status of storage in regulatory frameworks.

Perform, Achieve and Trade (PAT) Scheme: The PAT initiative in Gujarat includes incentivizing large energy intensive units to reduce specific energy consumption resulting in the issuance of Energy saving Certificates (ESCerts) for exceeding the targets. However, the energy efficiency initiatives are hindered by several factors, often interconnected. Suboptimal outcomes are often result due to lack of proper monitoring and evaluation in energy efficiency projects, and political intrusion in the independent institutions governing energy efficiency interventions impacting the effectiveness. Additionally, policy level inconsistencies and operational challenges with ESCerts create uncertainty and fluctuations in the price hindering the signaling effect for energy efficiency investments. Potential suggestion may be adopted for successful implementation is that it is important to maintain the stability of ESCerts to attract investment in energy efficiency projects. This could be addressed by setting a floor price for ESCerts which could reduce market uncertainties and could go a long way toward attracting the necessary capital for investment.[56]

Domestic Efficient Lighting Programme (DELP)/ UJALA scheme: The project UJALA initiative replaces over 8.73 lakh lamps, increasing energy efficiency and resulting in significant electricity savings for enterprises and municipalities. The state's overall efforts to save energy are further strengthened by the installation of 2.96 lakh lamps by local authorities but the challenges persist, Careful planning and designing energy-saving projects after coordinating with many stakeholders are essential. Building capacity, educating the public, and advising local governments all need financial investments. Reforming municipal street lighting administration and practices, such as standardizing procurement procedures, baseline establishing techniques, and monitoring and verification processes, would require government commitment. It is essential for municipalities to implement Standard Offer Programs (SOPs) that are both straightforward and uniform to effectively plan and carry out street lighting projects. Initiatives aimed at increasing capacity are crucial for municipal corporations and Urban Local Bodies (ULBs) alike.[57]

Energy Conservation Building Code (ECBC): Embracing the ECBC will reduce environmental impact and enhance energy efficiency. By establishing minimum energy performance requirements, the (ECBC) fosters sustainable development and paves the way for buildings to achieve energy neutrality substantial investments in ECBC awareness and education among ECBC members (builders, stakeholders, architects) is important for successful implementation[58] likewise ensuring that construction projects comply with the prescribed energy efficiency standards, Effective enforcement of building codes, technological readiness, training and capacity building for workforce, including architects, engineers, and construction workers are needed to understand and implement the

[56] Sarangi, G. and Taghizadeh-Hesary, F. (2020). ADBI Working Paper Series UNLEASHING MARKET-BASED APPROACHES TO DRIVE ENERGY EFFICIENCY INTERVENTIONS IN INDIA: AN ANALYSIS OF THE PERFORM, ACHIEVE, TRADE (PAT) SCHEME Asian Development Bank Institute.
[57] Bank, T. (2015). Energy-Efficient Street Lighting-Implementation and Financing Solutions Republic of India Energy-Efficient Urban Street Lighting India: Energy-Efficient Street Lighting-Implementation and Financing Solutions.
[58] MoEFCC. (2022). India's long-term low-carbon development strategy. Ministry of Environment, Forest and Climate Change, Government of India.

requirements ECBC efficiently, integration with local building practices and adequate policy support and alignment with broader sustainability goals is needed for effective energy conservation measures.

2.3.4. Gujarat State Climate Change Adaptation Initiatives and Measures

Climate Change Adaptation plans have been described at the sectoral level with detailed programmes developed in the Gujarat SAPCC. Gujarat has identified priority sectors for climate change adaptation strategies. The selection of sectors is based on the extent of climate change impact on them. The brief of the planned Climate Change Adaptation plans in the selected sectors are discussed below.[59] As per Gujarat State Disaster Management Act, 2003, a State Disaster Management Plan (SDMP) has been developed by keeping in mind the vulnerability of the State to various hazards. Gujarat State Disaster Management Plan, 2020-21 (GSDMP) provides further clarity about the actions, roles and responsibilities necessary to adequately prepare for and respond to various disasters situations in a coordinated manner.

2.3.4.1. Agriculture

In agriculture sector the major climate vulnerabilities are unpredictable monsoons to a sensitive climate agriculture sector it requires a combination of adaptive strategies and technological interventions like creating a customized weather alert system for farmers, incorporating data on their specific location and cultivated crops. This information aids in timely decisions on planting, irrigation and pest management. The GIS database complements this by offering comprehensive insights into field characteristics, including soil types, nutrient levels, irrigation, drainage, chemical applications, and crop production, and facilitating effective crop management.[60]

Utilizing satellite imagery for direct yield estimation, reduces the need for crop cutting experiments.[61] These speeds up yield assessment and claim settlement, ensuring timely and proportional payouts to farmers. Additionally, leveraging modern ICT technologies, such as the Internet of Things, GPS (Global Positioning Systems), sensors, robotics, drones, precision equipment, actuators and data analytics, are used to identify the farmers needs and select suitable solutions to their problems. These innovations increase the accuracy and timeliness of decisions taken and improve crop productivity.

By adopting the current sensor and IoT technologies in agriculture, each characteristic of conventional farming practices is rehabilitated. The incorporation of wireless sensors and IoT in smart farming answers many of the issues facing conventional agriculture; for example, land suitability, drought monitoring, irrigation, pest control and yield maximization.

2.3.4.2. Water Resources

To ensure successful implementation of adaptation plans related to water management in Gujarat the success factors are measured by engaging and involving relevant stakeholders, including local communities, farmers and experts in the planning, implementation and monitoring of water management initiatives.

Integrated approach to water management in important by considering various aspects like drinking water supply, irrigation, flood protections and dams projects. Proper coordination between agencies and department is crucial for success. Water conservation can be achieved by effective monitoring and data collection by establishing a robust monitoring system to track water usage, storage and conservation effects helps in evaluating the effectiveness of the schemes by making necessary adjustments. Offering incentives or rebates to individuals, households and businesses that implement water-saving measures can encourage greater participation in conservation efforts. Additionally investing in water efficient appliances, leak detections and wastewater treatments facilities can lead to

[59] https://ccd.gujarat.gov.in/Images/Gujarat-State-Action-Plan-on-Climate-Change.pdf
[60] Dhanaraju, M., Chenniappan, P., Ramalingam, K., Pazhanivelan, S., & Kaliaperumal, R. (2022). Smart Farming: Internet of Things (IoT)-Based Sustainable Agriculture. Agriculture, 12(10), 1745. https://doi.org/10.3390/agriculture12101745
[61] Pancharatnam, P. and Mahendiran, S. (n.d.). Understanding the potential of crop insurance in India: A study of the Pradhan Mantri Fasal Bima Yojana (Prime Minister's Crop Insurance Scheme). Centre for Budget and Policy Studies.

significant water savings and establishing clear metrics and reporting for making stakeholders accountable and informed.

2.3.4.3. Disaster Management

With the adoption of the Gujarat State Disaster Management Act 2003 (GSDM 2003) and the establishment of the Gujarat State Disaster Management Authority (GSDMA), Gujarat has taken a significant step towards proactive disaster management. The creation of the Gujarat Hazard Risk and Vulnerability Atlas and the Gujarat State Disaster Management Plan are two examples of this extensive effort's dedication to resilience and readiness. Among the many approaches, actions like planting mangroves, building cyclone shelters, and developing innovative technology for adapting to droughts indicate a significant influence, offering increased community safety, sustainable resource management, and increased resilience to disasters. Some of the critical factors for the successful implementation of the project are:

- Mangrove conservation must be assessed in a timely manner in relation to Cyclones and Tsunamis. Ensuring that the precautions implemented adhere to the most recent standards, are placed strategically, and provide the necessary training to the appropriate staff to respond to cyclones and tsunamis efficiently.
- Drought management adoption can encourage farmers to implement water-saving techniques and technology. They provide farmers with information and tools to help them convert to drought-resistant crop types. They must be regularly inspected and maintained to guarantee that check dams, ponds, bunds, and percolation tanks are efficient in storing water.
- Flood management involves evaluating flood-protective structures and making the required improvements, including constructing stone walls, erosion-reduction techniques and flood-diversion channels; Using land management techniques in regions vulnerable to flooding; and using the newest data sources and technologies to improve the flood forecasting system.

2.3.4.4. Rural Livelihood

The rural livelihood initiative aims to empower vulnerable communities, including tribal community development, with a focus on the holistic development of communities addressing the social sectors. This initiative also incorporates climate change adaptation to safeguard communities dependent on natural resources in the face of environmental challenges. There will be several challenges to achieving these strategies; hence, specific measures and a governance approach to create an enabling ecosystem for rural livelihood are very important.

- Conducting Vulnerability assessments based on the specific local context.
- Implementing a whole-of-government strategy with coordination across administrative sectors and levels.
- Exploring effective measures in the specific context through an itinerant and experimental approach.
- Prioritizing Cooperation with local communities is vital to regional empowerment.
- Engaging Cooperation with non-governmental stakeholders is essential.
- Cooperation with vulnerable groups is indispensable as they should be agents of change.
- Enacting legal provisions to safeguard and empower vulnerable groups.
- Within an enabling ecosystem, all stakeholders become a resource of empowerment and innovation.[62]

[62]How to Create an Enabling Ecosystem for the Empowerment of Vulnerable Groups Module 10 Training Toolkit on Government Innovation for Social Inclusion of Vulnerable Groups Division for Public Institutions and Digital Government Curriculum on Governance for the SDGs.

2.3.4.5. Coastal Regions

To preserve vulnerable coastal populations, the Sagar Khadi Sarvangi Vikas Yojana and associated coastal conservation projects are important initiatives. Numerous advantages stem from these programs, including habitat preservation, preventing saline incursion and taking proactive steps to address climate-related issues like severe heat, flooding, storms and rising sea levels. There are specific challenges to understanding the successful implementation of the projects: land and forest degradation, threats to water resources, degradation of coastal and marine environments, climate change and sea level rise, waste and pollution, natural disasters, etc..[63] There are regulations which expected to address the following pressures, to able address these challenges, integrated environmental management is very much necessary and also engaging and involving the local council in the preparation of adaptation plans is crucial to foster ownership and ensure that coastal and marine governance takes a decentralized and practical approach in addressing the issues facing the coastal and marine environment.

Some potential recommendations and regulations that may be considered for the effective implementation of adaption strategies are as follows:

- Excavation or removal of materials from seashore.
- Wastes handling and management onboard vessels (mineral ore export vessels, fishing vessels, exploration or drilling vessels).
- Controlling unsustainable exploitation of mangroves.
- Controlling pollution from oil drilling and exploration activities.
- Coastal infrastructural development (Oil refineries, jetties, hotels, bridges, roads, ports, homes, industrial or processing plants, shipyards, mariners etc.).

2.3.4.6. Forest

It is a great effort with numerous benefits and a comprehensive approach to forest protection. This initiative helps to preserve important forest ecosystems and the environment by minimizing the use of forest resources during drought years, lowering reliance on woody materials, encouraging afforestation in forest regions, locating and limiting the sources of forest fires, and putting in place rigorous monitoring and watershed management. For successful implementation there are factors considered for sustainable development which includes preventing forest fires through improved natural resource management policies, enforcement of legislation, establish operational procedures for monitoring land and forest fires, and strengthening regional firefighting capabilities as well as other mitigation measures.[64]

2.3.4.7. Biodiversity

The success factors which result in the proper implementation of land and water protection and management are political will, enabling policies with transparency and performance, cohesive communities, and clear and coherent public communication is a crucial success. Environmental impact assessment and policies could be improved by synchronizing the impact of infrastructure with scientific knowledge and local contexts. Greater coherence in decision-making could facilitate crucial environmental programs, although environmental ministries may be limited by dependency on other ministries with different goals. Finally, as in other cases, more participatory approaches could help address challenges in restoring and conserving corals, mangroves, seagrass beds, and lagoons.[65]

[63] Developed for Port Loko, Bonthe, Moyamba and Western Area Rural District Councils (With technical support from the Environment Protection Agency).
[64] Qadri, S. (n.d.). Fire, Smoke, and Haze Association of Southeast Asian Nations.
[65] Mader, A. (n.d.). Policy brief: Biodiversity challenges and solutions in Asia and the Pacific.

2.3.4.8. Health

The effort by GoG on Ahmedabad's Health Action Plan (HAP), which addresses several environmental elements to improve public health, is an important initiative. The plan offers several advantages, promoting a healthier and more resilient community, from implementing energy-efficient solutions and monitoring climate change to tracking diseases and improving air quality. To ensure the success of adaptation plans, the following actions are essential for effective implementation. Raising public awareness about the links between climate change and health and the potential to improve health by mitigating climate change severity.

- Establishing networks for disseminating information, tools, guidelines, and training materials.
- Providing technical and policy support for the public health response to climate change.
- Developing national plans and strategies considering both current and anticipated climate change hazards to manage climate-sensitive health risks.
- Strengthening health infrastructure, human resources, surveillance, early warning, communication, and response systems for climate-sensitive risks and consequences.
- Facilitating active participation of the health sector in the preparation of national action programs.
- Assess the health impacts of the decisions made on climate change by other sectors facilitate the health sector to actively participate in the preparation of national programs of action.[66]

2.4. Climate action gaps/ challenges in the successful implementation of SAPCC

Gujarat has sector wise economic growth strategy and plans discussed in the strategy document[67] and in section 2.2 to reach a GDP of USD 500 billion by FY 2026-27 and contribute significantly to the economic pursuit of India to become a USD 5 trillion economy by FY 2026-27. However, there is minimal mention of climate change impacts that may incur to achieve the ambitious economic strategy and plans. Economic activities in certain sectors like Manufacturing Sector (development of industrial infrastructure, estates, sectoral industrial parks, etc.), Transport Sector (Greenfield and brownfield expansions of ports, construction of elevated freight corridor, enhancing road capacity, doubling the existing rail network at key industrial areas and ports, development of semi high speed rail, development of air freight hub, etc.) and Energy Sector (~21 GW of RE capacity addition by FY 27, green hydrogen parks, electric mobility, etc.) require heavy investment and infrastructure development in form of power consumption, raw materials extraction, transportation and usage, plants, machineries, equipment, etc. which may have a negative climate impact in achieving the economic pursuits.

Incorporating climate mitigation and adaptation actions into sectoral growth strategies emerges as a pivotal avenue for fostering sustainable development. The key entry points lie in the growth strategies laid out for various sectors. It would be advisable to include dedicated sections on sector specific climate actions in the strategy document. Within the agricultural sector, the growth strategy gains substantial reinforcement through the advocacy of low-carbon, climate-smart farm mechanization techniques. The implementation of conservation tillage methods, such as zero-till, strip-till, ridge-till, and mulch-till, unlocks a myriad of advantages. Notably, the application of mulch on the soil surface reduces evapotranspiration, leading to a remarkable conservation of one million liters of water per hectare compared to conventional practices. Furthermore, the adoption of conservation tillage, particularly no-till, stands as a commendable contributor to soil organic carbon sequestration, surpassing the levels achievable with traditional tillage methods. The integration of renewable energy-based irrigation and the promotion of low carbon transportation options further fortify the agriculture sector's alignment with climate action goals, providing a comprehensive approach to sustainable practices.

In the realm of manufacturing growth strategies, a nuanced approach is indispensable. Encouraging the electrification of production processes, the decarbonization of energy sources, and the meticulous enhancement of energy efficiency in manufacturing processes represent pivotal entry points. The

[66] Protecting Health from Climate Change. (2016). WHO.

[67] Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy: https://www.gidb.org/usd-5-trillion-economy-task-force-report

cultivation of a circular economy, particularly within industries like textiles, automobiles, electronics, and energy storage, promises substantial contributions to the reduction of environmental impact. Through the advocacy of sustainable practices, the manufacturing sector can wield its influence in perpetuating long-term climate resilience and fostering a regenerative industrial ecosystem.

Within the services sector, the integration of climate action into the growth strategy unfolds across multifaceted dimensions. Prioritizing energy efficiency in buildings, coupled with the strategic decarbonization of transportation, encapsulates the transformative potential within this domain. The introduction of innovative financial products tailored for climate action projects not only propels economic growth but also accentuates the sector's commitment to sustainable practices. By championing eco-tourism and embracing sustainable tourism practices, the services sector can emerge as a beacon of responsible environmental stewardship. Simultaneously, the incorporation of sustainable construction methods bolsters the commitment to reducing the carbon footprint associated with infrastructural development. In essence, addressing these nuanced entry points across sectors ensures the seamless integration of comprehensive and effective climate action into broader economic growth strategies, fostering a resilient and sustainable future.

It is thus important to consider climate change impacts of the economic pursuits and shall be aligned in the strategy and plans for economic growth. Gujarat's climate change mitigation and adaptation plans mentioned in the Gujarat SAPCC document are discussed in the section 2.3, it is important to tag climate change mitigation and adaptation plans in the economic growth strategy and plans as current strategy document does provide an arrangement of tagging Gujarat's economic growth with climate action plans.

Ensuring effective and meaningful implementation of the SAPCC plans rely on a number of approaches, including tackling the political economy of climate change, addressing institutional bottlenecks, moving towards investment-ready plans and better leveraging available resources. There are a number of obstacles to SAPCC implementation that have been found connected to inadequate leadership, institutional barriers, the quality of the plans and resource constraints. Research was conducted based on the compilation of insights drawn from experience of working with state governments (Gujarat, Assam, Maharashtra and Rajasthan) during the formulation of their SAPCCs which looked at the challenges of drafting, implementing, and monitoring SAPCCs.[68] States faced several challenges during the different stages of SAPCC implementation (drafting, implementing, monitoring and evaluation). Most prominent challenges identified in the first phase of SAPCCs were:

- Availability of required granular information on climate parameters
- Lack of capacity (technical and institutional) and adequate resources (technical and finance)
- Lack of intrastate departmental coordination
- Inability to mainstream climate change concerns in sectoral regulations and policies
- Limited leadership and guidance to steer climate actions in various departments.
- Absence and/ or uptake of monitoring and evaluation frameworks

Lack of Climate Change Science Context

The lack of climate change context due to the practical difficulties faced during conceptualization and assessment of climate risks is one of the major issues identified It was found in the research study[69] that there is a lack of climate change expertise at the state level that obstructs their ability to undertake any sort of scientific assessment. Challenges were also observed in prioritizing climate activities and limited capacity to include climate additionality to existing developmental activities and severity of this issue is further increased due to inadequacy of climate data and fragmentation of data across various entities.

[68] https://www.teriin.org/projects/nfa/files/working-paper-subnational-action.pdf
[69] https://www.teriin.org/projects/nfa/files/working-paper-subnational-action.pdf

Insufficient Political Momentum

The SAPCCs follow a top-down set-up wherein the guidelines issued by the central government form the basis for SAPCC formulation at the state level. Although the responsibility of SAPCC lies with the state government, it was found that the states lack motivation, urgency and ownership to devise these plans as indicated through unclear division of responsibilities as well as untimely action on the proposed climate change measures. Furthermore, the inadequacy in political ownership and motivation affected financial allocation towards climate measures adversely.

Divergence in Institutional and Planning Processes

Lack of interdepartmental coordination has been identified as one of the major barriers affecting all the SAPCC phases of drafting, implementing and monitoring. The communication and coordination gaps are quite persistent between the centre and states and also between the departments within states. There is absence of transparency between states and the centre on numerous issues, such as specific expectations and outcomes from SAPCCs, funding and technical arrangements and guidelines.

Limited Availability of Finance

In India, finance flows to climate adaptation constitute a small portion of the green finance portfolio. Only USD 1.1 billion out of a total USD 50 billion was invested in climate adaptation in FY 19-21.[70] The poor and untimely availability of finance has been found to be a huge barrier to any state-level action. Some of the key financing challenges include limited access to additional funding sources other than state budgets, uncertainty in the source of funding and insufficient allocation under state government budgets. It was found that most of the states had given probable budgetary allocations in their respective sectoral recommendations. States possess limited capacity to mobilize resources from additional sources, such as national climate change funds (Adaptation Fund) and international funds like Green Climate Fund (GCF), particularly due to their inability to draft technical proposals.

The Climate Change Fund of Gujarat (CCFG) is aiming to channelize the investments from the developed countries and other donor agencies as well as national policies that promote low carbon development in Gujarat. The fund will be utilized to implement Climate Change Mitigation and Adaptation projects to reduce the state's vulnerability to climate change. This would be a unique fund dedicated for effective implementation of the SAPCC and other climate change initiatives at state level.[71] However, recent activities on the implementation of this fund with respect to climate change mitigation and adaptation strategies mentioned in the SAPCC do not have a clear visibility.

GoI also floated dedicated climate funds like the National Clean Energy and Environment Fund (NCEEF) and the National Adaptation Fund on Climate Change (NAFCC) for financing climate actions. The National Bank for Agriculture and Rural Development (NABARD), being the Accredited Entity (AE) for the Adaptation Fund (AF), Green Climate Fund (GCF) and NAFCC anchors the process of developing and submitting concept notes around such projects to them. As a recent development, the Small Industries Development Bank of India (SIDBI) has been accredited as a National Implementing Entity (NIE) for the GCF. Most States are aware of these funds and are working towards availing the same, but often experience difficulties in identifying ideas for potential concept notes to meet the investment criteria and modalities of such funds.

Absence of climate budgeting framework

The Climate Change Department (CCD) formally recognized a separate budget from its end which would fund specific programmes under each of the line departments, this was called the Climate Change Budget Scheme. However, department-wise reporting of the exact expenditure on programmes with climate orientation, given the absence of any climate budgeting framework, is an issue that need to be addressed.[72] States are expected to slowly move towards this exercise of highlighting precisely

[70] https://shaktifoundation.in/wp-content/uploads/2023/03/Climate-Resilience-Landscape-for-India.pdf
[71] https://ccd.gujarat.gov.in/Portal/Document/1_29_1_1_29_1_CCFG-GR.pdf
[72] https://shaktifoundation.in/wp-content/uploads/2017/11/Financing-State-Climate-Actions.pdf

the expected expenditure towards climate actions. The initiative to earmark certain portions of the Climate Change Department's budget towards funding climate change related schemes of other departments could pave the way towards this effect.

Inconsistency in climate finance ask by the states

Another study identified that the activities proposed in the SAPCCs resulted in arbitrary financial demands by the states, not always in sync with their requirement or the action they were planning to take. For example, Madhya Pradesh demanded INR 5,000 crore, while Tamil Nadu demanded INR 400,000 crore, even though the later has slightly less population. This resulted into huge variations in budget requirement by states.[73] Also, a top–down approach has been followed in planning and implementation, but research suggests that to get effective results at the ground level, top–down approach must be integrated with bottom–up approach.

Absence of Monitoring and Evaluation Frameworks

The analysis of SAPCC 1.0 documents indicated that monitoring and evaluation (M&E) were completely absent or insufficiently analyzed for a majority of states. At present, most of the M&E activities are limited to tracking financial allocations made towards each proposed activity and do not really account for physical progress. For a few states that have devised M&E frameworks under their climate plans, issues such as lack of expertise, irregularity in organizing steering committee status meetings, and coordination across departments hinder the process further.

SAPCC as a standalone document

In most states SAPCCs have functioned as a stand-alone document with limited recognition of the activities of other line departments, which if integrated, can bring forth collective climate action. Moreover, the scope of SAPCCs is largely restricted to state jurisdiction, without a clear vision at further de-centralised governance systems. Districts and cities are still largely neglected areas for climate actions in the SAPCCs.

Pilot Projects Replication

Pilots and demonstration projects, in general, have emerged as a useful tool, but suffer from lack of in-built design of upscaling and replication of demonstration is not a prevalent one. Further for undertaking climate actions and replication, while the focus is largely concentrated on finance, its access and its mobilisation within means of implementation and capacity building needs a greater focus. Building institutions and structures are crucial component of capacity building, an aspect largely marginalised.[74]

2.5. Potential measures to better implement plans and strategies in the SAPCC

India considers climate change and related factors as one of the greatest threats to its socioeconomic developmental goals. States play a critical role in undertaking measures and implementing the actions required for change on the ground. Several vital changes are required across state and non-state actors to undertake ambitious low carbon and climate-resilient pathways.[75]

- **Long-term climate planning -** State climate action plans need to adopt a long-term approach, phase out the associated complexities, and establish accountability among the various involved institutions.
- **Roadmap for climate resilience -** States need evidence-based roadmaps that serve as guiding documents for climate-resilient development and include various developmental pathway.
- **Integrated and coordinated actions -** Climate-resilient development needs to be integrated with mitigation, environmental, and ecological measures that are grounded in science-based targets and

[73] https://cdn.cseindia.org/attachments/0.40897700_1519110602_coping-climate-change-volII.pdf
[74] https://www.downtoearth.org.in/blog/climate-change/state-action-plans-on-climate-change-need-upscaling-and-capacity-enhancement-66796
[75] https://shaktifoundation.in/wp-content/uploads/2023/03/Climate-Resilience-Landscape-for-India.pdf

adaptable to the local context. States also need to ensure that the various line departments work together to implement climate plans.

- **Building local institutional capacity to augment state ecosystems -** A strong stakeholder ecosystem can augment state government efforts through an inflow of evidence-based research, informed opinions, and technical assistance.
- **Funding climate action -** Lack of financial resources is one of the biggest barriers to states' low-carbon and climate-resilient development. While there are multiple instruments that can help states raise funding for such development, it is essential that states themselves begin allocating higher funding for climate action within their budgets to ensure long-term impact.
- **Participative climate action planning -** Given that various stakeholders are involved in state-level climate action, participatory planning for climate action in states is necessary.
- **Evidence-based planning and implementation -** Provide state governments with the knowledge support that they require to develop effective roadmaps for low-carbon and climate-resilient development and making sure the roadmaps are absorbed within the State Transition Plans/ SAPCCs/ State Budgets.
- **Government capacity building -** Enhance the capacities of government officials to execute the measures outlined in the roadmaps through technical assistance and house experts within the government by setting up a project management unit (PMU).
- **Enhancing local institutional capacities for climate action -** Incubate and/or augment capacity within the existing local ecosystem by training existing resources on climate change issues, engaging new actors through institutional grants, and providing other hand-holding support as required.
- **Cross-learning at the sub-national level -** Work with partners across India to ensure cross-state diffusion of the learnings and findings from "model" states.

Climate change mitigation efforts (potential solutions and innovations to combat the problem) and adaptation efforts (adjusting to current or expected climate change impacts) are the key topics that dominate the discussion, and the idea of climate change resilience pathways is gaining momentum. The best climate-resilient pilot practices to replicate and upscale are the ones that are built around the two key pillars of climate resilience: people who are aware of climate risks and how to address them and the availability of technical and financial resources to address climate change challenges.

Exploring additional and new climate finance potential

In the long run the resources will have to be mobilized with the help of the private sector as well. Although Gujarat SAPCC highlights climate change action financing options including the Climate Change Fund of Gujarat (CCFG), it is also important to estimate additional resource requirements, and explore existing, additional and new climate finance potential. In addition to the financing options included in the revised SAPCC of Gujarat published in 2021, several strategies can also be considered for enhancing climate finance potential through the CDM and exploring CDM potential in energy efficiency, waste management, forestry and industry initiatives, and exploring other market-based opportunities for forest conservation, such as Reduced Emissions for Deforestation and Degradation.[76] GoG may actively explore various major funds and schemes contributing to addressing climate risks which are: [77]

- National Adaptation Fund on Climate Change (NAFCC): Aims to scale up climate change adaptation interventions by financing projects/ programmes based on climate scenario and vulnerability analysis.

[76] https://www.adaptation-undp.org/sites/default/files/downloads/undp-alm_casestudy_india_oct2012.pdf
[77] https://shaktifoundation.in/wp-content/uploads/2023/03/Climate-Resilience-Landscape-for-India.pdf

- Climate Change Action Programme (CCAP): Strengthens scientific and analytical capacity and the institutional framework on climate change and supports the implementation of climate-related actions at the national and sub-national levels.
- National Clean Energy Fund (NCEF): Ministry of Finance has established NCEF to support research and innovation projects related to clean energy and the environment.
- Fund to support the strengthening of climate change centres: Department of Science and Technology is supporting development of a knowledge centre on climate change at the state level through this fund.
- Integrated Power Development Scheme: Focuses on strengthening sub-transmission and distribution networks in urban areas through the metering of distribution transformers/ feeders/ consumers in urban areas.
- Unnat Jyoti by Affordable LEDs for All (UJALA): Provides light-emitting diode (LED) bulbs to domestic consumers, with a target to replace 77 crore incandescent bulbs with LED bulbs.
- Jal Jeevan Mission: Ministry of Water Resources, River Development and Ganga Rejuvenation provides financial support to various states to provide safe and adequate drinking water.
- Prime Minister Krishi Sinchayee Yojana: Extends support to facilitate irrigation and improve water use efficiency in a focused manner, along with farm productivity.
- Rashtriya Krishi Vikas Yojana: Incentivises states to increase their investment in agriculture and allied sectors. It also helps in achieving the goals of reducing the yield gaps in important crops and maximising returns to farmers.
- Compensatory Afforestation Fund Management and Planning Authority (CAMPA) Funds: Promote afforestation and regeneration activities as a way of compensating for forest land being diverted to non-forest uses.
- National Disaster Response Fund (NDRF): This fund is managed by GoI which covers expenses for emergency response and disaster relief & rehabilitation.
- National Rural Livelihood Mission: Aims to alleviate rural poverty and create sustainable livelihood opportunities for the rural poor.

Additionally, GoG is looking forward to setting up an entity looking into Green/ Climate Finance at the Gujarat International Finance Tec-City mentioned in the SAPCC of Gujarat but further activities in the area are not clear presently for its implementation. Additional finances from international sources can be sought by the GoG and efforts should be made to attract more finances from international sources which may include bilateral agreements or multilateral mechanisms through the United Nations Framework Convention on Climate Change (UNFCCC) or otherwise. The UNFCCC had created dedicated climate funds like the Adaptation Fund (AF), Global Environment Facility (GEF) and Green Climate Fund (GCF) which finance specific adaptation and mitigation actions in developing countries.

Linking innovations projects of line departments with climate mitigation and adaptation benefits

There is scope for customizing line departments' efforts based on the nature of projects they are interested to develop. While line departments often oversee innovations and robust demonstrative projects, there may not be an explicit link between such project and their climate mitigation and adaptation benefits. Hence, conscious efforts to set out the climate focus of their sectoral projects within the State could be taken in consultation with the Climate Change Department/Department of Environment. The line departments could adopt the following actions to identify the climate benefits of its projects.[78]

- ***Mitigation benefits:*** Each department could periodically but mandatorily estimate potential reductions GHG Emissions expected of their schemes/ programmes. A sample estimation of the schemes/ programmes specific to a region could provide the mitigation potential of the scheme/ programme thereby helping them prioritise and design innovations at the ground level and also be

[78] https://shaktifoundation.in/wp-content/uploads/2017/11/Financing-State-Climate-Actions.pdf

used as a criterion to assess the climate mitigation benefits of their programmes while developing Detailed Project Reports (DPRs).

- ***Adaptation benefits:*** It is important for departments to assess the sectoral vulnerabilities to climate change within the State as a prerequisite and thereafter understand how their programmes help reduce these vulnerabilities or build resilience.
- ***Budget contribution to adaptation/ mitigation:*** A simple weighted climate budgeting exercise could help departments understand the climate orientation of their current budgets and thereafter develop exclusive climate interventions which do not fall within the scope of their current department schemes.

Increase focus on institutional and human capacities

Strengthening of human and institutional capacities would be the critical driver for upscaling, replication and mainstreaming of climate actions. The role of state-run institutions and civil society organisations is crucial. Without strong structures and institutions of building human and institutional capacities, the challenges of alleviating the vulnerabilities of local communities would remain a distant unachievable goal. Some experiences have shown that states such as Tamil Nadu and Madhya Pradesh, which have stronger institutional structures have been able to deliver their SAPCCs and NAFCC projects more effectively. It would also help in improved capacity to mobilize resources from additional sources, such as national climate change funds (Adaptation Fund) and international funds like GCF and GEF, and ability to draft technical proposals.

Mainstreaming SAPCC with different sectoral plans and policies

It is difficulty for a SAPCC to achieve its objectives if implemented as a standalone plan. It has to be mainstreamed in different sectoral plans and policies and implemented through a coordinated effort from several departments in the state.

Localisation of SAPCC

For the convergence of state and national programmes, the district level provides a unique entry point for strengthening decentralised climate governance. Now the revised SAPCC published in 2021 is accomplished, one of the enabling actions that should be taken is to further downscale the climate change mitigation and adaptation actions to the district level. Localizing SAPCC actions will lead to more contextual implementation or required interventions enabling sustainable long-term impact.[79]

Prioritising options for addressing climate change

Proposed strategies and activities to address climate change should be classified as high, medium or low priority. These climate change mitigation and adaptation options can be classified based on needs expressed in stakeholder consultations, timeframe, available resources and cost-benefit analysis can also play a role in prioritizing these activities. It is important to set out options and evaluate and rank them according to criteria (cost-effectiveness, cost-benefit, feasibility, ease of implementation, 'no-regrets', robust to different scenarios, transformative change, etc.). Climate action in Gujarat needs to focus on both adaptation as well as mitigation which keeping disaster management as a high priority.

Actions that deliver benefits for growth and development while mitigating climate change

Several proposed actions aim to move Gujarat toward a low carbon pathway. These green growth strategies include sustainable urban transport, enhancing efficiency and low-carbon options in power generation, exploring possibilities for eco villages for tourism, etc. Imposing green tariffs for incentivizing clean energy production and availing carbon market opportunities also support the national principle of promoting new and innovative forms of market and regulatory and voluntary mechanisms for sustainable development.[80]

[79] https://wsds.teriin.org/eventregistration/public/agendafile/1648723481_EU_GIZ_Thematic%20track_SAPCC_03032022.pdf
[80] https://www.adaptation-undp.org/sites/default/files/downloads/undp-alm_casestudy_india_oct2012.pdf

Climate Law

India lacks a climate law but many of the states have taken it upon themselves to have a climate goal, such as Himachal Pradesh, Ladakh and Bihar. Even with the absence of climate law, these institutions can take responsibility provided adequate resources are available.[81] In 2012, Mexico became the first middle-income country to create a comprehensive national climate change law. Its law established a federal agency, the National System on Climate Change (SINACC), to develop policies and coordinate their implementation. A recent study, based on interviews of Mexican stakeholders involved in SINACC found that the law established clearer responsibilities across government, promoted the involvement of subnational and non-state actors and strengthened political discourse and commitment towards long-term climate action.[82]

It is important for Gujarat to work towards a climate law/ rule/ regulation for effective implementation of proposed climate change mitigation and adaptation actions by line departments and climate change department which would also help in future drafting and implementation of climate action strategies and plans.

Frequent revision of SAPCC as per the requirements

Climate change affects are changing every year on a significant scale. It has become important to review the climate change actions/ strategies/ plans laid out in SAPCC or climate change action road map and make necessary changes/ updates as per the requirements, evolution of the scientific knowledge, socio-economic understanding, policy landscape on climate change, changing context/ circumstances in the state and national NDC and SDG goals. SAPCC should remain as a working document, which can be updated and refined on a regular basis. It is important to consider stakeholders in the process and vast stakeholder consultations will be necessary for having the support of the local communities who will be the most vulnerable to the effects of climate change. Both climate change adaptation and mitigation need to be given equal attention.

State Knowledge Management Centre on Climate Change

To continuously enhance the expertise and capacity building at the department level and state level and linking all the sectors and climate change, it is important to establish a State Knowledge Management Centre on Climate Change. The successful example of it can be taken from Madhya Pradesh which focuses on establishing a link between all the sectors and climate change. For this, the Madhya Pradesh state government adopted a vision document 2018, which acted as a guiding document highlighting the key aspects of good governance, change and development. For greater transparency of the strategies and actions being undertaken, policy briefs based on the SAPCC were developed that provide in-depth understanding of the situation of climate change in the state.

Dedicated Monitoring and Evaluation (M&E) framework

Study on first phase SAPCCs revealed that there is an absence of M&E due to delays in the implementation of strategies.[83] Furthermore, no specific institutional framework has been developed to supervise the implementation specifically for M&E. Effective M&E issues become even more pertinent for tracking progress on adaptation actions, which do not have a fixed baseline unlike mitigation issues. M&E framework can help evaluate the impacts and define the success of the SAPCC which can be done by many ways including commissioning baseline studies for each sector to evolve appropriate sectoral criteria, identifying M&E indicators, monitoring and evaluating the progress of the integration of climate concerns into developmental policies and planning and the capacity of various line departments and their personnel to internalize climate change concerns.[84] The Government of Odisha has been the only state to publish a SAPCC progress report after the closure of the first phase of the

[81] https://wsds.teriin.org/eventregistration/public/agendafile/1648723481_EU_GIZ_Thematic%20track_SAPCC_03032022.pdf
[82] https://www.wri.org/insights/india-revises-state-climate-plans-who-should-have-voice
[83] https://www.teriin.org/projects/nfa/files/working-paper-subnational-action.pdf
[84] https://www.adaptation-undp.org/sites/default/files/downloads/undp-alm_casestudy_india_oct2012.pdf

SAPCC implementation (2010–15) which reflects the success of the sound M&E framework developed by the state.[85]

Coordination among departments

Coordination mechanisms is important between different line departments for making SAPCC implementation efficient. A convergence in planning processes within various state departments, climate change department and central ministries maximize the benefits through an integrated planning approach, which is essential to SAPCC formulation and implementation process given the vast potential of convergence.

Balanced Integration

Madhya Pradesh claims it has tried to adopt a bottom-up approach to develop its SAPCC in phase 1. However, other states like Mizoram, Odisha, Gujarat, Punjab, Uttar Pradesh and Tamil Nadu have not done any bottom–up planning, even though the SAPCCs of some states highlights that it should be done. A balanced integration of top–down planning with bottom–up planning is the key to true success of any adaptation efforts at the local level.[86]

Development of effective institutional mechanisms to promote sectorial alignment

Many of the states follow a similar institutional model comprising a state-level steering committee under the. Although such a model does fairly well on taking inputs from respective line departments, it lacks an integrated approach towards mitigating and adapting to climate change. Each line department contributes in its own capacity to develop their own set of climate change strategies, all of which contribute to a broader climate change objective. However, these strategies are misaligned despite having scope for acting synergistically. It is, therefore, suggested that states can possibly develop core working groups that can help them reorient towards a long-term cross-sectorial planning. An effective institutional mechanism must also include representation from local governments and communities/ community level organizations to use the experience of these communities in the decision-making process.[87]

Collaborative Efforts for Climate Change Adaptation

Two Indian states have already demonstrated the benefits of including stakeholders from inside and outside government in the policymaking process: Local experts helped Madhya Pradesh adopt Climate-Resilient Cattle as the department brought together veterinarians, data scientists, milk cooperatives and local governments to address the issue, and Uttarakhand Forest Communities benefitted from coordinated government efforts as the Forest Department has been working with forest communities to improve their resilience to climate change. These examples highlight that in order to successfully implement climate action, governments need to coordinate among various agencies, as well as consult with local experts, affected communities and those responsible for implementing policies on the ground.[88]

Involvement of Expert Group

From rural and urban development to public health and gender equality, climate change affects a range of social issues. Involving groups that work on these issues can improve climate policies. In 2015, France held a wide-ranging stakeholder consultation process while developing its Energy Transition for Green Growth Law. The group responsible for implementing the law, the Council for a National Energy Transition (CNTE), includes 50 members representing labor, business, environmental NGOs, consumer interest NGOs, locally elected authorities and members of parliament. It has guided the development and early implementation of France's Low-Carbon National Strategy by providing technical and policy

[85] https://www.teriin.org/projects/nfa/files/working-paper-subnational-action.pdfs
[86] https://cdn.cseindia.org/attachments/0.40897700_1519110602_coping-climate-change-volII.pdf
[87] https://www.teriin.org/projects/nfa/files/working-paper-subnational-action.pdf
[88] https://www.wri.org/insights/india-revises-state-climate-plans-who-should-have-voice

expertise that the government wouldn't have on its own.[89] GoG may work with group of experts in early stages for effective implementation of SAPCC 2.0 as on the ground expertise may help Gujarat in achieving Climate Change strategies.

Role of Insurance in the Transition to a Low Carbon Economy

Climate risk are of two types – first is physical risks that can damage properties and disrupt supply chains to cause enormous losses to economies, exacerbated by a lack of climate risk mitigation infrastructure and other capacities. Second, the overall shift in policy, technology, and market sentiment raises costs, reduces incomes, and strands assets. In the absence of appropriate financing mechanisms like public insurance schemes, this can create sizeable implicit contingent liabilities for governments. Insurance offers coverage opportunities for the entire life cycle of renewable energy projects. In the agriculture sector, insurance against multiple risks can contribute to the overall cost-effectiveness of crop insurance schemes against climate-related risks.[90]

Climate Budget Coding and Climate Budget Tracking

Climate Budget coding refers to the process of tagging climate-change related activities within budget items and assigning specific codes to programmes and projects so that climate relevant expenditure can be tracked. Climate Budget Tracking is a systematic way to trace and link budgetary allocations to their respective expenditures and outputs in climate-relevant activities within the Integrated Financial Management Information System.[91]

Review of Climate Finance strategies/Climate Responsive Budgeting initiatives

State governments, including those in Kerala, Bihar, Chhattisgarh, Assam, Maharashtra and Odisha, have been using various tools to assess the 'climate change relevance' of various interventions so as to estimate the extent to which a programme addresses climate change. Some state governments follow the UNDP's Climate Public Expenditure and Institutional Review (CPEIR) methodology.

2.5.1. Recognized best practices for implementing climate change mitigation and adaptation strategies

2.5.1.1. Climate Change Mitigation Measures

There are three main climate change mitigation approaches which are discussed below:[92]

- Employing decarbonization technologies and techniques that reduce CO_2 emissions, such as renewable energy, fuel switching, energy efficiency, nuclear power, etc. Most of these technologies are well established and carry an acceptable level of managed risk.
- Capture and sequester CO_2 from the atmosphere and are termed negative emissions technologies, also referred to as carbon dioxide removal methods.
- Altering the earth's radiation balance through the management of solar and terrestrial radiation. Such techniques are termed radiative forcing geoengineering technologies, and the main objective is temperature stabilization or reduction.

India's strategy for decarbonization reconciles growth in energy consumption, with a reduction and ultimately elimination of CO_2 emissions, through a combination of demand-side and supply-side actions on energy. On the demand side the strategy relies on:[93]

[89] https://www.wri.org/insights/india-revises-state-climate-plans-who-should-have-voice
[90] https://blogs.adb.org/blog/navigating-climate-risk-crucial-role-insurance-transition-low-carbon-economy?gclid=CjwKCAiAu9yqBhBmEiwAHTx5p_LEvFxK7jef5IchEB8vFKUmhy2WWLKTVsCpfKe9qRBNY_IjQ5dmIxoCT6YQAvD_BwE
[91] https://www.cbgaindia.org/wp-content/uploads/2023/01/climate-responsive-budgeting-framework.pdf
[92] https://link.springer.com/article/10.1007/s10311-020-01059-w
[93] https://www.brookings.edu/articles/managing-climate-change-a-strategy-for-india/

- Increasing energy efficiency through adoption of energy-saving technologies, combined with lifestyle changes, which will moderate the growth of energy demand for any given growth of income.
- Shifting from direct use of fossil fuels to electricity as the final energy source wherever possible. Electrification of transport is the most obvious possibility which saves on use of petrol and diesel.

On the supply-side the strategy relies on:

- Shifting away from electricity generation using fossil fuels (mainly coal, and also gas) to electricity from RE (mainly solar and wind). This transformation on the supply-side is critical for reducing emissions from other demand-side sectors such as transport.
- Developing green hydrogen (H_2) as a substitute for fossil fuels in hard to decarbonize areas.

The above actions must be accompanied by expanding forest area to increase natural carbon sinks and developing CO_2 capture and sequestration techniques to make them commercially viable to offset emissions from residual use of fossil fuel that may remain. India has been using mitigation instruments to accelerate the transition towards a low-carbon economy. Some of the key instruments that have been and are being implemented in India are Perform, Achieve and Trade (PAT), Renewable Energy Certificate (REC) trading scheme, Coal cess, and sectoral incentives like feed-in tariffs, generation-based incentives (GBI), accelerated depreciation for solar and wind electricity.[94]

2.5.1.2. Climate Change Adaptation Measures

In addition to steps aimed at mitigation, it is also necessary to take steps aimed at adaptation to the climate change. These changes include increased frequency and severity of extreme weather events such as heat waves, droughts and floods which could disrupt agriculture and lead to food and water shortages; decline in labor productivity which could lower household incomes; rising sea levels which could lead to coastal flooding in low lying regions, displacing millions of inhabitants; and loss of biodiversity and ecosystems which could negatively impact livelihoods of many people.[95] The World Bank has laid out six Adaptation Principles to Build Resilience to Climate Change which are discussed below.[96]

- **Foundations: Rapid, robust, and inclusive development -** Poverty and the lack of access to basic services—including infrastructure, financial services, health care, and social protection—are strong predictors of vulnerability to climate change. The poorer communities are at more risk of climate change affect. No adaptation strategy can be successful without ensuring high-vulnerability populations have the financial, technical, and institutional resources they need to adapt.
- **Priority Area 1: Facilitate the adaptation of people and firms -** It's critical to boost the adaptive capacity of households and firms. Governments can make information on climate risks available, clarify responsibilities and liabilities, support innovation and access to the best technologies, and ensure financing is available to all, especially for solutions that come with high upfront costs.
- **Priority Area 2: Adapt land use plans and protect critical public assets and services -** In addition to direct support to households and businesses, governments must also play a role in protecting public investments, assets, and services. If countries have the right data, risk models, and decision-making methods available, the incremental cost of building the resilience of new infrastructure assets is small.
- **Priority Area 3: Help firms and people manage residual risks and natural disasters -** Risks and impacts cannot be reduced to zero. Governments must develop strategies to ensure that when

[94] https://www.ceew.in/sites/default/files/CEEW-EDF-Mitigation-Instruments-for-India's-Climate-and-Development-Goals-PDF-14Oct19.pdf

[95] https://www.brookings.edu/articles/managing-climate-change-a-strategy-for-india/

[96] https://www.worldbank.org/en/news/feature/2020/11/17/the-adaptation-principles-6-ways-to-build-resilience-to-climate-change

disasters do occur, people and firms can cope without devastating long-term consequences, and can recover quickly. Preparation such as better hydromet data, early warning and emergency management systems reduces physical damage and economic losses.

- **Priority Area 4: Manage financial and macro-fiscal issues -** Coping with climate change impacts in all sectors at once requires strategic planning at the highest levels. Through many impacts in many sectors, from floods affecting housing prices to changes in ecosystems affecting agriculture productivity, climate change will affect the macroeconomic situation and tax revenues. Spending needs for adaptation and resilience need to be added on top of existing contingent liabilities and current debt levels.

- **Application: Prioritization, implementation and monitoring progress -** Governments must not only prioritize actions to make them compatible with available resources and capacity; they must also establish a robust institutional and legal framework and a consistent system for monitoring progress.

The current economic strategy document of Gujarat[97] does not have the provision for climate change mitigation and adaptation plans and principles to follow. GoG may consider the alignment of climate change mitigation and adaptation plans and principles while revising the economic strategy in future and the World Bank's six principles to build resilience to climate change may be considered as a guiding content. The actions pertaining to six principles of climate change adaptation are discussed below.[98]

Table 2: Actions pertaining to six principles of climate change adaptation

Adaptation Principle	Actions	Lead Ministry for Actions	Sample targets and indicators
Foundations: Rapid, robust, and inclusive development is the first priority **Lead Ministry:** Economy or Finance	Increase economic productivity and growth, while keeping buffers for shocks • Good governance • Investment in human capital • Investment in efficient infrastructure and trade network	Economy or Finance	• Average productivity growth • Economic growth • Debt-to-GDP ratio • Structural deficit
	Ensure that economic growth is inclusive • Improve the livelihoods of smallholder farmers • Achieve universal access to infrastructure services • Accelerate financial inclusion, access to health care, and social protection coverage • Improve health care and universal health coverage • Ensure adaptation strategies include support for people in conflict zones, who are particularly vulnerable	Economy or Finance	• Poverty headcount or change in poverty headcount (last five years) • Average income of farmers • Percentage of farmers with access to fertilizers or improved seeds • Average share of household budget spent on food and beverages • Access to modern energy, improved water, or sanitation • Number of power or water outages per year • Share of population with a bank account, health care coverage or covered by social protection
Priority Area 1: Facilitate the adaptation of people and firms **Lead Ministry:** Economy or Finance	Assess disaster and climate risks, and make the information available People and firms need information on: • Threats from natural hazards • Threats to human capital • Threats to key sectors • Cross-border threats, including risks linked to food prices	Environment (or disaster risk management or climate change agency)	• Number of weather or hydrological observation stations operational in the country • Real-time availability of hydromet observations • Percentage of country covered by high-resolution digital terrain model or hazard maps for current and future risks • Risk assessment for main economic sector done and publicly available

[97] Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy: https://www.gidb.org/usd-5-trillion-economy-task-force-report
[98] https://openknowledge.worldbank.org/entities/publication/2dc19238-096a-5907-89c2-d4b99e6cb4d3

Adaptation Principle	Actions	Lead Ministry for Actions	Sample targets and indicators
			• Data platform providing easy access to hazard and climate change scenario data
	Clarify responsibilities and align incentives with adaptation and resilience objectives Allocating responsibilities may require significant institutional and legal reforms.	Economy or Finance	• Law allocating responsibilities and liabilities for disaster risk management and climate change impacts passed • Target level of residual risks published and made publicly available-for example, through residual flood risk maps
	Facilitate access to technologies through research and development investments and trade policies	Economy or finance, with environment/infrastructure	• Share of farmers using improved crops and climate-smart practices • Share of research and development (R&D) or percentage of patents related to climate change adaptation • Total amount invested in R&D on adaptation-related or resilience related challenges • Amount invested by the public or private sector in R&D on adaptation-related or resilience related challenges
	Ensure financing is available to all, and provide support to the poorest and most vulnerable people	Economy or finance, with social affairs/social protection	• Number of firms/people accessing dedicated financing instruments such as guarantees, subsidized loans • Total borrowing for adaptation through dedicated windows • Share of poor and vulnerable population receiving support for adaptation • Total subsidy/spending targeting poor and vulnerable populations to support adaptation action
	Facilitate structural change in the economic system • Support sunrise sectors and activities to maximize their development potential • Manage sunset sectors and activities to facilitate a smooth transition • Support economic diversification to hedge against climate risks	Economy or finance	• Strategy to manage the decline of negatively affected sectors published, or to support the development of nonaffected or positively affected sectors published • Share of GDP, employment or exports in sectors expected to be negatively or positively affected • Measure of economic diversification
Priority Area 2: Adapt land use plans and protect critical public assets and services **Lead Ministry:** Economy, planning, investment, or infrastructure	Identify critical public services and assets	Economy, planning, investment, or infrastructure	• Critical infrastructure and services identified • Inventory of public assets and infrastructure prepared, including hospital, school, and university buildings, their condition, exposure to hazards, and maintenance history • Gaps in infrastructure and public assets identified • Investment plans to increase the resilience of public services and infrastructure systems completed
	Design and implement a government-wide strategy to increase the resilience of infrastructure and public assets • More resilient infrastructure is good economics, but a governance and financing challenge • Improving decision making and governance with the right institutions	Economy, planning, investment, or infrastructure	• Strategy to manage critical assets and infrastructure is approved and published • Agency in charge of coordinating resilience of critical assets and infrastructure is created and operational

Adaptation Principle	Actions	Lead Ministry for Actions	Sample targets and indicators
			• Asset management systems with evidence-based maintenance plans are in place • Construction standards for infrastructure and building are updated, accounting for local hazards and criticality • Expected recovery time for critical infrastructure systems—power, transport, water—after a major event • State-owned enterprises have included climate change in their strategy and decision making
	Revise land use and urban plans to make them risk-informed • Mandate land use and urban planning to accounts for long-term risks • Explore the implications of climate change for internal migrations and regional economic impacts • Systematically consider nature-based solutions • Consider strategic retreat when risk reduction is impossible or unaffordable	Interior, planning, investment, infrastructure, or environment	• Percentage of country/ municipalities with revised land use or urbanization plans that include current and projected hazards • Share of population living in (or relocated from) high-risk areas, fragile buildings or retrofitted fragile buildings • Areas impossible or too costly to protect against climate change impacts identified and communicated to the public • Regulation mandating the provision of climate and hazard information to buyer in real estate markets
Priority Area 3: Help firms and people manage residual risks and natural disasters **Lead Ministry:** Interior or environment	Save lives (and money) with hydromet, early warning and emergency management systems	Interior and environment	• Daily weather forecasts are produced by the hydromet agency and an easy-to communicate alert system is in place • Communication channels are in place to efficiently communicate early warnings to the population and emergency services • Average distance to closest shelter • Capacity of shelters or emergency services—for example, number of emergency medical service units, and trained health emergency professionals • Duration communities can operate safely and independently—for example, water and food storage and medical supplies
	Provide all firms and households with risk management instruments	Economy or finance, with social affairs or protection	• Overall strategy to manage residual risks and disasters is prepared and approved • Coordination mechanisms between various preparedness actors are in place-for example, ministries or agencies for crisis management, social protection, food security and agriculture, finance • Fraction of the population covered by at least one financial instrument to cope with shocks-for example, insurance, social protection, or access to emergency borrowing
	Develop the insurance sector, building on public-private partnerships	Economy or finance	• Share of population with disaster insurance

Adaptation Principle	Actions	Lead Ministry for Actions	Sample targets and indicators
			• Share of population with access to emergency loans from financial institutions • Share of population with financial savings in a bank account
	Build a social protection system that is responsive to shocks • Ensure that social protection systems can be scaled up in case of disaster • Strengthen social protection systems, especially delivery systems and pre-arranged finance • Ensure resilience measures support long-term adaptation and do not lock people into a place or activity	Social affairs or social protection	• Stress test of existing systems completed, including delivery mechanisms • Contingency plan to scale up social protection systems developed and approved • Share of population covered by social protection or in social registry, including potential beneficiaries
	Help firms develop business continuity plans and financial preparedness	Economy or finance	• Fraction of firms with BCPs or disaster insurance coverage • Number of area based BCPs
	Be prepared to build back better after disasters, with contingency plans and financing	Economy, planning, environment, investment, or infrastructure	• Resilient recovery and reconstruction plan ready for implementation, with revised land use and standards • Pre-approved contracts for emergency interventions (such as debris removal) or reconstruction (such as road repairs) approved, with enhanced standards
Priority Area 4: Manage financial and macro fiscal issues **Lead Ministry:** Economy or finance	Include contingent liabilities (explicit and implicit) from natural disasters • First dimension: public and private asset reconstruction costs and environmental shocks in the planning and budgeting process • Second dimension: impact on tax revenues	Economy or finance	• Risk to public assets and corresponding contingent liabilities assessed • Emergency and social protection spending needs and corresponding contingent liabilities assessed • Explicit and implicit contingent liabilities quantified and included in budget documents • Risk to GDP and tax revenues estimated and included in budget documents
	Develop a financial strategy to manage contingent liabilities, combining multiple instruments • Revenue and resource mobilization solutions • Expenditure-side challenges and solutions	Economy or finance	• Percentage of explicit and implicit contingent liabilities covered by reserve funds, contingent credit lines, insurance products or similar instrument • Process for managing inflow of international aid in place in case of major disasters, including using existing financial instruments to coordinate delivery • Post-Disaster Public Financial Management and Engagement Framework (PD-PFM Review) conducted and approved • PD-PFM principles and processes approved
	Anticipate and plan for long-term macroeconomic impacts • Explore the possible impact on long-term GDP growth • Evaluate impacts on tax revenues, spending needs, and public debt sustainability	Economy or finance	• Sector-level adaptation plans collected, harmonized, and costed, and an estimate of public adaptation spending needs produced • Long-term plan to diversify tax revenues away from vulnerable sectors approved

Adaptation Principle	Actions	Lead Ministry for Actions	Sample targets and indicators
			• Climate and disaster impacts included in debt sustainability assessment or financial sector assessment program • Share of tax revenues originating from high vulnerability sectors
	Communicate and mitigate disaster and climate risk exposure of the financial sector and pension systems	Economy or finance	• Regulations of banks, insurers, and large investors include specific disaster and climate risk requirements • All banks, insurers, and large investors conduct stress tests for climate and disaster risks, including at least two climate scenarios • All banks, insurers, and large investors provide a quantified estimate of their exposure to natural hazards
Application: Prioritization, implementation and monitoring progress **Lead Ministry:** Finance/ economy and ministry or agency in charge of climate change (often environment)	Create a strong institutional and legal framework, with appropriate stakeholder involvement • Adjusting the mandate of existing ministries, agencies or institutions • Creating new agencies or committees where needed • Establishing an overarching coordinating body	-	Six actions discussed on the left to effectively implement an adaptation and resilience strategy
	Design an adaptation and resilience strategy with prioritized actions Long term should be considering while selecting short-term priorities. Selected short-term interventions need to: • Build the foundation for future interventions—for example, by establishing the right institutions and governance systems • Demonstrate the value of investing in resilience—for example, by supporting pilot and demonstration projects that can then be scaled up and generalized • Prevent irreversible impacts—for example, by implementing interventions that cannot wait	-	
	Set concrete sector-level targets to guide implementation by line ministries	-	
	Screen all public policies and expenditures for disaster and climate risks, and align them with adaptation targets	-	
	Allocate appropriate funding to the adaptation strategy	-	
	Track progress over time, and review and revise the strategy	-	

3. Implementation Roadmap for sectoral climate change interventions

The significance of prioritising climate change awareness while fostering economic growth is underscored by empirical evidence suggesting the potential consequences of climate change on economic development. According to studies, climate change is likely to significantly slow economic development, a tendency that will be evident in areas like Asia and Africa. These results are extremely relevant to India since, by 2100, uncontrolled climate change is predicted to reduce GDP by staggering 10% compared to a scenario without such environmental stressors. The same may hold true for the Gujarat state's GSDP. Not only will it have an economic impact, but the combination of a failing environment and harsh weather might seriously hamper progress towards development. Extreme events, which can set back years of progress, coupled with a declining environment, are poised to hinder resilience in coping with the fallout of these calamities.[99]

This translates the urgency for Gujarat to prioritize climate change measures within its economic growth framework. The climate change impacts will not only diminish government revenues due to decreased productivity but also necessitate increased spending to address the aftermath, which would intensify fiscal strains by further reducing government incomes and amplifying expenditure, thereby adversely affecting budgets. This effect is very important for a state like Gujarat, where the goal is steady economic progress. The state of Gujarat shall prioritize climate change activities to protect its economic prosperity and sustainability.

Climate Change and Environment Action Plans (CCEAP) have been developed for multiple districts of India. The plans for Ahmedabad and Rajkot districts were developed in collaboration with the Climate Change Department (GoG), Gujarat Ecological Education and Research (GEER) Foundation and Forests and Environment Department (GoG). The CCEAP aims to complement the SAPCC version 2.0 and provides sector-wise recommendations from a climate perspective, with an aim to complement India's 2030 NDC commitments.[100] Potential short, medium and long term measures GoG may consider to effectively manage the climate change plans and strategies in the economic growth sectors that are discussed below.

3.1. Energy Sector

The economic strategy document of Gujarat discusses about the contribution of the energy sector in GSDP, growth ambition of the sector from FY 22 to FY 27, energy consumption over next 5 years, RE capacity addition of ~21 GW, RE procurement obligations, attracting private capital in emerging technologies, offshore/ nearshore wind generation/ solar thermal power, floating solar generation, biomass-based generation and Waste to Energy, grid stability, green hydrogen parks and RE powered Electric Mobility. The sector economic strategy minimally touch upon the climate change impacts and how energy sector like addition of RE instead of coal-based energy can aid in minimising the climate change impacts, and the alignment of climate change plans within the energy sector economic growth pursuits may be considered. The following table highlights the key recommendations related to minimising climate change impacts of the energy sector that may be considered while formulating or revising economic growth plans.

Table 3: Climate change interventions, timeframe and implementation framework for Energy sector

Recommendation	Timeframe for action	Framework for implementation
Increase the share RE generation by advancing rooftop and ground mounted installations and other RE installations	• Short to medium-term (government) buildings)	• Policy framework and RE targets exist: Renewable Energy Policy 2023, Solar Power Policy 2021, Surya Urja Rooftop

[99] Policy Department Economic and Scientific Policy Climate change impacts on Developing Countries -EU Accountability. (2007)
[100] https://www.vasudha-foundation.org/wp-content/uploads/Full-Action-Plan-Ahmedabad.pdf and https://www.vasudha-foundation.org/wp-content/uploads/Full-Action-Plan-Rajkot.pdf

Recommendation	Timeframe for action	Framework for implementation
	• Medium-term (commercial buildings) • Medium to long term (residential and others)	Yojana, Waste to Energy Policy 2022, Wind Repowering Policy 2018, Wind-Solar Hybrid Power Policy-2018, Small Hydel Policy 2016 • Create awareness in residential sector
Aggressively promote battery storage for RE	Short to medium term	• Additional financial support can be created
Encourage captive use of RE, particularly, in rural areas for small industries and creation of local entrepreneurs	Short to medium term	• Policy framework exists: Policy for Development of Small scale distributed solar projects 2019 • Need to create awareness
Promote green municipal bonds to mobilise untapped investments towards green projects, such as RE infrastructure development, waste management etc.	Medium to long term	• Needs policy formulation • Collaboration among various stakeholders required • Create specific financial instruments
Upgrade DISCOM infrastructure and their supply network to reduce AT&C losses, billing inefficiencies etc. Additionally, introduction of smart billing system would help reduce power thefts and increase billing efficiency, helping the DISCOM generate more income	Short to medium term	• Policy framework and targets exist: Restructured Accelerated Power Development and Reforms Programme (R-APDRP), UDAY Scheme 2015, Integrated Power Development Scheme (IPDS) • With optimum push, this initiative can help India align with the Paris Agreement targets
a) Ensure regular PAT compliance of DISCOMs and other designated consumers (DCs) in the district; b) Increase the number of DCs for PAT scheme in the district and ensure the compliance of targets	• a) Short term and continuous • b) Medium to long term	• Policy framework exists but targets need to be revised gradually: National Mission on Energy Efficiency specifically PAT • Ensure Monitoring and Evaluation • Collaboration required
Ensure compliance of renewable purchase obligations (RPO) and increase the RPO targets gradually	Medium to long term	• Policy framework exists
Encourage faster penetration of Street Lighting National Programme (SLNP) which would ensure that all street and public lighting fixtures are replaced with energy efficient LED bulbs, prioritising premises and recreational areas of all government / public institutions	Short term	Policy framework and schemes exist: National Mission for Enhanced Energy Efficiency, Streetlight National Programme (SLNP) 2015, UJALA Scheme 2015, Municipal Energy Efficiency Programme (MEEP)
Advanced metering infrastructure (AMI): Expedite installation of smart meters in collaboration with GUVNL	Short to medium term	• Policy frameworks exist: Smart Cities Mission, Smart Meter National Programme (SMNP) • Need to create awareness in residential sector
Smart meters along with its associated IT infrastructure would allow the DISCOM to obtain real time energy consumption data	Short to medium term	• Policy frameworks exist: Smart Cities Mission, Smart Meter National Programme (SMNP) • Need to create awareness in residential sector
Replace/ upgrade existing inefficient pumping infrastructure with energy-efficient pumps/ solar pumps for supply of piped drinking water in both rural and urban pockets.	Short to medium term	• Relevant schemes and programmes can help achieve this: Municipal Energy Efficiency Programme (MEEP), Smart Cities Mission, Sustainable Habitat Mission • Inter departmental collaboration
In agricultural sector, promote use of energy efficient water pumps (provided by EESL), and solar pumps (through PM-KUSUM and SKY)	Short to medium term	• Policy framework exists: PM KUSUM, Surya-Shakti Kisan Yojana (SKY)

Recommendation	Timeframe for action	Framework for implementation
Increase community awareness on and access to energy-efficient appliances and fixtures	Medium term	• Additional financial support can be created • Relevant programmes exist: Standards and Labelling Programme • Create awareness through dedicated IEC and long running campaigns
Provide additional incentives over and above existing schemes/ programmes on energy efficient appliances.	Medium term	• Additional financial support can be created • Create awareness through dedicated IEC and long running campaigns
Enhance public awareness towards energy-efficient BEE star-labelled home appliances	Short term and continuous	• Needs collaborations and awareness
Energy Conservation Building Code (ECBC) to be incorporated in the building by laws for all ULBs, as a pathway to buildings having net zero energy consumption	Medium to long term	• Policy framework exists: ECBC • Inter-departmental collaboration required • Capital incentives/ relevant exemptions over and above the existing provisions from the district administration are required
District administration in collaboration with the ULBs can implement the India Cooling Action Plan (ICAP) and achieve its objectives, in tandem with the District Heat Action Plan	Medium term	• Policy framework exists: India Cooling Action Plan 2019 • Needs inter departmental collaboration • Capital incentives/ relevant exemptions from the district administration required
Replace diesel powered backup with RE-powered backup in a phased manner. This can essentially be promoted in government / commercial / institutional buildings with built-up area >20,000 sqft	• Short to medium term (govt. buildings) • Medium to long-term (privately-owned, commercial, institutional, and others)	• Policy intervention is required • Proper policy backup can mitigate GHG emissions and align India with Paris targets • Needs inter departmental collaboration
Encourage fast penetration of UJALA scheme in every household	Short to medium term	• Schemes and programmes exist: UJALA Scheme 2015
Installing rainwater harvesting setups in buildings that can considerably reduce energy dependence on submersible motors for groundwater pumping	Short term	• Schemes and programmes exist: Comprehensive General Development Control Regulations, Urban Development and Urban Housing Development (GoG), Sustainable Habitat Mission • Awareness generation required
Encourage residential societies to adopt solar thermal water heaters	Short term and continuous	• Schemes and programmes exist: Policy for Development of Small scale distributed solar projects 2019 • Inter departmental collaboration required • Scheme to be implemented as a part of green buildings
Digital tools like GIS and remote sensing can be used to identify opportunities to reduce energy demand as well as where energy efficiency interventions hold the most value	Medium to long term	• Needs policy intervention and infrastructural development

The primary departments/ agencies for the implementation of the above discussed recommendations may be Energy Efficiency Services Limited (EESL), Gujarat Energy Development Agency (GEDA), Urban Local Bodies (ULBs), Urban Development and Urban Housing Department (GoG), Panchayati Raj Institutions (PRIs), Energy and Petrochemicals Department (GoG). The supporting departments/ agencies that may be considered are Climate Change Department (GoG), Department of Agriculture (GoG), Ports and Transport Department/ GSRTC, Road and Building Department (GoG), Urban Development Authorities, District level Committee on Climate Change and Environment, and Smart City Development Limited of respective cities.

3.2. Transportation Sector

The economic strategy document of Gujarat discusses about growth ambition of the transportation sector from FY 22 to FY 27 focused on Ports, Roads, Rail and Air. It discusses about the next 5-year sector growth strategy focusing on greenfield and brownfield expansions of ports, new road constructions and capacity enhancement of roads, doubling the existing rail at key industrial areas and ports, development of semi high speed rail connectivity, rail connectivity in Special Investment Regions (SIRs) and development of air freight hub. The sector economic strategy does not touch upon the climate change impacts to be considered while achieving the growth plans of the sector and alignment of climate change plans within the transportation sector economic growth pursuits. The following table highlights the key recommendations related to minimising climate change impacts of the transportation sector that may be considered while formulating or revising economic growth plans.

Table 4: Climate change interventions, timeframe and implementation framework for Transportation sector

Recommendation	Timeframe for action	Framework for implementation
Generate awareness and disseminate information to encourage adoption of electric vehicles	Short term and continuous	• Inter departmental collaboration • Dedicated long running campaigns required
Make all public transport (PT) modes low carbon intensive, such as shifting current fossil fuel-based vehicles to electric powered or hybrid vehicles	Medium to long term	• Policy framework and budgetary provisions exist: FAME II, Gujarat EV Policy 2021, National Electric Mobility Mission Plan
Initiate transition of intermediate public transport (IPT) vehicles to electric by incentivising IPT operators through subsidies, separate lanes and dedicated parking space	Medium term	• Policy framework: FAME II, Gujarat EV Policy 2021, National Electric Mobility Mission Plan
District administration, ULBs (for office use and solid waste transport activities) and all district-level government offices can adopt e-vehicle fleets. Also, all these offices can install charging infrastructure at the earliest	Short to medium term	• Needs policy backing
Develop robust and widespread charging infrastructure	Medium	• Policy framework exists: FAME II, Gujarat EV Policy 2021, National Electric Mobility Mission Plan • Inter departmental collaboration required
District administrations in collaboration with the ULBs and state officials, may explore options to provide incentives to e-vehicle owners over and above existing programmes through exemptions on road tax, exclusive parking and continuation of the existing subsidy scheme for women and students	Short term	• Some policy framework exists, needs to be enhanced towards holistic integration of e-vehicles in the district transport regime
Promote fast registration of EVs at RTO	Shor term	• Existing policy framework can be enhanced
Encourage and promote adoption of EVs for all delivery operations within the district	Short to medium term	• Policy framework is required
Implement policy measures to discourage use of private vehicles by parking policy for vehicle ownership, no car days on certain roads and Parking allowed only in dedicated areas	Short to medium term	• Policy framework is required • Needs research and interdepartmental collaboration
Improve infrastructure to increase modal share of Non-Motorised Transport (NMT) transport in urban areas, such as by introduction of segregated cycle lanes	Medium term	• Requires policy based on research and inter departmental cooperation
Upgrade public transport infrastructure to include RE and ECBC compliance. Roadside hoardings near such	Short to medium term	• Can be pushed forward by aligning with existing policy framework for solar rooftop

Recommendation	Timeframe for action	Framework for implementation
infrastructure can also be powered through RE		• ECBC compliance of public transport infrastructure needs to be mandated by building bye-laws
Energy efficiency of infrastructure in railways - Installing solar panels along electrified tracks and on railway station rooftops; Installing optimal light control systems and appliances, smart sensors and building management systems at station buildings; Equipping electric traction rolling stock with regenerative capability and feedback to the grid	Medium term	• Needs inter-departmental collaboration

The primary departments/ agencies for the implementation of the above discussed recommendations may be Gujarat State Road Transport Corporation (GSRTC), Gujarat Metro Rail Corporation Limited (GMRC), Regional Transport Offices or Road Transport Offices (RTOs), Urban Local Bodies (ULBs) and Energy Efficiency Services Limited (EESL). The supporting departments/ agencies that may be considered are Transport Department (GoG), Roads and Buildings Department (GoG), Climate Change Department (GoG), Gujarat Energy Development Agency (GEDA), District level Committee on Climate Change and Environment, Urban Development Authorities and Smart City Development Limited of respective cities

3.3. Manufacturing Sector

The economic strategy document of Gujarat discusses about the contribution of the manufacturing sector in GSDP and GVSA, growth ambition of the sector from FY 22 to FY 27, next 5-year sector growth strategy focusing on emerging and growing sub sectors, export development, industrial infrastructure development, investment promotion, enhancing manufacturing competitiveness and skill development. The sector economic strategy does not touch upon the climate change impacts to be considered while achieving the growth plans of the sector and alignment of climate change plans within the manufacturing sector economic growth pursuits. The following table highlights the key recommendations related to minimising climate change impacts of the manufacturing sector that may be considered while formulating or revising economic growth plans.

Table 5: Climate change interventions, timeframe and implementation framework for Manufacturing sector

Recommendation	Timeframe for action	Framework for implementation
Develop an incentive system, similar to a 'cap-and-trade' system at district level for enhancing energy efficiency of MSMEs in coordination with the state energy department	Medium term	• Requires policy framework, based on research and inter-departmental cooperation
Promote combined heat and power (CHP)/ co-generation for running captive power plants	Medium term	• Policy framework exists: Gujarat Industrial Policy 2020, National Mission on Enhanced Energy Efficiency • Inter-departmental collaboration required • Need to create awareness to popularize the initiative
Optimise equipment efficiency: Equipment that are not usually turned off during downtime, such as heating or cooling equipment, pumps, alarm systems, etc., need to be energy-efficient	Medium term	• Policy framework exists: Gujarat Industrial Policy 2020, National Mission on Enhanced Energy Efficiency
Invest in green projects, such as plantation drives and afforestation activities within and around industrial areas	Short term	• Policy framework exists • Improved monitoring and evaluation will give recommendation a further push
Target better Monitoring & Evaluation (M&E) of energy audits to improve accountability	Short to medium term	• Policy framework already exists • Inter-departmental collaboration is required for successful implementation

Recommendation	Timeframe for action	Framework for implementation
Create appropriate district-level rules to enable and encourage industries to use recycled water from their plants rather than freshwater	Short term	• Policy framework exists (Reuse of Treated Wastewater Policy 2018). However, it needs to be upgraded in collaboration with responsible agencies and departments

The primary departments/ agencies for the implementation of the above discussed recommendations may be Industries and Mines Department (GoG). The supporting departments/ agencies that may be considered are Climate Change Department (GoG), Industries Commissionerate, Gujarat Industrial Development Corporation (GIDC), Gujarat Industrial Investment Corporation, Gujarat Energy Development Agency (GEDA), Energy and Petrochemicals Department (GoG), District Industries Centre, Gujarat Urja Vikas Nigam Ltd. (GUVNL)-Uttar Gujarat Vij Company Ltd. (UGVCL), District level Committee on Climate Change and Environment

3.4. Agriculture and allied sector

The economic strategy document of Gujarat discusses about the contribution of agriculture and allied sector in GSDP and GVSA, growth ambition of the sector from FY 22 to FY 27, next 5-year sector growth strategy focusing on important sub sectors, production trends of agriculture and allied sectors, growth opportunities & challenges, existing Government schemes/ support, seed, irrigation, farm mechanization, market orientation and processing, diversification through horticulture, fisheries, dairying, and development of Agribusiness Extension Bureau. The sector economic strategy does not touch upon the climate change impacts to be considered while achieving the growth plans of the sector and alignment of climate change plans within the agriculture sector economic growth pursuits. The following table highlights the key recommendations related to minimising climate change impacts of the agriculture and allied sector that may be considered while formulating or revising economic growth plans.

Table 6: Climate change interventions, timeframe and implementation framework for Agriculture and allied sector

Recommendation	Timeframe for action	Framework for implementation
Agriculture		
Promote sustainable farming practices and programmes, like use of non-chemical fertilisers and zero budget natural farming	Short to medium term	• Policy framework exists: National Mission for Sustainable Agriculture, Rashtriya Krishi Vikas Yojana, Remunerative Approaches for Agriculture and Allied Sector Rejuvenation (RAFTAAR) • Budgetary provisions are available
Promote adoption of alternative ways of managing crop residue other than burning	Short to medium term	• National level policy exists: National Policy for Crop Residue Management • Policy framework is required at state level • Collaboration is required • Farmers to have easy access to markets/ industries that would take crop residue/ stubble
Farmers should be encouraged to follow the recommendation given in Soil Health Card Scheme	Short to medium term	• Policy framework exists: Soil Health Card • Can be implemented by generating awareness
Promotion of micro-irrigation (MI) to improve water use efficiency. It saves water, energy and fertiliser consumption	Short to medium term	• Policy framework is available: Pradhan Mantri Krishi Sinchayee Yojana, National Mission on Micro Irrigation • Enable swift procedures and subsidy disbursement for adoption of micro-irrigation • Consider providing additional subsidies
Encourage adoption of latest technologies like Solar pumps (under PM KUSUM Yojana and SKY), Star-rated energy efficient pump system (EEPS) and Smart control panels and	Short to medium term	• Policy framework is available: PM KUSUM Yojana, SKY • Capital investment support, over and above the existing policy can be considered

Recommendation	Timeframe for action	Framework for implementation
internet of things based systems for optimum resource utilisation (water and energy)		
Enhance the efficiency/ network of cold storage systems and initiate a gradual shift to RE powered cold storages	Medium to long term	• Policy framework exists and can be enhanced: National Mission on Food Security • Capital investment required • Align with solar rooftop policies and ECBC
Encourage millet cultivation (requires less water to grow, shows good productivity under extreme climate conditions and is nutritionally rich)	Medium to long term	• Needs creation of appropriate financial mechanisms to encourage farmers to grow millets • Requires research collaboration
For overall reduction in electricity and water consumption, subsidies can be reduced by some percentage in a phased manner	Medium to long term	• Policy intervention needed • Awareness needs to be created among the farming communities, followed by collaborations
Livestock		
Promote grasslands and cultivation of cattle feedstock for good quality forage and to manage fodder scarcity	Short to medium term	• Policy framework exists: National Livestock Mission, Rashtriya Krishi Vikas Yojana • Research inputs required • Collaboration between different communities (farming and pastoral) is needed
Promote cattle breeds with higher productivity. Productivity of indigenous cattle should also be improved (e.g., through provision of Nand Ghars)	Medium to long term	• Policy framework exists: National Programme for Dairy Development, Livestock Health and Disease Control, National Programme for Dairy Development, Intensive Cattle Development Programme • Research collaboration required (to ensure biodiversity of the region is not impacted) • Awareness generation • Monetary support to the pastoral community required
Promote use of waste from livestock and poultry as an important source of organic manure for various crops, such as, sugarcane, potato etc. for enhancing crop production	Short to medium term	• Policy framework is available • Collaboration between different communities (farming and pastoral) is needed
Forestry and green spaces		
Ensure minimum diversion of forest land for any activity or project and promote compensatory afforestation (of the same species)	Short to medium term	• Policy framework and budget provisions exist: Compensatory Afforestation Fund, Integrated Development of Wildlife Habitat (IDWH), Management and Planning Authority (CAMPA) • Policy implementation required • Stringent monitoring and evaluation
Measures to increase trees outside forest area and green spaces: Setting up of urban parks, transplanting trees with the help of tree transplanter machine, Initiate afforestation activities on wastelands and fallow lands, Development of green belt along the major terrain roads and surrounding the industrial areas, etc.	Medium to long term	• Policy framework is available: National Afforestation Programme (NAP), Green India Mission (GIM) • Requires capital investment • Research collaboration and inter departmental cooperation are required
Ensure ULBs regularly monitor survival of the trees post plantation.	Short to medium term	• Monitoring and evaluation required • Collaboration among different stakeholders is needed

Recommendation	Timeframe for action	Framework for implementation
Various aspects of joint forest management (JFM) need to be promoted	Short to medium term	• Exclusive communication strategy and information, education and communication (IEC) material to be developed and used • Provisions of monetary support
Develop participatory forest fire management strategies such Collecting baseline forest fire data in respect to perceptions, beliefs, expectations and behaviour of local people with regard to forest fires; Training local communities to tackle forest fires; Organising awareness programmes in local schools; Building capacities to develop an early warning system	Medium to long term	• Provisions of monetary support • Exclusive communication strategy and Information, Education and Communication (IEC) material to be developed and used • Requires collaboration among different stakeholders
Promote regeneration of degraded and open forest areas through corporate social responsibility (or similar mandates) and encourage corporates to dedicate some percent of their profit for greening the spaces around their units/ factories	Long term	• Needs strengthening of the existing policy framework • Needs different stakeholder collaboration

The primary departments/ agencies for the implementation of the above discussed recommendations may be Agriculture, Farmers' Welfare and Co-operation Department (GoG), Animal Husbandry Department, (GoG) and Gujarat Forest & Environment Department (GoG). The supporting departments/ agencies that may be considered are Climate Change Department (GoG), Gujarat Green Revolution Company (GGRC), Rural Development Department (GoG), Irrigation Department (GoG), Energy and Petrochemicals Department (GoG), Gujarat Urja Vikas Nigam Limited (GUVNL), Gujarat Water Resource Development Corporation (GWRDC), Animal Husbandry Co-operation, Gujarat Agro Industries Corporation (GAIC), Anand Agriculture University, Agricultural Produce Market Committee (APMCs), District level Committee on Climate Change and Environment, Urban Local Bodies (ULBs) and Urban Development Authorities.