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WHITE PAPER ON

IMPLEMENTATION OF PANCHAMRIT IN GUJARAT STATE

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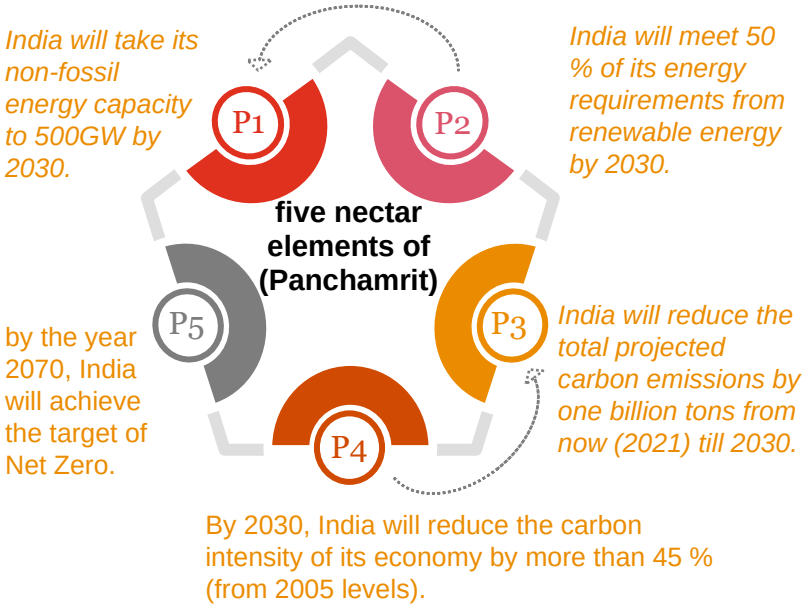
Abbreviations

BU	Billion Units
CAGR	Cumulative Annual Growth Rate
CCD	Climate Change Department, Government of Gujarat
CCUS	Carbon Capture Utilisation and Storage
CEI	Chief Electrical Inspector
CUF	Capacity utilisation Factor
EPD	Energy & Petrochemicals Department
EV	Electric Vehicle
FY	Financial Year
GDP	Gross Domestic Product
GEDA	Gujarat Energy Development Agency
GETCO	Gujarat Energy Transmission Company
GP	Gujarat's Panchamrit
GUVNL	Gujarat Urja Vikas Nigam Limited
GW	Giga Watts
GWh	Giga Watt Hours
InSTS	Intra-State Transmission System
ISTS	Inter-State Transmission System
MNRE	Ministry of New & Renewable Energy
MoP	Ministry of Power
MtCO2e	Million tons of carbon dioxide-equivalent
MTPA	Million tonnes per annum
MU	Million Units
MW	Mega Watts
MWh	Mega Watt Hours
NDC	Nationally Determined Contributions
RE	Renewable Energy
RPO	Renewable Purchase Obligation
TFEC	Total Final Energy Consumption
T&D	Transmission and Distribution
UNFCCC	United Nations Framework Convention on Climate Change

1. Executive Summary

India's announcement of the "Panchamrit" initiative at COP26 stands as a pivotal stride in the global battle against climate change. The genesis of the Panchamrit initiative is rooted in India's recognition of the urgent need for transformative action to address the escalating climate crisis.



P1: The first element of Panchamrit target proposes increasing the non-fossil energy generation capacity, which includes renewable energy (solar, wind, waste to energy, small hydel etc), large hydro as well as nuclear power projects.

P2: The Panchamrit 2 drives consumption side pull for renewable energy through various policy/ regulatory interventions such as Renewable Purchase Obligation (RPO), carbon credits, carbon tax, and voluntary initiatives like RE100 commitment.

P1 and P2 are correlated. P2 is defining the energy mix desired from the demand side and share of renewable energy into that. P1 provides a supply side drive to produce such required quantum of renewable energy through use of various non-fossil energy technologies.

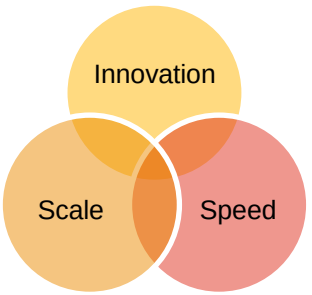
P3: Panchamrit 3 drives India's scale of deflection in reducing carbon emissions due to environmentally sensitive development pathway. Panchamrit were announced in 2021, India aims to reduce 1 billion tonnes of its gross emissions between 2022 and 2030 as compared with business-as-usual scenario.

P4: Panchamrit 4 reflects India aims to decouple economic development from carbon emissions. It presents India's ambition to foster economic progress and become a developed country during the *Amrit Kaal* (by 2047 – 100th anniversary of India's independence) on a decarbonised pathway.

Further, **P5**: India emphasises on *Vasudhaiva Kutumbakam.* It underscores the importance of considering today's economic prosperity while ensuring a high quality of life for future generations. Therefore, India aims to pursue a sustainable pathway that integrates economic development, energy security, affordability, and decarbonization in a synergistic manner. India has set the long-term goal to achieve Net Zero by 2070.

Gujarat's focus on climate change

Gujarat has been a front runner in India sustainable growth pathway. Gujarat was the first state to create a dedicated Climate Change Department, focused entirely on the activates towards sustainable development and climate action. Gujarat's climate commitment reflects – **Innovation, Scale** and **Speed.**



Gujarat has hosted India's initial wind project in 1984. Recently, it commissioned the world's largest 5.2 MW wind turbine. Additionally, Gujarat established the inaugural solar park, "Charanka solar park," in 2012, and now developing the largest renewable energy park, with a capacity of 30 GW in Khavda. Continuing the efforts and motivation of Government of Gujarat, this paper intends to define the Panchamrit elements for Gujarat and its action plan to achieve those targets.

Panchamrit for Gujarat

National targets for Panchamrit cannot be uniformly derived among states due to their varying economic scale, economic structure, population, and resource potential. Certain states must lead the transition by signalling pertinent policies, nurturing incubation ecosystems, making astute economic decisions, and acknowledging their unique climate vulnerabilities to pave the way forward. Gujarat is determined the same as tabulated below:

Table 1: Gujarat's Panchamrit (GP1 to GP5)

Sr. No	Panchamrit for Gujarat
GP1	120 GW non-fossil energy capacity by 2030
GP2	55% of energy requirements from renewable energy by 2030
GP3	Reduction of total projected carbon emissions from 2022 to 2030 by 145 million tons
GP4	Reducing the carbon intensity of the state's economy to 60% below 2005 level
GP5	Achieve Net65 by 2030

GP2: 55% of energy requirement from renewable energy by 2030

Energy can be consumed in electric as well as thermal form. Considering commercially feasibility at the material scale over given time horizon, the focus is on the electrified use of renewable energy. Several emission intensive end-uses (in transport, and industrial applications) would transition to electrified means.

P2 indicates the share of renewable energy from the total electricity consumed within the states. GP2 determines the quantum of renewable energy needed in Gujarat – both through power utilities as well as direct use by consumers.

At present, 23% of Gujarat’s electricity is sourced from renewables. Ministry of Power's notification on the RPO will drive utilities to procure 43.33% of its electricity from renewable sources by 2030. The competitiveness of renewable energy is set to scale RE adoption more intensely in Industrial end-users. Upcoming industries/ expansion of existing industrial units in Gujarat will likely procure electricity majorly from renewable sources due to facilitation of Green Open Access and Energy Banking. CEA has projected a total electricity demand of 302 BUs for Gujarat by the year 2030. Out of this, Gujarat aims to fulfil 166 BU through RE sources by 2030, which implies **sourcing 55% of its total energy needs from renewable sources by 2030**.

GP1: 120 GW non-fossil energy capacity by 2030

Non-fossil capacity includes RE as well as Nuclear power. Given longer gestation period of planned nuclear projects, and limited local resources for hydro power, Gujarat’s non-fossil capacity mix is planned accordingly. Gujarat is likely to scale up wind and solar power more innovatively with offshore wind, land neutral solar (floating, canal top, Agrivoltaics) and through RE hybrids. At present, 21% of Gujarat’s electricity is sourced from renewables excluding hydro power, vs India’s 14%.

P1 indicates the scale of generation capacity hosted within the state, irrespective of where it is utilized. At present Gujarat hosts 22 GW of installed RE capacity, of which 9.5 GW is procured by Gujarat's power utilities, while the rest is for captive/ open Access use within and outside Gujarat; and export to other state utilities.

State utility, GUVNL, procures RE power at the GETCO periphery as delivery point. From July 2025, the waivers on inter-state transmission charges are expected to reduce, most of the upcoming requirement for utility’s RE power would be hosted within the state. GETCO is already planning ~ 65 GW of additional evacuation capacity. Gujarat is supporting both private use of RE power within and outside the state, as well as supporting other state’s energy requirements. Under development RE parks at Dholera and Khawda will support ~ 26 GW of RE capacity designated for export to other states. Additionally, re-powering of wind projects established before 2010, will further add to overall generation capacity. Aggregating all of above, the expected capacity is around 118 GW. Hence, **Gujarat targets 120 GW of renewable energy capacity by 2030**.

GP4: By 2030, reducing the carbon intensity of the economy to 60% below 2005 level

Gujarat contributes to 8% of India's GDP, 18% of industrial output, and 30% of exports. Gujarat is set to play a pivotal role by contributing to 10% of India's GDP to make it a USD 5 trillion economy in this decade. Gujarat has higher per capita energy consumption, consequently, higher emissions for its economy too. Carbon intensity of economy in Gujarat was at 2,426 tCO2e/ Rs. Lakh vs India's 2,110 tCO2e/ Rs. Lakh in 2018 – putting it on relatively high baseline levels.

It is noteworthy that Gujarat has already exhibited a strong commitment to reducing the emission intensity of its economy. In 2018, the state achieved a notable 35% reduction in carbon emission intensity compared to 2005 while India stood at 21% reduction. Looking ahead from 2018 to 2030, China, known for the best reduction rate, achieved a 39% reduction in intensity from 2005 to 2018, displayed a CAGR of -3.76% which Gujarat aims to perform in near future. With that aspiration Gujarat targets that **by 2030, it will reduce the carbon intensity of the economy to 60% below its 2005 level.**

GP3: Reduction of total projected carbon emissions from 2022 to 2030 by 145 million tons

Gujarat would experience relatively faster economic growth. Given unique composition of its economy, its share in India's Net Emission would marginally increase from 9.7% to around 10.4% but share in Gross Emissions would rise to 14.5%. Gross Emissions are estimated by adding the above determined Net Emissions with estimated carbon-offsets. Emissions should be seen in the context of economic growth. As highlighted above, emission intensity of Gujarat's GDP will be decarbonised at far higher pace than that of India.

To achieve this, Gujarat is set to accelerate significant efforts on carbon-offsets in this decade, which are largely through Forestry and CCUS. Gujarat's state action plan for climate change, the state intends to expand its forest cover to encompass 5 million hectares. This is expected to contribute 166 $MtCO_2e$ to carbon offset. With an estimated CO_2 storage potential of 20% of India's overall capacity and considering India's target of carbon removal through CCUS activities at 35 million tonnes per annum (MTPA) by 2030, Gujarat will aim to cut 7 MTPA carbon through CCUS activities by 2030.

Gujarat's share in Gross Emissions would be of 14.5% of the country by 2030. India aims to reduce 1 billion tonnes of carbon emissions from 2022 to 2030. Correspondingly, Gujarat aims to **reduce total projected carbon emissions from 2022 to 2030 by 145 million tons.**

Around 80% of the India's emissions are coming from Energy Sector, of which majority contributors are from power, industries and transport segments. Power sector will reduce carbon footprint with its focus on energy efficiency and non-fossil fuel focus, and Transport sector would electrify to displace use of petroleum under Gujarat's EV policy 2021. Industry sector would need to contribute majorly in decarbonising pathway by 2030.

GP5: Gujarat will achieve Net-65 by 2030

The journey towards net zero emissions involves 1) Reducing the Gross Emissions; and 2) Offsetting emissions by an amount equivalent to the residual Gross Emissions. This ensures that the Net Emissions ultimately reach zero. India has set an ambitious target of achieving net zero emissions by 2070. Since other Panchamrit targets are with the targeted timeline till 2030, Gujarat has considered 2030 to define its milestone.

Considering the projected gross emissions for 2030 and the offset accounted for through initiatives such as forestry and CCUS, **Gujarat sets a specific target to achieve Net-65 by 2030**. This signifies that 35% of gross emissions will be offset through strategic measures like afforestation and CCUS, contributing significantly to the state's journey toward achieving a more sustainable and balanced emissions profile.

Roadmap for implementing Panchamrit in Gujarat

To achieve Panchamrit targets, each of them would require closer monitoring at the key indicator level at yearly interval. Therefore, Gujarat lays out the following roadmap of key indicators to provide unambiguous pathway to achieve all Panchamrit targets on or before 2030.

Table 2: Key indicators baseline, targets and factor of change to achieve all Panchamrit

Sr. No	Indicators	Baseline (FY22-23)	Target (FY29-30)	*Factor of change*
1.	RE share in state's total requirement	23%	**55%**	*+32%*
2.	State's total energy requirement (BU)	139	**302**	*217%*
3.	State's total RE requirement (BU)	32	**166**	*518%*
4.	RE Requirement by utility (BU)	22	**98**	*445%*
5.	RE Requirement – Captive/OA/ rooftop (BU)	10	**68**	*680%*
6.	Renewable Energy Installed capacity (GW)	20	**120**	*+100*
7.	Export of RE outside Gujarat (GW)	3	**38**	*+35*
8.	Solar (GW)	9	**71**	*+62*
9.	Wind Onshore (GW)	10	**37**	*+27*
10.	Wind Offshore (GW)	-	**5**	*+5*
11.	Bio Energy (GW)	0.11	**1.0**	*+0.89*
12.	Hydro Pumped Storage Projects (GWh)	-	**4,800**	*+4,800*
13.	Battery energy storage (GWh)	-	**4,200**	*+4,200*
14.	Reduction in carbon intensity of economy vis 2005	-36%*	**-60%**	*-24%*
15.	GSDP's emission intensity ($kgCO_2e$/ Rs. Lakh)	2,426*	**1,563**	*-36%*
16.	GDP (real terms) of Gujarat (Rs. '000 Cr.)	1,183*	**2,061**	*174%*
17.	Net emission ($MtCO_2e$)	287*	**322**	*112%*
18.	Net Emissions from Power sector ($MtCO_2e$)	94*	**136**	*145%*
19.	Net Emissions from Transport sector ($MtCO_2e$)	22*	**32**	*145%*
20.	Net Emissions from Industries ($MtCO_2e$)	101*	**138**	*137%*
21.	Offsets from forestry ($MtCO_2e$)	(5)*	**(166)**	*-161*
22.	Offsets from CCUS ($MtCO_2e$)	-	**(7)**	*-7*
23.	Gross emissions ($MtCO_2e$)	292*	**496**	*169%*
24.	Net emission% (Net x)?	Net98*	**Net65**	*-33%*

* Refers to 2018 baseline

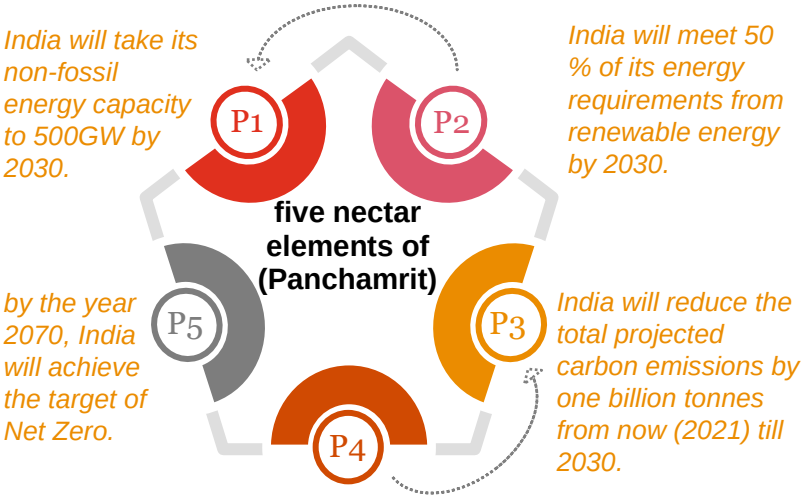
Each of above indicators are set to experience large factor of change over next seven (7) years. To enable it in timely manner several interventions are identified in this whitepaper. They are classified in following categories:

A. **Policy and regulatory measures:** to provide directional visibility, establish investment frameworks and tools to mitigation risks;
B. **Infrastructure and capital matters:** to ready catalyst infrastructure, define the scale investments needed;
C. **Stakeholder ecosystem:** to layout clear roles and responsibilities among key stakeholders, promote collaboration, drive innovation through knowledge sharing and streamline processes.

Towards the end, possible action plan for key stakeholder entities is provided to enable timely actions in the journey of this sustainable transition.

2. Context of Panchamrit

India's announcement of the "Panchamrit" initiative at COP26 stands as a pivotal stride in the global battle against climate change. With a multifaceted approach encompassing five vital elements, this ambitious initiative embodies India's commitment to fostering sustainable development and combating the pressing challenges of climate change. The genesis of the Panchamrit initiative is rooted in India's recognition of the urgent need for transformative action to address the escalating climate crisis. Motivated by the imperative to curtail greenhouse gas emissions and transition towards a low-carbon economy, India has pronounced a comprehensive strategy that aligns with the nation's sustainable development goals. Panchamrit" translates to "nectar with five elements" in Sanskrit.



P1: The first element of Panchamrit target proposes increasing the non-fossil energy generation capacity. No-fossil includes renewable energy (solar, wind, waste to energy, small hydel etc), large hydro as well as nuclear power projects. By investing in clean energy technologies and scaling up renewable energy infrastructure, India aims to significantly decarbonise the supply mix. With the accelerated growth of the economy, an anticipated increase in per capita consumption, the investments required in expanding new generation capacity will lean more towards cleaner sources of energy.

P2: The Panchamrit 2 commits to meet 50% of India's energy requirements from renewable energy sources by the year 2030. This specific target drives consumption side pull for renewable energy through various policy/ regulatory interventions such as Renewable Purchase Obligation (RPO), carbon credits, carbon tax, and volunteer initiatives like RE100 commitment. Further low cost of electricity generation through solar and wind sources already makes it commercially attractive vis conventional sources, hence it's integration of higher scale is emphasised.

P1 and P2 are correlated. P2 is defining the energy mix desired from the demand side and share of renewable energy into that. P1 provides a supply side drive to produce such required quantum of renewable energy through use of various non-fossil energy technologies.

P3: Panchamrit 3 drives India's scale of deflection in reducing carbon emissions due to environmentally sensitive development pathway. Around 80% of the India's emissions are coming from Energy Sector, of which majority contributors are from power, industries and transport segments. Panchamrits were announced in 2021, India aims to reduce 1 billion tonnes of its gross emissions between 2022 and 2030 as compared with business-as-usual scenario.

P4: Panchamrit 4 reflects India aims to decouple economic development from carbon emissions. India is one of the fastest growing economy and sustainable development is the key focus for its growth. This goal presents India's ambition to foster economic progress and become a developed country during the *Amrit Kaal* (by 2047 – 100th anniversary of India's independence) on a decarbonised pathway.

This can be evident from that fact that the Nationally Determined Contributions (NDC) of India at the United Nations Framework Convention on Climate Change (UNFCCC), as declared in 2015 were updated in August 2022 with bigger goals, considering that India will achieve the goal of reducing in the emissions intensity of its GDP by 33 to 35 per cent and share of on-fossil installed capacity of 40%, way earlier then then committed timeline of 2030 and hence should target bigger goals towards climate action.

Further, **P5**: India emphasises on *Vasudhaiva Kutumbakam.* It underscores the importance of considering today's economic prosperity while ensuring a high quality of life for future generations. Therefore, India aims to pursue a sustainable pathway that integrates economic development, energy security, affordability, and decarbonization in a synergistic manner. India has set the long-term goal to achieve Net Zero by 2070.

By aiming for 2070, India acknowledges the need for a gradual transition that allows developing countries to catch up in their utilization of the carbon budget while developed nations work on spearheading technological advancements and facilitating the availability of affordable capital. This timeline allows for a more equitable and inclusive approach to global efforts in achieving sustainability goals while balancing the responsibilities and capabilities of nations at different stages of development.

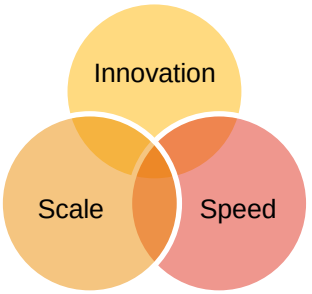
Setting context for Gujarat

Gujarat has been a front runner in India sustainable growth pathway. Gujarat was the first state to create a dedicated government department i.e., the Climate Change Department, focused entirely on the activates towards sustainable development and climate action. Through its action plans, the department take continuous efforts in enabling policies and collaborating with various government departments towards promoting low-carbon technology and creating a cleaner and greener environmental.

Gujarat has become a significant contributor to India's renewable energy capacity. With India aiming for 500 GW of non-fossil fuel-based installed capacity by 2030, Gujarat intends to add another 100 GW to its existing 22 GW renewable energy portfolio. Its goal is to uphold its leadership position in the Renewable Energy sector and spearhead India's transition toward achieving net-zero emissions. Gujarat has been at the forefront of renewable energy development, hosting India's initial wind project in 1984. Recently, it achieved a significant milestone in innovation by commissioning and testing the world's largest 5.2 MW wind turbine in the state. Additionally, Gujarat established the inaugural solar park, "Charankha solar park," in 2012. Presently, the state is actively developing the largest renewable energy park, with a capacity of 30 GW in Khavda.

Continuing the efforts and motivation of Government of Gujarat, this paper intends to define the Panchamrit elements for Gujarat and its action plan to achieve those targets. Gujarat's commitment reflects,

- **Innovation** - fostering new and emerging technologies;
- **Scale -** bringing change at the scale to make it mainstream and strategic contribution in making India's transition toward net-zero emissions, and
- **Speed** - rapidly advancing its renewable infrastructure.



3. Panchamrit for Gujarat

India has already announced its national aspirations on contributing to the global pursuit of climate action goals. However, the state targets cannot be uniformly derived due to their varying economic scale, economic structure, population and resource potential. Certain states must lead the transition by signalling pertinent policies, nurturing incubation ecosystems, making astute economic decisions, and acknowledging their unique climate vulnerabilities to pave the way forward.

The state of Gujarat is committed to maintaining its leadership in climate action through persistent endeavours. It is advocating low carbon technologies, fostering the adoption of renewable energy, and promoting sustainable lifestyles. Inspired by India's overarching vision encapsulated in the Panchamrit initiative, Gujarat is defining its own targets, that harmonize with India's national ambitions.

Our approach

Our approach recognizes that electricity requirements dictate power generation capacity and the portion of renewable energy (RE) within it. The state utilities and consumers can procure power from the generators located anywhere in India. Similarly, the generation capacity hosted in the state can supply power to the utilities and consumers located anywhere in India. P1 indicates the scale of generation capacity hosted within the state, irrespective of where it is utilized. P2 indicates the share of renewable energy from the total electricity consumed within the states. We have calculated P2 to determine the quantum of renewable energy needed in Gujarat; and subsequently estimate the targeted RE capacity within the state for its own need. Since Gujarat it RE resource rich state, it is set to support other states' clean energy transition through export of renewable energy. Hence, that is factored-in while determining P1.

P3 defines the absolute scale of avoided carbon emissions, while P4 defines emissions in correlation with economic growth. We have defined P4 through internationally comparable economical setups which correlate with Gujarat's profile. That estimated the carbon intensity in GDP as expected by 2030 as P4. That defines the 'net carbon emissions', which are used to calculate absolute carbon emissions and its reduced quantum as compared to Business-As-Usual (BAU) pathway to quantify P3.

All above measures will aim to reduce the gross carbon emissions. From such reduced gross emissions, carbon-offset interventions will aim to reduce net emissions further. The horizons for various projections are till year 2030, beyond which there are high variability risks. Therefore, we have focused to consider 2030 as the timeframe to define Net-Reduction target for Gujarat as P5.

55% of energy requirement from renewable energy by 2030

Interpreting India's objective of attaining "50% of its energy needs from renewable sources by 2030," Gujarat's corresponding goal is assessed.

Energy can be consumed in electric as well as thermal form. Renewable energy transition of thermal forms through non-electric renewable energy sources (e.g., biofuels, solar thermal) are yet to become commercially attractive at scale. They are anticipated to commercialize on larger scale in the long-term, hence not considered very high contributor for the timeline till 2030. However, several end-uses (in transport, and industrial uses) would transition to electrified means of using energy. Hence, the electrification of energy use is considered as one of the key factor for the period till 2030.

In year 2021, renewable energy (RE) contributed only 3.6%[1] of India's Total Final Energy Consumption (TFEC). Within the TFEC, electricity accounts for approximately 21%. Further, renewable energy contributes 19% of total electricity consumption. This aligns with the global trend emphasizing sustainable, efficient, and low-carbon energy systems. The increasing portion of electricity in TFEC signifies a shift towards cleaner power sources,

[1] India Energy statistics 2023, MoSPI - Link

enhancing energy efficiency, and integrating technological innovations to curtail environmental impact and steer towards a more robust energy landscape. Accordingly, the energy requirement under this Panchamrit element has referred to the electricity requirement. In FY23, the renewable energy (RE) share in electricity requirement of India was 24%, whereas Gujarat stands at 23%.

Table 3: Share of renewable energy in Gujarat's electricity requirement

	India	Gujarat
Electricity requirement - FY23 (BU)	1,507	139
Electricity requirement from RE (Incl large hydro) - FY23 (BU)	366	32
RE % share (Incl large hydro) in electricity requirement - FY23	24%	23%

The consumption of RE by utilities primarily driven by regulatory framework of RPO. As per the Ministry of Power's notification on the RPO and Energy Storage Obligation Trajectory until 2029-30, the state needs to procure 43.33% of its electricity from renewable sources by 2030. Prosumers, essentially consumers utilizing rooftop solar projects, are consuming from only renewable energy through rooftop solar and rely of utilities for remaining electricity requirement. Further to enable higher RE integration, prioritize initial years with battery energy storage system (BESS) for faster deployment, and development of pumped hydro storage projects (PSP) in later years for majority balancing needs.

With the competitiveness of renewable energy costs compared to conventional sources, it is anticipated that upcoming industries/ expansion of existing industrial units in Gujarat will likely procure electricity majorly from renewable sources. Additionally, existing industries are expected to transition to renewable energy, aiming to cover at least 90% of their open access requirements.

The Central Electricity Authority (CEA) has projected a total electricity demand of 302 billion units (BU) for Gujarat by the year 2030. This estimation encompasses the electricity needs of utilities, captive consumers, and prosumers. Out of this, the state aims to fulfil 166 BU through RE sources by 2030, which corresponds to setting target of **sourcing 55% of its total energy needs from renewable sources by 2030**.

120 GW non-fossil energy capacity by 2030

India has set the target of Non-Fossil Capacity – which includes Renewable Energy technologoes as well as Nuclear power. Since, new capacities for Nuclear projects would not come to on a material scale in gujarat by 2030, it is considered accordingly.

As per Ministry of Power (MoP) RPO notification, states to serve up to 1.4% of electricity requirement through hydro. As there are limited local resources, Gujarat may need to obtain hydro power from elsewhere. Alternatively, exceeding wind RPO can offset its hydro needs. Given abundant wind resources, Gujarat is set to prioritizes solar and wind to meet its hydro power obligations. The cost of generating electricity from renewables (solar and wind) have become more cost competitive. Accordingly, we have considered the renewable energy capacity mix. If the share of RE is considered excluding hydro power, Gujarat is at 21% as compared to India's 14%.

Table 4: Share of non-hydro renewable energy in Gujarat's electricity supply mix

	India	Gujarat
Electricity requirement - FY23 (BU)	1,507	139
Electricity requirement from RE (Incl large hydro) - FY23 (BU)	366	32
RE % share (Incl. large hydro) in electricity requirement - FY23	24%	23%
Electricity requirement from RE (excl. large hydro) - FY23 (BU)	204	30
RE % share (excl. large hydro) in electricity requirement - FY23	14%	21%

When assessing the target for energy generation capacity within Gujarat, it's essential to consider two aspects:

Out of Gujarat's 22 GW of installed RE capacity on Nov 2023, approximately 9.5 GW is allocated for Gujarat's utilities to cater to local energy needs, while the rest is designated for captive/ open Access use within and outside Gujarat; and export to other state utilities. This allocation underscores that Gujarat's RE capacity is not merely reflection of its utilities' RE power requirement. It is supporting both private use of RE power within and outside the state, as well as supporting other state's energy requirements.

Taking into account Gujarat's renewable energy requirement of 166 BU, essential to achieve the target set under Panchamrit 2, there's an additional requirement of approximately 134 BU of renewable energy in the state by 2030. To meet this requirement, considering an average Capacity Utilization Factor (CUF) of 23% from diverse renewable energy sources, an expected renewable energy capacity of 83 GW is anticipated by 2030.

Table 5: RE capacity for Gujarat's electricity requirement

	Gujarat
Requirement served from RE - 2023 (BU)	32
Existing RE capacity –2023 (GW)	22
State's RE requirement – 2030 (BU)	166
Additional RE requirement – 2030 (BU)	134
Capacity addition for RE requirement of Utility – 2030 (GW)*	31
Capacity addition for RE requirement of Captive/Self consumption – 2030 (GW)*	30
Capacity addition for RE requirement – total for Gujarat – 2030 (GW)	61
Cumulative RE capacity – 2030 (GW)	83

Meeting the Gujarat utility's needs internally: Considering the utility's electricity requirement, the state utility, GUVNL, has been issuing tenders for renewable energy projects with the delivery point specified as the GETCO periphery. However, it's crucial to note that starting from July 2025, the waivers on inter-state transmission charges are expected to reduce. Consequently, current and upcoming projects if planned outside Gujarat would need to incorporate these charges while bidding. This will potentially affect the competitiveness of developers compared to if those projects are hosted within the state. Since the substantial renewable energy potential already available within the state, GETCO is planning an additional evacuation capacity of about 65 GW, specifically designed for renewable energy in the state. This initiative aims to incentivize and encourage the development of more renewable energy projects within Gujarat itself. The state has taken proactive measures by initiating projects, including several wind projects established before 2005. Further, replacing the turbines below 2MW, there exists a potential of 4.7 GW repowering in the state, which will further contribute to the state's overall generation capacity.

Captive demand met by in-state projects: Apart from utilities, captive and open access consumers also seek to transition to renewable energy. The intermittent nature of renewable power and variance between supply profile of reenwables and demand profile of their industry creates a specific challenge for them migrate significant share of their electricity requirement to renewables. Banking arrangements with the electricity grid can facilitae them. There is no established framework for inter-state energy banking, hence, the reliance of capacity hosting state's electricity grid is inevitable. Therefore, it becomes necessary for such renewable energy projects to be hosted within the state. Gujarat has already activated banking facility under Green Open Access Rules. This will support captive/ Open Access consumers in their renewable energy transition.

It is anticipated that beyond the existing 22 GW capacity, an additional 61 GW of renewable energy capacity will need to be developed within the state. This projection indicates a total cumulative capacity of 83 GW by the year 2030.

Exports meeting other states' needs: Gujarat has substantial potential for renewable energy resources. It's clear that state is continue to export power to other states to meet their clean energy requirements.

In FY22, among the 17 GW of installed capacity, approximately 3 GW was connected to the Inter-State Transmission System (ISTS). During the same period, the inter-state transmission network offered a total transfer capacity of 9.3 GW during solar hours and 9.7 GW during non-solar hours, facilitating the inter-state transaction of power.

Gujarat is currently establishing largest Renewable Energy Park in Khavda, with a capacity of 30 GW, which will be ISTS-connected. Within this park, around 5.7 GW is allocated to GSECL and GIPCL, intended for purchase by GUVNL. Additionally, 8 GW of park capacity is allocated to NTPC and SECI, which is expected to be for the purpose for supplying power to utilities in other states. Furthermore, approximately 14.2 GW of the park's capacity is allocated to private entities, allowing them to utilize the capacity for internal consumption or export power to other states, consdiring the connectivity of ISTS and applicable charges. Another significant solar park is underway in Dholera, with 1 GW reserved for GUVNL's purchase and 4 GW allocated to SECI, expected to supply power to utilities in other states. Together, these two projects are anticipated to contribute around 26 GW of capacity designated for power export to other states. Additionally, Gujarat is open to further projects aimed at exporting power to other regions.

Aggregating all of above, the expected capacity is around 109 GW. Further, anticipating higher export capabilities considering the significant RE potential in the state, **Gujarat targets 120 GW of non-fossil energy capacity by 2030**. Of which, 83 GW will be for state's own requirement and reamining ~38 GW will be from exports from RE parks and non park RE projects,to support the RE requirement of other states. The capacity split among various renewable energy sources can be determined either based on the available potential within the state or by comparing the current mix of sources and the RPO obligation.

Table 6: Target and baseline of Gujarat's Panchamrit 1 & 2 (GP1 & GP2)

Sr. No	Panchamrit for Gujarat	Target by 2030	Baseline (year)	*Factor of change*
GP1	**120 GW non-fossil energy capacity by 2030**	120 GW	20 GW (FY23)	*+600%*
GP2	**55% of energy requirements from renewable energy by 2030**	55%	23% (FY23)	*+239%*

By 2030, reducing the carbon intensity of the economy to 60% below 2005 level

Gujarat contributes to 8% of India's GDP, 18% of industrial output, and 30% of exports. The state's Gross State Domestic Product (GSDP) has grown exponentially over the past two decades. With an ambitious aim to become a USD 500 million economy by 2027, Gujarat plays a pivotal role in India's goal of becoming a USD 5 trillion economy and will be contributing to 10% of India's GDP. The state has witnessed remarkable growth in the industrial sector, agriculture, and infrastructure development. Today, Gujarat is attracting both domestic and international investments. Given these factors driving high economic growth, it may be challenging for Gujarat to carve out cost-efficient trajectory of reducing the carbon emission intensity of its economy.

The state's significant contribution to India's GDP, industrial output, and exports, coupled with its ambitious growth targets, have necessitated increased energy consumption in per capita terms; and, consequently, higher emissions for its economy too. The rapid economic growth and industrial development in Gujarat reflects in relatively high baseline levels of carbon emissions.

Table 7.Gross carbon emissions (MtCO2e)[2]

	2005	2018	CAGR
India	1,673	3,134	*4.94%*
Gujarat	142	292	*5.72%*
Gujarat's share in emissions	8.48%	9.31%	

Table 8. Emission intensity of Gujarat and India

	India	Gujarat
Carbon net emission in 2005 ($MtCO_2e$)	1,585	139
GDP in 2005 (Rs. Cr.)	5,914,614	367,073
Carbon intensity 2005 (tCO_2e/Rs. Lakh)	2,680	3,780
Carbon net emission in 2018 ($MtCO_2e$)	2,953	287
GDP in 2018 (Rs. Cr.)	13,992,914	1,183,020
Carbon intensity 2018 (tCO_2e/ Rs. Lakh)	2,110	2,426
Reduction of intensity from 2005 levels by 2018	**-21%**	**-35%**
CAGR of emission intensity of GDP (2005-18)	**-1.82%**	**-3.31%**

Despite its increased share in emissions, Gujarat is indeed a driver state for India's economic growth. The state's significant economic contributions and industrial development are integral to India's overall progress. As such, an increase in Gujarat's emission share is somewhat inevitable as it continues to support India's growth.

It is noteworthy that Gujarat has already exhibited a strong commitment to reducing the emission intensity of its economy. In 2018, the state achieved a notable 35% reduction in carbon emission intensity compared to 2005, boasting a Compound Annual Growth Rate (CAGR) of -3.31%. In contrast, India achieved a 21% reduction in emission intensity from 2005 to 2018, with a CAGR of -1.82%. This disparity underscores Gujarat's leadership and resolute commitment to decarbonize state economy.

The state's remarkable rate of emission intensity reduction has significantly outpaced the national average, contributing to India's achievement of its Nationally Determined Contribution (NDC) and panchamrit target of a 45% reduction in emission intensity. Gujarat's efforts have played a crucial role in amplifying India's climate action, steering the country towards its ambitious long-term goal of reaching net-zero emissions by 2070.

Looking ahead from 2018 to 2030, both Gujarat and India are expected to intensify their commitment to decarbonization. Given Gujarat's progressive nature and its consistent efforts surpassing the national average, it is imperative to compare with internationally prominent performance over the same period. China offers one such demonstration in reducing carbon emission intensity of GDP. China, known for the best reduction rate over the past 30 years, achieved a 39% reduction in intensity from 2005 to 2018, displaying a CAGR of -3.76%[3] which Gujarat can aim to perform in near future.

Table 9.China's emission intensity reduction from 2005 to 2018

Carbon intensity 2005 (gCO_2e/USD)	790
Carbon intensity 2018 (gCO_2e/USD)	480
Reduction of intensity from 2005 levels by 2018	**-39%**
CAGR of emission intensity of GDP (2005-18)	**-3.76%**

[2] GHG platform India – Link
[3] CO2 emissions intensity of GDP, IEA - Link

Gujarat is likely to continue leadership with accelerated reduction of carbon emission intensity of GDP till 2030, similar to that exhibited by China in the past. Considering the emission intensity reduction rate of -3.76% for Gujarat's trajectory indicates that the state's emission intensity in 2030 is projected to be 1,563 tCO2e/Rs. Lakh. While India's emission intensity in 2030 is anticipated to align with its Nationally Determined Contribution (NDC), representing a 45% reduction from its 2005 intensity, resulting in 1,474 tCO2e/Rs. Lakh.

Due to a lack of specific GDP projections for Gujarat in 2030, we have assumed that Gujarat's contribution will be 10% of India's GDP[4]. For consistency in calculating emission intensity in 2030 for Gujarat, the GDP is considered at a constant base price of 2011-12.

India's nominal GDP in 2030 is estimated at INR 53,553,723 crores, applying a GDP deflator of 2.60 yields India's GDP in 2030 at a constant base price of 2011-12 as INR 20,597,586 crores[5]. Assuming Gujarat's contribution is 10% of this figure, Gujarat's GDP is estimated to be INR 2,059,759 crores in 2030. These considerations provide a comprehensive basis for evaluating and projecting net emissions in 2030 for both Gujarat and India in 2030. Following table illustrates an aspiration of Gujarat, indicating target that **by 2030, it will reduce the carbon intensity of the economy to 60% below its 2005 level.**

Table 10. Emission intensity of India and Gujarat in 2030

	India	Gujarat
Carbon net emission in 2030 (Mt)	3,036	322
GDP in 2030 (Rs. Cr.)	20,597,586	2,059,759
Carbon intensity 2030 (tCO_2e/Rs. Lakh)	1,474	1,563
CAGR of emission intensity between 2024-30	-2.95%	-3.76%
Reduction of intensity from 2005 levels	**-45%**	**-60%**

With above target, Gujarat's net emissions should not exceed 322 $MtCO_2e$. Energy sector is contributing about 80% of the emissions and inside energy. Around 90% emissions are contributed[6] by three sectors, power, industries, and transport, which becomes the key strategic parameters for us to examine.

The forecasted carbon emissions in the power sector for 2030 are derived by applying the projected emission factor for India in that year, as outlined in the National Electricity Plan[7]. This calculation, combined with the anticipated electricity consumption for 2030 as per Panchamrit 2, results in an estimated 136 million tonnes (Mt) of carbon emissions. This constitutes 43% of the total projected carbon emissions for 2030.

In the context of the Transport sector, following an observed increase from 5% to 7% between 2005 and 2018, it is presumed that transport emissions could potentially represent 10% of the

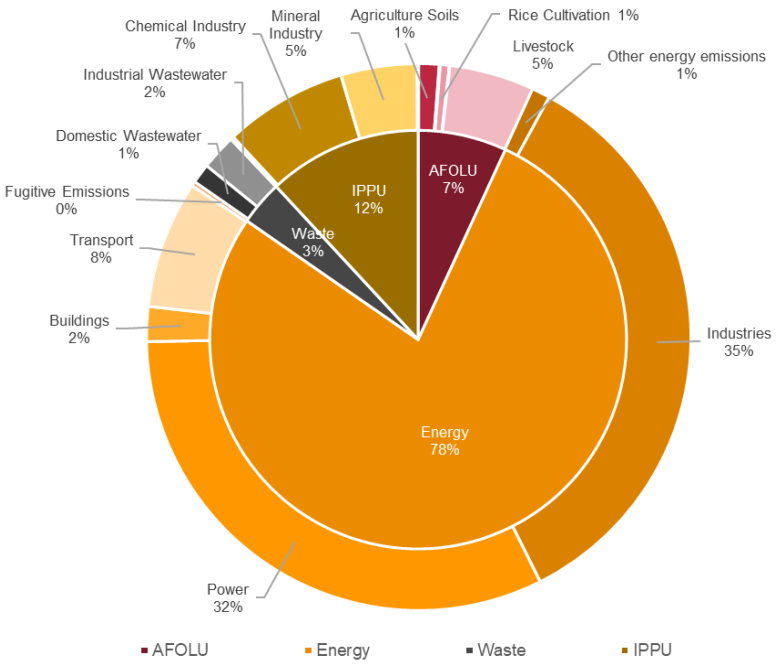


Figure 1.Contribution of sectors in Gujarat's emission in 2018

[4] Strategy for Government of Gujarat to enable India to become a USD 5 trillion economy, GIDB - Link
[5] IHS Markit - Link
[6] GHG platform India – Link
[7] CEA National Electricity Plan - Link

total carbon emissions in 2030, assuming a similar growth trend.

Contrastingly, emissions from other sectors (agriculture, fisheries, land emissions, waste, etc.) saw a notable reduction from 20% in 2005 to 10% in 2018. Projecting a continued decline in line with this trend, it is anticipated that emissions from these sectors will only contribute 5% to the total carbon emissions in 2030, primarily due to the shift towards electricity for irrigation, etc.

As per these estimations, the industry sector is anticipated to be the major contributor, accounting for the remaining 42% of carbon emissions in 2030. This analysis provides a detailed breakdown of the expected distribution of carbon emissions across various sectors, offering valuable insights into potential sources and their respective contributions to the overall carbon footprint in 2030.

Reduction of total projected carbon emissions from 2022 to 2030 by 145 million tons

India aims to reduce 1 billion tonnes of carbon emissions by 2030, showcasing a strong commitment to combat climate change. Considering the Net Emissions as estimated earlier, Gross Emissions are estimated considering the carbon-offsets, which are largely through Forestry and CCUS.

India aims to establish a carbon sink, removing 2.5 to 3 billion tonnes of carbon dioxide equivalent (CO2e) between 2021 and 2030. This equates to an annual removal rate of approximately 333 million tonnes of CO2e over the span of nine years. As outlined in Gujarat's state action plan for climate change, the state intends to expand its forest cover to encompass 5 million hectares. With a carbon stock density estimated at 72 tonnes per hectare, this is expected to contribute 166 $MtCO_2e$ to carbon offset. This will serve a dual purpose by not only capturing carbon but also aligning with the global imperative to enhance biodiversity and increase green cover.

Furthermore, Gujarat is actively adopting advanced technologies. The state's smart use of technology underscores its commitment to finding practical and efficient ways to lower emissions. With an estimated CO_2 storage potential of 20% of India's overall capacity and considering India's target of carbon removal through CCUS activities at 35 million tonnes per annum (MTPA) by 2030, Gujarat will aim to cut 7 MTPA carbon through CCUS activities by 2030. This not only aligns with the national CCUS agenda but also positions Gujarat as a leader in innovative solutions for reducing emissions.

Table 11: Carbon offsets in 2030 (MtCO2e)

	Forestry	CCUS[8]	Total carbon offsets
India	333[9]	35	**368**
Gujarat	166[10]	7	**173**

Table 12: Emissions / offsets (MtCO2e)

	2005	2018	2030
India's net emissions	1,585	2,953	3,036
India's offsets	154	230	368
India's gross emissions	**1,739**	**3,183**	**3,404**
Gujarat's net emissions	139	287	322
Gujarat's offsets	3	5	173
Gujarat's gross emissions	**142**	**292**	**496**
Gujarat's share in Gross Emissions		**9.2%**	**14.5%**

[8] Gujarat's CO_2 storage potential is ~20% of India
[9] India will create a carbon sink of 3 Gt from 2021 to 2030. In the span of 9 year, per year removal will be 333 Mt CO2e
[10] Derived from Gujarat state action plan for climate change

As indicated above, Gujarat is anticipated to contribute 14.5% in the Gross Emissions by 2030. With collective efforts from multiple fronts, Gujarat aims to **reduce total projected carbon emissions from 2022 to 2030 by 145 million tonnes** to correspond with India's reduction target of 1 billion MtCO2e.

The ongoing analysis delves into various low-carbon technologies and targets for reducing Gross Emissions till 2030, with a particular focus on Gujarat. As highlighted earlier, key sectors like - power, industries and transport have high impact on the magnitude of carbon emissions. Therefore, it is imperative to implement targeted measures for effective and strategic emission reduction in these sectors.

At the core of emission reduction strategies for Power Sector lies the crucial augmentation of RE capacity. Drawing insights from Panchamrit 1 data, the planned addition of 98 GW of RE capacity, is anticipated to lead to a substantial reduction of approximately 105 million tons of CO2 equivalent in the power sector by 2030. This underscores the pivotal role that the widespread adoption and scaling of renewable energy technologies can play in mitigating emissions and fostering a cleaner energy landscape.

Furthermore, Gujarat's EV policy for 2021 stands out as a proactive initiative within the Transport Sector. The policy, with a targeted incorporation of 2 lakh EVs by 2025 (already achieving 1.6 lakh), aligns seamlessly with India's ambitious target of deploying 1.6 crore EVs by 2030. Gujarat's commitment to contributing at least 5%, amounting to around 8 lakhs of EVs, is not just a numerical target but a strategic move toward cleaner and sustainable mobility. Each lakh EV has the potential to reduce emissions by 0.3 million tons[11]. Consequently, the envisaged deployment of 8 lakh EVs in Gujarat is expected to yield a substantial reduction of approximately 2.4 million tons of carbon emissions, further emphasizing the positive impact of transitioning to electric mobility.

The residual emissions reduction is envisioned to be primarily driven by the Industry Sector. This necessitates the implementation of advanced energy efficiency measures within industrial processes. The emphasis here is on fostering innovation, optimizing operations, and adopting sustainable practices to contribute meaningfully to the overarching emissions reduction goals.

In essence, this integrated approach strategically addresses emission hotspots within the energy sector, delineating a comprehensive roadmap for substantial emissions reduction. The synergy of renewable energy adoption, electric vehicle integration, and industrial efficiency enhancements collectively positions Gujarat on a trajectory toward a more sustainable and environmentally conscious future.

Table 13 :Target and baseline of Gujarat's Panchamrit 3 & 4 (GP3 & GP4)

Sr. No	Panchamrit for Gujarat	Unit	Target by 2030	Baseline (year)	*Factor of change*
GP3	**Reduction of total projected carbon emissions from 2022 to 2030 by 145 million tons**	MtCO2e	-145	0 (2021)	*-145*
GP4	**Reducing the carbon intensity of the state's economy to 60% below 2005 level**	%	-60%	-36% (2018)	*-24% of 2005 level*

Gujarat will achieve Net-65 by 2030

India has set an ambitious target of achieving net zero emissions by 2070. However, when assessing this goal at the state level, it requires careful consideration of several variables. One possible approach involves determining the specific year when Gujarat itself is projected to attain a net zero emissions status. Yet, this calculation is subject to uncertainty, primarily because the Panchamrit target objectives are centred on achieving goals by 2030. Projections beyond this period remain uncertain. Therefore, we have focused to consider 2030 as the timeframe to define Net-Reduction target for Gujarat as P5.

[11] Estimates by the Gujarat Energy Research and Management Institute (GERMI)

The journey towards net zero emissions involves 1) Reducing the Gross Emissions; and 2) Offsetting emissions by an amount equivalent to the residual Gross Emissions. This ensures that the Net Emissions ultimately reach zero.

Table 14: Net Emission position

	2005	2018	2030
India's net emissions	1,585	2,953	3,036
India's offsets	154	230	368
India's gross emissions	1,739	3,183	3,404
Gujarat's net emissions	139	287	322
Gujarat's offsets	3	5	173
Gujarat's gross emissions	142	292	496
Gujarat's Net Emission position		**Net98**	**Net65**

Considering the projected gross emissions for 2030 and the offset accounted for through initiatives such as forestry and CCUS, **Gujarat sets a specific target to achieve Net-65 by 2030**. This signifies that 35% of gross emissions will be offset through strategic measures like afforestation and CCUS, contributing significantly to the state's journey toward achieving a more sustainable and balanced emissions profile.

Table 15:Target and baseline of Gujarat's Panchamrit 5 (GP5)

Sr. No	Panchamrit for Gujarat	Unit	Target by 2030	Baseline (year)	*Factor of change*
GP5	**Achieve Net65 by 2030**	%	65%	98% (2018)	*-33%*

4. Roadmap to implement Panchamrit

GP1- 55% of energy requirement from renewable energy by 2030: At present, 23% of the state's electricity is sourced from renewables, projected to climb due to heightened RPO for utilities and captive consumers favouring renewable energy considering the cost of generation. In FY25, rapid growth in renewable share is foreseen, as the Ministry of Power's RPO trajectory surpasses GERC's by 1.6 times. Additionally, the allure of open access projects predicts a surge in captive consumption from 16% to 25% of the state's demand by 2030.

GP2- 120 GW Renewable Energy Installed capacity by 2030: Gujarat is presently hosting 22 GW of renewable energy. Additional RE capacity is anticipated to meet the escalating demand. Allocation among resources hinges on their existing proportion in the capacity mix and aligns with RPO specifications. In captive setups, parity between solar and wind sources is expected, reflecting an equal division based on projected needs. Later, we can expect the emergence of offshore wind projects and pumped hydro projects, both of which necessitate substantial policy support and the development of enabling infrastructure due to their lengthy development timelines. This strategy aims to satisfy both the current resource composition and the stipulated requisites outlined by RPO guidelines.

GP3- Reduction of total projected carbon emissions from 2022 to 2030 by 145 million tons: Gujarat would experience relatively faster economic growth. Given unique composition of its economy, its share in India's Net Emission would marginally increase from 9.7% to around 10.4%. Share in Gross Emissions would rise to 14.5%. For faster rate of decarbonising its economy, Gujarat is set to accelerate efforts on carbon-offsets in this decade, which are largely through Forestry and CCUS.

GP4- Reducing the carbon intensity of the state's economy to 60% below 2005 level: Gujarat leads not only in the economic expansion, but also in the pace of decarbonizing in India. Carbon intensity of economy in Gujarat was at 2,426 tCO2e/ Rs. Lakh vs India's 2,110 tCO2e/ Rs. Lakh in 2018 – putting it on relatively high baseline levels. In 2018, the state achieved a notable 35% reduction in carbon emission intensity compared to 2005 while India stood at 21% reduction. Looking ahead from 2018 to 2030, China, known for the best reduction rate, achieved a 39% reduction in intensity from 2005 to 2018, displayed a CAGR of -3.76% which Gujarat aims to perform in near future.

GP5- Achieve Net65 by 2030: From adoption of low carbon technologies gross emission are going to reduce, and further due to carbon offsetting interventions, the Net Emissions would be 35% less from the Gross Emissions by 2030

Table 16: Targets and yearly roadmap for key indicators

Sr. No	Indicators	Baseline (FY22-23)	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	Target (FY29-30)	*Factor of change*
1.	RE share in state's total requirement	23%	24%	35%	38%	42%	47%	51%	**55%**	*+32%*
2.	State's total energy requirement (BU)	139	156	174	194	217	242	271	**302**	*217%*
3.	State's total RE requirement (BU)	32	38	60	75	92	113	137	**166**	*518%*
4.	RE Requirement by utility (BU)	22	24	43	52	62	73	85	**98**	*445%*
5.	RE Requirement – Captive/OA/ rooftop (BU)	10	13	18	23	30	40	52	**68**	*680%*

Sr. No	Indicators	Baseline (FY22-23)	FY 23-24	FY 24-25	FY 25-26	FY 26-27	FY 27-28	FY 28-29	Target (FY29-30)	*Factor of change*
6.	Renewable Energy Installed capacity (GW)	20	28	51	75	86	93	105	**120**	*+100*
7.	Export of RE outside Gujarat (GW)	3	3	7	14	28	35	37	**38**	*+35*
8.	Solar (GW)	9	13	25	39	47	53	61	**71**	*+62*
9.	Wind Onshore (GW)	10	12	18	24	27	30	35	**37**	*+27*
10.	Wind Offshore (GW)	-	-	-	-	1	2	3	**5**	*+5*
11.	Bio Energy (GW)	0.11	0.2	0.2	0.3	0.4	0.5	0.7	**1.0**	*+0.89*
12.	Hydro Pumped Storage Projects (GWh)	-	-	-	-	-	1,400	2,900	**4,800**	*+4,800*
13.	Battery energy storage (GWh)	-	-	600	1,600	2,200	3,000	4,200	**4,200**	*+4,200*
14.	Reduction in carbon intensity of economy vis 2005	-36%*	-48%	-50%	-52%	-54%	-55%	-57%	**-60%**	*-24%*
15.	GSDP's emission intensity ($kgCO_2e$/ Rs. Lakh)	2,426*	1,967	1,893	1,822	1,754	1,688	1,624	**1,563**	*-36%*
16.	GDP (real terms) of Gujarat (Rs. '000 Cr.)	1,183*	1,812	1,923	1,964	1,980	2,001	2,028	**2,061**	*174%*
17.	Net emission ($MtCO_2e$)	287*	356	364	358	347	338	329	**322**	*112%*
18.	Net Emissions from Power sector ($MtCO_2e$)	94*	113	117	120	124	128	132	**136**	*145%*
19.	Net Emissions from Transport sector ($MtCO_2e$)	22*	27	27	28	29	30	31	**32**	*145%*
20.	Net Emissions from Industries ($MtCO_2e$)	101*	115	118	121	124	128	131	**138**	*137%*
21.	Offsets from forestry ($MtCO_2e$)	(5)*	(74)	(85)	(97)	(111)	(127)	(145)	**(166)**	*-161*
22.	Offsets from CCUS ($MtCO_2e$)	-	-	-	-	-	(2)	(4)	**(7)**	*-7*
23.	Gross emissions ($MtCO_2e$)	292*	431	449	455	458	467	479	**496**	*169%*
24.	Net emission% (Net x)?	Net98*	Net83	Net81	Net79	Net76	Net72	Net69	**Net65**	*-33%*

* *Refers to 2018 baseline*

5. Specific interventions needed

To reach set targets, identified interventions encompass policy and regulatory measures that enhance sectoral visibility, establish frameworks for investors, mitigate risks, enable actions, and ensure best practice compliance. Infrastructure and capital interventions assure available infrastructure, enabling large-scale investments and fostering sustainable growth. Stakeholder ecosystem interventions streamline procedures, promote collaboration, and drive innovation through knowledge sharing.

A. Policy and regulatory

1. **Adopt MoP's RPO trajectory:** MoP has notified updated RPO target till 2030. The MoP RPO trajectory for FY25 is around 1.6 times of GERC FY24 mandate. To align with India's goal, GERC would need to revise its RPO trajectory in FY24

2. **Adopt MoP's RGO guidelines**: The MoP in October 2023 has published draft Renewable generation Obligation for coal and lignite-based generation plants. GERC may adopt the same guidelines for Gujarat.

3. **Shift irrigation load to 100% daytime**: With increased solar generation during daytime, shifting agriculture demand to daytime will reduce grid balancing requirement. Achieving MNRE allocation to Gujarat under KUSUM scheme alone can enable the state to achieve its distributed renewable purchase obligation.

4. **Incentive framework for demand-side-management** to increase wider participation by consumers in such programs which aligns the load pattern in line with RE supply curves.

5. **Certainty on banking arrangement** becomes necessary for consumers to increase RE consumption after a certain limit, because of intermittent generation of RE. Long term visibility is critical to assess bankability of the projects.

6. **Regulatory easement:** GUVNL need to determine attractive green tariff. The tariff needs to include inbuild high PLF RE sourcing, additional ESS. There should be no Cross Subsidy Surcharge or Additional Surcharge for RESCO roof top solar project on buildings of govt and public institutions.

7. **Shifting towards land efficient and blended RE solutions**: Land is the sacred medium for RE project development. With increasing urbanisation while maintaining the food security requires optimal utilisation of available land resources. Redefining the utility's procurement plan to shift to hybrid or flexible and dispatchable RE, since it enables optimum utilisation of land and transmission along and optimise the cost of balancing source due to blended configuration.

8. **Agrivoltaics in desert neighbouring regions:** Gujarat has a vast region with deserts. To arrest the expansion of desert area, the surrounding districts should be encouraged to host Agrivoltaics. With increasing urbanisation and to maintain the food security Gujarat should study the Agrivoltaics project development in China and leverage the available space. Gujarat to mark geographies with potential of agrivoltaics and publish it for investors to develop projects. The cost of agrivoltaics projects is higher than utility level projects, so to make the projects viable for both investor and energy procurer govt need to design incentivised scheme or VGF scheme for agrivoltaics project development.

9. **Promoting land-neutral RE** like floating / canal-based solar through mandating government departments, controlling the water bodies, to utilise certain % of available area for solar projects.

10. **Encourage private sector involvement in park development** to attract investments, expand capacity, and expedite growth. Currently, only a portion of Khavda RE Park is developed by private entities, while the rest rely on PSUs. Promoting private renewable energy park development will boost participation, speed up progress, and facilitate the transition of captive consumers to RE

11. **Balance centralised and distributed RE capacity** for optimal uses of T&D network. GERC should adopt MoP RPO notification mandating 4.5% of procurement through distributed RE. Policy for small scale procurement needs revision, since it proposes power purchase tariff based on the average tariff discovered from last 6 month through competitive bidding process conducted by GUVNL. It is appealing if technology prices continue declining, as observed particularly in solar over the last decade; however, that is not the case now. Therefore, separate guidelines for tariff based competitive guidelines required for distributed RE or should determine FiT for distributed RE. Promotion of small-scale rooftop wind projects and creating state level incentivised scheme similar to roof top solar projects required to take leverage of the wind potential in land light manner.

12. **Enabling waste-to-energy** projects through mandatory procurement of power by municipalities. Gujarat is a state with one of the highest collection efficiencies in urban areas, brings an advantage of supply chain security for developer.

13. **Encourage higher hub heights for Onshore wind project development**.: As per latest report published by NIWE Gujarat has potential of more than 180 GW onshore wind potential at 150 m height. GUVNL/GPCL need to encourage project development of higher hub height wind projects for optimal electricity generation at a lesser area.

14. **Scaling up EV programme:** With current policy largely targeting 2wheelers, going ahead all passenger vehicles should be targeted to shift to electricity by providing fiscal incentives and creating charging infra. The EV policy need to be extended beyond 2025 till 2030 for achieving the specified target.

15. **Incentive schemes for biomass aggregation and supply chain, dedicated catchment areas:** MNRE has reinitiated the national biomass program and providing incentives for development of projects. GEDA can design an incentive scheme for biomass aggregation and supply chain, dedicated catchment areas.

16. **Policy on allotment of PSP appropriate sites:** Since PSP requires time of around three to four years in development, in order to enable PSP deployment in FY28, necessary policy measures to ease the clearances and mechanise the allocation of sites to be issued in 2024

17. **Geographic restriction on fossil fuel capacity addition:** Fossil fuel-based power projects are essential for baseload management and optimal integration of RE power in the grid until sufficient nuclear power energy becomes available, or energy storage becomes a cost friendly viable solution. To reduce state's carbon footprint, capacity addition of thermal projects should be outside Gujarat.

18. **Enabling energy efficiency:** Promoting and incentivising smart enabled energy efficient appliances, Stricter implementation of ECBC codes, community-based cooling and heating. Encourage adoption of High-Efficiency Industrial Equipment. Incentivize the adoption of high-efficiency industrial equipment, such as heat pumps and other electrification technologies, for low and medium temperature process heat, along with encouraging the use of LEDs

19. **Decarbonization of Industries:** Formulate comprehensive policies to facilitate the shift from fossil fuel-based energy to electrified energy in industrial processes. Implement incentives, subsidies, and regulations to encourage industries to adopt cleaner and more sustainable energy sources.

20. **Focus on service sector expansion in economy mix which has relatively lesser carbon footprint:** Gujarat has higher share of manufacturing sector in its industrial basket which leads to highest carbon emitter state in India. GIDB to focus on service sector expansion in economy mix in future.

21. **Cap-and-trade mechanism:** Need of regular accounting of emissions and hence starting from major sector, emission norms to be created in line with the carbon standard under development at central level

22. **State-Level Carbon Market Activation:** Establish a state-level carbon market to incentivize emissions reduction and trading within Gujarat. Develop a regulatory framework and mechanisms to facilitate the functioning of the carbon market.

23. **Carbon Capture Utilisation and Storage:** Identifying major emitters in Gujarat and mandating them to implement CCUS within a timeframe. Develop a strategic roadmap for creating markets and revenue models for captured carbon. Implement policies to encourage industries to capture and utilize carbon, fostering economic opportunities in the process Introduce financial incentives such as tax credits, grants, or subsidies for industries adopting CCUS technologies. Set up a dedicated R&D wing to identify and assess CCUS storage sites. Facilitate technology transfer from international experts and organizations to local industries.

24. **Afforestation:** Formulate Forest policy emphasizing on afforestation, preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment. Deploy local afforestation task force at district level to oversee planning, execution and monitoring of afforestation efforts. Involve local communities for collaborative advancement by doing capacity building workshops, tree adoption programs where local communities take responsibility for nurturing and protecting specific trees and reward communities and task forces that demonstrate exceptional results in afforestation.

B. Infrastructure & Capital

1. **Feasibility of resource potential:** Based on earlier studies by MNRE, Gujarat is only expected to have 36 GW potential, considering an assumption of only 3 % wasteland utilised for solar. Given increased module efficiency and availability of actual potential to be assessed and mapped. Creation of landbank will facilitate easy identification of land; Similar land bank can also assist wind projects to reduce its development time.

2. **Feasibility of resource adequacy:** Gujarat's huge RE potential can support other states also to transition to RE, whereas resources like hydro, which is useful for grid balancing purpose is limited in the state. Resource adequacy assessment can guide optimum utilisation of resources within and from other states depicting clear plan for generation and evacuation capacity augmentation.

3. **Repower pre-2010 installations of onshore wind projects** to uplift productivity of high windy sites

4. **Enabling offshore wind**: Despite its superior performance compared to onshore wind, remains costly and requires policy measures to reduce expenses. Establishing a domestic value chain in next two to three years would ultimately drive long-term cost efficiencies. It also requires supplementary infrastructure like port facilities, seabed cables, and foundations, aside from the conventional onshore wind project requirements. Establishing this ecosystem becomes crucial for timely project execution.

5. **Exploring off-river pumped hydro project**: Since limited potential is available in the state, designating a nodal agency to identify and conduct feasibility assessment of sites and preparing a guideline for allocation for development of projects.

6. **Creating demonstration of BESS use cases at GTD levels:** Both for transport sector and power sector view, batteries are going to play critical role, where domestication is necessary

7. **Program for EV Fleet Service and Government Mobility Migration:** Launch a comprehensive program to transition fleet services and government mobility to electric vehicles (EVs) and enhance the integration of renewable energy with EV charging infrastructure, incorporating battery swap technology for increased efficiency.

8. **EV Charging Ecosystem on Public-Private Partnership (PPP) Basis:** Establish an EV charging ecosystem through a Public-Private Partnership model and encourage private sector participation in the development, maintenance, and expansion of EV charging infrastructure across the state.

9. **Speed up evacuation infra for export-oriented projects:** Early focus to speed up Khavda and Dholera evacuation infra to avoid implications of ISTS charges

10. **Load flow studies for distribution network augmentation** required considering the impact of adoption of EV, electric cookers, roof top solar and solar irrigation projects. GEDA to publish Policy guidelines for

increasing adoption of electric cooker. Distribution network upgradation by DISCOMs to be done to ensure higher RE integration at distribution level.

11. **Rapid strengthening STU capacity and IPTC bids: Transmission augmentation** faces a significant risk related to right-of-way access. Dedicated taskforce required to such risk and prompt resolution of priority issues.

12. **Investment in T&D segments:** to add 6x renewable generation capacity, huge investment requirement in transmission and distribution network expansion as well as capacity augmentation. Exploring financing opportunity to mobilise enough finance and faster regulatory approval for capex schemes.

13. **Infrastructure and financing interventions** could involve creating financial products like the “green climate fund” for large-scale green finance at government level.

14. **Amplify the carbon sink through forestry in Gujarat:** The state should invest in advanced afforestation technologies, like GIS mapping, to precisely identify suitable areas.

15. **Mangroves Forest Expansion Program for coastal areas:** Initiate a targeted mangroves forest expansion program in coastal areas of Gujarat.

16. **Commercial pilots for CCUS use case:** various industrial transitions such as CCUS requires technology proof and also commercial viability; hence implement commercial pilots to demonstrate various use cases of Carbon Capture, Utilization, and Storage (CCUS) and incentivize initial such projects to enable large scale adoption

C. Stakeholder ecosystem

1. **Update RE resource potential in GJ across technologies:** Identify and map potential, specially of solar, to provide visibility of available land parcels, and upcoming evacuation infrastructure for RE projects

2. **Resource adequacy**: GUVNL to explore inter-state RE banking and seasonal deals, consultation with other states for bilateral sharing of resources

3. **De-risking distributed RE projects** through providing LC/ Payment security mechanisms for respective project developers

4. **Single window clearance for PSP at GoG level:** notify nodal agency, enabling timely allocation, clearances for sites to reduce the project development period.

5. **Offshore wind projects:** notify nodal agency for timely progress on the program

6. **MSW based Waste to Energy projects:** No royalty on MSW supplied, activate project specific tariffs, speedy PPA by GUVNL and cost sharing among discoms

7. **RPO compliance non-utility users** can be enforced for utility as well as non-utility users by GERC/ GEDA by developing RPO monitoring portal

8. **Collaborative effort to de-register old vehicles:** Facilitate joint efforts between the Transport Department and the Environmental Protection Department (EPD) to de-register old vehicles, ensuring a smoother transition to cleaner and more sustainable transportation.

9. **Unified approach to industrial emission reduction:** Industries Department and the Environmental Protection Department (EPD) to jointly address and reduce industrial emissions, promoting cleaner and greener industrial practices.

10. **Enhanced Monitoring for Green Belt and Urban Forest Preservation:** Implement stricter monitoring measures for preserving buffer zone green belts and urban forest areas, ensuring the protection and enhancement of crucial ecological spaces in the region.

11. **Standardized emission accounting system:** Implementation of a standardized emission accounting system is deemed necessary for consistent monitoring of progress.

12. **Streamlining processes** is vital to facilitate consumers' transition to renewable energy sources. Gujarat's RE policy proposes development of "Single Window Clearance Portal" for registration and approvals of RE projects. The portal should be evolved to integrate with other processes such as connectivity approval of GETCO and approvals from CEI etc.

13. **Actively engaging stakeholders** and tackling hurdles in renewable energy development. Sustained endeavours will pave the way for expanding capacity at the necessary pace to reach the designated target.

14. **Awareness campaigns** towards efficiency and sustainable consumptions to promote adoption of clean energy and low carbon technologies. Further, behavioural change to adopt to demand side management.

6. Possible action plan

The action plan outlines the specific steps and responsibilities for different stakeholders involved to ensure the successful attainment of the state's established target. Successful attainment of the targets hinges on the timely implementation of the action plan.

For the period FY2023-24 and FY2024-25

Energy & Petrochemical Department:	• Pursue GERC on regulatory matters on (i) Revision of RPO trajectory and adoption of RGO trajectory; (ii) Regulatory framework for forecasting, deviation and settlement for energy storage with or without RE (iii) Green energy open access regulations providing clear methodology and long term certainty of charges • Prepare guidelines for procurement of distributed RE through Tariff Based Competitive Bidding • Policy to create value chain for development of offshore wind • Allow private sector to develop RE parks • Draft policy for allocation and development of PSP and nomination of the nodal agency • Establish dedicated PMU cell to help expedite progress on off-shore wind, Pumped Storage Projects, and Green Hydrogen Valley • Consultation with Urban Development Department for creating a mandate for municipalities for procurement of waste to energy power • Consultation with Narmada and Water Resources, Water Supply and Kalpsar Department for Mandate for water department and authorities for setting up floating/canal based solar to utilize water bodies • Designate nodal agency for conducting feasibility of off-river pumped hydro project in Gujarat and develop mechanism for allocation of sites • Implement financial incentives or grants for the establishment of Grid-Integrated Rapid Solar EV Charging Hubs
Gujarat Urja Vikas Nigam Limited	• Conduct feasibility for resource adequacy at state level and in consultation with other states for bilateral sharing of resources • Revise procurement plan to hybrid and flexible and dispatchable RE projects • Demand side management to shift consumer demand matching with RE generation profile to reduce balancing constrains through incentives • Shifting of 100% agriculture demand to daytime • Further procurement of thermal capacity should have projects located outside of Gujarat • Creating demonstration of BESS use cases at GTD levels
Climate Change Department	• Perform annual energy or emissions audits and reporting within power, industry, and transport sectors to ensure consistency, accuracy, and reliability • Conduct study for agrivoltaics in desert neighbouring regions • In consultation with Industries department, prepare comprehensive policies to facilitate the shift from fossil fuel-based energy to electrified energy in industrial processes
Gujarat Energy Development Agency	• Establish dedicated program management cell to help tracking and timely coordination for implementing Panchamrit roadmap in Gujarat • Awareness programs and incentive programs for smart enable energy efficient appliances. • Incentive schemes for biomass aggregation and supply chain, dedicated catchment areas • Reassess potential solar and creation of land banks • Monitoring portal for RPO compliance of Utilities and other obligated entities • Creating Single Window Clearance for PSP projects

Gujarat Pollution Control Board	• Develop targeted policies for CCUS investments, offer funding assistance, and incentivize the private sector. • Introduce carbon pricing in the form of cap-and-trade mechanism and reduce the cap every year to support deep carbonization.
Forest and Environment Department	• Involve local communities in afforestation efforts. • Formulate forest policy emphasizing on afforestation, preservation, maintenance, sustainable utilization, restoration, and enhancement of the natural environment. • invest in advanced afforestation technologies, such as GIS mapping, to accurately identify suitable areas for afforestation. • Deploy local task forces strategically for effective implementation of afforestation programs.
Ports and Transport Department	• Develop a road transport policy roadmap that includes short, medium, and long-term goals and policy support for transport sector decarbonization
Private sector	• Adoption of higher hub heights for wind power projects

For the period FY2025-26 and FY2026-27

Energy & Petrochemical Department	• Expedite PSP project development within Gujarat through fiscal and procedural facilitations
Gujarat Urja Vikas Nigam Limited	• Procure energy storage capacity on BESS and PSP project, announce bid calendar for 3 years
Climate Change Department	• Perform annual energy or emissions audits and reporting within power, industry, and transport sectors to ensure consistency, accuracy, and reliability. • Creation of financial products like “green climate fund” for large-scale green finance at state government level • Activating state level carbon market
Gujarat Energy Development Agency	• A Incentivize high-efficiency industrial equipment, such as heat pumps and other electrification technologies, for low and medium temperature process heat, along with encouraging the use of LEDs. • Implement Energy Conservation Building Code (ECBC) in newly constructed commercial buildings
Gujarat Pollution Control Board	• Support innovation in CO2 capture, R&D, and establish research institutes for CCUS. • Establish a transparent regulatory body for the efficient deployment of CCUS technologies, initially utilizing existing infrastructure.
Forest and Environment Department	• Reward communities and task forces that demonstrate exceptional results in afforestation • invest in advanced afforestation technologies, such as GIS mapping, to accurately identify suitable areas for afforestation. • Conduct capacity building workshops, tree adoption programs
Ports and Transport Department	• Offer incentives to achieve the goal of having electric vehicles account for over half of all new passenger car sales by 2030. • Development of port in Gujarat for offshore wind projects

For the period FY2027-28 till FY2029-30

Energy & Petrochemical Department	• Policy measures to scaleup offshore wind projects
Gujarat Urja Vikas Nigam Limited	• Development of PSP projects for balancing needs
Gujarat Pollution Control Board	• Establish a legal framework ensuring safe CO2 storage for CCUS. • Support innovation in CO2 capture, R&D, and establish research institutes for CCUS
Forest and Environment Department	• Reward communities and task forces that demonstrate exceptional results in afforestation
Ports and Transport Department	• Offer incentives to achieve the goal of having electric vehicles account for over half of all new passenger car sales by 2030.

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