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Tamil Nadu Green Climate Company

GOVERNMENT OF TAMILNADU
TRUTH ALONE TRIUMPHS

Tamil Nadu Climate Change Mission

VIRUDHUNAGAR

DISTRICT DECARBONISATION ACTION PLAN

VASUDHA FOUNDATION
Green ways for a good earth!

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“Tamil Nadu has always led the nation in showing how growth and responsibility can go hand in hand. We are steadily building on our actions toward becoming a Net-Zero economy well before 2070. These District Decarbonisation Action Plans take this commitment deeper by bringing climate action closer to the people, to our villages, towns, and industries. When every district and every citizen joins hands, Tamil Nadu will demonstrate how sustainability can take root in local action and collective responsibility.”

Thiru M.K.Stalin

Honourable Chief Minister of Tamil Nadu

“For Tamil Nadu, economic progress and environmental care go hand in hand and they are central to how we plan and govern. These District Decarbonisation Action Plans reflect our commitment to ensuring that development also builds climate resilience. They will guide each district to grow responsibly, aligning prosperity with the health of our land, air, and water. This is how we see the future of Tamil Nadu where fiscal discipline, environmental stewardship, and people’s well-being move forward together.”

Thiru Thangam Thennarsu

Honourable Minister for Finance,
Environment and Climate Change, Tamil Nadu

“The District Decarbonisation Action Plans strengthen Tamil Nadu’s commitment to integrating climate priorities into development planning. They bring together policy, people, and business to act on shared goals of resilience and sustainability. This approach reflects our focus on turning data and collaboration into practical outcomes that safeguard our environment and support inclusive growth. This is where the strength of Tamil Nadu truly lies, in turning science and policy into action that uplifts people and protects nature.”

Tmt. Supriya Sahu, I.A.S.

Additional Chief Secretary to Government, Environment, Climate Change & Forest Department, Tamil Nadu

“The District Decarbonisation Action Plans reflect Tamil Nadu’s participatory and bottom-up approach to climate action. They combine data, local experience, and cross-sector coordination to help districts plan and act with clarity. Through collaboration between departments, industries, and communities, TNGCC is working to ensure that every local effort contributes meaningfully to the state’s long-term climate goals.”

Thiru A.R. Rahul Nadh, I.A.S.

Director, Department of Environment and Climate Change, Tamil Nadu

Preamble

The District Decarbonisation Action Plan for Virudhunagar aims to guide the district toward a low-carbon, climate-resilient, and economically inclusive future. As an industrial and agricultural hub in a semi-arid region, Virudhunagar requires tailored strategies that integrate climate science, energy modelling, and local realities.

Grounded in historical emissions analysis, climate projections, and sectoral assessments, the plan outlines mitigation and carbon sequestration strategies across industry, transport, power, agriculture, buildings, and waste. It presents three scenarios—Business as Usual (BAU), Moderate Effort Scenario (MES), and Aggressive Effort Scenario (AES)—with the potential to reduce emissions by up to 85 percent by 2050, while aligning with state and national climate targets.

Some mitigation measures such as industrial electrification, energy-efficient retrofits, fertiliser reform, and adoption of clean transport—may involve transitional costs. However, these are outweighed by long-term gains in energy security, job creation, public health, and ecosystem restoration. For example, shifting from fossil-based captive power to renewables and promoting electric mobility can reduce emissions while boosting industrial competitiveness and air quality.

The plan emphasises nature-based solutions, such as agroforestry, social forestry, and improved forest management. Repurposing fallow and barren land to enhance carbon sinks not only enables annual CO_2 sequestration but also improves soil health, restores degraded ecosystems, supports biodiversity, and enhances water retention. Though these interventions may require upfront investments and community engagement, they offer long-term co-benefits including livelihood support and climate resilience.

Conversely, a business-as-usual approach may seem cost-effective in the short term but risks intensifying climate vulnerabilities like water stress, extreme heat, and declining agricultural productivity. The plan takes a forward-looking approach by advocating systemic decarbonisation, sustainable resource use, and climate-informed governance.

By aligning economic growth with ecological sustainability, the Action Plan positions Virudhunagar as a district-level model for climate action—advancing Tamil Nadu's decarbonisation goals and contributing to India's net-zero ambition.

This brief provides a snapshot of the decarbonisation and climate action plan of Virudhunagar, including infographics on the need for climate resilience and decarbonisation in the district in an easy-to-understand manner. It also includes ready to implement projects for near term, sectoral interventions elaborated in a decadal plan.

Executive Summary

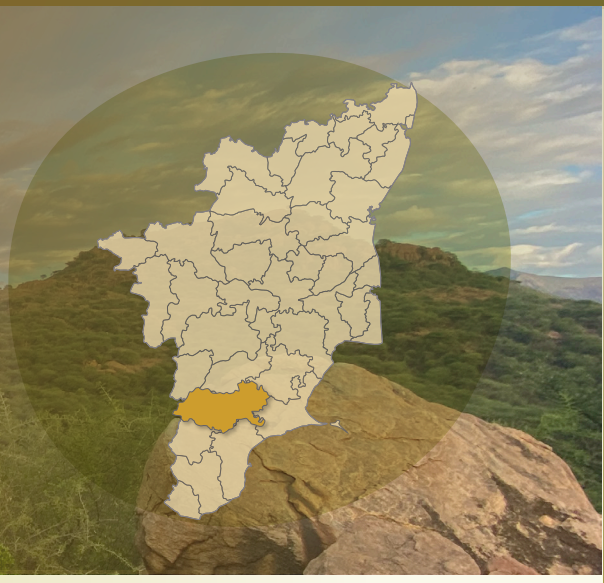
The Virudhunagar district, located in the southwest region of Tamil Nadu, is home to 21.5 lakh people and is a hub of industrial activities. The district is known for cement manufacturing IPPU in Alangulam and Thulukkapatti, as well as its textile industry which is based in Rajapalayam and is further supported by the PM Mega Integrated Textile Regions and Apparel Park (MITRA) in the Kumaralingapuram village. These, alongside the other industrial subsectors, are supported by a robust network of 41,604 Micro, Small and Medium Enterprises (MSMEs) that supply raw material and offer allied services. While the economy of Virudhunagar is industry-led, contributing 45 percent of Gross Value Added (GVA), the district still retains a distinct rural character with 53 percent of land used for agriculture which also employs 66.3 percent of its population.[1]

Virudhunagar district experiences semi-arid climatic conditions with high inter-annual climate variability, making it particularly vulnerable to climate change impacts. Virudhunagar faces high climate vulnerability due to rising temperatures (up to 2.8°C by 2090) and erratic monsoon patterns under RCP 8.5. Historical data show increasing trends in heatwaves and extreme rainfall, heightening risks to agriculture, industry, and public health.

The very industries that define Virudhunagar's economic profile also pose a challenge of Greenhouse Gas (GHG) emissions in the district. In 2022, cement manufacturing and industrial energy including captive power plants accounted for 37 percent (1023 $ktCO_2e$) and 21 percent (592 $ktCO_2e$) of Virudhunagar's total gross emissions (2790 $ktCO_2e$). Witnessing a rapid expansion, road transport contributed to 17 percent (471 $ktCO_2e$), followed by emissions from livestock at 9 percent (252 $ktCO_2e$), building at 7 percent (201 $ktCO_2e$) and other sources.

Land-based sequestration was estimated at 171 $ktCO_2e$ in 2022, with agroforestry and social forestry interventions on fallow and wastelands offering considerable scope to enhance carbon removals and further reduce the district's overall emissions footprint.

Why Should Virudhunagar Transition Towards a Low-carbon, Climate Resilient Future?



DISTRICT HIGHLIGHTS

~41,000 MSMEs
Concentrated in textile, fireworks, paper and paper products and cement manufacturing

Fireworks and matches manufacturing hub

47% of GDDP
is contributed by the service sector, and 29% by industries

CLIMATE PROFILE

1,243 mm
Annual rainfall

18.9°C to 37.6°C
Annual temperature range

0.2°C to 2.8°C
Projected increase in maximum summer temperature by 2090

Drought, Heat-stress and Forest Fire Risks

Projected increase in rainfall by 2090

10% – 43%
in SW monsoon

18% – 51%
NE monsoon rainfall

GHG EMISSIONS (2022)

2,791 $ktCO_2e$
Gross emissions

2,620 $ktCO_2e$
Net emissions

Key Contributors
% of gross emissions

37%
Cement production (IPPU)

21%
Industrial energy

17%
Road transport

(-171) $ktCO_2e$
Annual sequestration

TRANSFORMATION POTENTIAL

Blended Finance and Community-Ownership Models

Robust Public Transport Ecosystem
for sustainable and shared intra-city mobility

(-1,428) $ktCO_2e$
Annual sequestration potential

1,614 $ktCO_2e$ Annual Mitigation Potential

Electrification of Heating Processes

Climate-resilient Multifunctional Green Spaces

Low-Carbon Interventions and Ecosystem-Livelihood Co-benefits

Blue-Green Ecosystem

-1,428 $ktCO_2e$*

Intervention

- Enhance the carbon stock density of existing forest cover
- Agroforestry in waste/fallow lands
- Restoration of Sanjeevi Malai

Resilience & Co-benefits

- Strengthens heat and drought resilience.
- Enhances water security and soil health
- Promotes biodiversity conservation and ecological balance
- Enables integrated water and agriculture efficiency management

Economics and Livelihood Improvement

- Promotes green jobs and local entrepreneurship
- Strengthens farmers' institutions and support market access.
- Supports livelihood opportunities for women and youth

Industrial Decarbonisation

749 $ktCO_2e$*

Intervention

- Electrify heating processes in industries
- Replace all diesel and coal based captive power plants with renewable energy

Resilience & Co-benefits

- Boosts energy access and health outcomes
- Improves air, water and soil

Economics and Livelihood Improvement

- Improves efficiency & operational performance
- Minimises supply chain disruption
- Skilling and reskilling of workforce for RE based O&M

Sustainable Public Transport

99 $ktCO_2e$*

Intervention

- Addition of 2000 intra-city electric buses by 2050
- Promotion of non-motorised transport and public bicycle sharing infrastructure

Resilience & Co-benefits

- Resilient transport access
- Cooler cities and cleaner air

Economics and Livelihood improvement

- Boosts sustainable mobility
- Green jobs, especially for women
- Better health, last-mile access

NMT: Non-motorised Transport; PBS: Public Bike Sharing; * denotes mitigation potential

What Does Climate-resilient Development Deliver?

- Reduced heatstress risks and improved health infrastructure.
- Strengthened market access for climate-smart and low carbon produce.
- Decent work and improved health outcomes, especially for factory workers
- Supports climate-informed planning and governance
- Enables water management through restoration, rejuvenation of water bodies and efficient urban and industrial water management.
- Bankable green projects | Access to global climate finance | Green jobs | Livelihood security

Low Carbon and Resilient Pathways for Virudhunagar

As the district's economy and population continue to grow, total greenhouse gas (GHG) emissions are expected to rise due to increasing energy demand across the industrial, building, and agriculture sectors, along with emissions from livestock, cropland activities, and waste.

Under the **Business as Usual (BAU)** scenario, total emissions are projected to reach **3535 $ktCO_2e$ by 2050**, driven by both **energy-related** and **non-energy-related** sources.

Emissions from the energy sector (excluding IPPU) are estimated to grow by 22 percent, rising from 1290 $ktCO_2e$ in 2022 to 1573 $ktCO_2e$ in 2050. This increase is primarily attributed to rising industrial activity, fuel consumption for cooking, and road transport.

Simultaneously, emissions from Agriculture, Forestry and Other Land Use (AFOLU) and the Waste sector are projected to increase by 21 percent, from current levels to 578 $ktCO_2e$ in 2050. The livestock sub-sector will be the largest contributor within this category, with emissions expected to reach 339 $ktCO_2e$. Aggregate and non-CO_2 sources on land, such as rice cultivation, agricultural soils, and biomass burning, will also grow, from 87 $ktCO_2e$ in 2022 to 115 $ktCO_2e$ in 2050.

Conversely, waste sector emissions are projected to decline from 138 $ktCO_2e$ in 2022 to 124 $ktCO_2e$ in 2050, mainly due to a significant reduction in solid waste emissions—dropping from 27 $ktCO_2e$ to just 2 $ktCO_2e$.

Emission Reduction Opportunities

Significant mitigation potential exists across both energy and non-energy sectors:

- Energy sector emissions can be reduced by up to 86 percent through: (a) Transition from LPG to PNG and electric cookstoves in buildings, (b) Increased uptake of electric vehicles (EVs) in transport, (c) Electrification of industrial heating processes and (d) Replacing diesel pumps and tractors in agriculture with solar or electric alternatives.
- These efforts are strongly supported by enabling policies such as the Tamil Nadu Electric Vehicle Policy 2023, Tamil Nadu Industrial Policy 2021, and the PM-KUSUM scheme.
- In the waste sector, deploying centralised sewage treatment systems (e.g., activated sludge process), septic tanks with Fecal Sludge Treatment Plants (FSTPs) at Gram Panchayat cluster level, and Decentralised Wastewater Treatment Systems (DEWATS) could collectively reduce emissions by 91 $ktCO_2e$.
- Adoption of Zero Liquid Discharge (ZLD) technologies and improved sludge waste treatment could further abate 8.7 $ktCO_2e$ by 2050.
- In the livestock sector, implementing balanced rationing, methanogen-suppressing feed additives, and manure management practices could yield an estimated reduction of 93 $ktCO_2e$, equivalent to 28 percent of projected livestock emissions in 2050.

Together, these interventions offer a clear pathway to significantly reduce emissions across sectors, supporting the district's transition to a low-carbon, climate-resilient future.

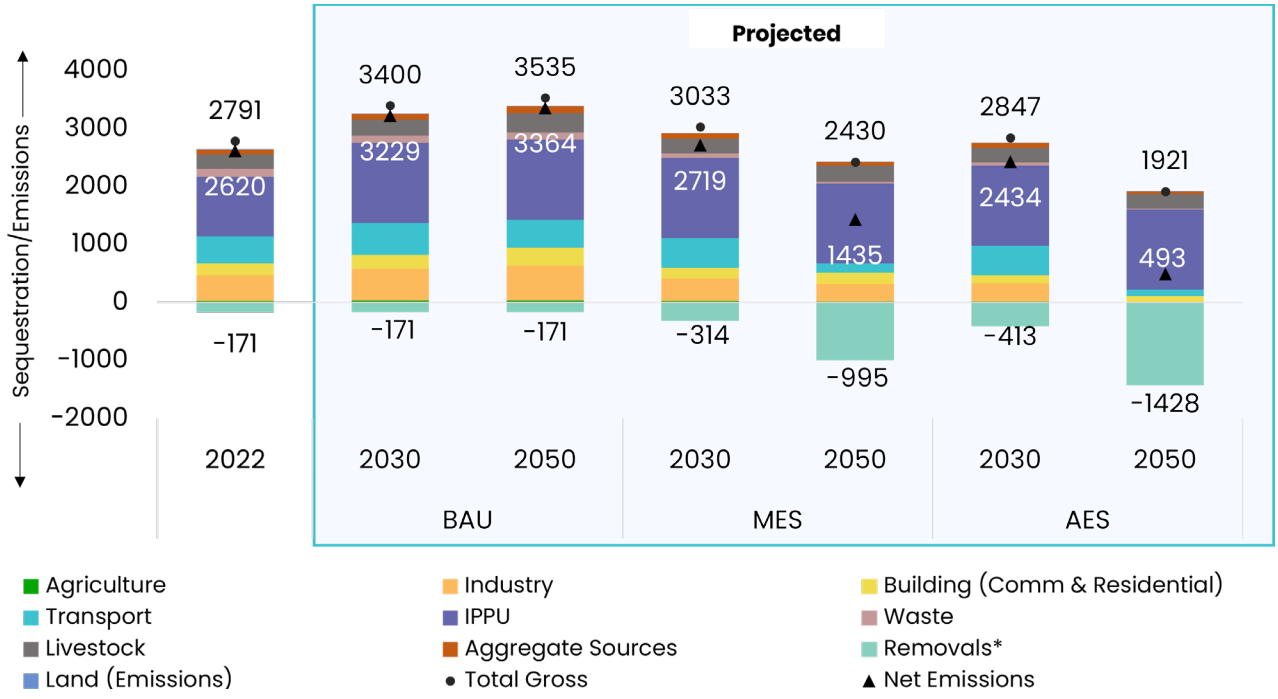


Figure 1: GHG emissions in Virudhunagar in 2022 (actual), 2030 and 2050 (projections) under BAU, MES and AES

(Source: Authors' analysis)

Key Sectoral Insights

The developed pathways focus on key emitting categories, exploring a range of distinct interventions aimed at reducing emissions while ensuring that the transition aligns with ongoing programmes and schemes at both the state and central levels. The pathways explore three emission scenarios for Coimbatore through 2050: Business as Usual (BAU), Moderate Effort Scenario (MES), and Aggressive Effort Scenario (AES) (Figure 2).

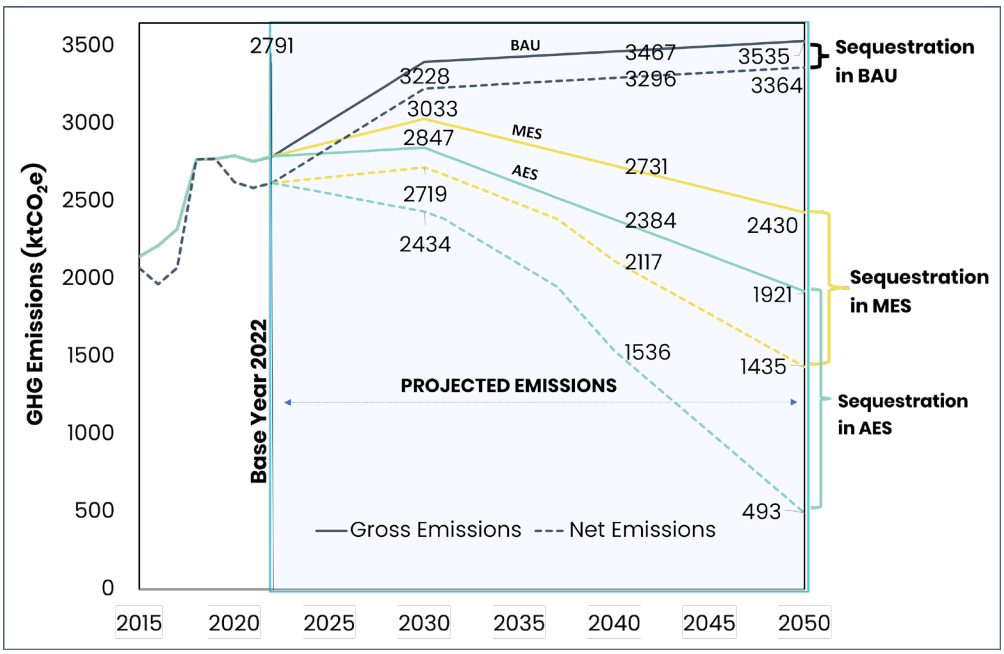


Figure 2: Economy wide GHG emissions in Virudhunagar under BAU and emission abatements under AES scenario by 2050

(Source: Authors' analysis)

Harnessing mitigation strategies suggested in the plan could enable the district to abate ~85 percent of its emissions by 2050. However, achieving carbon neutrality in the district would require the complete decarbonisation of hard-to-abate cement industries.

Gross GHG emissions in BAU are projected to reach 3,535 $ktCO_2e$ by 2050 from 2,791 $ktCO_2e$ in 2022, driven primarily by industrial growth and increased energy demand in buildings and transport sectors. Virudhunagar could abate 3020 $ktCO_2e$ of these emissions (85% reduction) through higher electrification of the transport fleet and industrial processes, use of renewable sources to replace fossil fuel based captive generation, waste management, and higher sequestration among other strategies.

The net emissions of 493 $ktCO_2e$ in 2050 will primarily come from IPPU emissions, which will require technological solutions such as carbon capture etc. However, the techno-economic feasibility of these solutions is yet to be explored at a larger scale in India.

Deep electrification and energy efficiency initiatives across end use sectors will lead to reduction of final energy consumption, making them key drivers of a sustainable energy future.

Virudhunagar's energy demand is projected to rise from about 29 PJ in 2022 to around 48 PJ by 2050 under BAU. Through energy efficiency measures, deep electrification (particularly in industry and transport), and fuel switching in buildings from LPG to PNG, total energy demand can be reduced to roughly 37 PJ in the AES 2025 scenario—about a 23 percent drop compared to BAU 2050. This shift is driven by higher EV adoption in transport (replacing gasoline and diesel vehicles) and electric furnaces in industry (replacing fossil-fueled processes), which together reduce fossil fuel consumption and improve overall system efficiency.

Deep electrification of end use sectors resulted in higher electrical energy consumption in AES over BAU—approximately 24 PJ in BAU 2050 to over 32.3 PJ in the AES scenario—while the contribution from fossil fuels such as diesel, gasoline, coal, and petcoke has declined.

Further, in the BAU 2022, electricity accounted for ~30 percent of the total energy mix. This share is expected to increase to 50 percent by 2050 due to current market dynamics and initiatives such as electric vehicle adoption, increased electricity use in the building sector, and electrification of agricultural pump sets etc. However, under the AES, the electricity share in the energy mix will rise further to 88 percent due to near complete electrification of the transport fleet, and higher electrification in industries.

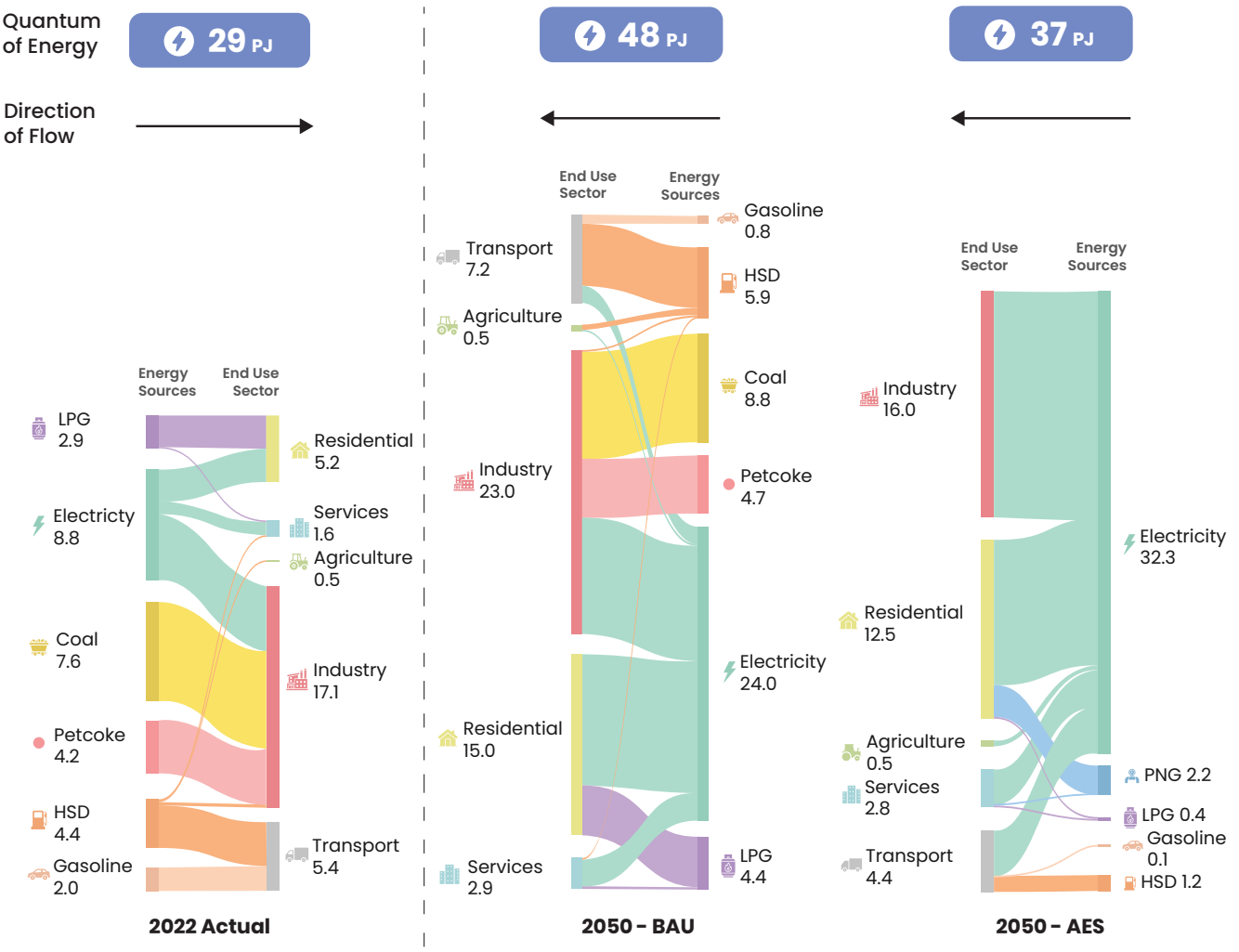


Figure 3: Energy sources and respective end-use sectors flow diagram in Virudhunagar across 2022 (actual) and 2050 (both BAU and AES scenarios)

(Source: Authors' analysis)

Decarbonisation of hard-to-abate cement sector will play a crucial role in reducing emissions in the district.

The GHG emissions from the industries in the district, including the captive power plant emissions and Industrial Processes and Product Use (IPPU) emissions, are expected to increase from 1615 $ktCO_2e$ in 2022 to 1985 $ktCO_2e$ in 2050 under BAU. The majority of these emissions are from cement production. At present, the cement production capacity in Virudhunagar is 2.4 MTPA, which is planned to increase to 3.1 MTPA with an inclusion of 0.7 MTPA RAMCO plant by 2027. Apart from this, Virudhunagar is a textile hub as well. Recently, PM Mega Integrated Textile Regions and Apparel Parks (MITRA) has been inaugurated in Kumaralingapuram village of district to further boost textile sector.

A 100 percent replacement of fossil fuels with clean fuels (such as green hydrogen for firing in Kiln) for heating, energy storage for power backups, electrification of heating processes, and replacing fossil fuel based CPPs with RE can fully decarbonise the industrial sector by abating 748 $ktCO_2e$ of projected emissions in 2050.

Further, adopting Carbon Capture and Utilisation (CCU), as the technology and market matures in the future, would enable the district to abate the process emissions in the cement sector, driving it closer to becoming carbon neutral.

Road transport electrification is critical to mitigate the transport sector's GHG emissions.

After Industries, road transport is the second highest GHG emitter in the energy sector, contributing 471 $ktCO_2e$ or 36.5 percent of energy related emissions in 2022. Despite projections of higher EV penetration in new vehicle sales owing to policy and market dynamics, diesel run vehicles will marginally increase emissions to 483 $ktCO_2e$ by 2050. A further push towards achieving 100 percent penetration of EVs in new sales of two-wheelers, three-wheelers, and four-wheelers and 80 percent penetration in heavy goods vehicles will further abate the GHG emissions. This will contribute to the reduction of ~78 percent of projected GHG emissions by 2050, with only 107 $ktCO_2e$ remaining. Due to the fleet electrification, an additional 513 GWh of electricity will be required by 2050 to power these vehicles.

Role of Behavioral Interventions in Road Transport: Non-motorised transport and smart traffic systems can further curtail emissions over and above the projected abatement. Using public transport for inter-city and intra-regional movement can result in 45 percent reduction in emissions in comparison to private vehicles in Virudhunagar. Assuming that 10 percent commuters in Virudhunagar shift from 4W cars to buses, this behavioral change could reduce GHG emissions by ~46 $ktCO_2e$ by 2050. Such a shift could also avoid the need for around~ 18,000 four-wheelers on the road, replaced with an addition of ~800 buses additionally smart traffic systems can reduce 25 percent of signal emissions by reducing idle time at intersection.

Electricity consumption in the district is expected to triple by 2050 compared to current level.

Electrification across sectors, higher space cooling needs, and economic growth in the district are expected to increase the district's electricity demand from 2,278 GWh to 7,488 GWh by 2050. Industrial deep electrification would increase industrial electricity demand to 3080 GWh by 2050, almost 41 percent of the total electricity demand of the district. (Figure 4a) A drastic increase in electricity demand is projected in the transport sector due to higher EV adoption, increasing its share in total electricity mix from nil in 2022 to 11.6 percent in AES 2025 (Figure 4b).

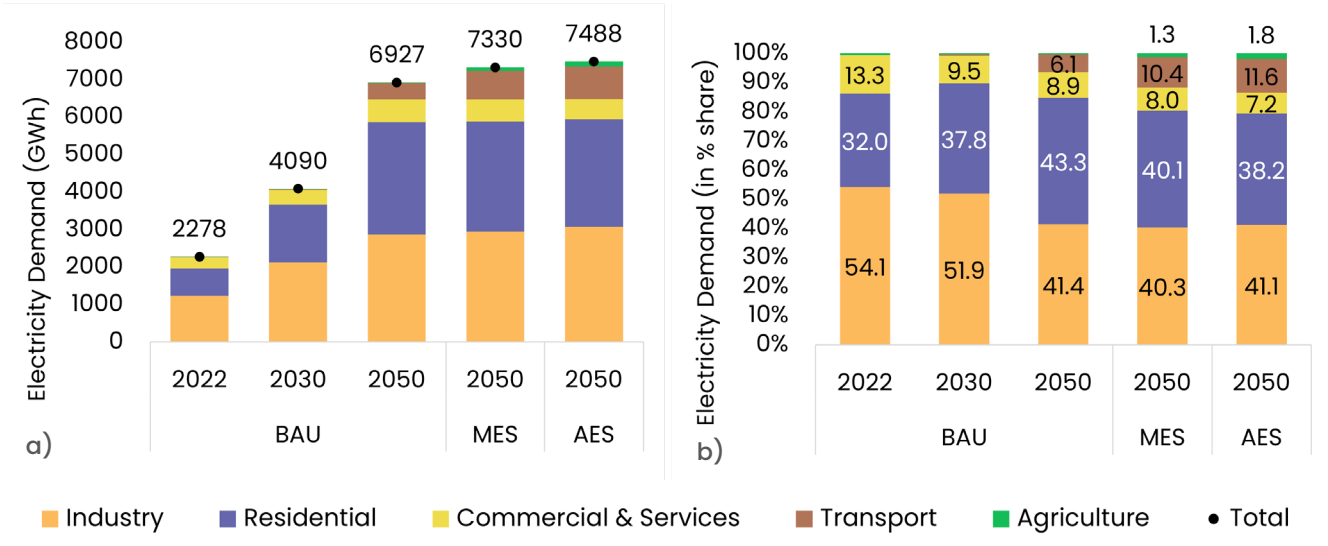


Figure 4a: Electricity demand projections across sectors and scenarios in GWh
4b: Electricity demand projections across sectors and scenarios in percentage share of total

(Source: Authors' analysis)

Residential demand for electricity is projected to increase from 728 GWh to 3,002 GWh by 2050, with that for space cooling accounting for 61 percent of it, at 1845 GWh by 2050. By maintaining a temperature setting of 26°C, it is possible to save up to 60 percent of the electricity required for space cooling, compared to operating air conditioners at 18°C.

Role of Behavioral Interventions in Building Sector: Setting the AC to a higher temperature (around 24–26°C) is both comfortable and energy-efficient. A conservative increase in the temperature setting by 2°C from 24°C to 26°C could reduce electricity demand by approximately 120 GWh. Additionally, smart lighting solutions can prevent 40 percent of lighting electricity usage or 98 GWh in Virudhunagar district.

Decarbonising electricity sector would require holistic assessment and implementation of various renewable energy sources.

Over and above the Scope 1 GHG emissions, which have been analysed in the plan, the electricity consumption related GHG emissions (Scope 2 emissions) contribute to almost 736 $ktCO_2e$ and could increase to 4383 $ktCO_2e$ by 2050 in absence of decarbonisation measures. To meet this demand from renewable sources, an additional equivalent capacity of 3 GW (in addition to 0.7 GW solar capacity) is required. Therefore, there is a need for exhaustive and holistic assessment of various solar energy sources such as utility scale PV plants, rooftop solar, floating solar, and agri-photovoltaic solar, bio energy, and wind energy in the district.

Decarbonising the non-energy sector would drive to carbon neutrality and potential carbon negative future.

As of 2022, total non-energy emissions (excluding IPPU) in Virudhunagar stood at 477 $ktCO_2e$ (~17% of total emissions), primarily led by livestock (53%, 252 $ktCO_2e$) and waste (29%, 138 $ktCO_2e$). In BAU, the total non-energy emissions are projected to increase by 100 $ktCO_2e$ to 578 $ktCO_2e$ (~16% of total emissions) by 2050, again with predominant contributions from livestock (59%, 339 $ktCO_2e$) and waste (21%, 124 $ktCO_2e$). Meanwhile, the emissions from aggregate sources and non-CO_2 emission sources on land, which includes emissions from rice cultivation, agriculture soil and biomass burning in cropland, increased from 87 $ktCO_2e$ (~18% of non-energy emissions) in 2022 to 115 $ktCO_2e$ (~20% of non-energy emissions) in 2050.

One third of projected non-energy emissions in 2050 can be abated by targeted interventions in livestock management—balanced rationing and feed additives to control methanogens, manure management—and waste sector.

In AES, through introduction of balanced rationing (90% of livestock), improved feed supplements, methanogen inhibiting substitutes (75% of livestock), and manure management practices, 93 $ktCO_2e$ of emissions from livestock category can be abated by 2050. Similarly, efficient waste management through centralised treatment for urban, septic tanks for rural and fecal sludge treatment plants at Firka level, effluent treatment plants with continuous monitoring systems for industrial wastewater, zero liquid discharge, composting organic waste, reuse etc. can abate 101 $ktCO_2e$ by 2050 from the largely static waste sector.

Half of the projected emissions from aggregate sources and non-co_2 emission sources from land can be abated by adoption of sustainable agriculture practices.

Replacing synthetic fertilisers and urea with organic fertiliser and nano urea and increasing the percentage of multiple aeration in the rice cultivated area would help to reduce the emissions from the agriculture sector. Under AES, increasing the multiple aeration for rice cultivation from 20% to 77% and transitioning 75% of agriculture area to organic fertiliser will reduce 42 $ktCO_2e$ and 24 $ktCO_2e$ of emissions respectively by 2050.

Additionally, scaling carbon sequestration through green space restoration (Sanjeevi Malai and other forest area) in Virudhunagar would help convert 61% of barren, fallow, and cultivable waste lands into agroforestry, social forestry, and other afforestation projects, and could boost carbon sequestration by 1238 $ktCO_2e$/year by 2050. The Sanjeevi Malai Hills restoration project serves as a model, showcasing the potential of community-driven afforestation, soil conservation, and biodiversity restoration. Scaling similar projects across Virudhunagar's degraded landscapes can significantly enhance carbon sequestration and promote ecological balance and biodiversity (Figure 5).

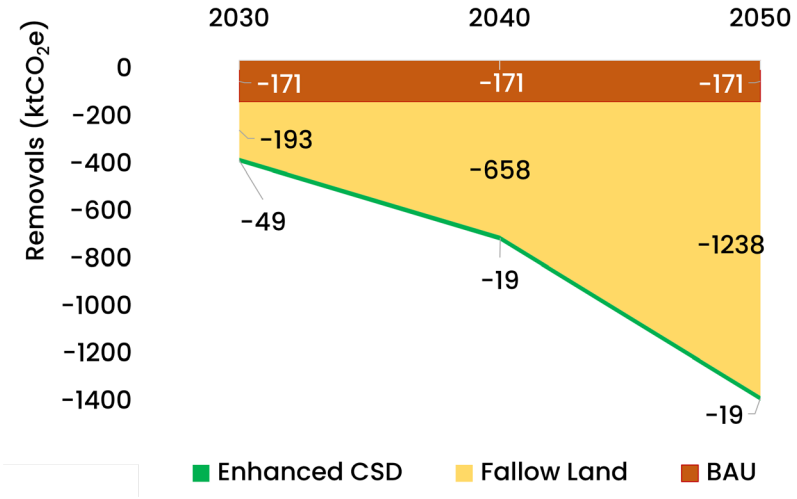


Figure 5: Carbon sequestration potential in Virudhunagar

(Source: Authors' analysis)

Communities have a catalytic role to play in operationalising decarbonisation of Virudhunagar in a sustainable manner.

Strategies for decarbonising Virudhunagar could be made sustainable by rooting them within community groups, with community members – particularly women, youth and other marginalised groups acting as anchors of these solutions. In doing so, local ownership of energy and climate solutions can be instilled and local livelihoods generated.

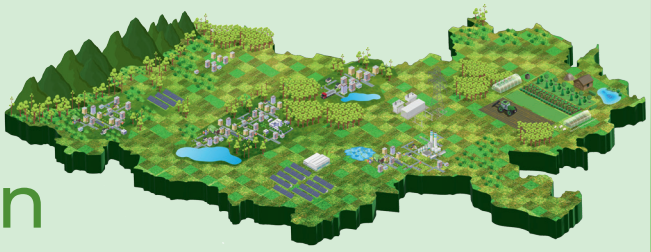
Models of community engagement in Virudhunagar's decarbonisation

S.no	Intervention	Scope of Community Engagement			Models of Engagement
		Low	Medium	High	
1.	**Green Space Restoration & Sequestration**	✗	✗	✓	**Community-led Forestry & Other Models** **Description:** Community led WADI, agroforestry, social forestry and other sequestration models. Most feasible for community engagement. **Lever Point**: Women SHGs, individual farmers and groups supported by Krishi Vigyan Kendras (KVKs) *Example: Tamil Nadu Tree Cultivation in Private Lands Project (TNPP) engaged farmers for market linked agroforestry*
2.	**Electrification of Road Transport**	✗	✗	✓	**Women E-Rickshaw Ecosystem** **Description:** Provides (additional) livelihoods to women while challenging social norms. In addition to e-rickshaw drivers, women can also be trained on repair and allied services. **Lever Point:** Udyam Sakhis under SRLM *Example: Women E-Rickshaws in UP supported by UPSRLM under 1 Million Jobs by 2027 vision*

S.no	Intervention	Scope of Community Engagement			Models of Engagement
		Low	Medium	High	
3.	**Clean Energy in Agriculture and Buildings**	✗	✗	✓	**Community-led Decentralised RE/Solar Systems** **Description:** Irrigation and solar energy solutions (including installation and maintenance) managed by community members, particularly women SHGs. Generates additional livelihoods while ensuring local ownership of DRE assets. **Lever Point:** Women SHGs, Farmer Producer Organisations under NABARD/SFAC/Khadi Commission *Example: Women SHGs as Irrigation Service Providers piloted in Bihar, Solar Saheli Project piloted in Madhya Pradesh, Rajasthan, Uttar Pradesh, Bihar, Odisha and SHG Solar Power Initiative in Telangana*
4.	**Decarbonisation of Industrial Sector**	✓	✗	✗	**Decarbonisation of MSME Value Chain** **Description:** EVs for transportation of goods from one factory/unit to another, and further to market; training of youth on green jobs; generation of additional jobs through need for repair/maintenance and allied services. Preferential interest rates to women owned green enterprises. **Lever Point:** Women and youth run e-rickshaws can be linked; Safai Sathis and other formal waste management groups; DLBCs for identifying aspiring women entrepreneurs *Examples: Saamuhika Shakti Programme in Bangalore, Karnataka focused on promoting micro entrepreneurship among women waste pickers. NEPRA in Indore also promotes decent work for waste pickers in a business set-up.*
5.	**Waste Management**	✗	✗	✓	**Community-led Waste Management** **Description:** Decentralised waste management, covering waste collection, segregation and processing (if any), owned and managed by local community groups (non-entrepreneurial). Women from disadvantaged communities could play a leading role in this. **Leverage:** Local Safai Sathi Groups *Example: Ecogram Project in Bangalore. Earth5R, a social enterprise in Mumbai, links green entrepreneurship with community driven waste models.*

Virudhunagar's decarbonisation strategy pivots on renewable energy integration, electrification of key sectors, and enhancement of natural carbon sinks. By implementing these measures, the district can significantly reduce its GHG emissions and enhance resilience – contributing its share to Tamil Nadu's decarbonisation goals.

Virudhunagar's
Path to Decarbonisation



Virudhunagar's path to decarbonisation hinges on electrified transport, clean energy, and enhanced sequestration with additional scope to decarbonise hard-to-abate industries.

Total Net Emissions (2022): 2,620 $ktCO_2e$

- **Annual Growth in Emissions (2005 to 2022): 3.7%**
- **Per Capita Emissions (2022): 1.21 tonnes CO_2e per capita**
- **Emission Intensity Reduction in 2022 w.r.t 2005: 57%**

INDUSTRIES

AMP: 748 $ktCO_2e$
21.19% of Gross Emissions

Shifting from the current **~87 MW** fossil-based captive power generation to an equivalent **105 MW** renewable energy capacity by 2040
AMP: 146 $ktCO_2e$ emissions

Replacing fossil fuel-based heating with **electricity-based heating** by 2050
AMP: 602 $ktCO_2e$ emissions

- Adopting material substitution **(LC3 and fly ash)** to reduce process emissions without compromising cement strength
- Exploring **carbon capture utilisation (CCU)** systems

TRANSPORT

AMP: 376 $ktCO_2e$
10.64% of Gross Emissions

100% penetration of electric **2W and 3W by 2035,** electric **4W and bus by 2040**, and **80%** of **electric trucks and trolleys** in new sales by 2050

Installation of **~475 charging stations** and development of allied infrastructure such as metering and grid infrastructure, to support fleet electrification by 2050

Stock of EVs in 2050

- *E-2W* **~6.8 lakh**
- *E-3W* **7,000**
- *E-4W* **2.6 lakh**
- *E-buses* **5,200**
- *E-trucks & trolleys* **11,000**

CARBON SEQUESTRATION

ASP: -1,428 $ktCO_2e$
40.4% of Gross Emissions

Restoration of Sanjeevi Malai

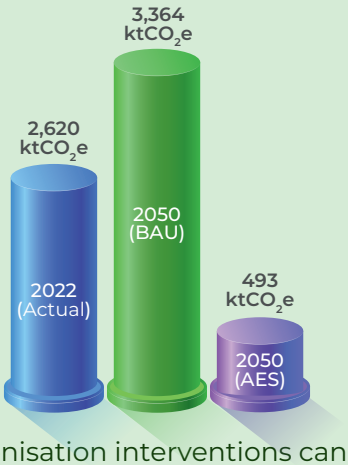
- Plantation of mixed species and assisted **natural regeneration**
- Encourage social forestry, participation of local communities, regular maintenance and monitoring

- Repurposing **1,40,653** ha of barren/fallow lands to horticulture, agro/social forestry
  ASP: -1,237 $ktCO_2e$/yr by 2050
- Enhance carbon stock density by 5% from the existing **~82.25 tCO_2/ha to 86.76 tCO_2/ha** through reforestation/ afforestation and sustainable forest management
  ASP: -19 $ktCO_2e$/yr by 2050
- Maintaining the current rate of forest cover increase and existing carbon stock density **ASP: -171 $ktCO_2e$/yr**

Increasing green spaces through **climate resilient bioparks, urban forests and floating gardens** can help reduce the heat stress

*AMP stands for annual mitigation potential

**ASP stands for annual sequestration potential



Decarbonisation interventions can abate ~2,871 $ktCO_2e$ of projected emissions by 2050

AMP: 194 $ktCO_2e$
5.49% of Gross Emissions

AGRICULTURE

- **90% balanced rationing** and **75% methanogen** inhibiting feed additives for livestock by 2050 **AMP: 93 $ktCO_2e$**
- Increase multiple aeration water regime from **20% to 77%** for rice cultivation by 2050 **AMP: 42 $ktCO_2e$**
- Replace existing **~330 diesel pumps** with off-grid solar pumps by 2030, and electrifying **~3000 tractors and tillers** by 2050 **AMP: 35 $ktCO_2e$**
- Replace synthetic nitrogen fertiliser and urea with **75% organic fertiliser** and **25% nano-urea** by 2050 **AMP: 24 $ktCO_2e$**
- **39** mini weather monitoring stations (rainfall and temperature)
- Capacity building to promote sustainable modernisation

AMP: 4,384 $ktCO_2e$ (Scope 2)

ELECTRICITY

Electricity consumption: **2,278 GWh (2022)**

Led primarily by:

50% Industrial Sector	35% Residential Sector

Deep electrification is expected to increase electricity demand by **three-fold** from 2,278 GWh (2022) to 7,488 GWh (2050)

Potential assessment for integration of additional **~3GW renewable energy** capacity and installation from 2040 onwards, till 2050

WASTE

AMP: 179.27 $ktCO_2e$
5.07% of Gross Emissions

- Improved wastewater treatment by 2040 **AMP: 91 $ktCO_2e$**
  - Urban: **171 MLD** centralised sewage treatment and **100% UGD connection**
  - Rural: Twin pit septic tanks for **1.9 lakh households** and **39 FSTPs** at Firka level
- Biogas plant (livestock waste) of **30,000 m^3/day** by 2050 **AMP: 64 $ktCO_2e$**
- Generate electricity through a **3 MW** biodegradable waste-to-energy plant by 2030, **AMP: 14 $ktCO_2e$**
- Setting up of ETPs and continuous treated effluent monitoring system for **2 MLD industrial wastewater** by 2050 **AMP: 9 $ktCO_2e$**
- 100% segregation at source and processing of municipal solid waste with zero landfilling through **39 rural and 15 urban recycling centres** and **15 urban composting** units **AMP: 1.27 $ktCO_2e$**

BUILDINGS

AMP: 195 $ktCO_2e$
5.52% of Gross Emissions

Urban green cover, reflective roofing, and cool surfaces can reduce ambient temperatures by **1–2°C** and lower cooling energy demand by **5 – 15%**

Residential

- Replace existing incandescent, CFL with **11 lakh LED bulbs**, **7 lakh BLDC fans** and other EE equipments (by 2030)
- Adopt **~7.5 lakh 3-5 star ACs** by 2030
- Save 7-12% electricity demand for space cooling against inefficient electrical system

Cooking

- Transitioning from LPG to PNG, and gradual adoption of **~1.7 lakh electric cook stoves**

Save: 60% cooking emissions by 2050

Commercial

- **100% electrification of the service sector** including replacement of **high-speed diesel (HSD)** in commercial DG sets (by 2035)

Scope 2 emissions are indirect GHG emissions from purchase of energy (electricity, steam, heat etc)

Implementation of the Decarbonisation Plan

Implementing this decarbonisation plan calls for a phased approach, prioritising high-impact and readily implementable projects in the short to medium term, particularly those that can be advanced by 2030. These initiatives are high-priority actions that are well-suited for near-term implementation, deliver developmental co-benefits alongside decarbonisation, and serve as foundational steps in advancing the district's transition toward a low-carbon future. Details on each project, including specific targets, implementation costs, and associated mitigation potential are as below:

Electrification of Road Transport: Virudhunagar's vehicle stock of 5.2 lakh 2-wheelers, ~5000 3-wheelers, ~47500 4-wheelers, ~3000 buses, and ~12700 heavy-good vehicles (trucks, trolleys) is significantly relied on fossil fuels (diesel, petrol, natural gas), as evident from less than 0.5 percent penetration of electric vehicles in total stock in 2022. As the economy grows, the mobility needs are expected to increase. Adding 200 electric buses to the vehicle stock by 2030 can abate 3.4 $ktCO_2e$ 1% of the gross emissions. Awareness generation over time can further nudge commuters to adopt public transport. A 10 percent shift of commuters from private vehicles to public buses is expected to result in need avoidance of ~18000 4W and abatement of ~46 $ktCO_2e$ by 2050.

Interventions	Departments	Expected Cost (Rs. Crores)	Available Finance
Addition of 200 electric buses by 2030	Tamil Nadu State Transport Corporation (TNSTC) and State Transport Department	360[2]	Rs. 55 crore available under PM E-DRIVE[3] with a supplementing Rs. 20 crore under TN EV Policy 2023[4] Furthermore, the Rs. 70 crore allocation made by SPCB to TN Transport Corporation[5] can be explored.

Replacing Diesel Pumps with Solar Pumps: Agriculture in Virudhunagar showcases heavy reliance on diesel pumps for irrigation purposes. As many as 330 diesel pumpsets in the district contribute 6 $ktCO_2e$ each year. Replacing them with solar/electric pumps by 2030 could completely abate these, negating 0.2% of the gross emissions directly.

Interventions	Departments	Expected Cost (Rs. Crores)	Available Finance
Replacing the existing 330 diesel pump with solar/electric pumps	Department of Agriculture	11.55	Rs. 10 crore available under PM KUSUM[6], at the rate of Rs. 0.0314 per 5HP pump

Promoting Energy Efficiency in Buildings: Electricity consumption in commercial buildings and public/street lights stood at 304 GWh in 2022, and is expected to double to nearly 614 GWh under BAU 2050. By replacing 8.5 lakh incandescent and CFL lights with LEDs and converting 80,000 street lights to smart LED systems by 2030, about 30-40% of energy demand can be avoided, saving 28 $ktCO_2e$ of emissions. By replacing 11 lakh incandescent bulbs with LED by 2050, the total annual mitigation potential could reach 35 $ktCO_2e$.

Interventions	Departments	Expected Cost (Rs. Crores)	Available Finance
Replacing 8.5 lakh incandescent lights with LED by 2030	Commissionerate of Municipal Administration, Directorate of Town Panchayats	13	Some allocations may be available under Street Lighting National Programme, but major coverage would only be possible through municipal finance.
Converting 80,000 street lights to smart LED systems by 2030		25	

RE Installation for Abating Scope 2 Emissions Across Sectors: The entire decarbonisation plan for Virudhunagar hinges on the district's capacity to transition from fossil based to renewable energy based grid electricity through an additional RE capacity integration of 3GW in addition to the existing 0.7 GW RE capacity. This RE based electricity will be essential for powering various electrification measures suggested in the plan over short, medium and long term and could abate 4384 $ktCO_2e$ of Scope 2 emissions by 2050. To achieve this, potential assessment is required to be conducted immediately for rooftop solar, utility scale, wind, floating solar and other technologies.

Interventions	Departments	Expected Cost (Rs. Crores)	Available Finance
Potential assessment for 3GW of additional RE capacity integration (in addition to existing RE capacity of 0.7 GW) by 2030, and subsequent installations	Tamil Nadu Green Energy Corporation Limited (TNGECL) and State Energy Department	16,500	Partial coverages under different RE schemes/policies, subjective to assessment results

Agro/Social Forestry in Fallow and Barren Lands: Virudhunagar district, with its dry plains and scattered hillocks, contains sizable stretches of fallow and underutilised lands of 258044 hectares. These lands offer significant potential for agro and social forestry interventions. By implementing targeted programs of social forests, agro forests and horticulture plantations with native species, an annual carbon sequestration potential of 193 $ktCO_2e$ can be leveraged by 2030, offsetting gross emission by 6%, apart from supporting soil conservation, rural livelihoods and improving overall biodiversity of the region. The initiative will contribute to improving the district's green cover, reduce heat stress, and create long-term resilience against climate change.

Interventions	Departments	Expected Cost (Rs. Crores)	Policies/Funding Schemes
Social and agro forestry in 35,163 ha of barren/fallow lands by 2030	Forest Department, Municipal Administration Department, Horticulture Department	492	Sub-Mission on Agro Forestry (SMAF), Green Tamil Nadu Mission, Green India Mission, State Compensatory Afforestation Fund Management and Planning Authority Fund (CAMPA), Trees Outside Forests in India initiative by MoEFCC and Government of Tamil Nadu

Further, expanding agro/social forestry over an additional 105489 ha has the potential to mitigate 1238 $ktCO_2e$ by 2050, offseting gross emissions by 35%.

Enhancing Domestic Wastewater Treatment: To overcome the risk of untreated discharge while also reducing the strain on existing infrastructure, the proposed intervention aims to achieve 100 percent treatment of domestic wastewater by 2040, thereby targeting a reduction in projected GHG emissions from 112 $ktCO_2e$ under BAU to 21 $ktCO_2e$ annually.

Emission Reduction Potential: **~90 $ktCO_2e$/year** by 2040 mitigating gross emissions by 2.61%.

Interventions	Departments	Expected Cost (Rs. Crores)	Policies/Funding Schemes
▸ Urban: raise centralised capacity to ≈ 171 MLD (≈ 20% surplus for peak flow) by 2040 ▸ Rural: add ≈ 171,200 households connected to septic-tank + 39 FSTPs. ▸ Advanced DEWATS for campuses > 2,500 m², resorts, restaurants etc	Municipal Administration Department, Tamil Nadu Water Supply and Drainage Board, Rural Development and Panchayat Raj Department, Tamil Nadu Pollution Control Board	547	Government initiated with possibilities for gap funding through private, CSR, Swachh Bharat Mission, Tamil Nadu Urban Development Project. Namakku Namae Thittam, Kalaignar Nagarpura Mempattu Thittam

Livestock Emission Reduction through Improved Feed and Manure Management: Livestock is the dominant source of emissions within the AFOLU (Agriculture, Forestry and Other Land Use) sector in Virudhunagar, contributing approximately 74 percent of total AFOLU emissions (excluding land). This initiative aims to reduce methane and nitrous oxide emissions from livestock by promoting balanced rationing, methanogen-suppressing feed additives, and improved manure management practices, thereby enhancing productivity and reducing the sector's climate impact. By 2030, emissions are expected to decrease from 277 $ktCO_2e$ under BAU to 251 $ktCO_2e$ in AES.

Emission Reduction Potential: ~**26 $ktCO_2e$/year** by 2030, mitigating gross emissions by 0.76%.

Interventions	Departments	Expected Cost (Rs. Crores)	Policies/Funding Schemes
Balanced rationing introduced in 30% and improved feed supplements like Harit Dhara and Tamrin plus in 25% of livestock . 30% reduction in manure management emission through GOBAR dhan scheme	Environment and Climate Change Department, Animal Husbandry Department	161	Farmer driven with possibilities of Government funds as subsidies under various schemes like Balanced Ration programme National Livestock Mission,NABARAD funded biogas projects

Further, balanced rationing introduced in 90%, improved feed supplements like Harit Dhara and Tamrin plus in 75% of livestock and 90% reduction in manure management emission through GOBAR dhan scheme by 2050 could mitigate 93 $ktCO_2e$/year, mitigating gross emissions by 2.64%.

Climate-Smart Rice Cultivation Programme: Rice fields are a significant source of methane (CH_4) emissions due to continuous flooding practices. The AWD method, which involves periodic drying of fields instead of continuous inundation, can significantly lower these emissions without compromising yield. This project proposes district-wide awareness, training, demonstration, and input support to scale up AWD in rice-growing areas of Virudhunagar.

Emission Reduction Potential: ~**4 $ktCO_2e$/year** by 2030 mitigating gross emissions by 0.13%.

Interventions	Departments	Expected Cost (Rs. Crores)	Policies/Funding Schemes
Scale up Multiple Aeration Water Regime (AWD method) from ~20% of rice-growing areas to 27% by 2030	Agriculture department, Environment and Climate Change department,Krishi Vigyan Kendras (KVKs)	62	Farmer driven with possibilities of Government funds as subsidies under various schemes

Further, scaling up Multiple Aeration Water Regime (AWD method) from ~20% of rice-growing areas to 77% by 2050 could mitigate 42 $ktCO_2e$/year, mitigating gross emissions by 1.18%.

Financial incentives and allocations made available under AMRUT 2.0, Swachh Bharat Mission, Tamil Nadu Industrial Policy 2021, National Biogas Programme, National Mission for Waste to Wealth, PM KUSUM, TN EV Policy 2023, National Mission for Sustainable Agriculture, Pradhan Mantri Krishi Sinchayee Yojana, National Afforestation Mission, Green India Mission, Green Tamil Nadu Mission, Compensatory Afforestation Fund Management and Planning Authority and other such policies/schemes are a few other schemes that could support these initiatives.

Virudhunagar Decarbonisation Plan

The decadal target and the activities along with their mitigation potential, cost estimate, and supporting policies are as detailed in the table below:

Key short, medium and long term interventions

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
A	**Waste Management**										
A.1	Domestic Wastewater Management	Set up adequate centralised wastewater treatment plants for urban	Government initiated with possibilities for gap funding through private, CSR	Facility to treat 135 MLD of wastewater	66 (1.95%)	Facility to treat addditional 20 MLD of wastewater	90 (2.61%)	Additional maintenance	91 (2.56%)	Swachh Bharat Mission-AMRUT 2.0, Kalaignarin Nagarpura Mempattu Thittam (KNMT), Tamil Nadu Urban Development Project (TNUDP) III, Namakku Namae Thittam	Commissionerate of Municipal Administration, Tamil Nadu Water Supply and Drainage Board, Tamil Nadu Pollution Control Board
A.2		Enhancing decentralised treatment	Market/ household driven with possibilities of Government subsidies	Retrofitting unsanitary septic tanks and unlined hole in the ground with leach pit or twin-pit septic tanks at household level for 1,34,750 households		Retrofitting unsanitary septic tanks and unlined hole in the ground with leach pit or twin-pit septic tanks at household level for 57,750 households		Additional maintenance			

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
A.3		Setting up Fecal Sludge treatment plant (FSTP) at firka level	Government or private initiative	20 FSTPs for 20 firkas		19 FSTPs for remaining 19 firkas		Additional maintenance			
A.4		Increase household connections to underground drainage,	Government initiated and funded	60 percent Households to be connected with UGD		100 percent Households to be connected with UGD		Additional maintenance			
A.5	Industrial Wastewater Management	Setting up of Effluent Treatment Plants (ETP) and Contionous Effluent Treatment Plants (CETPs) along with continous treated effluent monitoring system	Market/ industry driven with possibilities of Government funds for industrial areas developed by the Government	Facility to treat 2 MLD	3 (0.08%)	Maintenace and additional facilities as per requirement	5 (0.16%)	Maintenace and additional facilities as per requirement	9 (0.25%)	Tamil Nadu Industrial Policy 2021	Environment and Climate Change department, Tamil Nadu Pollution Control Board

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
A.6	Solid Waste Management	Dry waste recycling centre	Government or private initiative	1. 20 recycling centres for 20 firkas at village level 2. 1 recycling centre per 1 lakh population (total 10 recycling centres))	0	1. 19 recycling centres for 19 firkas at village level 2. Additional 5 recycling centre (total 15 recycling centres)	1.04 (0.03%)	Maintenace and additional facilities as per requirement	1.27 (0.04%)	Swachh Bharat Mission, Solid Waste Management Rules 2016	Commissionerate of Municipal Administration, Tamil Nadu Pollution Control Board, Rural Development and Panchayat Raj department
A.7		Composting Centres	Government or private initiative	10 composting centre (1 per 1 lakh population)		5 additional composting centre (total 15)		Maintenace and additional facilities as per requirement			
A.8		Stakeholder capacity building and awareness generation for holistic and sustainable waste management	Government initiated with possibilities for gap funding through private, CSR	Ongoing initiative		Ongoing initiative		Ongoing initiative			

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
	Total Mitigation Potential				**69 (2.03%)**		**96.04 (2.8%)**		**101.27 (2.85%)**		
B	**Green Spaces & Carbon Sequestration**										
B.1	Restoration and Conservation of Existing Forest Area and Tree Cover	Maintaining the current carbon stock densities to ensure the carbon sequesteration of -170.8 $ktCO_2e$ per year	Government initiated with possibilities for gap funding through private, CSR	Strengthening protection around existing reserved forest areas with additional measures of protection like: strengthening the fencing; eliminating encroachment; levying penalty on defaulters; etc.	170.8 (5.02%)	Strengthening protection around existing reserved forest areas with additional measures of protection like: strengthening the fencing; eliminating encroachment; levying penalty on defaulters;etc.	170.8 (4.93%)	Strengthening protection around existing reserved forest areas with additional measures of protection like: strengthening the fencing; eliminating encroachment; levying penalty on defaulters;etc.	170.8 (4.83%)	Compensatory Afforestation Fund Management and Planning Authority Fund (CAMPA), Nagar Van Yojana, Rashtriya Krishi Vikas Yojana (RKVY), National Afforestation Programme, Sub-mission on Agroforestry (SMAF) - Har Medh Par Ped Scheme ; Kalaignarin All Village Integrated Agriculture Development Programme (KAVIADP) National Agriculture Development Programme (NADP) ; CCUS Policy	Forest Department, Environment and Climate Change Department, Commissionerate of Municipal Administration

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
B.2		Promoting social and agroforestry in land classified as barren or fallow, land put to non-agricultural uses of cultivable waste land	Private driven for private lands and Government initiated for Government lands with possibilities for gap funding through private, CSR	Social and agroforestry in 35,163 ha of land (~14 percent of 2,58,044 ha) In the subsequent years, continuous monitoring and maintenance of the plantations need to be undertaken	193 (5.69%)	Social and agroforestry in 49,228 ha of land (~19 percent of 2,58,044 ha) In the subsequent years, continuous monitoring and maintenance of the plantations need to be undertaken	658 (18.97%)	Social and agroforestry in 56,261 ha of land (~22 percent of 2,58,044 ha) In the subsequent years, continuous monitoring and maintenance of the plantations need to be undertaken	1,238 (35.02%)	Tamil Nadu Climate Change Mission ; Green India Mission; Green Tamil Nadu Mission; Trees Outside Forests in India' initiative by MoEFCC and Governemnt of Tamil Nadu;	
B.3		Enhancing Carbon stock density in Sanjeevi Malai etc	Government initiated with possibilities for gap funding through private, CSR	Enhancement of carbon stock density by ~2 percent increase from 82.25 t/ha to 83.75 t/ha	49 (1.43%)	Enhancement of carbon stock density by ~4 percent increase from 82.25 t/ha to 85.26 t/ha	19 (0.56%)	Enhancement of carbon stock density by ~5 percent increase from 82.25 t/ha to 86.76 t/ha	19 (0.55%)		
	Total Mitigation Potential				**413 (12.14%)**		**848 (24.56%)**		**1,428 (40.04%)**		

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
C	**Sustainable Agriculture Practices**										
C.1	Promote Modern Cultivation Techniques to Optimise Agricultural Inputs and Maximise Outputs	Use of organic fertiliser and compost in place of urea in agricultural production	Farmer driven with possibilities of Government funds as subsidies under various listed schemes	15 percent agriculture area transitioned to organic fertiliser	4.66 (0.14%)	45 percent agriculture area transitioned to organic fertiliser	14.31 (0.41%)	75 percent agriculture area transitioned to organic fertiliser	24.39 (0.69%)	National Mission for Sustainable Agriculture, Chief Minister's Manniyur Kaathu Mannuyir Kappom Scheme (CM MK MKS), National Mission on Natural farming	Agriculture department, Horticulture department, Environment and Climate Change department, Animal Husbandry department
C.2		Use of nano urea in place of urea in agricultural production	Farmer driven with possibilities of Government funds as subsidies under various kisted schemes	30 percent of urea requirement met through nano urea		55 percent of urea requirement met through nano urea		25 percent of urea requirement met through nano urea			

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
C.3		Capacity building programmes can be conducted through Krishi Vigyan Kendra for creating awareness on climate resilient practices	Government initiated with possibilities for gap funding through private, CSR	Can be an ongoing initiative		Can be an ongoing initiative		Can be an ongoing initiative		National Innovations in Climate Resilient Agriculture (NICRA), Paramparik Krishi Vikas Yojana	
C.4		Establish local network of mini weather monitoring stations to monitor rainfall and temperature as well as to be able to forecast extreme weather conditions	Government or private initiative	20 mini weather monitoring stations	NA	19 mini weather monitoring stations	NA	Additional maintenance		Krishi Decision Support System, Agricultural Infrastructure Fund (AIF)	

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
		- this can help inform farmers of appropriate sowing, harvesting and irrigation timings									
C.5	Emission Reduction from Rice Cultivation	Increase the percentage of multiple aeration in the rice cultivated area	Farmer driven with possibilities of Government funds as subsidies under various schemes as listed	Increase in multiple aeration from 20 percent to 27 percent	4 (0.13%)	Increase in multiple aeration from 20 percent to 51 percent	20 (0.57%)	Increase in multiple aeration from 20 percent to 77 percent by 2050	42 (1.18%)	Chief Minister's Manniyur Kaathu Mannuyir Kappom Scheme (CM MK MKS)	

	Key Intervention	Activity/ Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Approximate AMP in 2050* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Policies/Fiscal Measures by State and Central Govt.	Departments
			Description of Financing the Activity (to be read with color codes)	Target	Approximate AMP in 2030* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target	Approximate AMP in 2040* ($ktCO_2e$/yr) (Percentage to BAU Gross Emissions)	Target			
C.6	Livestock Management	feed inputs for livestock - Tamarin plus and Harit Dhara and balanced rationing to reduce methane emissions from enteric fermentation. Implementation of GOBARdhan scheme for manure management	Farmer driven with possibilities of Government funds as subsidies under various schemes as listed	Balanced rationing introduced in 30 percent and improved feed supplements like Harit Dhara and Tamrin plus in 25 percent of livestock . 30 percent reduction in manure management emission through GOBAR dhan scheme	26 (0.76%)	Balanced rationing introduced in 60 percent and improved feed supplements like Harit Dhara and Tamrin plus in 50 percent of livestock . 60 percent reduction in manure management emission through GOBAR dhan scheme	57 (1.65%)	Balanced rationing introduced in 90 percent and improved feed supplements like Harit Dhara and Tamrin plus in 75 percent of livestock . 90 percent reduction in manure management emission through GOBAR dhan scheme	93 (2.64%)	Balanced Ration Programme (BRP) GOBAR dhan scheme	
	Total Mitigation Potential				**34.66 (1.03%)**		**91.31 (2.63%)**		**159.39 (4.51%)**		

Purely Government Backed/ Investment | Market Driven | Partially backed by Government

Energy Sector

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
Interventions to Mitigate Scope 1 Emissions									
A	**Decarbonising the Energy Sector**								
A.1	Shift from Fossil-Fuel to RE based Captive Power Generation	Replacing/tying up PPAs from existing ~87 MW fossil-fuel based Captive Power Plants (CPPs) to equivalent renewable energy capacity of ~105 MW (solar, wind and GH2) by 2050.	40% of the existing tied up capacity (equivalent RE capacity 40 MW)	5 (1.62%)	55% additional capacity (equivalent RE capacity ~60 MW)	129 (3.72%)	5% of the balance (equivalent RE capacity 5 MW)	146 (4.13%)	- 100% electricity tax exemption for 5 years on power generated and consumed from captive sources - Concessions on land purchase or lease through reduced stamp duty available under Tamil Nadu Industrial Policy 2021
A.2	Use of Electric Cookstove in Cooking	Adoption of ~1.4 lakh electric cookstoves in residential cooking by 2050	0.7 lakh	77 (2.27%)	0.2 lakh	91 (2.63%)	Remaining 0.5 lakh	137 (3.88%)	Potential of covering 0.7 lakh electric cookstoves (worth 13.3 crores) under National Efficient Cooking Program (NECP) which provides cookstoves at a low cost.
A.3	Use of Biogas using Waste (Livestock waste, Food Scaps etc)	Installing a biogas plant of approx 30000 m3/day capacity, considering 50% realisation of total potential of 60000 m3/day of the district	40%	22 (0.64%)	Additional 10%	26 (0.75%)	50%	58 (1.64%)	Potential of coverage of 10 small biogas plants of 25 m3/day capacity (worth Rs. 0.07 crores) by 2026 under National Biogas Programme. Higher coverage subject to scheme extension.

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
A.4	Replacement of diesel pumps with solar pumps for irrigation	Conversion of 330 diesel pumpsets to off-grid solar pumps by 2030	100%	6 (0.16%)	NA	6 (0.17%)	NA	6 (0.17%)	Potential of covering 330 solar pumps worth ~INR 10 crore (Rs. 314,088 per 5HP pump) under PM KUSUM (Component B)
A.5	Use of EV tractor and tillers for agriculture land preparation	Electrifying ~8000 tractors and tillers by 2050	1480	5 (0.16%)	3760	19 (0.55%)	2760	29 (0.82%)	-
A.6	Replacement of HSD by Biodiesel in Diesel Generator for Backup Supply / Renewable based Backup Supply Support	"Replacement of HSD by Biodiesel in Diesel Generator for Backup Supply / Renewable based Back-up Supply Support a. Exploring biodiesel availability production in the district (assessment) b. Pilot implementation of biodiesel use in commercial DG sets / RE based backup supply support c. Using biodiesels in all the DG sets in the districts"	To be assessed						

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
B	**Shift to Electric Mobility**								
B.1	Shift to Electric 2-Wheeler	Increasing the share of EV in 2W sales to achieve 100% penetration (upto ~5 lakh EV 2W) by 2050	1 lakh	10.41 (0.31%)	Additional 2 lakh	32 (0.92%)	Additional 2 lakh	50.3 (1.38%)	The current market price of EV 2W are comparable with the ICE counterparts, hence market dynamics will decide the pace of 2W EV sales. However, a sum of Rs. 50 crore (Rs. 50 crore + Rs. 0.3 crore) is available under current center and state policies (PM E-DRIVE Scheme 2024 and TN EV Policy 2023) for 1,00,000 2W EVs. Higher coverage is possible subject to scheme extension.

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
B.2	Shift toElectric 3-Wheeler	Increasing the share of EV in 3W sales to achieve 100% penetration (~7500 EV 3W) by 2050	1000	1 (0.03%)	2701	1.9 (0.05%)	3463	4 (0.11%)	The current market price of EV 3W are comparable with the ICE counterparts, hence market dynamics will decide the pace of 3W EV sales. However, a sum of Rs. 3.75 crore (Rs. 0.75 crore + Rs. 3 crore) is available under current center and state policies (PM E-DRIVE Scheme 2024 and TN EV Policy 2023) for 1000 3W EVs.
B.3	Shift to Electric 4-Wheeler	Increasing the share of EV in 4W sales to achieve 100% penetration (upto ~2 lakh EV 4W) by 2050	0.25 lakh	14.95 (0.44%)	Additional 1 lakh	64 (1.85%)	Additional 0.75 lakh	103 (2.91%)	Maximum incentive of up to Rs. 1.5 lakh per 4W commercial vehicle is available under TN EV Policy 2023 for a maximum of 3000 vehicles per year.

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
B.4	Shift toElectric Buses	Increasing the share of EV buses in sales and achieving 100% penetration (upto ~2000 EV buses) by 2050	200	16 (0.47%)	Additional 1100	76 (2.19%)	Additional 500	99 (2.8%)	"The current market price of e-Buses are comparable with the ICE buses, hence market dynamics will decide the pace of e-Buses sales. However, a sum of Rs. 75 crore (Rs. 55 crore + Rs. 20 crore) is available under current center and state policies (PM E-DRIVE Scheme 2024 and TN EV Policy 2023) for 200 e-Buses."
B.5	Shift to Electric Heavy Goods Vehicles (HGVs)	Increasing the share of electric Heavy Goods Vehicles (trucks, trolleys) in sales to achieve 80% penetration (upto ~2000 EV HGVs) by 2050	100	5 (0.16%)	Additional 1200	93	Additional 500	120 (3.4%)	-
B.6	Creation of EV Charging infrastructure	Installation of ~475 charging stations in total by 2050	39	NA	166	NA	270	NA	Incentives worth Rs. 1 lakh for slow charging and Rs. 10 lakh for fast charging stations are available under TN EV Policy 2023 and further coverage under PM E-DRIVE subject to scheme extension.

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
C	**Decarbonisation of the Industry**								
C.1	Exploring Electrification of Heating Processes in Industries to Reduce Fossil Fuel Consumption (Furnace Oil, HSD etc)	Fully Electrified kiln via plasma generator for heating in industries in place of fossil fuel based heating by 2050	40% of the target	237 (6.97%)	20% additional achievement	363 (10.47%)	Remaining 40% of the target	603 (17.06%)	-
Total Scope 1 Mitigation Potential ($ktCO_2e$)			**1355 (38.34%)**		**901.2 (25.99%)**		**1355 (38.34%)**		
Interventions to Mitigate Scope 2 Emissions (Electricity Sector)									
a	Addition of Renewable Energy (RE) Capacity to Meet the Domestic Electricity Demand at District Level	- Additional RE capacity integration of ~3 GW (in addition to existing RE capacity of 0.7 GW) a. Potential Assessment for various RE sources including rooftop solar, utility scale, wind, floating solar, agro PV and others) b. Installation as per assessment	NA	0	1 GW of the RE capacity target	1,533	~2 GW of remaining capacity	4,384	- Subsidy maximum up to Rs. 78,000 for rooftop system under PM Surya Ghar Muft Bijli Yojana

	Key Intervention	Activity/Target	Short Term (till 2030)		Medium Term (2030-40)		Long Term (2040-50)		Incentive under Central/State Schemes and Policies
			Target	AMP in 2030 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2040 ($ktCO_2e$/yr)	Additional Target	Cumulative AMP in 2050 ($kTCO_2e$/yr)	
b	Energy Efficiency Improvements	Installation of ~7.5 lakh 3/5 star EE ACs in residential spaces to replace old/inefficient ACs	3 lakh	50	4.08 lakh	143	0.46 lakh	154	
		Installation of 3/5 star EE refrigeration units up to a total of 7 lakh by 2050	6.5 lakh	6	0.5 lakh	7	0.00	8	
		Replacing existing ~11 lakh incandescent bulbs and CFL bulbs and CFL tubelights with LED in residential space by 2030	8.5 lakh	2	2.5 lakh	6	NA	10	
		Replacing ~0.8 lakh street lights with LED lights by 2030	100%	25	NA	25	NA	25	
		Adoption of ~7 lakh BLDC fan by 2050	6.3 lakh	2	0.6 lakh	4	0.1 lakh	4	
c	Utilising Biodegradable Waste to Generate Electricity	Installation of waste to energy plant of 3 MW (the plant will require ~90 tons waste per day) by 2030	100%	14	NA	14	NA	14	Potential for covering 3MW project worth INR. 6 crore (Rs.2 crore/MW) under National Mission for Waste to Wealth (Policy for Promotion of City Composting)
Total Scope 2 Mitigation Potential ($ktCO_2e$)			**85.3**		**1,718.1**		**4,586**		

*AMP = Annual Mitigation Potential

Note: Percentages denote AMP as a share of respective BAU emissions.

Purely Government Backed/ Investment	Market Driven	Partially backed by Government

Endnotes

1 District Statistical Handbook 2022-23

2 Chennai recently deployed 120 electric buses under the MTC fleet with a total investment of Rs. 207.9 Crore. Since the cost of electric buses could vary by seating capacity and features, this investment is taken as a comparable figure for Virudhunagar too. An average of Rs. 1.8 Crore is assumed per electric bus.

3 Scheme valid till March 2026, unless extended.

4 Scheme valid till December 2025, unless extended.

5 https://tnpcb.gov.in/PDF/About_Us/Announcementgos/GONo116_16625.pdf

6 Scheme valid till December 2026, unless extended.

Notes

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