सत्यमेव जयते

Government of Tripura

TRIPURA ENERGY VISION 2030 ROADMAP

July 2023

RTI INTERNATIONAL

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EXECUTIVE SUMMARY

Tripura State's dedication to sustainable development aligns with the Government of India's vision, as evidenced by the unveiling of the "Sustainable Development Goals (SDG) Vision 2030 Tripura" in 2020. To support this vision in the energy sector, Research Triangle Institute (RTI) International India collaborated with the Government of Tripura to create "The Energy Vision 2030 Roadmap." This strategic roadmap outlines essential interventions to ensure the sector's sustainable growth, emphasizing *affordability, availability, and reliability of energy supply*. In harmony with the national vision of *"Sabka Saath Sabka Vikas,"* Tripura's forward-looking approach and collaborative efforts exemplify a commitment to inclusive and environmentally conscious progress.

The Energy Vision 2030 Roadmap paves the way for transformation across Generation, Transmission and Distribution segment and highlights major objectives from development of renewable energy, modernization of distribution utilities to upgradation of distribution infrastructure and cross border power exchange for ensuring energy security, industry investments and revenue generation for the government and the utilities.

Section 1 highlights the economic growth trajectory and causal relationship between economic growth and electricity consumption which sets the context for energy requirement and exploitation of different sources of energy to cater to the increasing demand from various sectors. As compared to State Government's expectation of 10.2% year on year growth of real GSDP/capita, energy consumption is growing at a 7% CAGR which needs to be accelerated to ensure socio-economic development in the state. There is an imminent need to explore potential contributors like industrial sector to the state economy.

Section 2 depicts the power sector scenario of Tripura encompassing Electricity Generation, Transmission and Distribution and highlights the major issues and thrust areas in the sector from generation efficiency improvement requirement, renewable capacity addition to strengthening of transmission and distribution network, infrastructure upgradation etc. Evaluation of these areas has helped in identifying various potential interventions required to strengthen the sector like development of low cost RE generation, conversion of open cycle gas plants to combined cycle, increase in cross border trading to tariff rationalization (reducing ACS-ARR gap), reduction in AT&C losses along with a list of key takeaways depicting the focus areas which will form the basis for the list of interventions mentioned as part of strategic roadmap.

RE sources	Potential
Solar	2.08 GW
Hydro	47 MW
Biomass	3 MW
Waste to Energy	2 MW

Source: MNRE

Section 3 highlights the key facets of the strategic roadmap and lists out interventions which need to be undertaken across Generation, Transmission, Distribution including adoption of new technologies like geothermal and green hydrogen that is proposed to be undertaken by Government of Tripura & utilities in a phase wise manner i.e., Short Term (2023-2024), Medium Term (2025-2027), Long Term (2028-2030) to ensure energy security and grid reliability for the last mile consumers. The strategic roadmap also lists key targets for Short Term, Medium Term and Long Term across the key focus areas and subsequently the investment requirement.

Target	Short Term (2023-2024)	Medium Term (2025-2027)	Long Term (2028-2030)
RE Generation	Nil	185 MW	500 MW
AT&C Losses	23%	16%	12%
Power Outage Duration	Urban areas - ~30 minutes Rural areas – ~1.5 hours	Urban areas – Nil Rural areas – ~1 hour	Zero power outage in urban and rural areas

Investment Requirement till 2030 (in crores)	
Power Generation	1800
Power Transmission	1700
Power Distribution	3300

The Energy Vision 2030 Roadmap, formulated by Research Triangle Institute (RTI) International India, aims to drive comprehensive sectoral transformation while fostering investment opportunities in the state. By ensuring the provision of accessible, and dependable energy supply, the roadmap actively contributes to the sustainable development of the region.

Section 1

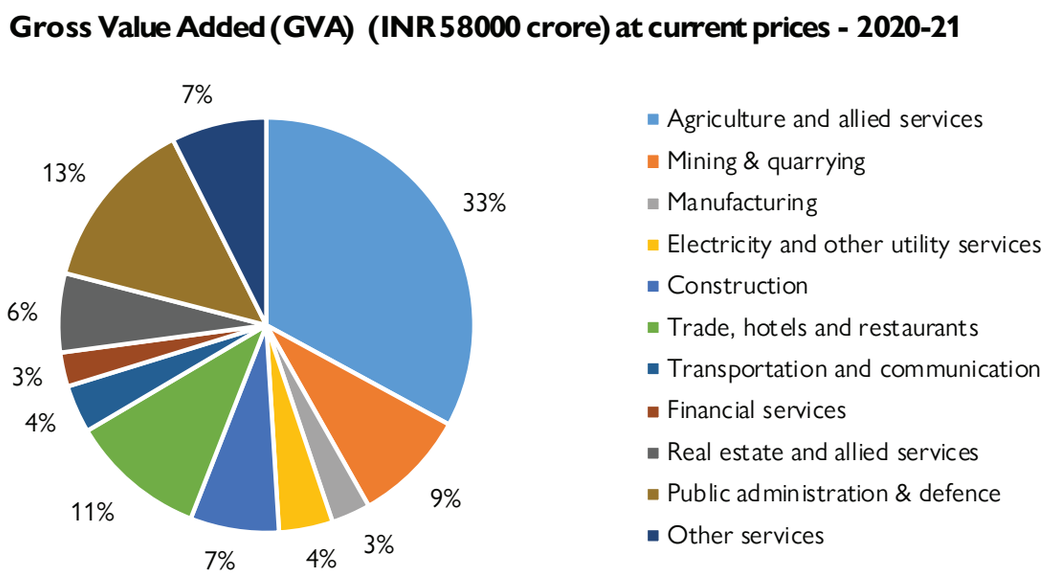
STRATEGIC CONTEXT

STRATEGIC CONTEXT

Tripura's economy is displaying promising growth trends, as evidenced by its Gross State Domestic Product (GSDP) reaching INR 64,778 crore (INR 580 billion) in FY22, marking an impressive 19% growth compared to the previous year. The state's economy is agrarian, with the agriculture sector contributing a substantial 33%, surpassing the national average contribution of agriculture to India's GDP, which stands at 20%. Public administration and defence follow with a contribution of 13%, highlighting the significant dominance of the agriculture sector in Tripura's economic landscape.

However, the Government of Tripura is proactively redirecting its focus towards fostering the development of the industrial sector. This includes the implementation of various incentive schemes, the establishment of Special Economic Zones (SEZs), and the creation of an Export Promotion Park. These strategic initiatives are aimed at stimulating industrial growth, attracting investments, and diversifying the state's economic base. By bolstering the industrial landscape, Tripura aims to achieve a balanced and resilient economy that contributes to sustainable economic progress and enhances overall prosperity in the region.

Figure 1: Sector wise GVA of Tripura (Bn INR) at current prices 2021 (Source: MOSPI, 2021)



Government of Tripura has released the Tripura Industrial Investment Promotion Incentive Scheme (TIIPIS) 2022, to boost the industrial development in the State. The key features of the scheme are mentioned below:

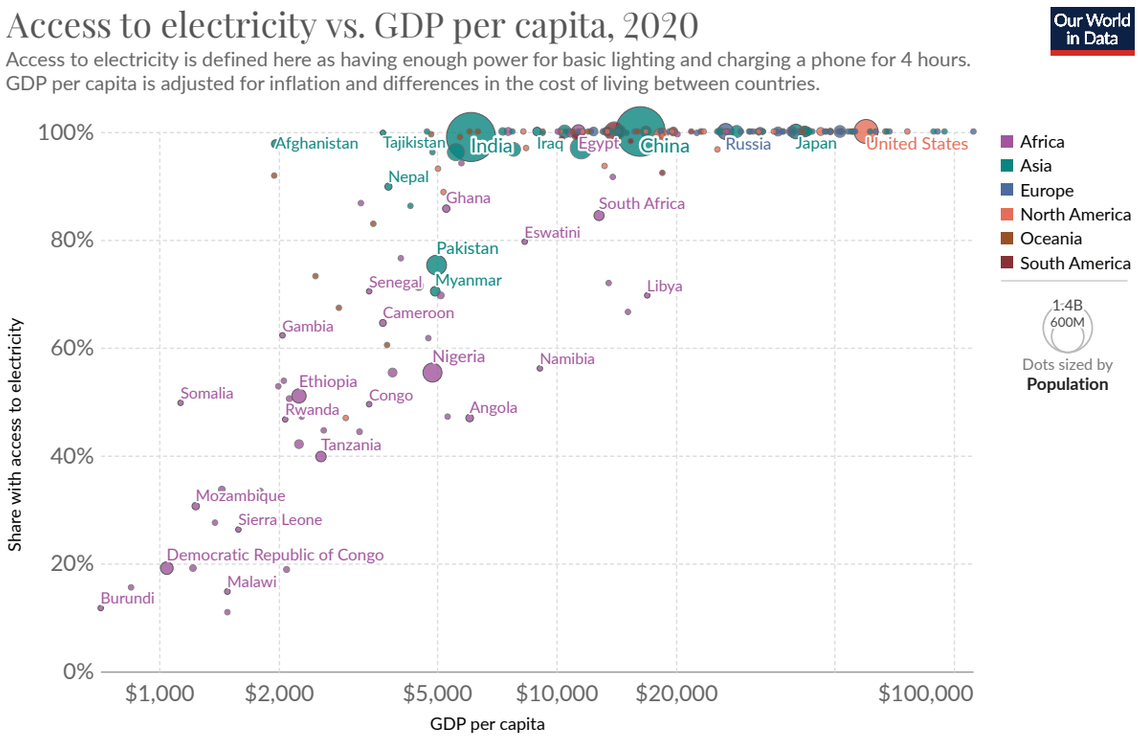
- 30% of the fixed capital investment as subsidy for all enterprises subject to a ceiling of INR one crore to each enterprise.
- 40% of the fixed capital investment as subsidy for thrust sectors like food processing, tea, rubber etc. subject to a ceiling of INR 1.25 crore to each enterprise.
- Power charges will be provided to all eligible industrial units with connected load of above 20HP @ INR.5.00 per unit.
- Industrial promotion subsidy equal to the net amount of GST actually paid by an enterprise shall be provided subject to an overall ceiling of INR 80 lakhs per annum.
- 100% exemption from the payment of earnest money and bid security deposits.

In addition, Special Economic Zones have also been created in South Tripura along with industrial areas like Bodhjungnagar and R.K. Nagar where industrial infrastructure like roads, power supply, water supply, gas supply etc. as well as social infrastructure like healthcare etc. are being developed to attract industrial investment in these areas. With development of industries in these areas and subsequent increase in GSDP there will be increase in electrical energy requirement to cater to the increasing demand of the industrial consumers.

1.1 ELECTRICITY – FUEL FOR ECONOMIC GROWTH

According to various global research organizations, access to electricity is the index of development and standards of living of the citizens and has a causal relationship with high GDP/capita. In addition to facilitating the economic development of the State, access to electricity is also linked to social development of the region in terms of providing better quality of life and creation of economic opportunities for the population.

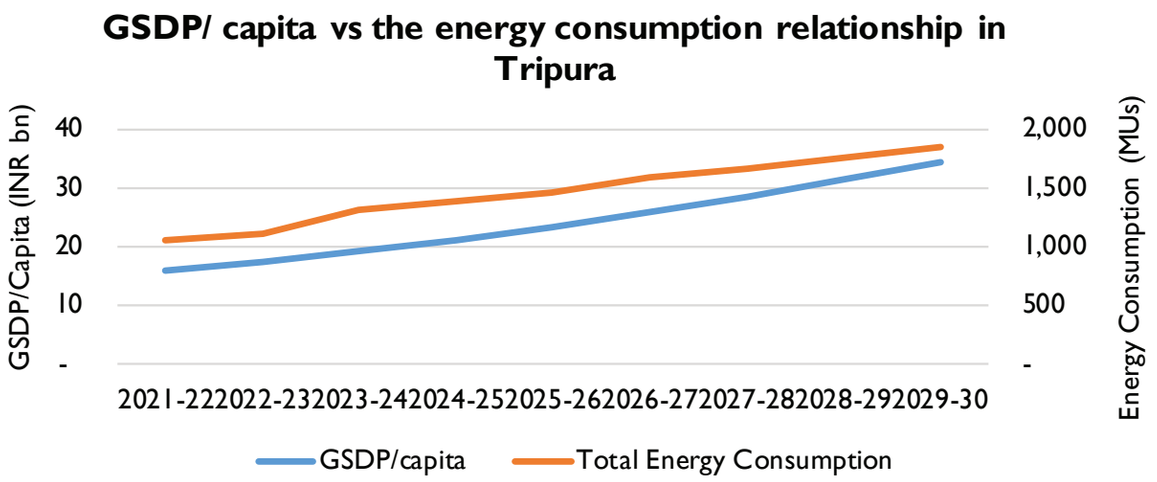
Figure 2: Co - relation of GDP/capita to Access to Electricity



(Source: World Bank)

This trend is reflective for Tripura as well. As per the SDG Vision 2030 Tripura, the State government is expecting a y-o-y 10.2% growth rate of real GSDP/capita while the energy consumption in Tripura is growing at a 7% CAGR, as per the 20th EPS report of CEA.

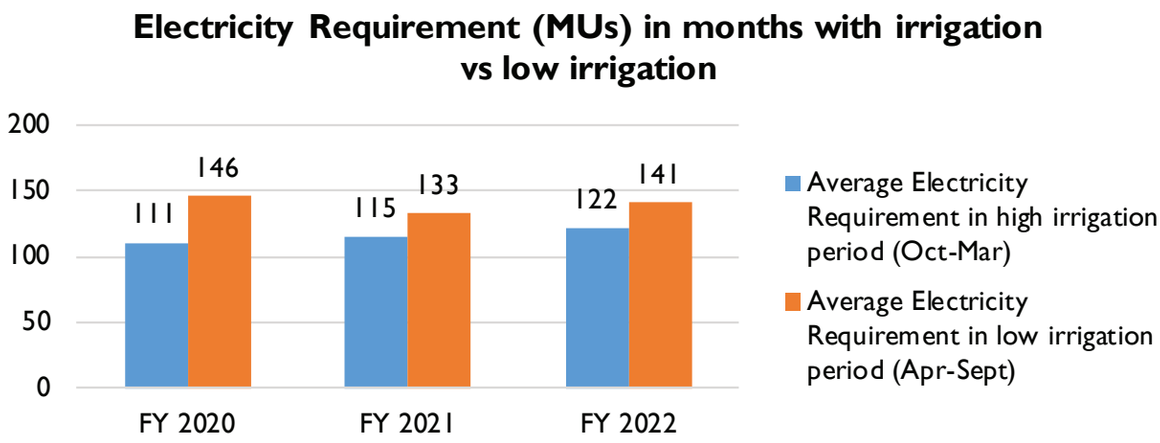
Figure 3: GSDP vs Energy Consumption Causal Relationship for Tripura FY23



(Source: Knoema, 20th EPS Report CEA)

However, agriculture sector which is the major contributor in GSDP is less correlated with electricity consumption as shown in the graph (energy requirement is low in months when usage of electricity for irrigation is high i.e., October to March compared to months when electricity usage is low for irrigation i.e., April to September).

Figure 4: Comparison of electricity requirement during high & low irrigation period FY20 - 22



(Source: LGBR, RTI Analysis)

On the other hand, Industrial sector (mining, manufacturing, and construction) which is second to agriculture in GSDP contribution is highly correlated with electricity consumption therefore, with various government initiatives to promote investment in the industrial sector, increase in electricity consumption is imminent. ***According to 20th EPS report of CEA, electricity consumption by HT Industries is expected to grow four times whereas for LT industries it will grow two times in the next 10 years.***

Hence, the advancement of the energy sector will hold a crucial position in catalysing the economic growth of the State of Tripura. The strategic development of renewable energy and other alternative sources, coupled with the augmentation of grid infrastructure, will play a pivotal role in meeting the surging electricity demand and ensuring widespread electricity access, especially for the last mile consumers. Initiatives by the Government of India on 24X7 Power for All, 100% electrification, Revamped Distribution Sector Scheme (RDSS), 500 GW RE by 2030, deployment of distributed energy resources and electric mobility solutions etc. will provide significant opportunity for the State of Tripura to develop and implement distributed and conventional renewable energy sources along with strengthening of grid infrastructure to cater to the increasing demand and contribute towards national RE deployment goals. These measures will not only bolster the state's economic prospects but also contribute significantly to sustainable development, reinforcing Tripura's position as a dynamic and progressive economy.

Section 2

TRIPURA POWER SECTOR SCENARIO

TRIPURA POWER SECTOR SCENARIO

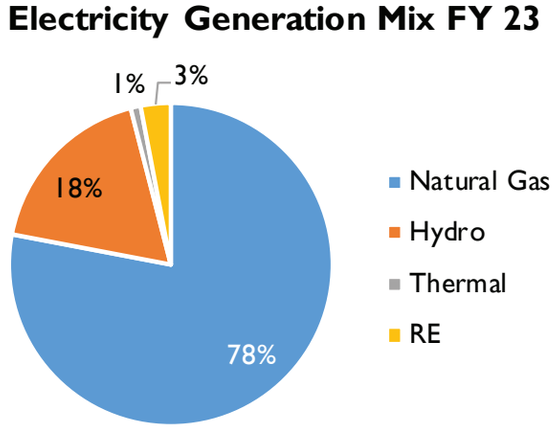
Before 2001, the Power Sector in Tripura was under the Department of Power, handling Generation, Transmission, and Distribution of electricity. In 1998, the renewable generation segment constituted in the name of Tripura Renewable Energy Development Authority (TREDA). Tripura Electricity Regulatory Commission (TERC) was formed in 2004 to regulate all aspects of Generation, Transmission, and Distribution. In 2005, the State department transformed into Tripura State Electricity Corporation Limited (TSECL) responsible for the entire power cycle. In 2015, Tripura Power Generation Limited (TPGL) took over the generation functions. These changes have led to improved management and development of energy sources in Tripura.

2.1 POWER GENERATION AND TRANSMISSION

2.1.1 POWER GENERATION

Power generation in Tripura comes under the purview of TPGL and is mainly comprised of two generation sources - natural gas and hydropower. The State generates 115 MW from its own power plants and procures another 426 MW through Long Term Open Access (LTOA). The generation is majorly dominated by gas; however, the gas power plants are open cycle gas power plants which has a lower thermal efficiency of 35% as compared to closed cycle power plants which features efficiency of around 60% with technology advancement. Therefore, conversion of open cycle to combined cycle will improve the efficiency of the plants by around 25% as well as will ensure lesser GHG emission thereby contributing to the sustainability aspects of development.

Figure 5: Electricity generation mix for Tripura



(Source: TPGL)

Table 1: Comparison of open and closed cycle plants

Parameters	Open Cycle Gas Turbine	Combined Cycle Gas Turbine
Thermal Efficiency	25 – 40%	>50%
CAPEX	Low	High
OPEX	High	Low
Exhaust Gases	Exits to atmosphere	Fed back into the cycle

Furthermore, the Baramuria gas-based generation plant, comprising two units with a total capacity of 42 MW, is unable to operate at its full capacity due to insufficient gas availability in the gas grid. The progress of other upcoming gas-based plants, such as OTPC's 363 MW plant at Palantana and NEEPCO's 101 MW plant at Monarchak, has come to a standstill due to the lack of gas supply. ***These plants were initially scheduled for commissioning by 2025, with OTPC's 363 MW plant requiring 1.6 MMSCMD of gas and NEEPCO's 101 MW plant requiring 0.5 MMSCMD of gas.*** However, their development has been hindered by the current gas unavailability, posing challenges to their timely implementation.

ONGC has discovered 11 gas fields and established 41 BCM of recoverable gas reserves out of 77.05 BCM of total in place reserves

While ONGC persists in its exploration efforts, they have recently disclosed the forthcoming production initiation of the Khubal gas field, equipped to process 0.44 MMSCMD of gas, is projected to commence operations in 2024. Nonetheless, alongside these endeavours, the augmentation of the gas grid network remains imperative to ensure a streamlined and efficient supply of gas to the relevant power plants.

North-East natural gas pipeline is being developed by Indradhanush Gas Grid Ltd. (Joint Venture of ONGC, IOCL, GAIL, OIL and NRL) which will connect Guwahati with capital cities of north-eastern states and will be connected with the upcoming Barauni-Guwahati natural gas pipeline

Therefore, focus should be given to the aspects mentioned below to improve the gas-based generation scenario.

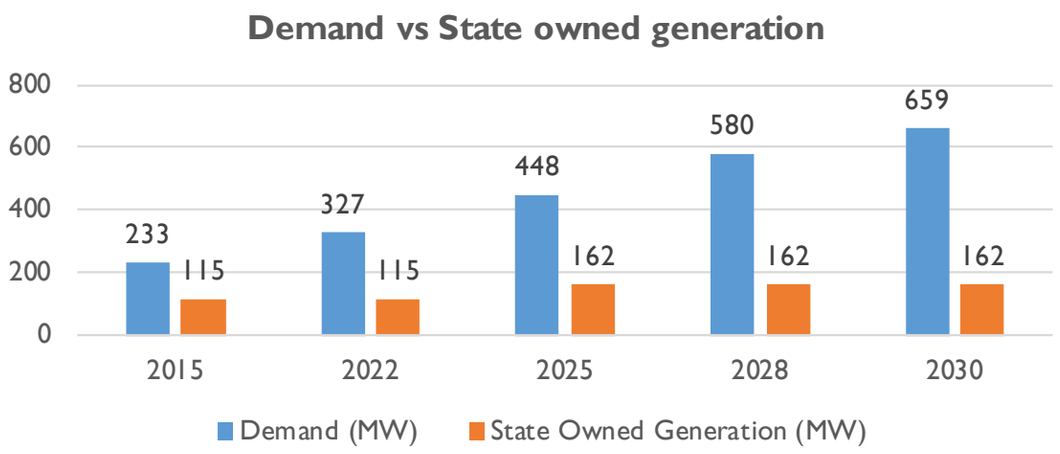
Coversion of OCGT to CCGT + **Exploration of gas reserves** + **Strengthening of gas grid network**

Apart from natural gas, hydropower is the other source of generation, however its weather dependent characteristic makes it less reliable in terms of availability. Therefore, TSECL is planning to diversify its energy generation with implementation and procurement of renewable energy generation in the State. It has installed ~7.8 MW of grid connected both utility scale (5 MW) and rooftop Solar (2.8 MW), 5 MW under Component A of KUSUM Scheme and is also currently procuring 100 MW from SECI solar power plant. In addition, 7.8MW of off-grid generation sources like micro grids have been installed and another 500 remote localities of Tripura have been identified for installing solar microgrid to ensure last mile electricity access. While this is a positive step towards energy diversification, there is huge RE potential in the State which need to be explored to cater to the increasing demand.

As shown in the graph, however with increasing demand in future, and unavailability of domestic supply, TSECL must procure power from generating plants outside the State to meet the demand. While TSECL is expected to benefit from cost-effective power supply through SECI's solar power plant and the upcoming gas-based power plants by OTPC and NEEPCO, it is crucial to emphasize the significance of developing

state-owned plants, particularly in the RE sector. Investing in state-owned renewable power plants will not only cater to future energy demands but also enable the utility to reduce dependence on more expensive power procurement. This strategic move is expected to positively impact the utility's balance sheet, ensuring greater financial stability and sustainability in the long run.

Figure 6: Demand vs State owned generation Tripura projections till 2030



(Source: TSECL)

Hence, a comprehensive emphasis on self-generation is imperative, ***as the peak load is projected to reach 659 MW by 2030, while the expected state-owned generation stands at 162 MW. This underscores the urgent need to bolster self-reliant power generation capabilities to bridge the gap between energy demand and supply, ensuring a stable and resilient power infrastructure for the state (cost of state-owned generation is low compared to power procured through LTOA and STOA).***

Table 2: Cost of power procurement from different sources

Source of power procurement	Power purchase cost (FY-2022-23) (INR)
Average rate (LTOA)	4.71
NTPC	6.71
OTPC	3.34
State owned hydro power plant	2.41
Solar power plant	3.50

Reduced efficiency of existing plants along with high cost of power procurement can lead to increase in cost of supply for TSECL.

Therefore, there is need to prioritize the improvement in efficiency of the existing power plants i.e., conversion of OCGT power plants to CCGT power plants ***(TPGL is currently in the process of converting 63 MW OCGT to 120 MW CCGT)***, exploration of gas reserves for development of new gas power plants and renewable energy generation.

2.1.2 DEVELOPMENT OF RENEWABLE ENERGY RESOURCES

Apart from improvement in efficiency of existing power plants, new power plants also need to be developed majorly focusing on alternate sources of energy like solar, biomass etc. which have adequate potential to aid the generation capacity and thereby reducing cost of power procurement for the State. Moreover, the generation costs from these power plants are low compared to power procured through LTOA. Significant amount of work has been done on development of decentralised resources like implementation of 2kW microgrid in twelve hamlets and 500 remote localities have been identified for implementation. TREDA has set a target of 500 MW DER implementation by 2030 through implementation of 3,00,000 solar PV streetlights, 1000 nos. 250 kW solar power plant covering all the villages, 2600 nos. 2 kW solar pumps under Component C of PM KUSUM scheme etc. However, development of new grid connected renewable energy projects is still at nascent stage apart from 130 MW floating solar with NTPC which is in planning stage and 5MW solar power under Component A of PM KUSUM scheme.

Table 3: RE potential

RE sources	Potential
Solar	2.08 GW
Hydro	47 MW
Biomass	3 MW
Waste to Energy (WTE)	2 MW

(Source: MNRE)

Table 4: Cost of power procurement from different sources as compared to cost of RE generation in the state

Source of power procurement	Power purchase cost (FY-2022-23) (INR)
Average rate	4.71
NTPC	6.71
OTPC	3.34
Solar (SECI)	2.61
Floating Solar	3.50

To achieve self-sustainability in energy availability and reduce greenhouse gas emissions, Tripura should prioritize the development of utility-scale solar power plants, including floating solar installations, taking advantage of its numerous stagnant water bodies. Additionally, the state should explore the potential of other renewable energy sources like biomass and hydro. By emphasizing these cleaner energy options, Tripura can decrease its reliance on external power sources and promote environmentally friendly electricity generation. This strategic approach will not only enhance energy security but also contribute to a greener and more sustainable future for the state.

2.1.3 POWER TRANSMISSION

Tripura has one of the most robust transmission networks among the north-eastern Indian states and has 86 sub stations of different voltage levels with transformation capacity of approx. 1246 MVA.

Table 5: Transformation capacity

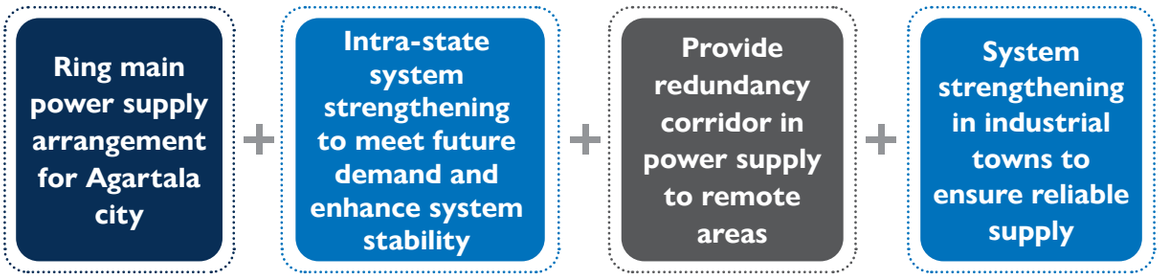
Voltage level (kV)	Transformation capacity (MVA)
132	522.5
66	220.8
33	502.4

(source: TSECL)

The State has robust connectivity with Bangladesh and other states in the north-eastern region like Mizoram. The state has total 1678 ckm of ISTS network and 12 ckm in planning or under construction stage. Apart from creation of robust infrastructure, various activities have undertaken for minimization of transmission loss, some of which are mentioned below

- Replacement of existing old and de-rated 66 KV network by upgrading to 132 KV level throughout the State
- Replacement of old switch gears and unreliable electromechanical protection relays by numerical relays
- Establishment of 132 KV link to develop ring-main in the system

In addition to the existing infrastructure development of new transmission lines and augmentation of transformation capacity need to be conducted in order to meet the increasing demand and to support both cross border and domestic power trading. Considering this, TSECL has planned to develop 9 nos. new transmission lines having total length of 453 ckm and 9 nos. of new substations with a transformation capacity of 752 MVA. It will also undertake reconductoring of 475 ckm of transmission lines and OPGW implementation for new 132 kV lines, thereby projecting total investment requirement of INR 1,692 crores. The development of these transmission lines and substations will facilitate in the following:



2.2 CROSS BORDER POWER TRADING

Cross border power trading has been one of the important pillars of revenue generation for TSECL. It not only helps the utility by generating revenue but also facilitates consumers through tariff rationalization by reducing the ACS-ARR gap. According to a report by Asian Development Bank, ***despite revenue subsidies of INR 400 million in FY-2021, TSECL incurred a loss of INR 1,445 million from intra-State power sales, which led to an ACS–ARR gap of INR 1.62/kWh which drops to INR 0.33/kWh when interstate power trade along with cross border power trade is considered, resulting in the reduction in TSECL's annual loss to INR 270 million and thereby minimizing the need for subsidies from the State government.***

TSECL has cross border arrangement with Govt. of Bangladesh for 192 MW of power supply (gas-based generation) on Round the Clock (RTC) basis till 2026. The power is supplied through two 400 kV transmission lines (radial mode) of 100 MVA capacity each. The table below provides further detail on the agreement.

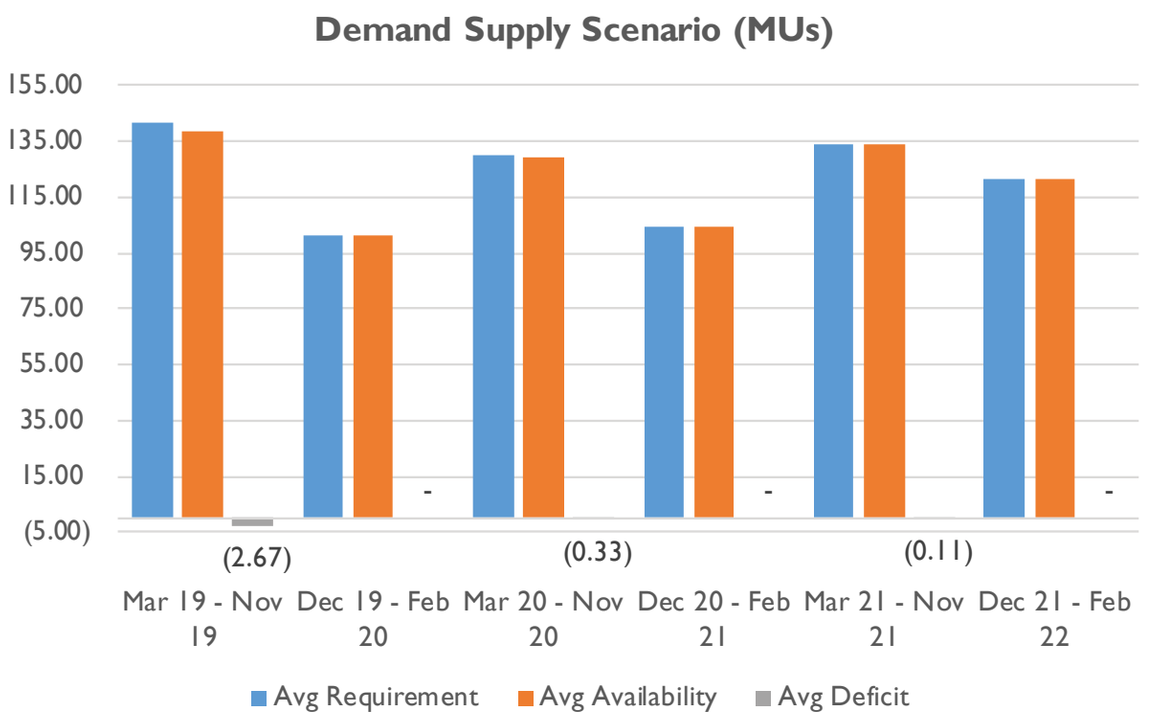
Entity and Country	Export (MW)	Import (MW)	Transmission Capacity (MW)	PPA Rates/ Tariff	Contract Type	Trader (if any)	Projection
							2025
Bangladesh	160 +20%	NA	200	Rs.6.27/ kWh with 2% fixed yearly escalation	RTC	NVVN	192 MW

Cross border power trading needs to be explored with countries like Bangladesh and Sri Lanka which are heavily dependent on fuel oil and diesel-based generation as it will help to generate further revenue streams for TSECL.

- ***The tariff for power exported (192 MW) to Bangladesh is INR 6.27 with escalation of 2% every year till FY 2025-26 which is significantly less than the marginal cost of electricity generated in Bangladesh from diesel (INR 21/unit), fuel oil (INR 11/unit) and imported gas (INR 7/unit).***
- ***Similarly for Sri Lanka, where generation is majorly dependent on oil and imported coal is affected due to unavailability of oil and unpredictable hydro generation leading to power outages. PGCIL envisaged deployment of either a 500-megawatt (MW) or a 1,000-MW undersea transmission system***

Furthermore, analysing the monthly demand-supply dynamics reveals a pronounced surge in power demand, particularly during the summer months from March to May, leading to power deficit during this period. Conversely, in the winter months from December to February, the demand is relatively low, resulting in no power deficit. This presents a strategic opportunity for power trading with neighbouring countries such as Bhutan and Nepal. Given their power deficit in winter and surplus in summer, Tripura can establish banking arrangements with these nations to procure cost-effective hydropower during the summer, effectively meeting its own demand, while reciprocally exporting power to them during the winter months. Such cross-border power exchanges offer a win-win situation, enabling Tripura to optimize its power resources and enhance energy cooperation with neighbouring nations.

Figure 7: Demand Supply Scenario FY20 - 22



(Source: TSECL)

Table 6: DAM MCP - IEX

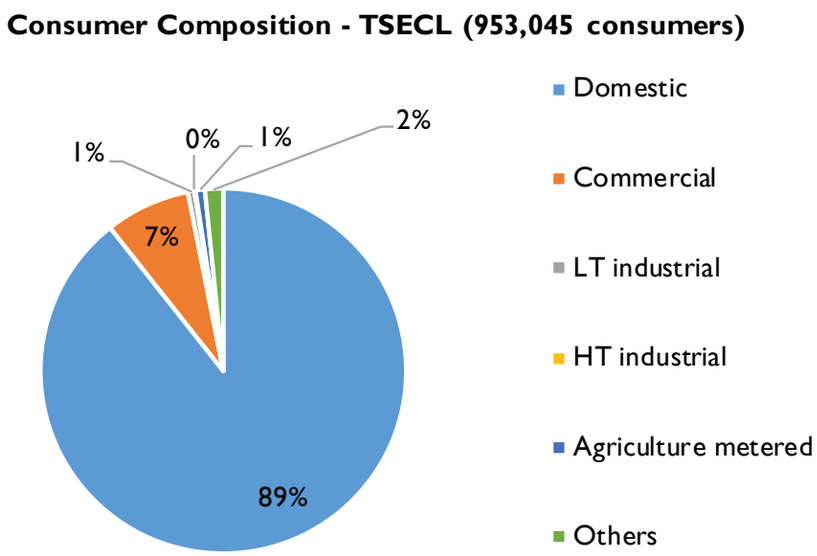
Time Block	Market Clearing Place (Power purchase rate of Bhutan from IEX in INR/kWh)
RTC	6.84
Evening	8.13
Day	7.90
Night	2.87
Morning	10.01

Development of low-cost generation in the State will help to generate revenue through both cross-border power trading and interstate trading by selling power at a higher price ***(cost of generation of state-owned hydro power plant is INR 2.41/kWh, solar power will cost around INR 3.5/kWh)***

2.3 POWER DISTRIBUTION

Power distribution in Tripura comes under the purview of TSECL and has 9 nos. electrical circle, 23 nos. electrical division and 79 nos. sub-division. It currently serves 953,045 metered consumers in the State which is highly dominated by domestic consumers followed by commercial and agricultural consumers which are majorly LT consumers.

Figure 8: Consumer composition of TSECL FY23



In the last 12 years, number of consumers has grown significantly, and it shows growth rate of around 100% in the last 12 years. Majority of this increase in demand can be attributed to the following factors

Better network connectivity and power quality + **Electrification under Saubhagya scheme** + **Investment promotion and industrial development**

In order to ensure that the demand is met TSECL has invested in upgrading the distribution system and strengthening its network. It currently has 18,886 km of 11 kV network and 32,900 km of 0.4 kV network along with HT:LT Ratio of 1.58. However, issues like high T&D loss, power outage, lower billing efficiency still prevails and are impacting the operational performance of the utility.

T&D Losses

- Dharmanagar - 36%
- Belonia - 34%
- Sepahijala - 31%

Billing Efficiency

- Dharmanagar - 64%
- Belonia - 66%
- Sepahijala - 69%

Collection Efficiency

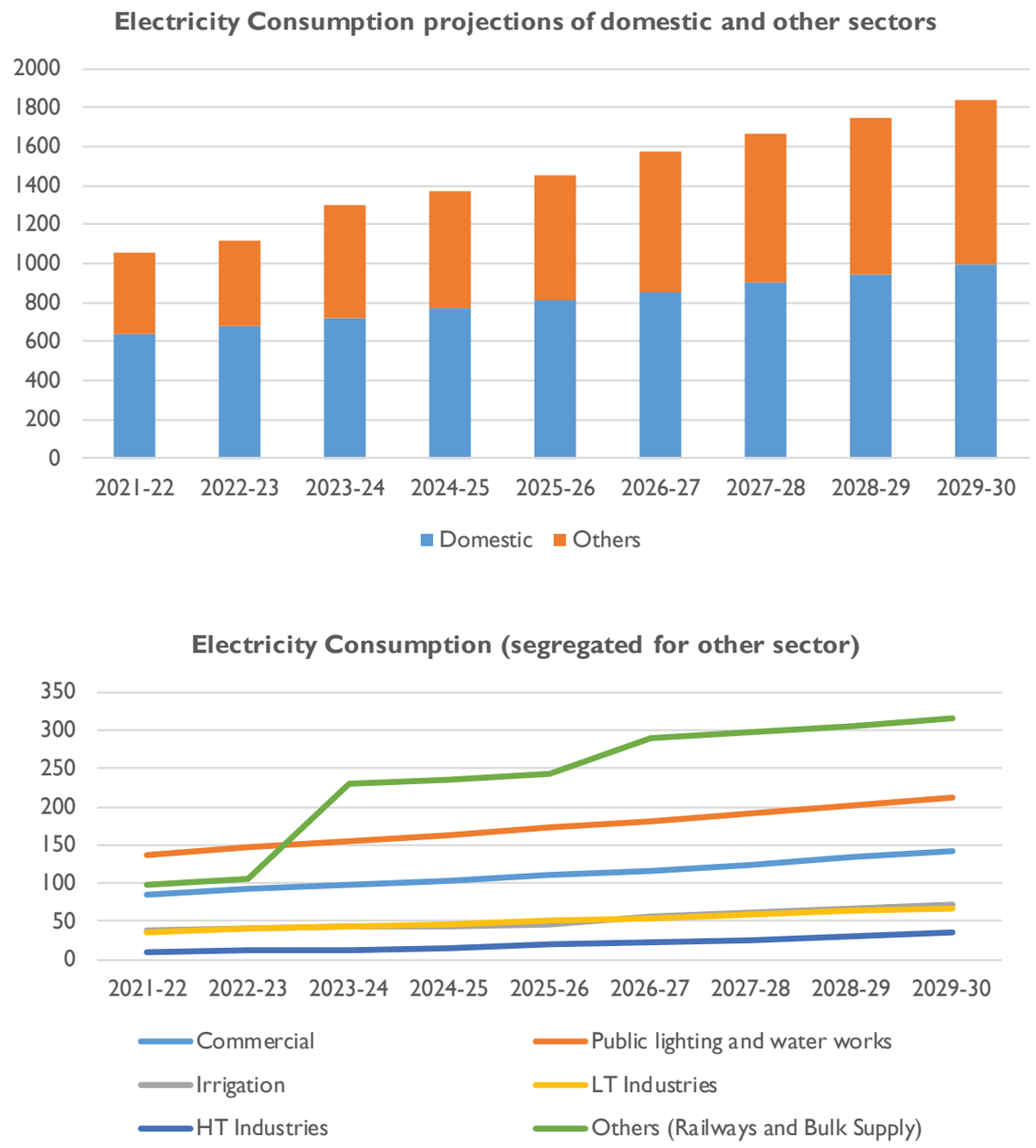
- Khowai - 81%
- Gomati - 87%
- Sepahijala - 89%

To improve the performance, TSECL has taken multiple grid modernization and revenue generation (through business process enhancement) initiatives. Some of the key initiatives are mentioned below:

Business Process Improvement	Operational Efficiency	Customer Engagement
• Implementation of ERP system • Implementation of Centralized Billing System	• Installation of Fault Passage Indicators, Ring Main Units, Auto Recloser & Fault Locators • Augmentation of 33/11 kV sub-station • AMI, DT & feeder metering	• Online bill payment • Consumer Grievance Redressal Forum • Customer Care Center • Special tariff for EV

Whereas future demand scenario shows that electricity consumption is projected to grow by more than 90% and peak load by 100% in next 10 years with railway traction and bulk supply contributing to maximum amount of electricity consumption and HT industries featuring maximum growth of six times

Figure 9: Category wise electricity consumption of Tripura projections till 2030



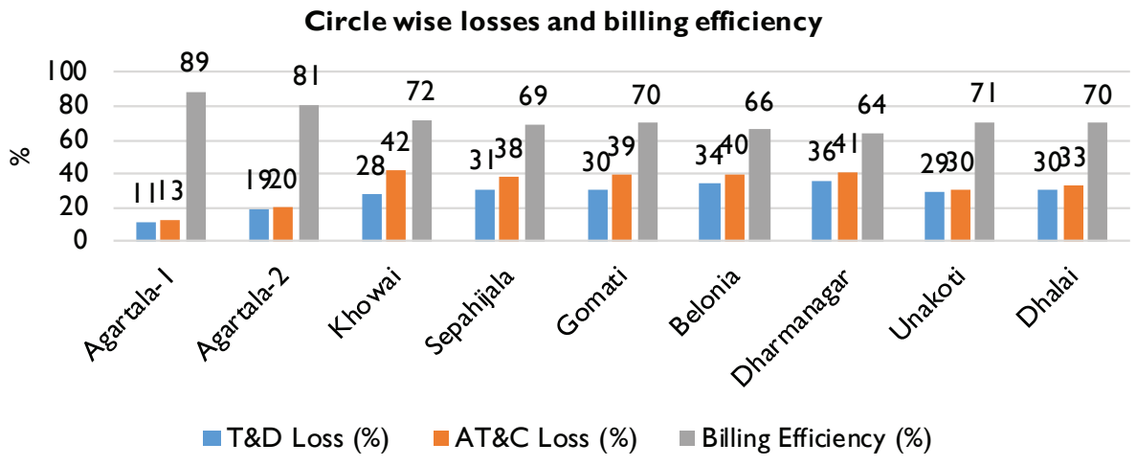
(Source: 20th EPS report, CEA)

the current electricity consumption. Domestic consumption which was constituting 61% of electricity consumption will reduce to 54% in the next 8 years thereby suggesting growth in other sectors which are power intensive like industries. Therefore, capacity upgradation and modernization of network infrastructure need to be conducted to reduce losses and power outages so that reliable and quality power can be delivered to consumers.

2.3.1 HIGH AT&C LOSS & POWER OUTAGE

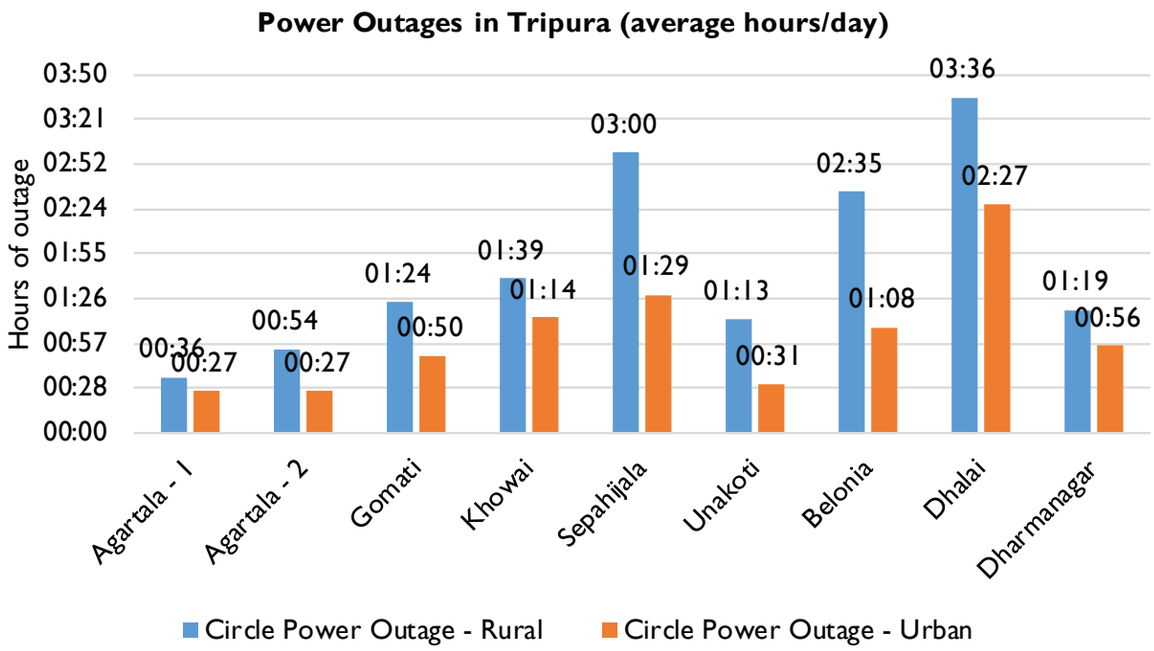
Although TSECL has conducted distribution network strengthening activities, ageing infrastructure along with antiquated technologies are resulting in high AT&C losses on the ground. The maintenance of the grid is a huge issue due to the geographical limitations, heavy rains, and storms in many parts of the State along with lack of upgradation effort in terms of preventive asset maintenance etc. The following graph below highlights the AT&C losses in all divisions of Tripura. The overall AT&C losses are ~30% even when UDAY scheme and other governmental initiatives were focused on bringing down the losses to <15%.

Figure 10: Circle wise efficiency losses in Tripura in FY22



As seen from the graph, many of the divisions suffer from heavy AT&C losses. Upon further analysis, low billing efficiency along with high T&D losses is a key contributor to the AT&C losses. Moreover, lack of proper maintenance of the assets, overloaded transformers, ageing equipment along with inefficient operations of the power plants has led to frequent supply interruptions in the State.

Figure 11: Outage in Urban and Rural circles of Tripura in FY22



Considering the AT&C loss and outage scenario, distribution network augmentation is needed in terms of sub-station capacity augmentation, DT augmentation, replacement of undersized conductors along with implementation of advance technologies for predictive maintenance, smart meters, real time monitoring of the grid etc. to ensure reduction in AT&C losses and reliable operation of the grid.

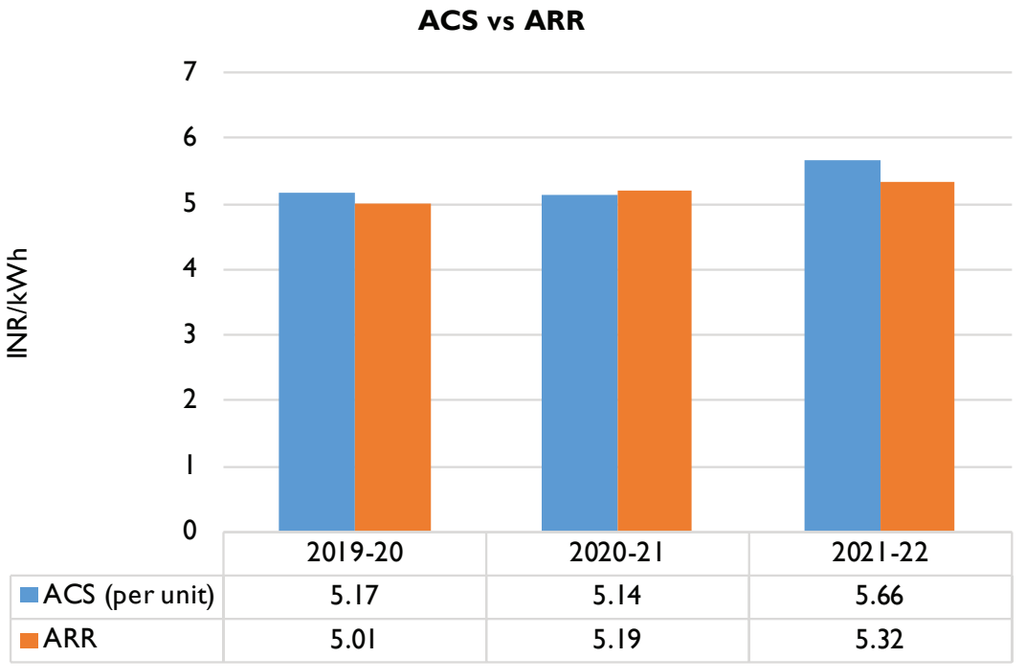
According to a study by Florence School of Regulations, the smart grid pilot project which involves implementation of 42,831 single phase smart meters and 2,459 three phase smart meters for 46,071 residential and industrial customers in the Agartala city has led to benefit of INR 50 million due to reduced losses and INR 82 million due to efficient billing in four years from FY 2017-18 to FY 2020-21.

Therefore, these interventions are proven to ensure better consumer experience while improving the distribution losses for the DISCOMs.

2.3.2 ACS-ARR GAP

High AT&C losses contributed by T&D loss and low billing efficiency along with increased number of LT consumers (Kutir Jyoti & Domestic) has led to increase in the ACS – ARR gap leading to non-realization of the actual cost incurred and has a negative impact on the balance sheet of the DISCOM (Although in FY 2020-21 it shows negative ACS -ARR gap, it is mainly due to contribution from cross border power trading).

Figure 12: ACS vs ARR – TSECL and TSECL -ABR/ACoS FY 2022-23



Category of Consumers	FY 2022 - 23				
	Sales (MU)	Revenue (Rs. Crore)	Average Billing Rate (Rs/kWh)	Average Cost of Supply (Rs/ kWh)	Cross Subsidy %
Kutir Jyoti	22.68	6.01	2.65	6.73	39%
Domestic	635.62	359.7	5.66	6.73	84%
Commercial	72.34	53.86	7.44	6.73	111%
Irrigation	42	24.31	5.79	6.73	86%
Water Works	84.18	56.26	6.68	6.73	99%
Industries	47.07	41.29	8.77	6.73	130%
Tea Coffee & Rubber	4.85	3.58	7.38	6.73	110%
Bulk Supply	88.55	66.01	7.45	6.73	111%
Public Lighting	46.6	27.98	8	6.73	89%
Mobile Towers	28.65	22.17	7.74	6.73	115%
Total	**1072.55**	**661.16**	**6.16**	**6.73**	**92%**

The significance of efficiency in power distribution cannot be understated, as any inefficiencies within this process have a cascading effect on all stakeholders upstream in the value chain. This includes adverse impacts on the operations and financial viability of the DISCOM (Distribution Company). To safeguard its own operations and financial health, TSECL (Tripura State Electricity Corporation Limited) must prioritize efforts to enhance its operational efficiency. By developing low-cost generation methods and implementing measures to reduce losses, TSECL can mitigate the negative repercussions of inefficiencies, leading to a positive impact on its overall balance sheet.

Based on the discussions above on key issues and required interventions, below mentioned are the key takeaways in terms of aspects which need to be considered for improvement in operational efficiency and revenue generation for the utilities

2.4 KEY TAKEAWAYS

In view of above and our understanding of the issues in Tripura's energy sector and its key challenges, it is amply clear that operational performance is affected due to inefficient asset management, slow implementation of advance technologies, low efficiency of power plants etc. resulting to unscheduled power outage, high losses, non-realization of actual cost incurred, thereby impacting the balance sheet of the utilities. Moreover employees, systems and resources required to operate a modern utility are inadequate. This has not only impacted operational and financial performance but also resulting in low customer satisfaction. Therefore, some of the following aspects need to be addressed to bring about a strategic and operational turnaround for the sector

Efficiency of existing power generation plants and implementation of RE

- State owned gas power plants are open cycle having efficiency of 35% which need to be converted to combined cycle power plants for better efficiency of around 60%
- Tripura has solar potential of 2 GW potential. Currently, 7.75 MW grid connected solar plant is operational and another 130 MW floating solar and 10 MW offgrid solar plant is in planning stage
- Presence of various stagnant water bodies gives opportunity for implementation of floating solar.
- Development of solar power will give Tripura opportunity to have low-cost power generation (INR3.5-3.9/kWh) which will reduce dependency on procurement of high-cost power (more than INR 4/kWh). Energy storage option to be considered for better peak load management and energy arbitrage
- Renewable energy generation will also open new opportunities for revenue generation like green hydrogen/ammonia which will also facilitate in bringing new industrial investment like fertilizer in the State
- Exploitation of biomass, mini and micro hydro, distributed solar resources for providing electricity to remote areas
- Presence of natural gas wells provides opportunity for new technologies like geothermal

Strengthening of transmission network

- System strengthening through development of new lines and capacity augmentation in industrial towns to ensure reliable supply and meet future demand
- Provide redundancy corridor in power supply to remote areas and reconductoring of lines to enhance network stability

Cross border power trading

- Development of low-cost generation will help in revenue generation through cross border trading by selling power at high cost in countries like Bangladesh and Sri Lanka where marginal cost of electricity is more than INR 7/kWh
- Banking arrangement with countries like Nepal and Bhutan to get cheaper power in summer when the demand is high and export power in winter to these countries
- Interstate transmission capacity to be strengthened to facilitate domestic power trading as revenue from domestic and cross border power trading has helped in reducing ACS-ARR gap by INR 1.29/ kWh in FY 2021

Distribution efficiency and network strengthening

- High AT&C losses contributed by high T&D loss and lower billing efficiency suggests upgradation of the network e.eg. replacement of old joints, installation of high-capacity conductors, 100% DT and feeder level metering etc.
- Smart metering to be conducted in phase wise manner to improve billing efficiency, loss reduction and better asset management and customer satisfaction through integration with GIS, CIS etc.
- Asset mapping and consumer indexing to be conducted.
- Implementation of advanced technologies for preventive maintenance, augmentation of sub-station capacity etc. need to be carried to reduce power outage
- Installation of capacitor banaks, Volt-VAR optimization need to be installed and proper load flow studies at feeder level need to be conducted for seamless integration of distributed resources
- Rationalization of tariff need to be conducted along with achievement of performance targets to realize the actual cost incurred
- Implementation of advanced technologies and integration with R-APDRP systems for operational efficiency and improvement in business process
- Capacity building and training of employees to ensure better operational efficiency through technology implementation

2.5 ALIGNING STATE TARGETS WITH ANTICIPATED DEMAND - SUPPLY SITUATION

The targets and recommendations for Tripura's Energy Vision must be aligned with the future demand and supply scenario. The table below presents the projections for Tripura's electricity demand and supply sourced and validated from key stakeholders in the Tripura's power department.

Parameter	FY22	FY23	FY24	FY25	FY26	FY27	FY28	FY29	FY30
Peak Demand (as per 20th EPS Report)1	327	333	393	448	512	545	580	618	659
Total Supply	541	541	581	638	638	638	638	638	638
• State level[2]	311	311	336	393	393	393	393	393	393
• LTOA	230	230	245	245	245	245	245	245	245
• CBT (-)	190	190	190	190	190	190	190	190	190
• Inter State Sale (-)	20	10	10	10	10	10	10	10	10
Gap	4	8	-12	-10	-74	-107	-142	-180	-221
Additional Requirement for the State	0	0	0	198	223	248	398	493	563
• RE Sources[3]				135	160	185	335	430	500
• LTOA[4]				63	63	63	63	63	63

[1]The off – peak demand is 210 MW in 2022 and goes till 430 MW in 2030, however, state energy procurement planning has to consider peak demand fulfilment

[2]The state level generation includes its current generation capacity of 115 MW, 57 MW state CGGT coming in from FY25 and power generation from the OTPC power plant

[3]The state owned RE generation needs to increase to 500 MW by 2030 to ensure peak demand fulfilment in the state

[4] Tripura has been allocated 7.68% of 2000 MW plant in Subansiri from FY25

NOTE: Tripura has prospects to procure 363 MW from OTPC CGGT and 101 from NEEPCO from FY25, however, it is highly dependent on gas availability and hence not considered as a part of the projection

It is interesting to note that while Tripura can manage its off-peak energy demand, the peak demand deficit is increasing y – o – y. This is primarily due to heavy reliance on gas-based generation and low development of other energy sources. Development of low-cost renewable energy sources along with gas-based generation will help the state in forgoing power procurement from sources outside the state which have higher cost of generation.

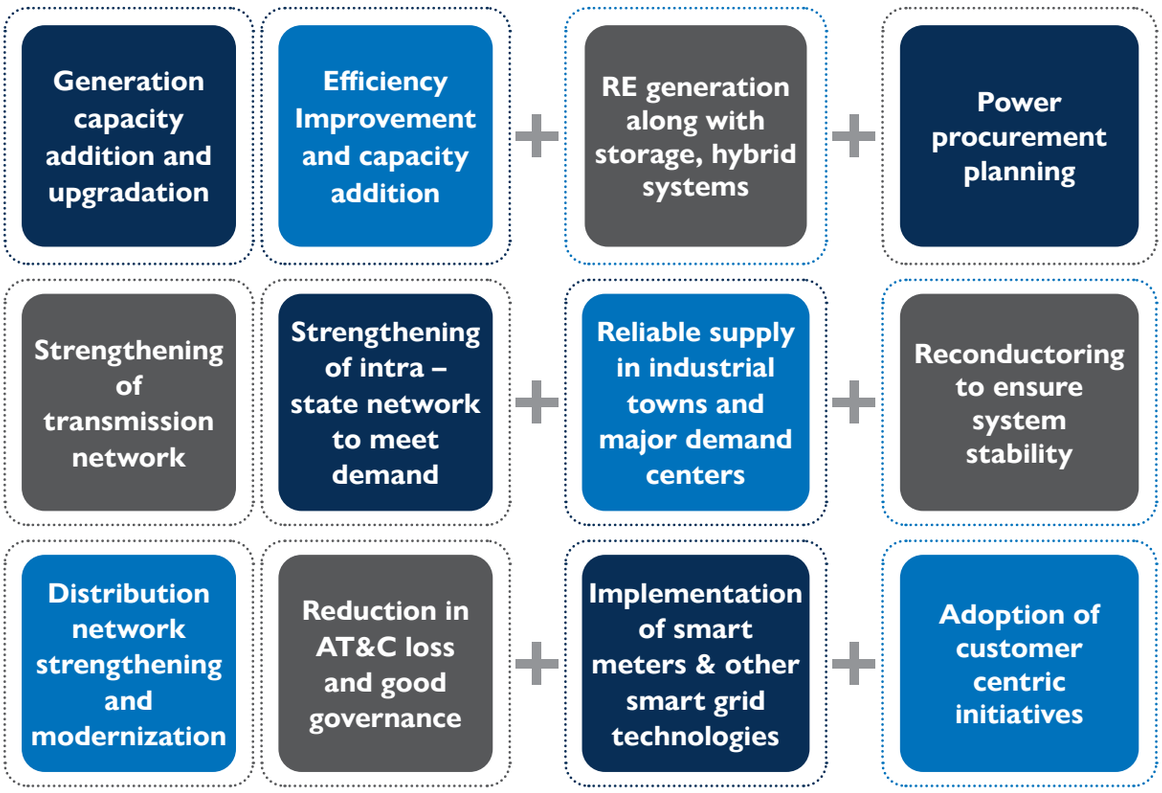
Section 3

KEY FOCUS AREAS AND WAY FORWARD

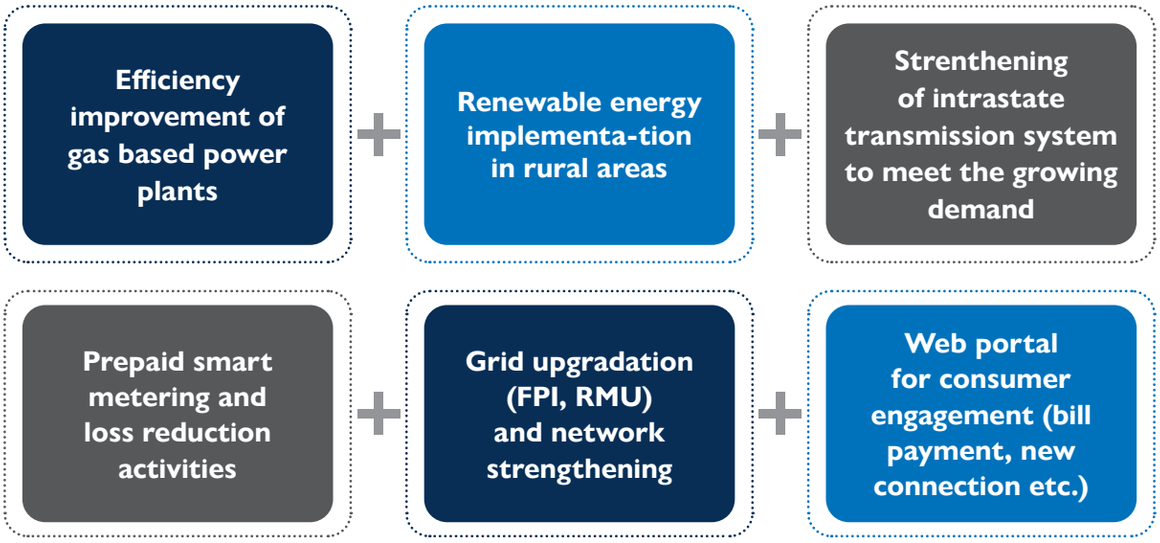
KEY FOCUS AREAS AND WAY FORWARD

India is spearheading its net zero journey with key initiatives starting from 500 GW of renewable energy, 5 million tonnes of green hydrogen, 30% of vehicles to be EV etc. by 2030, which will require accelerated implementation of renewable energy assets along with grid modernization exercises to accommodate those intermittent and variable demand side resources and to ensure reliability and quality of power supply at the tail ends.

The State of Tripura also shares the Vision of Govt. of India on sustainable development and came out with a Vision Roadmap 2030 depicting the targets to be achieved and activities to be carried out to meet the specified objectives under the SDGs. Under SDG-7 which calls for "affordable, reliable, sustainable and modern energy for all", action plan has been Stated out which focuses on implementation of renewable energy sources along with efficient power procurement and supply of reliability and quality power. Therefore, the congruence of activities set out in the SDG Vision 2030 Tripura document with the national objective towards sustainable development provides plethora of opportunities for the State government and power utilities to focus and work in the above-mentioned areas, some of which have already been undertaken/ being undertaken by TSECL and TPGL.



Mapping of focus areas with recent utility initiatives



Considering the key issues as mentioned in previous chapter and mapping it with the focus areas, below mentioned is the strategic roadmap highlighting the activities that need to be undertaken by TSECL, TPGL and TRDEA to ensure sustainable development while ensuring energy security and grid reliability for the last mile consumers. The activities have been recommended phase wise i.e., short term till 2024, medium term till 2027 and long term till 2030.

3.1 STRATEGIC ROADMAP

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
1. Distribution Efficiency Improvement and Infrastructure Upgradation	1.1 Network strengthening and augmentation	1.1.1 Undertake measures for reconductoring of HT/LT lines to avoid overloading in areas with high demand 1.1.2 Underground cabling for urban feeders in Agartala districts 1.1.3 Augmentation of sub-station capacity in urban areas and addition of 11 kV feeders in the urban and rural areas 1.1.4 All old wire joints on overhead LV lines must be replaced with properly crimped joints in major districts 1.1.5 Earthing and structural strengthening to be carried out 1.1.5 Installation of Fault Passage Indicator, Ring Main Unit, Auto Recloser & Fault Locator in major areas	1.1.1 Undertake measures for reconductoring of HT/LT lines to avoid overloading of lines in entire service area 1.1.2 Underground cabling of urban, rural, and mixed feeders in major districts especially in areas affected by heavy rain and storm 1.1.3 Augmentation of sub-station capacity in urban and rural areas and addition of 11 kV feeders in the urban and rural areas 1.1.4 All old wire joints on overhead LV lines must be replaced with properly crimped joints in entire service area 1.1.5 HT:LT ratio improvement in urban areas 1.1.6 Installation of Fault Passage Indicator, Ring Main Unit, Auto Recloser & Fault Locator in entire service area	1.1.1 HT:LT ratio improvement in rural areas 1.1.2 Underground cabling of urban, rural, and mixed feeders in all districts 1.1.3 Network model of the distribution grid up to DT level is regularly updated and modelling studies undertaken for assessing various scenarios of network upgrades to balance demand and supply in an optimal manner 1.1.4 Hotline maintenance including bare hand work methods implemented in urban areas

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
1. Distribution Efficiency Improvement and Infrastructure Upgradation	1.2 Business process and operational efficiency	1.2.1 AT&C loss reduction target to 23% by 2024 1.2.2 100% GIS Assets and Consumer indexing to be carried out 1.2.3 100% metering need to be carried out 1.2.4 Average power outage duration of 30 minutes in urban areas and 1 hour 30 minutes in rural areas 1.2.5 Integration of ERP with GIS and other IT and automation systems 1.2.6 Implementation of demand response for better peak load management in major districts for select customers with loads >20kW 1.2.7 Analyse the electricity consumption behaviour and pattern of residential customers area-wise and align systems to support their usage pattern and minimize outages; model the reliability of grid equipment 1.2.7 Approval of a manpower plan (including training plan) in alignment with the approved roadmap to build adequately skilled workforce in all line of businesses to support the implementation of the initiatives prescribed in the approved roadmap	1.2.1 AT&C loss reduction target to 16% by 2027 1.2.2 Zero power outage in urban areas and average power outage duration of 1 hour in rural areas 1.2.3 Addition of capacitor banks to ensure better power quality with the integration of DERs 1.2.4 Prepare plan for mobile workforce management (MWFM) systems 1.2.5 Integration of smart meter data with billing system 1.2.6 Deployment of analytical tools with artificial intelligence to support decision making based on near real-time grid operations data by all key decision makers in all Line of Businesses; dash boards with relevant information are made available in each LOB 1.2.7 Prepare comprehensive plan for technology interventions and realignment of systems for transformation to DNO and enabling retail competition	1.2.1 AT&C loss reduction target to 12% by 2030 1.2.2 Zero power outage in urban and rural areas 1.2.3 Inventories are tracked remotely using appropriate systems which are integrated with the ERP, GIS and mWFM systems 1.2.4 Asset performance trend analysis and event audit reports are available for all key assets and systems 1.2.5 AMI-GIS Integration to enhance the visualization of the network to provide safety, reliability, and operational benefits

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
1. Distribution Efficiency Improvement and Infrastructure Upgradation	1.3 Implementation of advance technologies	1.3.1 Pilot project on preventive maintenance using drones or Infrared Camera to detect hot spots and weak joints to avoid any un-wanted breakdowns 1.3.2 Smart metering for Agartala district 1.3.3 Digital transformation roadmap citing the key technologies and integration requirement along with implementation plan for the same	1.3.1 Use of drones or Infrared Camera to be used to detect hot spots and weak joints so that preventive maintenance can be carried out to avoid any un-wanted breakdowns in 3 districts 1.3.2 Smart metering for at least 5 major districts in line with RDSS 1.3.3 Implement Voltage and Reactive Power (Volt-VAR) Optimization (VVO) systems in key service areas 1.3.4 Implementation of Distributed Energy Resource Management System to help utilities manage grid in more reliable manner 1.3.5 Implementation of outage management system safe, efficient field operations related to outage restoration and OMS data with customer call centre 1.3.6 Residential customers are encouraged to participate in demand response programs	1.3.1 Use of drones or Infrared Camera to be used to detect hot spots and weak joints so that preventive maintenance can be carried out to avoid any un-wanted breakdowns in all 9 districts 1.3.2 Implementation of Advance Distribution Management System in Agartala and major districts 1.3.3 Smart metering covering both urban and rural areas for all the districts 1.3.4 Extension of Voltage and Reactive Power (Volt-VAR) Optimization (VVO) systems to entire service area 1.3.5 Extension of Outage Management System (OMS) to entire service area; integration of OMS with GIS, AMI and ERP
2. Efficiency Improvement of existing plants	2.1 Efficiency improvement of gas power plants	2.1.1 Conversion of all open cycle gas power plants (OCGT) to combined cycle power plants (CCGT)	2.1.1 Feasibility study and DPR preparation for new gas-based power plants 2.1.2 Commissioning of 3rd unit (323 MW) of OTPC Palatana power plant and 101 MW NEEPCO gas-based power plants	2.1.1 Implementation of new gas-based power plants

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
3. Acceleration in Implementation of Renewable Energy Sources	3.1 Grid scale renewable energy implementation	3.1.1 Feasibility study and DPR for implementation of grid connected solar power in the State 3.1.2 Assessment of energy storage at the distribution level with the envisaged integration of various DERs in the distribution grid 3.1.3 Development of RE policy citing targets, incentives etc. to facilitate RE development in the State 3.1.4 Renewable energy planning along with its supporting infrastructure based on the requirement e.g., green hydrogen, RE for EV, RE for industries need to be carried out 3.1.5 Solarization of agriculture pumps for at least 50% of the total pumps in the state 3.1.6 Promotional support to accelerate implementation of rooftop PV in urban areas	3.1.1 Implementation of grid connected solar power plants 3.1.2 Facilitating single window option for customers for implementation of rooftop solar 3.1.3 Deployment of energy storage systems (ESS) for grid balancing in urban areas with high penetration of rooftop PV 3.1.4 Promotion of Diesel Generator set replacement program with Batteries (which can participate in load balancing) at customer premises 3.1.5 Pilot on Peer-to-Peer (P2P) trading of rooftop solar using blockchain 3.1.6 Solarization of agriculture pumps for entire state 3.1.7 Assessment of wind power potential at 120-meter height	3.1.1 Deployment of energy storage systems (ESS) for grid balancing on all feeders serving critical infrastructure and high value customers 3.1.2 Implementation of smart microgrid for critical infrastructures in the State 3.1.3 Feasibility study for wind power development at places identified with wind power potential at 120 m height
	3.2 Renewable energy sources for rural areas and off grid solutions	3.2.1 Implementation of solar microgrid in at least 100 of the 500 hamlets 3.2.2 Feasibility study and implementation plan for biomass generation in rural areas 3.2.3 Implementation plan for development of mini and micro hydro 3.2.4 Mapping of transmission infrastructure with potential mini and micro hydro power plants to ensure power evacuation from those generating facilities 3.2.5 Implementation of 1000 nos. of 2 kW solar pumps under Component B of PM KUSUM scheme 3.2.6 Implementation of 75,000 solar streetlights 3.2.7 Implementation of 100 nos. solar RO plants	3.2.8 Implementation of solar microgrid in at least 250 of the 500 hamlets 3.2.9 Installation biomass power plants in 50% of the identified areas 3.2.10 Installation of mini and micro hydropower plants 3.2.11 Implementation of 5000 nos. of 2 kW solar pumps under Component B of PM KUSUM scheme 3.2.12 Implementation of 2,00,000 solar streetlights 3.2.13 Implementation of 600 nos. solar RO plants	3.2.1 Implementation of microgrid in all the 500 hamlets 3.2.1 Installation biomass power plants in 100% identified areas 3.2.2 Implementation of 8000 nos. of 2 kW solar pumps under Component B of PM KUSUM scheme 3.2.3 Implementation of 3,00,000 solar streetlights 3.2.4 Implementation of 1000 nos. solar RO plants

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
3. Acceleration in Implementation of Renewable Energy Sources	3.3 New and Innovative renewable technology options	3.3.1 Feasibility study and DPR preparation of floating solar plant in various lakes in Tripura like Rudrasagar and Khowra and in reservoirs 3.3.2 Feasibility study for implementation of green hydrogen/ammonia need to be carried out on priority basis to promote investment in fertilizer and other related industries which will open new revenue stream for the Govt. (natural gas pipelines will help in transportation) 3.3.3 Pre-feasibility study for assessment of geothermal potential need to be carried out considering presence of natural gas wells will be added advantage 3.3.4 Pre-feasibility study for assessment of potential for carbon capture and storage as Tripura is having natural gas reserves has good potential for carbon capture in geological formations	3.3.1 Implementation of floating solar plants apart from 130 MW floating solar in Dumbur lake 3.3.2 Implementation of green hydrogen plant having capacity of producing 80-100 kg of hydrogen per day 3.3.3 Preparation of detailed project report and implementation plan for development of geothermal power plants in Tripura	3.3.1 Implementation of floating solar, hybrid RE plants for enhancing State generation capacity to open up revenue opportunities through interstate and cross border power trade 3.3.2 Implementation of additional green hydrogen power plants based on requirement from fertilizer and other related industries 3.3.3 Pilot project and implementation of geothermal power plants in the State 3.3.4 Pilot project and implementation of carbon capture and storage technology
4. Strengthening of transmission infrastructure and energy trading	4.1 Strengthening of transmission infrastructure	4.1.1 Augmentation of 132 kV sub stations supplying the major demand centres like industrial towns and major cities	4.1.1 Reconductoring of the 132 kV lines having higher loadings to ensure system stability 4.1.2 Development of new 132/33 kV sub stations and transmission lines to facilitate ring main power supply arrangement for Agartala city 4.1.3 Development of new 132 kV lines to strengthen the intra state transmission system and provide redundancy corridor in power supply to remote areas	4.1.1 Strengthening of intra state transmission system in rural areas through required augmentation of sub stations and development of new lines 4.1.2 Condition based maintenance of circuit breakers and power transformers

Focus Areas	Sub Focus Area	Short term (2023-2024)	Medium term (2025-2027)	Long term (2028-2030)
4. Strengthening of transmission infrastructure and energy trading	4.2 Cross border energy trade	4.2.1 Assessment of potential opportunity for cross border power trading with Nepal, Bhutan and Myanmar based on demand pattern and supply availability through low-cost clean energy facilities	4.2.1 Development of implementation plan along with evaluation of low-cost generation options for carrying out cross border power with Nepal, Bhutan, and Myanmar 4.2.2 Assessment of potential opportunity for cross border power trading with Sri Lanka to be carried out based on demand pattern and supply availability through low-cost clean energy facilities 4.2.3 Implementation plan for additional power trading arrangement with Bangladesh 4.2.4 Evaluation of opportunities to supply clean energy in case of tripartite agreement among Bhutan, India, and Bangladesh 4.2.5 Renew of power trading contract with Bangladesh	4.2.1 Establishment of contract for power trading with Sri Lanka
	4.3 Domestic energy trade	4.3.1 Optimization of power sale options in terms of short term and medium-term market including exchange to increase revenue potential for TSECL	4.3.1 Implementation plan for export of clean energy to eastern and other north-eastern States with addition of renewable energy generation in the State 4.3.2 Augmentation of transmission infrastructure to support additional interstate power exchange	4.3.1 Implementation of green hydrogen export to neighbouring States

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