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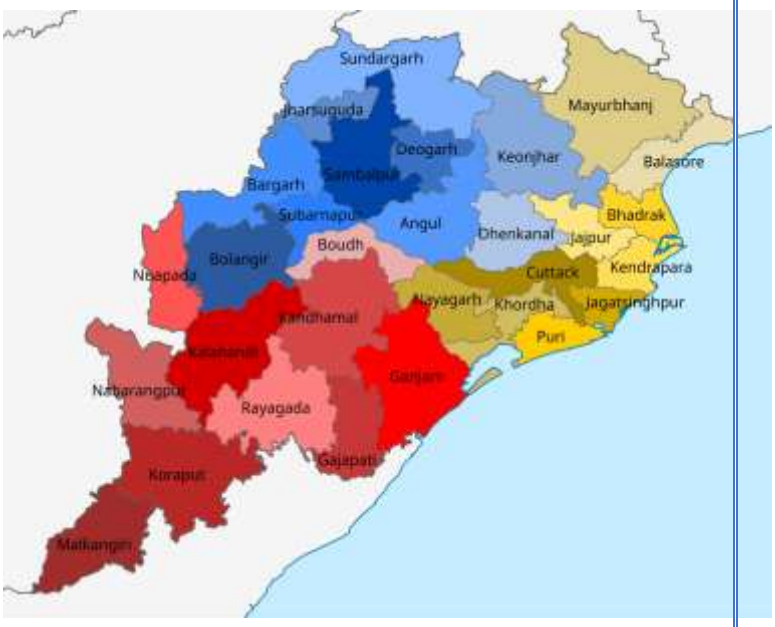

Energy Transition in Odisha

Progress, Challenges, and Policy Insights

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https://dstcpr.niser.ac.in

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Project Name: Energy Transition, Tribal Education and Innovations for Tribal Education in Eastern India

Principal Investigator: Amarendra Das

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ABOUT

DST- Centre for Policy Research, National Institute of Science and Educational Research, Bhubaneswar, Odisha

In December 2021, the Ministry of Science and Technology, Department of Science and Technology (Policy Research Programme) made an open call for the submission of Expressions of Interest in STI Policy Research towards the Establishment of the Center for Policy Research (CPR) by the academic and research Institutes in India. After multiple rounds of consultations and review, the DST-CPR at NISER received the final sanction order from the Government of India, Ministry of Science & Technology, Department of Science & Technology, bearing the letter No DST/PRC/CPR/NISERBhubaneswar-2023 (G)(PCPM) dated 29/03/2023. The primary focus of the DST-CPR at NISER is to study the Energy Transition, and the secondary focus is to study Tribal Education and Innovations for Tribal Education in Eastern India covering Odisha, Bihar, Chhattisgarh, Jharkhand, and West Bengal.

Suggested Citation

Srivastava, A., Das, A., & Rout, S. K. (2025). Energy Transition in Odisha: Progress, Challenges, and Policy Insights. Report#2. DST-Centre for Policy Research, NISER, Bhubaneswar, India.

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List of Abbreviations

GRIDCO	Grid Corporation of Odisha
DISCOM	Distribution Companies
OPGC	Odisha Power Generation Company
OSEB	Odisha State Electricity Board
OHPC	Odisha Hydro Power Corporation
OPTCL	Odisha Power Transmission Corporation Limited
AT&C Loss	Aggregate Technical and Commercial Losses
DoE	Department of Energy, Odisha
OREDA	Odisha Renewable Energy Development Agency
OECBC	Odisha Energy Conservation Building code
CESU	Central Electricity Supply Utility of Odisha
WESCO	Western Electricity Supply Company of Odisha
NESCO	Northern Electricity Supply Company of Odisha
SOUTHCO	Southern Electricity Supply Company of Odisha
TPCODL	Tata Power Central Odisha Distribution Limited
TPWODL	Tata Power Western Odisha Distribution Limited
TPNODL	Tata Power Northern Odisha Distribution Limited
TPSODL	Tata Power Southern Odisha Distribution Limited
OERC	Odisha Electricity Regulatory Commission
OREP	Odisha Renewable Energy Policy
GEDCOL	Green Energy Development
CEA	Central Electricity Authority

Executive Summary

This report provides a comprehensive analysis of Odisha's energy landscape, focusing on the state's infrastructure, policies, and transition toward renewable energy sources. It highlights both the significant progress achieved and the challenges encountered in Odisha's pursuit of a sustainable and resilient energy future. The report examines key aspects of the energy sector, including installed capacity, energy mix, power consumption, energy intensity, power distribution, distribution losses, and major policy initiatives. It also explores the state's ongoing efforts in promoting renewable energy through solar power projects, wind energy development, hydroelectric power, biomass, and waste-to-energy initiatives. These developments reflect Odisha's commitment to diversifying its energy portfolio and reducing dependence on conventional fossil fuels.

The identified challenges are followed by targeted recommendations to address them effectively. These include enhancing solar photovoltaic installations through innovative solutions such as floating solar and canal-top solar projects to mitigate land availability constraints. To manage peak demand in this industry-intensive state, the adoption of pumped hydro storage is proposed. Strengthening the reliability and performance of Distribution Companies (DISCOMs) is also emphasized, as it contributes to both improved infrastructure and the state's financial health.

Furthermore, upskilling for green jobs and facilitating the transition of unskilled labourers are recognized as essential components of Odisha's energy transition, fostering inclusivity and socio-economic development. The implementation of a climate budget is also recommended to align financial planning with climate action goals, ensuring more effective and strategic resource allocation.

In summary, this chapter presents a comprehensive overview of Odisha's energy journey—highlighting its achievements, identifying key challenges, and proposing actionable recommendations for a sustainable and resilient energy future. With strategic planning, innovative solutions, and inclusive policies, Odisha is well-positioned to advance toward a more sustainable and prosperous energy landscape.

Energy Transition in Odisha

Progress, Challenges, and Policy Insights

1. Introduction

The Sustainable Development Goals (SDGs), established through the Conference of Parties (CoP) meetings, encompass a wide range of development objectives, including poverty reduction and the environmental, economic, and social dimensions of sustainability. India, with its large and diverse population, has articulated its post-2020 Nationally Determined Contributions (NDCs), comprising eight distinct goals. These reflect the country's commitment to tackling global challenges, particularly focusing on emission reduction, renewable energy adoption, and forest conservation. In recent years, there has been significant progress in scientific and socio-economic understanding of climate change.

Despite a reduction in fossil fuel and coal usage for power generation, conventional energy sources still account for approximately 69% of India's total electricity generation. As of November 2023, renewable energy makes up 31% of the installed capacity. This reflects notable progress, yet highlights the challenges that remain in India's energy transition. Moreover, the country's electricity generation is closely tied to its urbanization and industrialization patterns, which continue to contribute significantly to global carbon emissions and climate change.

India, as the world's fifth-largest economy and a rapidly growing nation, faces unique challenges in achieving the Sustainable Development Goals (SDGs), due to its vast population and diverse socio-cultural landscape. Odisha, the second-highest carbon-emitting state in the country, primarily relies on coal-based power generation and energy-intensive industries, making it a significant contributor to emissions. Despite its industrial growth, the state continues to struggle with high levels of poverty, with a considerable portion of its population employed in carbon-emitting sectors—highlighting a complex economic dependence on polluting industries. Additionally, Odisha's geographical vulnerability to extreme climatic events, coupled with its high poverty rate and a large indigenous population reliant on natural resources, further exacerbates its susceptibility to the adverse impacts of climate change.

As Odisha undergoes rapid economic development and urbanization, the urgency for effective mitigation strategies becomes increasingly critical. Addressing the dual challenges of poverty alleviation and environmental sustainability requires a balanced and inclusive approach. This involves substantial investments in renewable energy infrastructure, the promotion of green technologies, and the implementation of robust climate-resilient strategies. By directing resources toward these sustainable development initiatives, Odisha can not only promote inclusive and equitable growth but also strengthen its resilience to climate-related risks. In doing so, the state can play a vital role in advancing both national and global sustainability goals, while building a thriving and resilient society for future generations.

This chapter offers a comprehensive analysis of Odisha's electricity regulation infrastructure, focusing on its overarching role, current generation capacity, and associated transmission and distribution losses. It provides a detailed examination of the state's existing energy mix, with particular attention to major power plants and their preparedness for transitioning to renewable energy generation. The chapter also reviews the status and potential of renewable energy adoption within the state's electricity framework.

In addition, it explores key policy initiatives related to electricity generation and the promotion of renewable energy (RE). These policies are not only outlined but critically assessed in terms of the challenges faced during implementation. The chapter concludes by offering practical suggestions to address these challenges. By integrating insights on regulatory structures, energy composition, and policy mechanisms, the chapter contributes to a deeper understanding of Odisha's energy sector, thereby supporting informed decision-making and strategic planning for a sustainable and resilient energy future.

Rest of the report has been designed as follows. **Section 2** outlines the Methodology, detailing the data sources, analytical frameworks, and tools employed in the study. **Section 3** provides an overview of The Odisha Economy, offering essential context by examining the state's economic structure, and growth trajectory. **Section 4** explores Odisha's Power Sector: Macro Scenario, focusing on generation capacity, energy mix, transmission infrastructure, and consumption trends. **Section 5** delves into Major Energy Policies, analyzing the regulatory framework and government initiatives shaping the state's energy transition. **Section 6** highlights Other Initiatives, including innovative projects, public-private partnerships, and community-level engagements aimed at promoting sustainable energy practices. **Section 7** identifies Challenges in Energy Transition, ranging from infrastructural bottlenecks and policy limitations to socio-economic barriers. Finally, **Section 8** presents Recommendations, offering actionable strategies to facilitate a just, inclusive, and resilient energy transition for Odisha. Together, these sections provide a holistic view of the state's energy landscape and chart a roadmap toward a sustainable energy future.

2. Methodology

The present chapter employs a research methodology grounded in secondary data analysis to explore the current landscape of energy transition in Odisha. Data have been collected from a range of credible and authoritative sources, including peer-reviewed research articles, government publications, and annual reports from both central and state-level departments. Special emphasis has been placed on analyzing key documents such as the Odisha Renewable Energy Policy, the State Climate Action Plan, and the Economic Survey of Odisha, which provide a comprehensive overview of policy frameworks, institutional mechanisms, and sectoral performance. These sources were chosen for their reliability, relevance, and depth of information on the state's renewable energy initiatives.

In addition to official policy documents, the study also incorporates findings from recent empirical studies and technical papers published by think tanks, national agencies like Niti Aayog, National Power Portal, GRIDCO Odisha, etc. The triangulation of these sources enables

a multi-dimensional understanding of the energy transition process. By synthesizing these insights, the chapter not only assesses Odisha's current progress in renewable energy deployment but also identifies critical challenges and proposes evidence-based strategic recommendations to facilitate a just and sustainable energy transition in the state.

3. The Economy of Odisha

Odisha's economy has demonstrated robust growth in recent years, outpacing national averages. In the fiscal year 2024–25, the state's Gross State Domestic Product (GSDP) expanded by 7.2%, surpassing India's growth rate of 6.4%. The size of Odisha's economy reached ₹9.5 lakh crore (approximately USD 114 billion), marking a 10% increase from ₹8.6 lakh crore in 2023–24.

Per capita income in Odisha rose by 10.6% to ₹1,82,548 in 2024–25, narrowing the gap with the national average of ₹2,00,162 to 8.8%. This upward trajectory reflects the state's diversified economic base, with significant contributions from agriculture, industry, and services sectors. Notably, the services sector is estimated to grow at 10%, contributing around 37.1% to the state's economy, while the industry sector is expected to grow at 6.1%, contributing 43.9% to the Gross State Value Added (GSVA). Odisha's strategic investments and policy initiatives continue to foster economic resilience and growth, positioning the state as a significant contributor to India's overall economic development.

Odisha has established itself as a power-surplus state, with electricity availability consistently exceeding demand. As of March 2023, the state's total contracted power capacity reached 8,150 MW, marking a 45% increase over six years from 2015–16 to 2021–22. This capacity comprises 53% thermal (4,298 MW), 30% hydro (2,466 MW), 12% solar (1,016 MW), 4% wind (350 MW), and 0.2% biomass (20 MW). Additionally, Odisha's captive power generation capacity stands at 12,517 MW, primarily coal-based, underscoring the state's significant industrial power infrastructure.

The state achieved complete village electrification by March 2020, fulfilling its "Electricity to All" initiative through dedicated efforts by the State Government. In line with environmental sustainability and climate change mitigation goals, Odisha is actively diversifying its energy portfolio. Notably, the government has announced plans to develop 1,000 MW of floating solar projects on reservoirs, aiming to enhance renewable energy capacity while minimizing land use. These initiatives reflect Odisha's commitment to transitioning towards a more sustainable and resilient energy future.

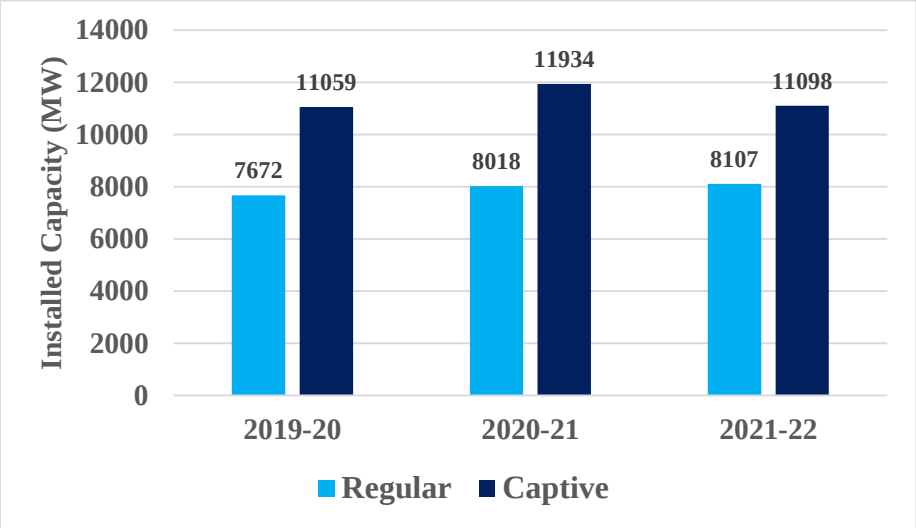
4. Odisha's Power Sector: Macro Scenario

4.1 Installed Capacity

The overall installed power capacity in Odisha is categorized into two segments: (i) Regular and (ii) Captive. Captive power plants are established by industries primarily for their own consumption, whereas regular power plants are managed by the state electricity authorities for supply to the grid or distribution companies. As of 2021–22, the installed capacity of regular

power plants stood at 8,107 MW, while captive power plants accounted for 12,171.31 MW, as illustrated in Figure 1.

Figure 1: ***Installed Capacity of Power Plants***

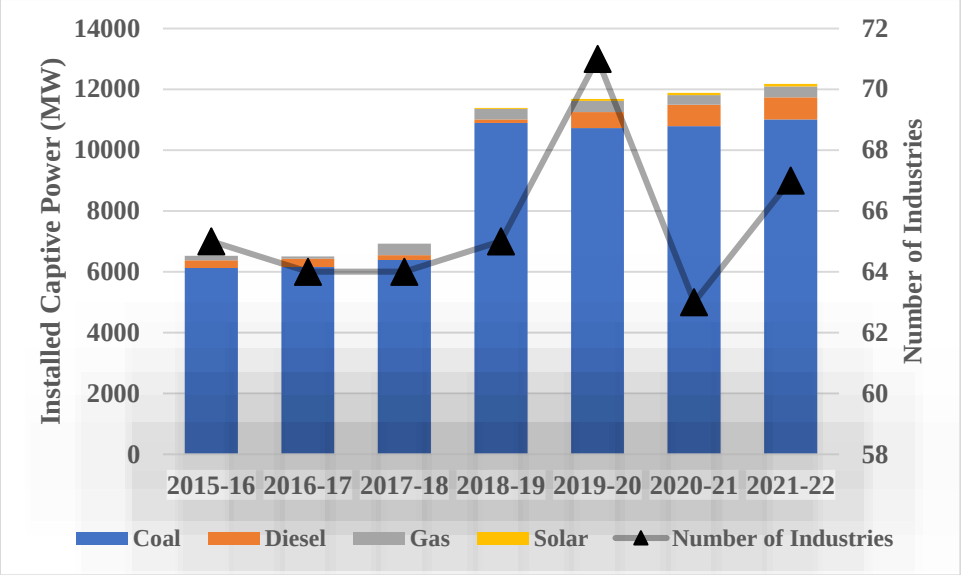


Source: Economic Survey Odisha, 2022-23

The year-wise growth of installed captive power capacity in Odisha, along with the number of contributing industries, is presented in Figure 2. This growth is closely linked to the expansion of industrial activity within the state. It is important to note that closed industries have not been included in the data shown in Figure 2. The total installed captive power capacity in Odisha exceeds 12,000 MW, driven by the energy needs of various industries.

Most captive power plants in the state primarily rely on conventional energy sources such as coal, diesel, and gas. The installed capacity of coal-based captive power plants has remained stable since 2019–20, while diesel-based power plants have shown a gradual increase since 2019. Furthermore, the installation of solar captive power plants has also grown steadily since 2019, reflecting the rising participation of industries in renewable energy generation.

Figure 2: ***Installed Capacity of Captive Power Plants (CPP)***

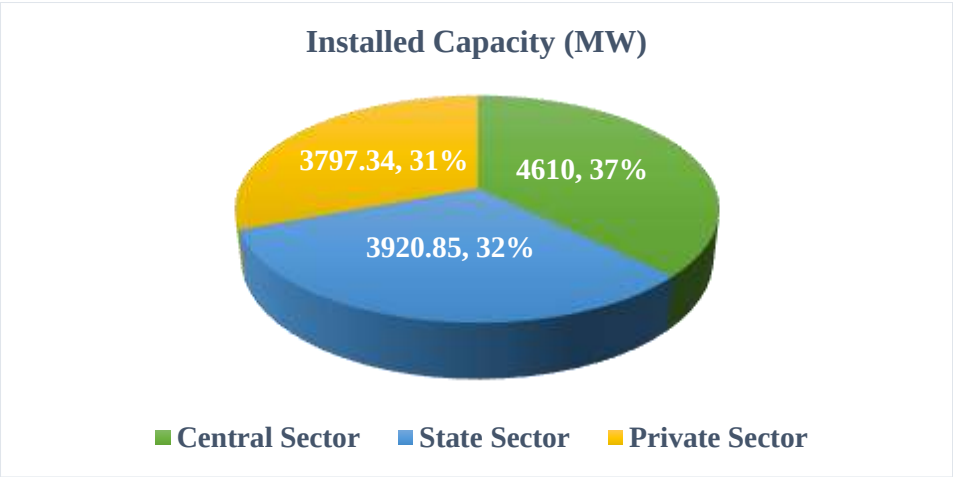


Source: Economic Survey, Odisha, 2022-23, Niti Aayog

To gain a clearer understanding of the sector-wise distribution of the total installed power capacity (greater than 12 MW) in Odisha for the year 2021–22, Figure 3 provides a detailed breakdown. The central sector holds the largest share, accounting for 37.3% of the total installed capacity, making it the most significant contributor among all sectors.

This dominance of the central sector reflects its strong role in power generation infrastructure, which typically includes large-scale thermal and hydroelectric power plants operated by central government agencies or public sector undertakings. The state sector and private sector contribute the remaining share, with their capacities varying based on specific regional demands, industrial growth, and investments in renewable energy. This distribution highlights the collaborative framework between central, state, and private entities in ensuring energy availability and supporting Odisha's growing power needs.

Figure 3: ***Sector-Wise Installed Capacity***



Source: GRIDCO, Odisha

In 2021–22, the state's share in the cumulative regular installed capacity of power projects was 8,107.1 MW, which increased to 12,328.19 MW in 2023, compared to 8,018.3 MW in 2020–21 (as shown in Figure 1), reflecting an absolute increase of 1.1%. Moreover, a growth of approximately 5.6% was observed when comparing the installed capacity in 2021–22 with that of 2019–20.

For a more comprehensive perspective, a comparison between power demand and availability from 2015–16 to 2021–22, as provided by GRIDCO, reveals a 45% increase during this period. Table 1 presents the time series data on both the contracted power capacity and the availability of power from various sources.

Table 1: Demand and availability of power by GRIDCO (in MW)

Year	*Demand (estd)*	*Availability of power from different sources*					*Installed capacity*	*Sold to other states*
		State sector	*Central sector*	*Other sources*	*Purchase from CPP*	*Total*		
2015-16	*2934*	*1466*	*1275*	*85*	*75*	*2900*	*5593.1*	*44*
2016-17	*3020*	*1851*	*998*	*28*	*85*	*2962*	*5509.1*	*156*
2017-18	*3062*	*1674*	*1205*	*74*	*45*	*2998*	*5810.8*	*45*
2018-19	*2912*	*1771*	*1079*	*259*	*54*	*3163*	*6011.5*	*33*
2019-20	*2810*	*2184*	*765*	*206*	*60*	*3215*	*7671.7*	*267*
2020-21	*2802*	*2671*	*882*	*15*	*61*	*3629*	*8018.3*	*669*
2021-22	*3088*	*2376*	*1279*	*107*	*66*	*3827*	*8107.1*	*614*

Source: GRIDCO, Odisha

The projected electricity demand in Odisha rose to 3,088 MW in 2021–22, marking an increase of 5.3% from 2,934 MW in 2015–16. During the same period, power availability also increased significantly—from 2,900 MW in 2015–16 to 3,827 MW in 2021–22. Notably, the state has maintained a surplus power supply since 2018–19, as the total available power has consistently exceeded the demand.

This surplus is largely attributed to the availability of fossil fuels within the state, enabling excess electricity generation, which is subsequently sold to other states. Such electricity exports contribute meaningfully to Odisha's economy. Moreover, the availability of low-cost power within the state fosters industrial development, as it encourages the establishment of energy-intensive industries and enhances the overall economic productivity through the sale of surplus electricity.

4.2 Odisha's Energy Mix

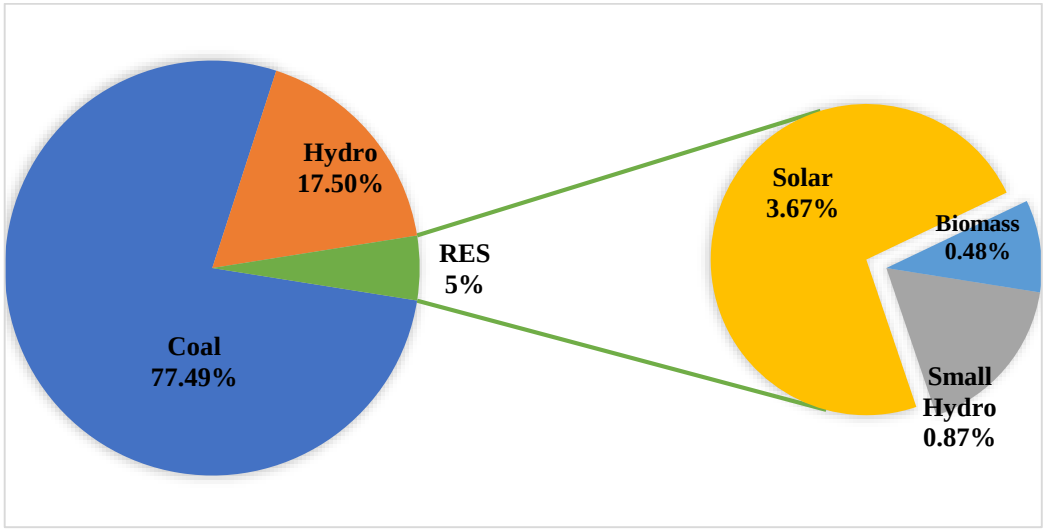
Power generation in Odisha continues to be predominantly based on conventional energy sources, particularly coal, which remains the backbone of the state's electricity supply. However, recognizing the environmental concerns, resource limitations, and long-term

sustainability challenges associated with conventional fuels, the state has been actively exploring and investing in non-conventional or renewable energy sources.

The power supply in Odisha for the year 2021–22 is not reliant on a single source but is derived from a diversified energy mix. This mix includes thermal power (mainly coal-based), hydroelectric power, nuclear energy, and renewable energy sources (RES). The renewable component of this mix comprises wind, solar, small-hydro, and biomass-based energy, all of which contribute significantly to the state's overall power generation strategy.

This approach of integrating various energy sources ensures a more resilient, sustainable, and environmentally responsible energy system. It also aligns with the national objective of increasing the share of renewables in the energy basket to reduce dependency on fossil fuels and curb carbon emissions. The specific contributions of each of these energy sources to Odisha's total power generation are depicted in Figure 4, offering a clear picture of the state's evolving energy landscape.

Figure 4: Contribution of different energy sources in total Energy Production



Source: National Power Portal

In 2021–22, Odisha's energy mix comprised both conventional and non-conventional power sources. The majority of the installed capacity is attributed to conventional sources, with approximately 77.50% derived from coal-based thermal power plants—carbon-emitting sources that rely on fossil fuels. Hydropower contributes around 17.50% to the state's energy portfolio.

In addition to conventional sources, Odisha is progressively integrating Renewable Energy Sources (RES), which account for about 5% of the total energy mix. Within the RES category, solar power contributes 3.67%, small hydro accounts for 0.87%, and biomass represents 0.48%.

In terms of installed capacity, coal-based thermal power leads with 9,450 MW, followed by hydropower with 2,154.55 MW. Among renewables, solar energy has an installed capacity of 451.24 MW, small hydro contributes 106.63 MW, and biomass adds 59.22 MW. Despite the growing role of renewables, coal remains the dominant source of power generation in the state.

4.3 Power Consumption

Power demand across all sectors in Odisha has been steadily increasing over time, with sector-wise growth detailed in Table 2. The major contributors to power consumption in the state include the domestic, industrial, commercial, and railway sectors. Notably, there has been a significant rise in electricity usage over the past six years (2017 to 2022), with domestic and industrial sectors witnessing an approximate increase of 1,835 million units (MU) and 1,240 MU, respectively—representing growth rates of around 29% and 21% compared to 2016–17.

Table 2: **Sector-wise Power Consumption (in million units (MU))**

Sector	***2016-17***	***2017-18***	***2018-19***	***2019-20***	***2020-21***	***2021-22***	***CAGR (%)***
Domestic	*6296*	*6757*	*7108*	*7543*	*8113*	*8130*	*4*
Commercial	*2035*	*2145*	*2363*	*2405*	*2029*	*2574*	*3.9*
Industrial	*5793*	*6425*	*7252*	*6713*	*5529*	*7035*	*3*
Public Lighting	*92*	*100*	*117*	*128*	*136*	*145*	*7*
Irrigation & Agriculture	*338*	*422*	*580*	*614*	*670*	*849*	*16*
Railways	*1118*	*1177*	*1206*	*1452*	*1368*	*1781*	*8*
Public waterworks	*260*	*254*	*298*	*316*	*312*	*383*	*6*
Bulk Supply & others	*411*	*449*	*446*	*557*	*451*	*537*	*4*
Total-consumption	*16343*	*17729*	*19370*	*19728*	*18608*	*21434*	*4*
Growth		*8.84%*	*9.26%*	*1.85%*	*-5.68%*	*15.19%*	

Source: OREP 2022, GRIDCO
NOTE: Compound Annual Growth Rate (CAGR) of Total Consumption for 6 years is 4%.

Total power consumption across all consumer categories rose by 15.2%, reaching 21,434 MU (GWh) in 2021–22, up from 18,608 MU (GWh) in 2020–21. Combined, the industrial and domestic sectors account for over 70% of Odisha's total power consumption. In 2021–22, the state registered a total of 94.9 lakh electricity consumers, out of which 72.62 lakh were domestic consumers in rural areas. This growth is primarily attributed to the state government's ambitious rural electrification program, the "Electricity to All" mission. As a result, the increase in domestic sector consumption is directly linked to the expansion of electricity access in rural regions.

Additionally, the transition of railway engines from coal-based to electric power has significantly contributed to the rise in electricity demand. However, data from 2019–20, 2020–21, and 2021–22 clearly show that the COVID-19 pandemic influenced sectoral consumption patterns. During this period, domestic power usage increased, while consumption in the industrial, commercial, and railway sectors declined due to lockdowns and reduced economic activity.

4.4 Energy Intensity

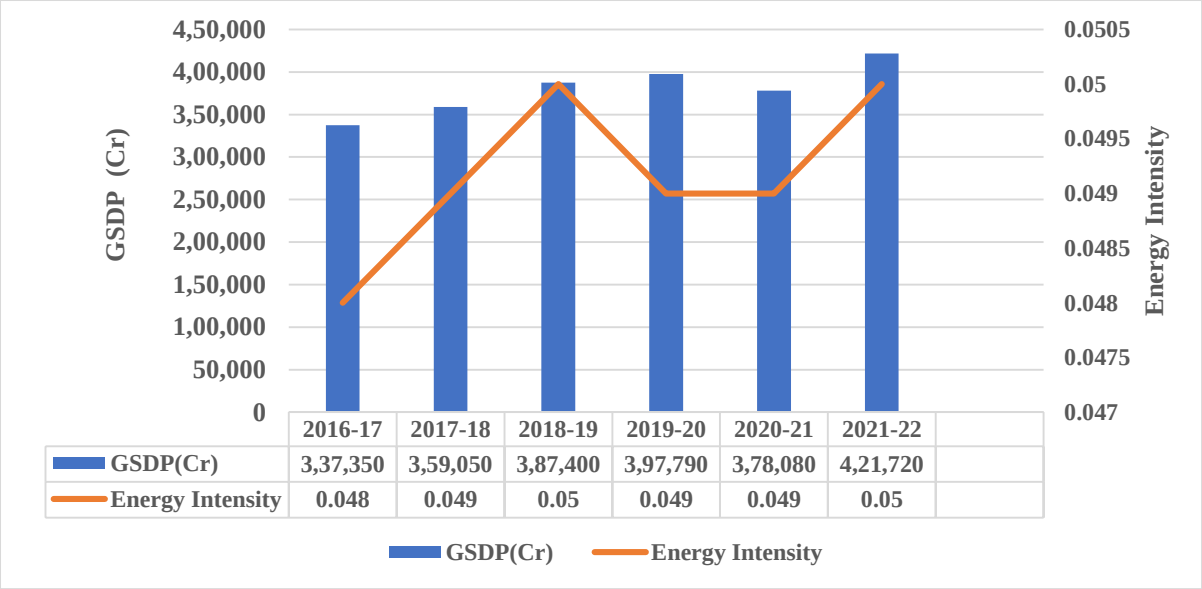
Energy intensity refers to the amount of energy consumed to produce one unit of economic output. It is an important indicator that reflects the efficiency of energy use within an economy. Specifically, in the context of a state like Odisha, energy intensity is measured as the total power (or energy) consumed per unit of Gross State Domestic Product (GSDP) generated.

A lower energy intensity indicates a more energy-efficient economy, where less energy is required to produce each unit of output. Conversely, a higher energy intensity suggests greater energy consumption for the same level of output, implying lower efficiency and potentially higher environmental impact. It is calculated as follows;

$$Energy\ Intensity = \frac{Total\ Power\ Consumption}{GDP}$$

The data on Gross State Domestic Product (GSDP) and total power consumption (as presented in Table 2) have been sourced from the Directorate of Economics and Statistics, Odisha and the Odisha Economic Survey, respectively. Figure 5 illustrates the trend in the state's energy intensity over the years from 2016 to 2022.

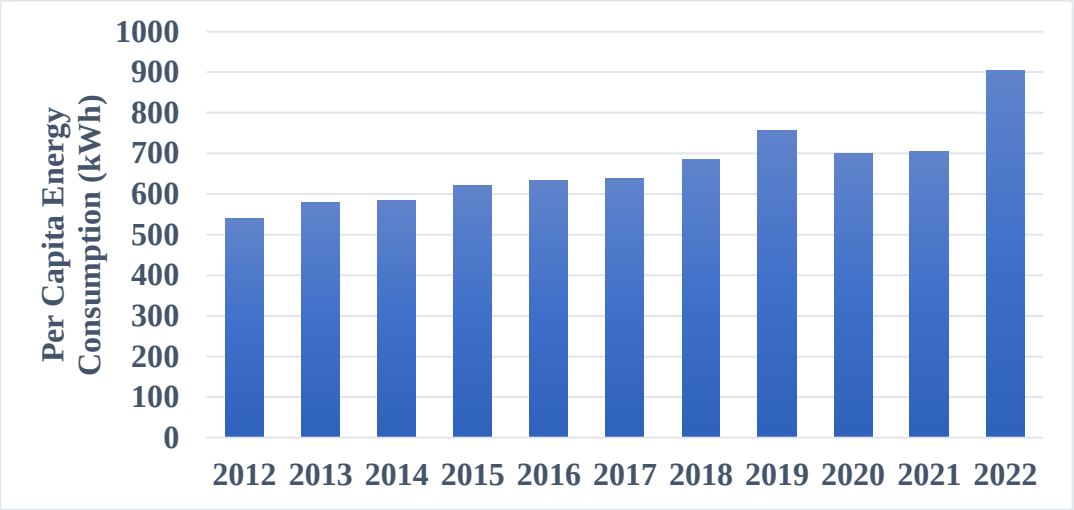
Figure 5: Energy intensity of the state over the year based on total power consumption



A steep increase in energy intensity was observed from 2016-17 to 2018-19, followed by a decline during the COVID-19 pandemic, which caused a significant halt in economic activities. Energy intensity then stabilized at a value of 0.05 in 2021-22, similar to the level recorded in 2018-19.

To better understand energy usage patterns and efficiency within Odisha's population, per capita energy consumption has also been analyzed, as shown in Figure 6. The year-wise growth of per capita energy consumption reflects the state's economic development, industrialization, urbanization, and rural electrification efforts. A steady linear increase in per capita energy consumption was evident from 2012 to 2019, followed by a decline in 2020 and 2021. This decrease is likely influenced by the shutdown of energy-intensive industries during the pandemic period.

Figure 6: ***Per Capita Energy Consumption growth from year 2012-2022***



Between 2012 and 2022, per capita energy consumption in the state increased significantly, rising from approximately 500 kWh to 900 kWh. This substantial growth of around 400 kWh reflects a period of considerable economic expansion, particularly evident in industrial and urban development.

Per capita energy consumption is a valuable indicator for assessing the pace of industrialization and urbanization within a region. The upward trend in energy use suggests a growing economy, greater access to energy-intensive services, and an increasing demand for electricity across various sectors.

4.5 Power Distribution

4.5.1 Institutional Structure and Area of Functioning

The distribution of electricity in Odisha is managed by four Distribution Companies (DISCOMs): Western Electricity Supply Company of Orissa Ltd. (WESCO), Northern Electricity Supply Company of Orissa Ltd. (NESCO), Southern Electricity Supply Company of Orissa Ltd. (SOUTHCO), and Central Electricity Supply Utility of Orissa (CESU). The overall mapping of these distribution companies along with their respective service areas is illustrated in Figure 7.

Figure 7: Distribution Companies and Their Control Areas in Odisha (Copyright)

4.5.2 Administrative Structure

The Orissa Electricity Reform Act of 1995 marked a significant milestone in the state's power sector by initiating a series of transformative changes. Odisha Power Generation Corporation Ltd. (OPGC), a joint venture between the Government of Odisha and AES Corporation of the United States, was established with the primary objective of augmenting power generation capacity in the state and enhancing its energy security. Enacted in 1995 and subsequently ratified by the President in 1996, this legislation paved the way for the restructuring of the Orissa State Electricity Board (OSEB), fundamentally altering its organizational structure. Under this reform, OSEB underwent a structural overhaul, resulting in the creation of separate entities responsible for electricity generation, transmission, and distribution. Notably, OSEB was bifurcated into GRIDCO (Grid Corporation of Odisha) and OHPC (Odisha Hydro Power Corporation), each entrusted with specific roles and responsibilities.

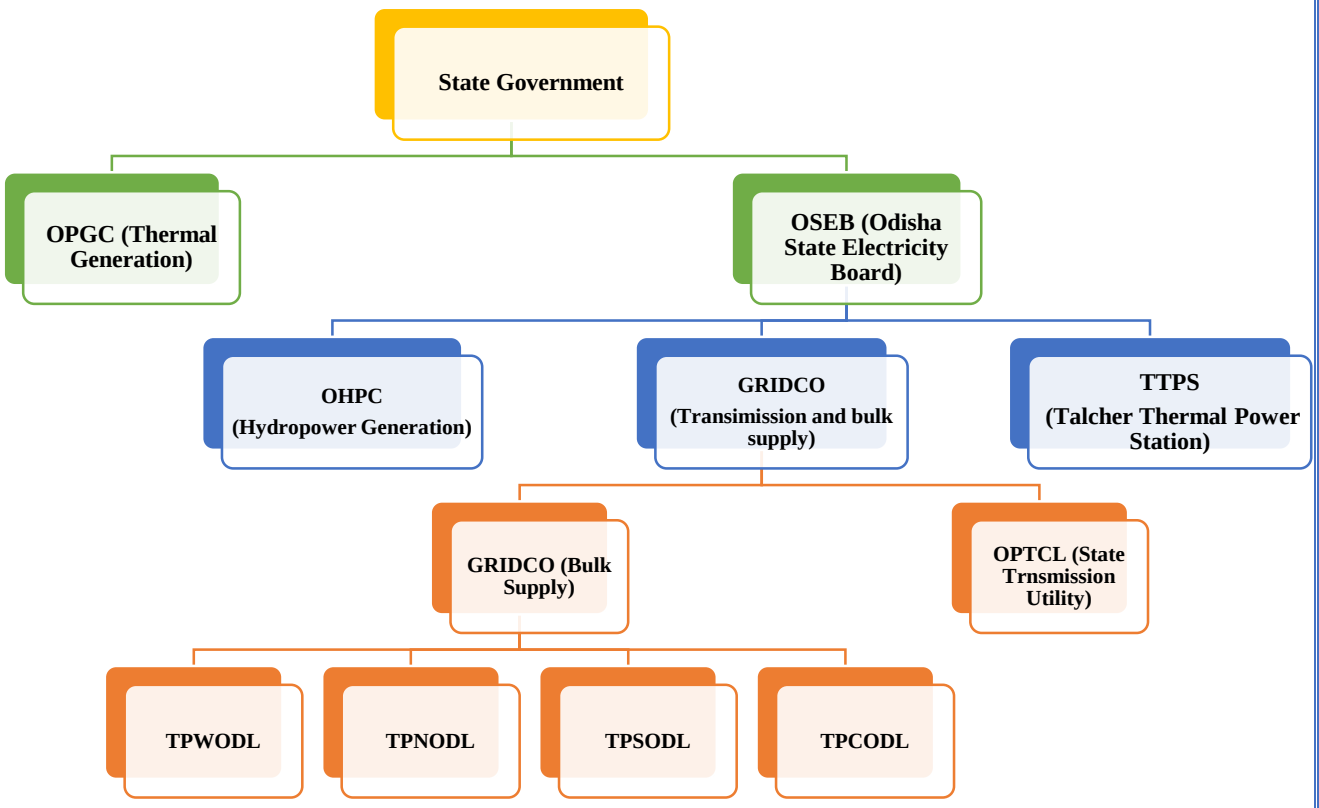
To improve operational efficiency and service delivery, distribution functions were decentralized. In 1997, GRIDCO decentralized its distribution operations, leading to the establishment of four regional distribution companies: WESCO (Western Electricity Supply Company of Odisha Limited), NESCO (North Eastern Electricity Supply Company of Odisha Limited), SOUTHCO (Southern Electricity Supply Company of Odisha Limited), and CESCO (Central Electricity Supply Company of Odisha Limited). This decentralization helped streamline power distribution across different regions of the state.

Continuing the trajectory of reform, in 2004, the transmission segment underwent a similar restructuring. This resulted in the separation of transmission, state transmission utility (STU), and state load dispatch centre (SLDC) functions from GRIDCO, leading to the formation of

Orissa Power Transmission Corporation Limited (OPTCL). OPTCL took on the vital role of ensuring the seamless transmission of electricity across the state, bolstering the reliability and efficiency of the power grid. Through these legislative and structural changes, the Orissa Electricity Reform Act of 1995 laid the foundation for a more dynamic and responsive electricity ecosystem in the state, fostering competition, innovation, and improved service standards.

As on 1 April 2021, the license of distribution in the CESU, WESCO, NESCO, and SOUTHCO was taken over by Tata Power and the DISCOMs are modified for different regions of the Odisha; Tata Power Central Odisha Distribution Limited (TPCODL); Tata Power Western Odisha Distribution Limited (TPWODL); Tata Power Northern Odisha Distribution Limited (TPNODL); Tata Power Southern Odisha Distribution Limited (TPSODL). The flow chart of the Odisha electricity regulation is shown in the Fig. 8.

Figure 8: ***Flow chart representation of the electricity regulation in Odisha State***



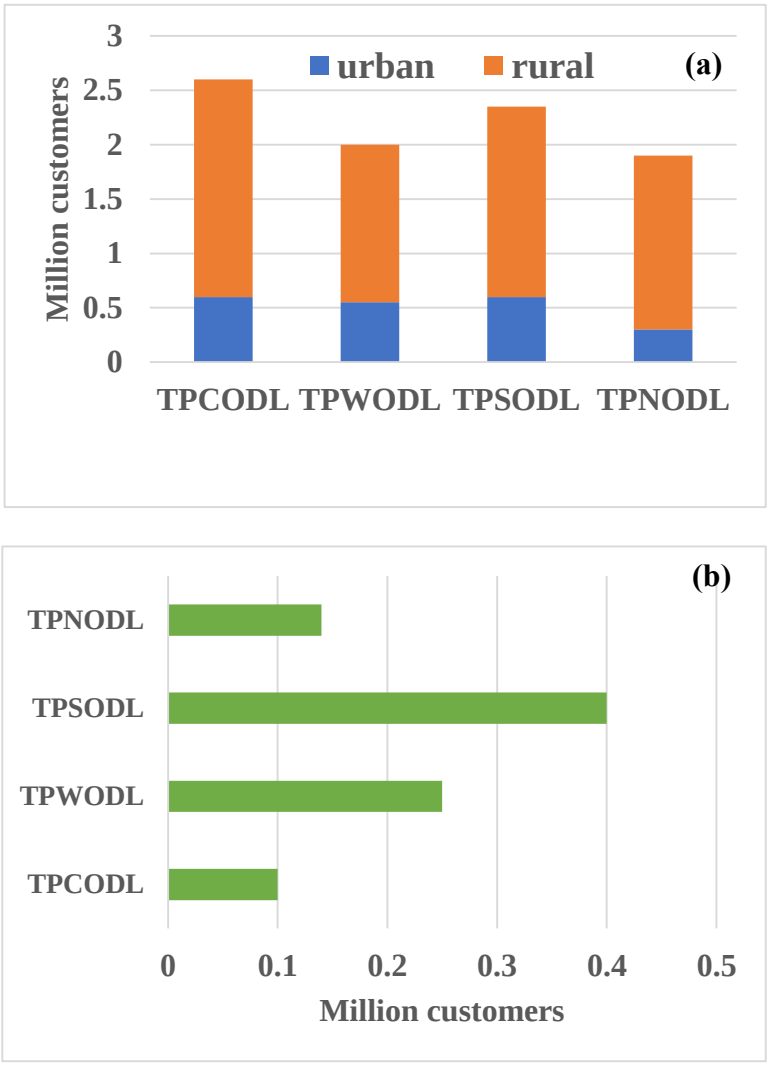
4.5.3 Four Distribution Areas

The different regions of Odisha comprise both urban and rural electricity consumers, distributed among the four distribution companies, as shown in Fig. 9(a). It was found that TPCODL has the highest number of consumers compared to the other DISCOMs. However, for each DISCOM, the proportion of rural consumers is relatively higher than that of urban consumers, as reflected in Fig. 9(a).

The number of consumers below the poverty line varies across the DISCOMs, as shown in Fig. 9(b). TPSODL has the highest number of consumers below the poverty line, whereas TPCODL

has the lowest. The disparity between the data in Figures 9(a) and 9(b) indicates that although TPCODL serves a large rural population, the share of consumers below the poverty line within its customer base is significantly lower compared to the other DISCOMs.

Figure 9: (a) Number of urban and rural customers served by each distribution company (Source: OERC, 2021; data from 2020). (b) Number of consumers below the poverty line for each distribution company.



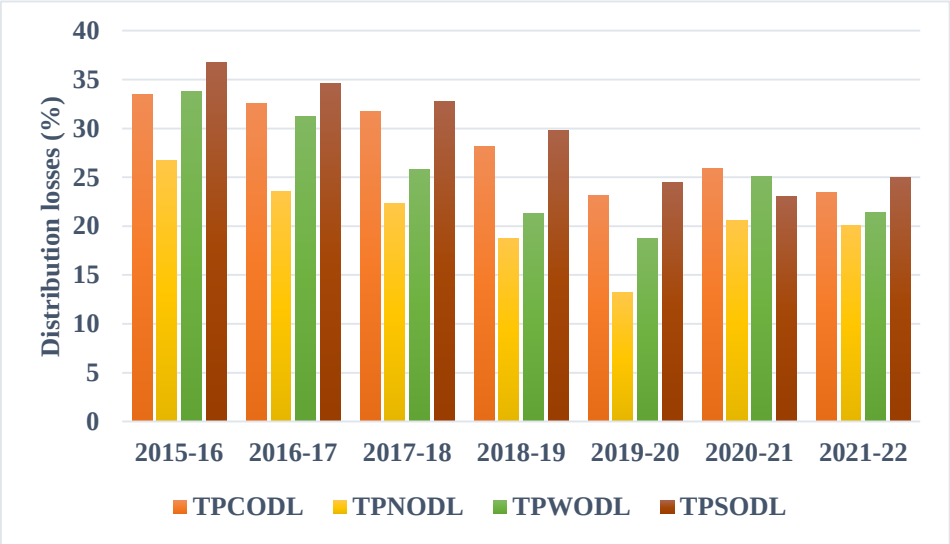
4.6 Distribution Losses

Electricity losses in Odisha present a significant challenge to the distribution sector. These losses hamper cost recovery, weaken the financial stability of distribution companies (DISCOMs), and discourage potential investments. Distribution losses typically refer to technical losses that occur from the point of generation to the end consumer. In contrast, Aggregate Technical and Commercial (AT&C) losses encompass not only technical inefficiencies but also losses due to electricity theft, billing inaccuracies, and nonpayment by consumers.

The year-wise distribution loss across the four DISCOMs is illustrated in Fig. 10. With advancements in technology and infrastructure, a declining trend in distribution losses has been

observed across all DISCOMs. Among them, TPNODL reported the lowest distribution loss, while TPSODL recorded the highest. In the year 2021–22, the variation in distribution loss among the DISCOMs was relatively small. TPNODL showed the minimum loss at around 20%, whereas TPSODL registered a maximum of approximately 25%, with the other two companies falling in between.

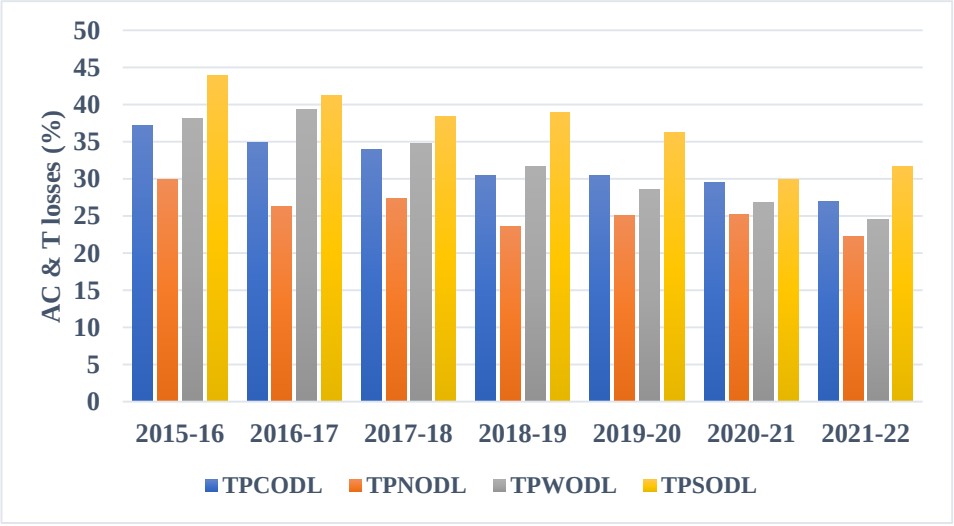
Figure 10: Historical Distribution losses in Odisha



Source: OERC (2021-22)

It is noteworthy that Fig. 9(b) shows TPSODL serves the largest number of below-poverty-line consumers, while Fig. 10 highlights its relatively high distribution loss. This may indicate that some consumers are using extra-heavy or inductive loads without proper disclosure to the DISCOM. Additionally, the persistence of older infrastructure—such as aging transformers, outdated distribution networks, and obsolete metering systems—could be a contributing factor to the high losses reported by TPSODL.

Figure 11: Historical AT&C losses in Odisha.



Source: OERC (2021-22)

Aggregate Technical and Commercial (AT&C) losses present a serious revenue challenge for distribution companies, restricting their capacity to upgrade infrastructure and extend electricity services. Reducing these losses requires focused efforts to enhance operational efficiency, enforce regulatory compliance, and encourage investments in modernization and technological upgrades.

Figure 11 illustrates the trend of AT&C losses from 2015–16 to 2021–22. During this period, TPSODL reduced its losses from 45% to 30%, while TPNODL brought its losses down from 30% to 22%—a notable improvement. Further reductions can be achieved through more accurate billing practices and comprehensive infrastructure improvements across the DISCOMs in Odisha.

4.7 Odisha's Energy Sector

The rapid expansion of agriculture, industry, and overall economic development depends heavily on the availability of reliable, high-quality, and affordable power. As a critical input in both production and consumption, the energy sector forms the backbone of any economy. It plays a vital role in nation-building and directly impacts environmental factors such as air and water quality, land use, forest resources, and climate protection, all while supporting a wide range of economic activities.

In Odisha, the energy mix is primarily dominated by thermal power, especially from coal-based sources, as discussed in the preceding section. The details of thermal and hydro power plants operating in the state are presented in Table 3.

Table 3: List of power plant of Odisha

S. No.	Name	System (authority)	Capacity (MW)
1	DARLIPALLI STPP Si-I	National Thermal Power Corporation Limited (NTPC)	1600
2	DEARANG	Jindal India Thermal Power Limited (JITPL)	1200
3	I.B. VALLEY	Odisha Power Generation Corporation Ltd. (OPGC)	1740
4	KAMALANGA	GMR Kamalanga Energy Limited	2100
5	STERITE TPP (VEDANTA)	Vedanta Limited - Jharsuguda	600
6	TALCHER STEP	NTPC	3000
7	BALIMELA	Odisha Hydro Power Corpn. (OHPC) Ltd.	510
8	HIRAKUND-I, II	(OHPC)	359.80
9	MACHKUND	Andhra Pradesh Power Generation Corporation Ltd (APGENCO)	114.75
10	RENGALI	OHPC	250
11	UPPAR INDRAVATI	OHPC	600
12	UPPER KOLAB	OHPC	320

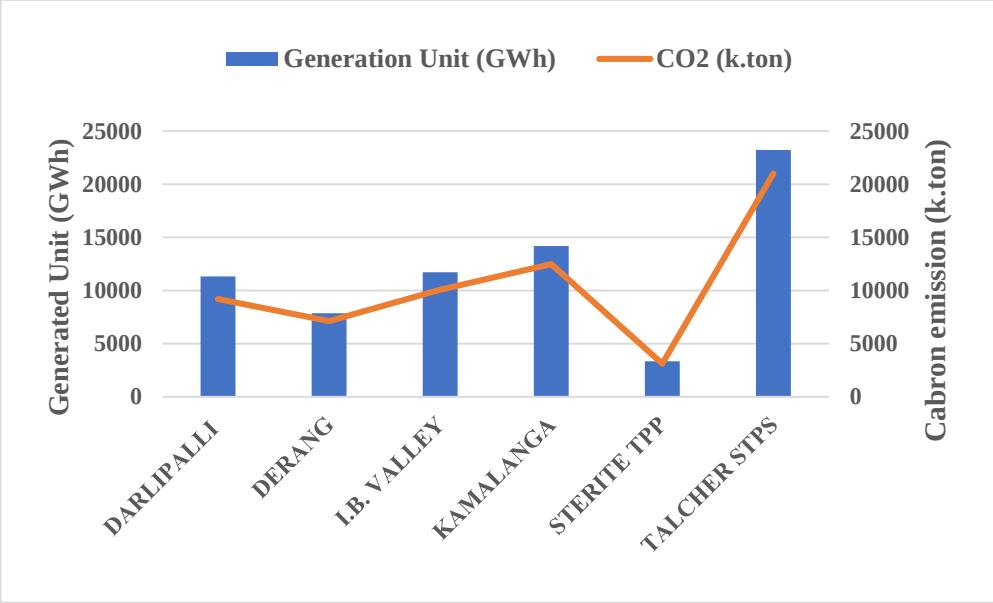
Source: CEA (2022-23)

The total power generation capacity of Odisha, combining thermal and hydro power plants, stands at 12,394.55 MW. In addition, the state has a solar photovoltaic (PV) generation capacity

of 451.24 MW and a biomass generation capacity of 59.22 MW. Major solar power installations have been developed by companies such as Aditya Birla Solar Ltd., Azure Power, CleanMax Solar, ReNew Power, Suzlon Energy Limited, Vikram Solar, and Welspun Energy Ltd. In contrast, biomass power plants are typically installed on a smaller scale by private agencies or individuals at the local level.

Thermal power plants dominate the state's power sector, accounting for around 70 percent of the total installed capacity. Owing to Odisha's rich coal reserves, most thermal plants are situated near coal mines, which helps ensure cost-effective electricity production. However, this reliance on thermal power significantly contributes to carbon dioxide emissions. The emissions from these plants are illustrated in Figure 12.

Figure 12: Thermal power plant power generation capacity and carbon emission



Source: CEA (2022-23)

The total carbon emissions from thermal power plants in Odisha amount to 52.88 million tons. According to data from NITI Aayog, electricity production across India contributes approximately 1,239,807 million tons of carbon emissions, accounting for nearly 52% of the country's total emissions. As per the Central Electricity Authority (CEA) report, Odisha ranks as the second-highest carbon-emitting state in India.

Ensuring the efficiency of thermal power plants is crucial from both economic and environmental perspectives. Given that coal is expected to continue playing a significant role in Odisha's power sector, it is essential to explore and implement decarbonization strategies to reduce the environmental impact.

5. Major Energy Policies

The energy sector in Odisha is set for significant growth, with an allocation of ₹4,352 crore dedicated to ensuring a reliable and high-quality power supply. This investment underscores

the government's commitment to strengthening electricity infrastructure and advancing renewable energy initiatives throughout the state.

- ❖ OERC revised regulation for the Renewable purchase obligation to enhance the Re deployment in the state. The major policies are tabulated in table 4

*Table 4: **Odisha state major policy***

S. No.	Scheme	Details	Agency
1	Odisha Renewable Energy Policy 2022	To increase the total RE share in Odisha energy mix by 47% by 2030, as per the RPO trajectory issued by the Ministry of Power.	Green Energy Development Corporation of Odisha Limited (GEDCOL) and Odisha Renewable Energy Development Agency (OREDA
2	OERC (Procurement of Energy from Renewable Sources and its Compliance) Regulations, 2021	Revised RPO targets from the solar and non-solar projects	OREDA
3	Biju Gram Jyoti Yojana, Biju Saharanchala Vidyutikaran Yojana	To electrify villages or habitations and electrification of un-electrified areas	District Collector's Office
4	OERC (Mini-Grid Renewable Energy Generation and Supply) Regulations, 2019	Facilitate the development and management of RE generation and supply through mini-grid projects.	OREDA

- ❖ The Biju Gram Jyoti Yojana, Deen Dayal Upadhyay Gramin Vidyutikaran Yojana, and Biju Saharanchal Vidyutkaran Yojana have received substantial funding of ₹50 crore, ₹56 crore, and ₹5 crore, respectively. These schemes focus on electrification projects in rural and underserved areas, aiming to enhance energy access and promote socio-economic development.
- ❖ The Odisha Renewable Energy Development Fund (₹67 crore) and Infrastructure Assistance to GEDCOL (₹41 crore) reflect the government's strong commitment to promoting renewable energy growth. These funds support the development of renewable energy projects and infrastructure, facilitating the transition towards cleaner energy sources. This includes initiatives such as mini and micro grids powered by renewable energy and the implementation of the Renewable Energy Cities (RE Cities) concept.
- ❖ To promote the development of renewable power projects—including Floating Solar, Rooftop Solar, and Wind Energy—an allocation of ₹250 crore has been made towards Viability Gap Funding (VGF). This financial support is designed to incentivize private investment in renewable energy infrastructure, thereby driving sustainable energy development in the state.
- ❖ Equity support of ₹110 crore has been allocated to OHPC Ltd. for the development of pump-storage projects, underscoring the government's focus on energy storage solutions

to improve grid stability and energy reliability. Additionally, ₹700 crore has been earmarked for the working capital of GRIDCO, the state-owned power transmission and distribution utility, to ensure operational efficiency and stability across the electricity supply chain.

5.1 Odisha's Readiness for the Energy Transition

At the 26th session of the Conference of the Parties (COP26) to the United Nations Framework Convention on Climate Change (UNFCCC) in Glasgow, the Government of India played a pivotal role in voicing the concerns and aspirations of developing countries on climate action. Amidst global discussions on climate change mitigation and adaptation, India presented a comprehensive framework detailing its commitments and targets for transitioning toward a low-carbon economy and a sustainable energy future.

India's climate action plan, articulated through five key elements known as the "Panchamrit" or "nectar," highlights the nation's ambitious yet pragmatic approach to tackling climate challenges:

1. *Aim to achieve 500GW of non-fossil energy capacity by 2030*
2. *Target to fulfil 50% of its energy needs through renewable sources by 2030*
3. *Commitment to reduce total projected carbon emissions by one billion tonnes by 2030*
4. *Pledge to decrease the carbon intensity of the economy by 45% by 2030 compared to 2005 levels*
5. *Ambition to attain net zero emissions by 2070*

The Odisha Renewable Energy Policy 2022-23 represents a strategic roadmap aimed at unlocking the full potential of renewable energy in the state. With a focus on fostering innovation, promoting investment, and facilitating a transition towards sustainable energy practices, the policy sets ambitious goals to drive socio-economic growth while safeguarding the environment.

Vision: *The overarching vision of the policy is to harness Odisha's renewable energy potential to ensure energy security, foster socio-economic development, and mitigate environmental impacts. By leveraging clean energy alternatives, the policy seeks to pave the way for a greener and more sustainable future for the state.*

Objectives: The policy outlines several key objectives to be achieved:

a) Accelerating Adoption of Clean Energy: One of the primary objectives is to expedite the adoption of clean energy alternatives and decarbonize the energy sector. This entails promoting the use of renewable energy sources for both grid-based electricity consumption and captive consumption by industrial consumers.

b) Harnessing Clean Energy Potential: The policy aims to capitalize on Odisha's abundant clean energy resources by facilitating the development of green energy projects across the state. By optimizing the utilization of available resources, the policy seeks to maximize the contribution of renewable energy to the overall energy mix.

c) Attracting Investment and Creating Job Opportunities: A key focus area is to attract investment in the clean energy sector, thereby stimulating economic growth and creating job opportunities. By fostering a conducive investment climate, the policy aims to catalyze the development of renewable energy infrastructure and ancillary industries.

d) Promoting Research and Development: The policy emphasizes the importance of research and development (R&D) in driving innovation and advancing emerging renewable energy technologies. By facilitating R&D initiatives and promoting collaboration between industry, academia, and research institutions, the policy seeks to spur technological innovation in the renewable energy sector.

e) Ambitious Capacity Addition Target: A significant milestone outlined in the policy is the target to add more than 10,000 megawatts (MW) of renewable energy capacity in Odisha by 2030. This ambitious target underscores the state's commitment to scaling up renewable energy deployment and reducing reliance on fossil fuels.

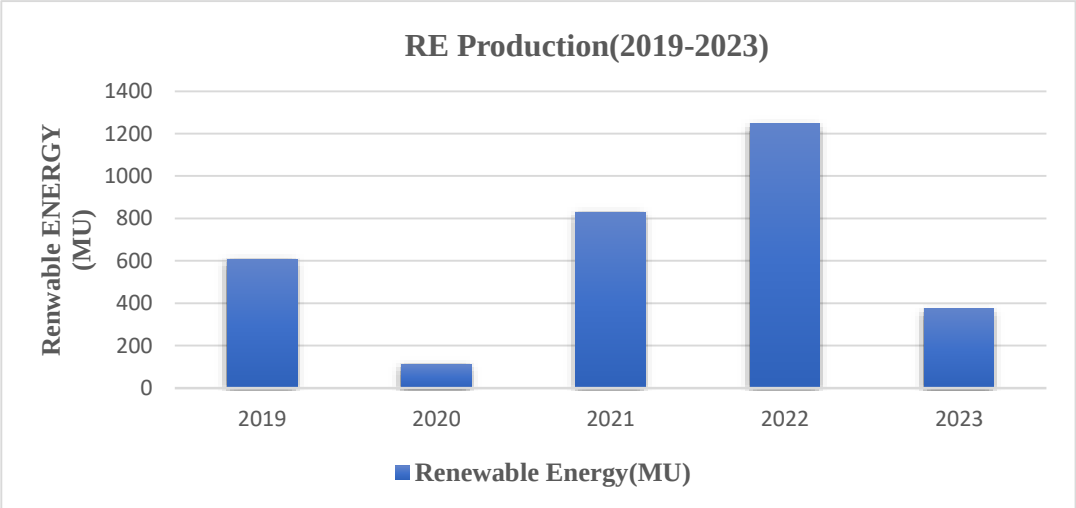
By articulating a clear vision, strategic objectives, and ambitious targets, the Odisha Renewable Energy Policy sets the stage for a paradigm shift towards sustainable energy practices in the state.

5.2 Steps Taken for Energy Transition

Several energy transition schemes initiated by the central and state governments are currently underway in Odisha, each with specific targets and deadlines for implementation. The state government is responsible for ensuring the effective execution of these schemes.

5.2.1 Promotion of Renewable Energy

Figure 13: Renewable Energy Production Trend



Source: CEA

Odisha has been actively promoting the adoption of renewable energy sources such as solar, wind, biomass, and hydroelectric power. This includes providing incentives for renewable energy projects, offering subsidies, and facilitating the establishment of renewable energy

generation units. A significant growth in the renewable energy (RE) sector has been observed since 2019, as depicted in Figure 5. The increase in RE production from 2019 to March 2023 is shown in Figure 13.

The dip in renewable energy production in 2020 was largely due to the impact of the COVID-19 pandemic across the country. With reduced electricity demand resulting from decreased economic activity, many power generation facilities—especially renewable ones—faced operational disruptions.

5.2.2 Renewable Energy Policy

The Odisha Renewable Energy Policy, 2022, provides a comprehensive framework to promote the development and adoption of renewable energy sources in the state. It addresses legal, operational, and environmental aspects while outlining clear targets, incentives, and regulatory mechanisms to accelerate the deployment of renewable energy technologies and attract investment in the sector.

The policy underscores the urgent need to decarbonize the energy sector and aligns with India's national commitments to reduce emissions intensity and increase electricity generation from non-fossil fuel sources. It seeks to harness Odisha's vast renewable energy potential, drive socio-economic development, and create an enabling environment for the optimal utilization of renewable energy.

Table 5:Revised RPO Targets (FY-2021-22)

Year	Solar	NON-SOLAR			Total RPO
		HPO	Other	Total	
2021-22	7.25%	0.18%	5.82%	6.00%	13.25%
2022-23	8.00%	0.35%	6.15%	6.50%	14.50%
2023-24	8.75%	0.66%	6.59%	7.25%	16.00%
2024-25	9.75%	1.08%	7.17%	8.25%	18.00%

Source: Annual Activity Report, 2021

The policy encompasses a wide range of renewable energy (RE) technologies, including solar, wind, biomass, hydro, and energy storage systems. It establishes a framework for the identification and allocation of RE projects through competitive bidding, allowing participation from both public and private sector entities. Incentives under the policy include exemptions from electricity duty, cross-subsidy surcharge, and stamp duty for RE projects. Additionally, the policy streamlines project approvals and clearances through a single-window facility to ease the implementation process.

Furthermore, the policy supports the development of green hydrogen and green ammonia projects and encourages innovation and capacity building within the RE sector. It promotes the use of green power by state government entities and integrates RE with electric vehicles and

their supporting infrastructure. The policy emphasizes the importance of grid-balancing assets, energy storage systems, and mini/micro grids. It also mandates a trajectory for Renewable Purchase Obligation (RPO) and Energy Storage Obligation (ESO), in line with the Ministry of Power's directives. To support these goals, the Government of Odisha has outlined specific RE generation targets for the state, as shown in Table 5.

The RPO targets are divided into two subcategories: solar and non-solar renewable energy power generation. The RPO trajectory will aid in the widespread dissemination of renewable energy across the state. The RPO compliance for the year 2021-22 is presented in Table 6.

Table 6: RPO Compliance for FY 2021-22

Category	Description	RPO Target (MU)	Plant Capacity	RPO Achieved (MU)
Solar	Land Based	**1521**	983	1526
	Rooftop		19	31
	Sub-Total		**1002**	**1557**
Non- Solar	HPO	7	18	7
	Small Hydro	1468	82	377
	Biomass		20	99
	Wind		322	907
	Sub-Total	**1475**	**442**	**1390**
Total		**2996**	**1444**	**2947**

Source: Annual Activity Report, 2021

5.3 Solar Power Projects Policies

The state government has been focusing on expanding solar power generation capacity through the development of solar parks, rooftop solar installations, and off-grid solar solutions. Initiatives such as the Odisha Solar Policy aim to promote the adoption of solar energy across various sectors.

5.3.1 Solar Park

A Solar Park is a designated area allocated for the development of solar power projects by state agencies or private sector entities. The policy aims to promote both utility-scale and distributed solar applications. To reduce generation costs and associated infrastructure expenses, solar parks with a minimum capacity of 25 MW or greater will be encouraged.

Developers of solar power parks are required to establish common infrastructure facilities such as power evacuation systems, roads, lighting, water supply, and administrative support. All projects will be developed under the Build-Own-Operate (BOO) model, with site awards granted for a 30-year period. According to the 2022-23 MNRE report, the sanctioned capacity of solar parks in Odisha is 40 MW.

5.3.2 Floating Solar PV plant

Odisha's vast water bodies and reservoirs provide ideal conditions for large-scale floating solar projects. The government aims to promote their development through this policy. The nodal agency, in coordination with the Department of Water Resources, will identify suitable sites for these projects. The Department will allow the development of floating solar plants on water

bodies under its control, offering nominal lease rents or upfront payments. Additionally, industries can establish floating solar plants to meet their energy requirements.

Floating solar projects offer benefits such as reducing evaporation by 2%, which enhances water availability for irrigation and hydropower. They also free up land that would otherwise be used for ground-mounted solar installations. According to the latest MNRE report for 2021-22, the total sanctioned capacity for floating solar parks in Odisha is 100 MW for Phase I and 200 MW for Phase II.

5.3.3 Canal top-solar

The provision for floating solar also applies to canal-top solar installations. This approach helps establish renewable energy power supply without occupying valuable agricultural land. Additionally, canal-top solar projects can reduce water evaporation and improve the efficiency of solar panels due to the cooling effect of water.

5.3.4 Non-Park Solar PV plant

The state encourages the establishment of non-park solar power projects with a minimum capacity of 1 MW. These projects will serve various purposes, including selling power to GRIDCO at tariffs determined through competitive bidding. Additionally, they will cater to captive usage within and outside the state, as well as facilitate power sales within and beyond the state through open access arrangements.

5.3.5 Roof-top Solar

The Government of Odisha continues to actively promote the installation of grid-connected rooftop solar PV projects on public buildings, domestic buildings, commercial, and industrial establishments. It maintains its commitment to encouraging all government buildings with available roof space to adopt rooftop solar facilities.

OREDA remains steadfast in its facilitation of rooftop PV development under net metering or gross metering, as applicable, on government buildings through the RESCO model. This ongoing policy reflects the state's sustained efforts towards promoting renewable energy adoption and sustainability. The RTS phase II solar PV installation up to march 2023 is 1.9 GW and the target for 2026 is to install 4 GW under this scheme.

5.3.6 Pradhan Mantri Kisan Urja Suraksha Evam Utahan Mahabhiyan (PM-KUSUM)

PM-KUSUM is a scheme initiated by the Government of India to support farmers in installing solar pumps and grid-connected solar power plants. The scheme has three components, namely PMKUSUM A, PMKUSUM B, and PMKUSUM C, each serving different purposes.

I. PMKUSUM A: This component focuses on promoting the installation of standalone solar pumps for irrigation purposes. Farmers in Odisha state can benefit from subsidies provided under PMKUSUM A to install solar pumps, reducing their dependence on diesel and electricity for irrigation. Under this scheme in the year 2020-21, 500 pumps have been installed in the state. 500 new pumps have been sanctioned under this scheme as per MNRE annual report 2022-23.

II. PMKUSUM B: PMKUSUM B aims to facilitate the establishment of grid-connected solar power plants on barren or cultivable land owned by farmers. By participating in PMKUSUM B, farmers in Odisha can generate additional income by selling surplus electricity to the grid. Under this scheme in the year 2020-21, 6000 pumps have been installed in the state. As per MNRE Annual Report 2022-23, 5741 pumps were sanctioned out of which 1138 have been installed.

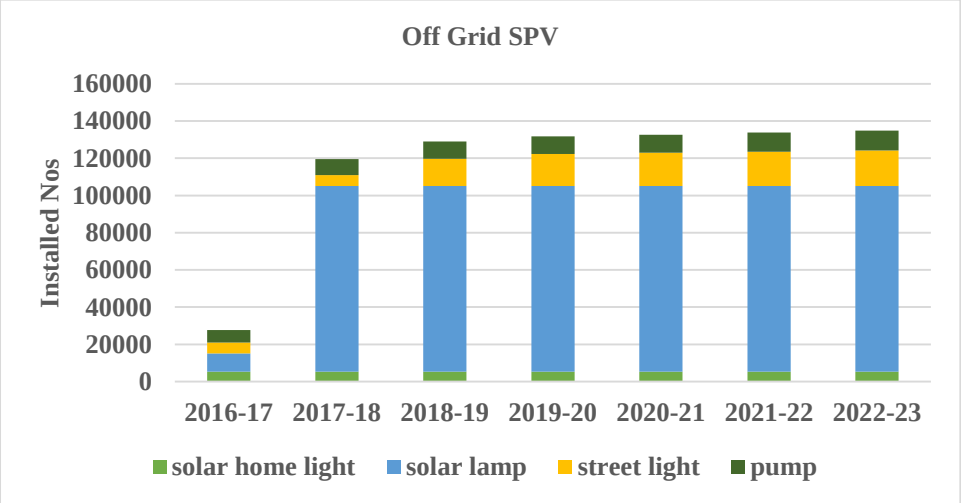
III. PMKUSUM C: PMKUSUM C targets the solarization of tube wells operated by DISCOMs (Distribution Companies). Under this component, DISCOMs in Odisha can solarize their existing tube wells, reducing their operational costs and dependence on conventional sources of energy. Odisha state nodal agency suggested feeder segregation. As per MNRE Annual Report 2022-23, 40000 pumps solar electrification was sanctioned out of which 10000 have been done successfully.

5.3.7 Off-grid Solar

Off-grid solar power plants are strategically installed in areas where grid electricity is unavailable or unreliable, primarily focusing on providing energy access to rural and remote regions. These installations mainly target institutions such as schools, hostels, police stations, hospitals, and panchayats to ensure they have a reliable power supply. To date, off-grid rooftop solar plants with a cumulative capacity of 7.71 MW have been installed, typically ranging from 0.5 kW to 30 kW per unit, as reported by OREDA.

In addition, the state government follows targets proposed by the MNRE for various off-grid applications such as home lights, solar lamps, street lights, and pumps. According to the MNRE report, the growth in off-grid solar PV installations for home lights, lamps, street lights, and pumps from 2016-17 to 2022-23 is shown in Fig. 14. A significant increase in solar lamp installations was observed between 2016-17 and 2017-18, driven by the Solar Lantern Mission initiated that year by IIT Bombay in collaboration with local agencies. Furthermore, the number of solar street lights installed in the state notably increased in 2018-19. Overall, all categories of off-grid solar installations have shown steady growth over the years.

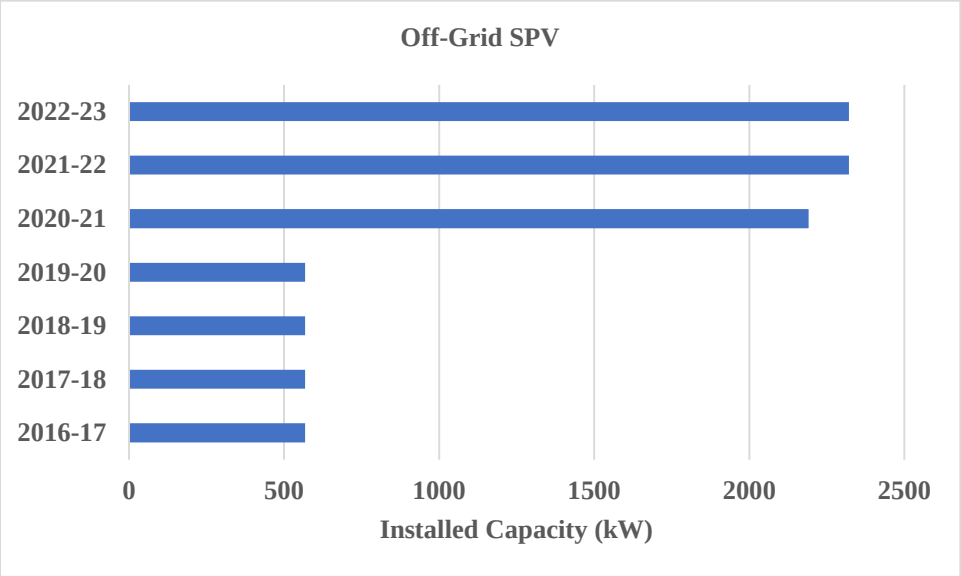
Figure 14: Off grid solar home light, lamp, street light and pump installation growth from 2016-17 to 2022-23



In Odisha, the installation of off-grid or decentralized solar photovoltaic (PV) plants has shown significant growth over the years. The data presented in Figure 15 highlights the year-on-year increase in off-grid solar PV capacity. For example, from 2016-17 to 2023, the capacity of off-grid solar PV plants rose from 567.15 kW to 2321.15 kW, representing a remarkable fourfold increase.

Despite this progress, the government's primary focus has shifted towards on-grid solar PV units, mainly due to the various challenges associated with standalone off-grid systems. Nevertheless, off-grid systems designed for specific applications such as street lighting, lamps, and pumps remain a priority for future implementation, reflecting ongoing efforts to promote decentralized and targeted solar energy use in Odisha.

Figure 15: Off grid solar PV plant installation growth from 2016-17 to 2022-23



5.3.8 Solar Based EV Charging Stations

This policy aims to reduce the carbon footprint associated with electric vehicles (EVs) by promoting access to affordable and environmentally friendly solar electricity for EV charging. The nodal agency, in coordination with OERC, OREDA, and DISCOMs, will develop appropriate mechanisms to facilitate the use of solar power for EV charging. These mechanisms may include integrating solar power with non-park solar and rooftop solar systems.

Solar installations for EV charging on government-owned land will be eligible for a 50% concession on land lease payments for the first 50 MW of installations under the non-park solar category throughout the policy period. The allocation of government land will be carried out in accordance with the guidelines specified in the relevant policy.

5.4 Wind Energy Development

The state has limited assessed potential for both offshore and onshore wind projects. However, this policy includes provisions to create an enabling environment for wind power developers to effectively harness the available wind energy resources. The objective is to facilitate the full development of wind-based energy projects.

This initiative is especially important in light of the recent Renewable Purchase Obligation (RPO) notification issued by the Ministry of Power, Government of India. The notification outlines a trajectory for Wind Power Obligation until 2029-30, indicating an expected increase in demand for wind-based energy solutions in the coming years.

Odisha, with its extensive coastline of approximately 450 kilometers, possesses significant wind energy potential estimated at 1,700 MW. However, wind power development has been slow due to the state's reliance on thermal power generation, supported by abundant coal reserves and existing thermal plants. Additionally, the average wind speed of 10.78 km/h is below the optimal range of 12–14 km/h required for efficient power generation, posing challenges for widespread wind farm installations.

Despite these limitations, the Odisha Renewable Energy Policy aims to create a conducive environment for wind power developers. Notably, the Damanjodi Wind Farm is the largest in the state, with an installed capacity of 99 MW. Recently, the Solar Energy Corporation of India (SECI) signed a power sale agreement with GRIDCO, Odisha's state-owned power distribution company, for 600 MW of wind power—marking a significant step forward in harnessing the state's wind energy resources.

5.5 Hydroelectric Power

5.5.1 Large Hydro Power Project

Odisha has an estimated large hydro potential of 3,314 MW. Currently, the state operates 2,099.80 MW of large hydro plants. Among these, six plants are managed by OHPC (Odisha Hydro Power Corporation), and one additional plant is operated jointly with Andhra Pradesh Power Generation Corporation (APGENCO), as detailed in Table 3.

Private developers, State Public Sector Undertakings (SPSUs), and Central Public Sector Undertakings (CPSUs) are eligible to participate in the bidding process, provided they meet the qualification criteria specified in the Request for Proposal (RfP) or Request for Qualification (RfQ). GRIDCO has the option to procure the entire saleable power from identified projects at tariffs determined by the Odisha Electricity Regulatory Commission (OERC) to fulfill the energy needs of Distribution Companies (DISCOMs). Additionally, GRIDCO may exercise the right of first refusal (ROFR) to procure up to 20% of the saleable power from projects allocated through competitive bidding.

5.5.2 Small Hydro Power Project

Small hydroelectric power plants typically have a capacity of less than 10 megawatts (MW) and are often constructed on rivers or streams with minimal environmental disruption. Larger hydroelectric projects, however, are viewed differently in terms of their renewable status due to significant environmental and social concerns. Odisha possesses considerable small hydro potential, much of which remains untapped for commercial use.

Private sector involvement is essential to unlocking this potential. Therefore, this policy aims to encourage extensive private participation in the development of Small Hydro Projects (SHPs) across the state. All projects will be developed under the Build-Own-Operate-Transfer (BOOT) model. In Odisha, most large hydroelectric power plants are undertaken by the Odisha Hydro Power Corporation (OHPC).

Since 2009, three Small Hydro Electric Projects (SHEPs) with a total installed capacity of 57 MW have been commissioned, supplying power to the State Grid. In the fiscal year 2019-20, these SHEPs exported around 299.657 million units (MU) of electricity to GRIDCO. Additionally, the 24 MW Lower Baitarani SHEP in Keonjhar district, commissioned in August 2020, is expected to contribute 100 MU of energy annually to the State Grid, increasing the total renewable energy capacity in the small hydro category to 81 MW. Construction is currently underway for two projects: the 18 MW Saptadhara in Malkangiri district and the 9 MW Bargarh Head Regulator in Bargarh district.

According to the latest MNRE report for 2022-23, Odisha has the potential for 220 small hydro power (SHP) plants capable of generating up to 286.22 MW of electricity. As of 2021-22, the installed capacity stood at 106.63 MW across 12 SHP plants, which has since increased to 115.63 MW with the addition of one more plant. Looking ahead, three new SHP plants with a combined capacity of 56.5 MW are expected to be sanctioned in the coming year.

5.5.3 Pumped Hydro-storage

The State aims to achieve a minimum of 43% renewable energy in its energy mix by 2030, in accordance with the Renewable Purchase Obligation (RPO) trajectory set by the Ministry of Power on July 22, 2022. All obligated entities are required to meet or exceed this target. As the share of renewable energy increases, challenges related to intermittency may arise, potentially affecting grid stability. To ensure a consistent and reliable power supply for consumers, the implementation of large-scale energy storage solutions becomes essential. Pumped Storage Hydro (PSH) plants are identified as key to addressing these challenges in the coming years.

Recognizing this, there is a strong need to promote the development of PSH projects, including off-the-river closed-loop pumped storage systems, within the State. These initiatives will not only enhance grid stability but also support the effective integration of renewable energy sources into the power system.

5.6 Biomass

Biomass energy, which is abundantly available in nature, holds significant potential to replace conventional fuels for energy generation if harnessed effectively. In Odisha, biogas—produced from organic materials such as cattle dung, farm biomass, agricultural residue, and municipal waste—presents a promising opportunity. This policy seeks to promote biomass-based energy generation, including biogas, bio-CNG, bio-manure, and biofuels, to support the development of bio-energy projects across the state. A transparent and competitive bidding process will be conducted by the Nodal Agency or an appointed bid coordinator, allowing participation from private developers, state public sector undertakings (SPSUs), and central public sector undertakings (CPSUs), subject to meeting defined qualification criteria.

GRIDCO may choose to procure the entire saleable power from selected projects to meet the energy requirements of DISCOMs through a tariff-based competitive bidding process, where bids are invited for a discount on the Generic Tariff. To ensure a reliable supply of feedstock, waste and fallow land will be allocated at suitable locations for establishing energy plantations, with the goal of meeting up to 20% of the annual biomass fuel demand. As of March 2022, the cumulative number of biogas plants established in the state stands at 271,752.

5.7 Waste to energy

This policy seeks to promote the utilization of biodegradable waste for electricity generation by facilitating the development of waste-to-energy projects across the state. Urban Local Bodies (ULBs) will be responsible for identifying suitable sites for setting up these facilities, after which the Nodal Agency will publish a list of the identified locations. Interested developers may prepare Detailed Project Reports (DPRs) based on these sites and approach the Nodal Agency for project development. Alternatively, developers may independently identify potential project opportunities, conduct feasibility studies, and submit DPRs to the Nodal Agency for evaluation and approval.

Once a waste-to-energy plant is established, GRIDCO will procure 100% of the electricity generated, in accordance with the National Tariff Policy, 2016, at a tariff determined by the Odisha Electricity Regulatory Commission (OERC). Developers are required to coordinate with GRIDCO and enter into Power Purchase Agreements (PPAs) to ensure the sale and off-take of power generated from their projects.

5.8 Green Hydrogen and Green Ammonia

The State Government recognizes the crucial role of Green Hydrogen and Green Ammonia in driving the energy transition. Plans are in progress to develop dedicated Green Hydrogen/Green Ammonia hubs to serve various sectors, including petrochemicals, fertilizers, steel, long-haul transport, city gas distribution, and exports. Incentives and concessions for such projects will be aligned with the guidelines of the National Policy. Additionally, GRIDCO and DISCOMs will supply renewable energy (RE) for Green Hydrogen production at a cost-plus-margin rate, as determined by the Odisha Electricity Regulatory Commission (OERC). To support this emerging sector, a separate state-level policy will be formulated to create a comprehensive ecosystem for Green Hydrogen and Green Ammonia, while interim incentives will be extended under the existing Industrial Policy Resolution until the new policy is enacted.

In terms of energy banking, open access and captive consumers within the state will be permitted to bank energy on a monthly basis, subject to regulatory provisions issued by the OERC. However, the withdrawal of banked energy will not be allowed during DISCOM peak hours. The applicable banking charges for all open access and captive consumers will be determined by the OERC. Specific banking charges for energy used in Green Hydrogen and Green Ammonia production will be established in accordance with the National Green Hydrogen Policy.

5.9 State Energy Efficiency Action Plan

The state government has been promoting energy efficiency and conservation measures to reduce energy consumption and carbon emissions. This includes initiatives such as energy audits, adoption of energy-efficient appliances, and awareness campaigns. Overall, 29 department and agencies are engaged in this plan.

5.9.1 Perform, Achieve, and Trade (PAT) Scheme:

Implemented by the Bureau of Energy Efficiency (BEE), this scheme targets energy-intensive industries and sets energy consumption reduction targets. Industries achieving energy savings beyond their targets can sell Energy Savings Certificates to those unable to meet their targets.

5.9.2 Energy Conservation Building Code (ECBC):

This code sets energy efficiency standards for buildings and promotes the adoption of energy-efficient practices in the construction sector.

5.9.3 Standards & Labelling Program:

This initiative focuses on enhancing the energy efficiency of appliances and equipment by establishing and implementing energy performance standards and labelling requirements.

5.9.4 National Mission for Enhanced Energy Efficiency (NMEEE):

This mission aims to promote energy efficiency and reduce energy consumption across various sectors through initiatives such as the Perform, Achieve, and Trade (PAT) scheme, market transformation for energy efficiency, and financing mechanisms.

5.9.5 UJALA (Unnat Jyoti by Affordable LEDs for All):

This program distributes energy-efficient LED bulbs at subsidized rates to encourage the adoption of energy-efficient lighting solutions.

5.10 Research and Development

The state government has been encouraging research and development (R&D) activities in the field of renewable energy and clean technologies.

5.10.1 R&D activity and pilot projects

The Nodal Agency (NA) will actively promote pilot projects, innovations, and research and development (R&D) activities aimed at advancing new Renewable Energy (RE) technologies and green microgrids for research and demonstration purposes. It will actively solicit innovative ideas and proposals from individuals, educational institutions, and corporate entities to accelerate the adoption of RE.

Additionally, the NA will establish a Project Screening Committee (PSC) with the following responsibilities: approving proposals and providing single-window clearance for prompt implementation, deciding on partial or full funding for innovative projects/R&D initiatives on a case-by-case basis, and approving the allocation of land and/or water bodies at concessional lease rates after due consultations and proper due diligence with concerned departments. All departments, district collectors, and state government entities are required to adhere to the

approvals and decisions made by the PSC in a timely manner. Any issues that arise will be brought to the attention of the Single Window Committee. On-grid RE projects utilizing innovative or new technologies may be eligible for Viability Gap Funding (VGF) from the RE Fund, provided on a case-by-case basis.

5.10.2 Renewable Energy Research Institute

The Department of Energy, Government of Odisha, will initiate and establish a Renewable Energy (RE) Research Institute in collaboration with international development agencies, national and international research/academic institutes, central and state government-owned Public Sector Undertakings (PSUs), and industry partners. This institute aims to foster research and innovation in both new and existing RE technologies. Key functions of the RE Research Institute include conducting basic and applied research to develop RE technologies, nurturing scientific talent within the state, and providing a platform for close stakeholder interactions.

It will also focus on research activities in emerging RE technologies such as biofuel, biogas, ethanol blending, geothermal, tidal, and other oceanic energies, as well as energy storage, efficiency, conservation, and carbon capture & sequestration. Collaborations with national and international institutions for scientific study of power markets, joint research initiatives with industries, and providing technical advice and consultancy services to government entities and industries will be facilitated.

The institute will conduct regular studies on the usage of Green Hydrogen and explore its technoeconomic viability for energy storage, mobility, and industrial applications in Odisha, engaging with national and international agencies to support research efforts and develop a commercial roadmap for Green Hydrogen utilization. Additionally, the institute will perform resource assessments for all technologies, assist industries in their energy transition, identify opportunities for monetizing research work, and design courses focusing on RE component manufacturing, installation, and operation & maintenance (O&M) in various educational institutions.

The Department of Energy, Government of Odisha, will administer the institute and establish detailed operational guidelines. It may allocate a portion of the RE fund to sponsor the RE Research Institute, with the state government providing grants to cover any revenue shortfalls from research monetization and sponsorship activities.

5.11 Empowering Workforce for a 'Just Transition'

The State Government is actively encouraging institutions such as ITIs, Diploma Institutes, Engineering Colleges, and Skill Development Centers to enhance their training offerings in the field of Renewable Energy (RE). These institutions are encouraged to design courses and provide training on various aspects of RE, including component manufacturing, project development, and operation & maintenance (O&M). The aim is to bridge the existing skill gap and cultivate a workforce that is better equipped for employment opportunities in the renewable energy sector.

Funding support for such training programs at ITIs and Skill Development Centers will be evaluated by the State Government on a case-by-case basis. Additionally, the government plans

to introduce specialized courses in these institutions focusing specifically on RE component manufacturing, installation, and O&M. These courses will provide students with specialized knowledge and skills in design, development, and operation of RE projects, thereby enhancing their employability and contributing to the growth of the renewable energy sector.

5.12 Round the clock RE Power Generation

As we move towards a shift from coal-based energy to cleaner alternatives, Round the Clock Renewable Energy (RE-RTC) will emerge as a crucial component in our energy landscape in the years to come. The State Government may contemplate offering special incentives for these projects on a case-by-case basis, particularly for fulfilling the demand of Distribution Companies (DISCOMs). When allocating identified projects, preference will be given to the development of Hybrid-RE projects, combining sources such as solar or floating solar with Pumped Storage Hydro (PSH), as well as solar with wind or any other RE technology. These projects will receive priority in terms of land or water body allocation and the establishment of State Transmission Utility (STU) connectivity.

In order to mitigate the fluctuations in Renewable Energy (RE) power injected into the grid, the State will actively encourage the development of RE Power Projects equipped with storage systems. Additionally, the promotion of RE projects integrated with storage systems (battery or any other direct/indirect storage) will extend to both captive consumption and third-party sale purposes.

6. OTHER INITIATIVES

6.1 Blending of Biomass Briquettes and Pellets with coal shall account for meeting other RPO

OERC, through a consultative process and guided by technical studies, will mandate the blending of 5-7% biomass briquettes and pellets in coal-based thermal generating stations. This directive aligns with the Ministry of Power Policy on Biomass utilization dated October 8, 2021, and any subsequent revisions. The quantity of biomass blending will correspond to fulfilling the Renewable Purchase Obligation (RPO) of captive generators through blending. Consequently, GRIDCO or DISCOMs will be considered to have fulfilled their RPO obligation to the extent of blending. This measure enables obligated entities to partially fulfill their RPO requirements while utilizing existing thermal capacities.

6.2 Integrated Power Development Scheme (IPDS)

The Integrated Power Development Scheme (IPDS) in Odisha is a comprehensive endeavor aimed at modernizing and fortifying the power distribution infrastructure across the state. It encompasses initiatives such as the augmentation of sub-transmission and distribution networks, installation of smart meters for accurate billing, and the implementation of IT-enabled systems for efficient management of electricity distribution. The overall details of the targets are given in the table 7.

Table 7: Under the IPDS scheme targets

Sl No.	Details	Executed Quantity
1	New 33 kV line (ckm)	236
2	New 33/ 11 kV sub-station (No)	14
3	New 1 1 kV lines (ckm)	517
4	New 1 1/0.433 KVA (Kilovolt Ampere) DTR (No)	1,983
5	New LT line with AB cable (clan)	3,405
6	Augmentation of 1 1/0.433 KVA DTR (No)	1,006
7	Augmentation/ R & M of 33 kV line (ckm)	210
8	Augmentation/ R & M of 11 kV line (ckm)	784
9	R & M of existing 33/ 1 1 kV sub-station (No)	166
10	New 33 kV Bay (No)	18
11	New II kV Bay (No)	47
12	33 kV UG cable (ckm)	17.6
13	Roof Top Solar (No)	67
14	Metering (I Phase)	3,09,826
15	Metering (3 Phase)	7,592
16	Modem	54,973

Through these quality measures, the scheme aims to enhance the efficiency, reliability, and quality of power supply to consumers while also reducing technical losses and improving overall system performance.

Moreover, the IPDS scheme in Odisha prioritizes consumer-centric initiatives, including grievance redressal mechanisms, public awareness campaigns on energy conservation, and the promotion of renewable energy sources. By focusing on the needs and interests of consumers, the scheme aims to enhance customer satisfaction and foster sustainable energy practices across the state.

6.3 Pradhan Mantri Sahaj Har Ghar Bijli Yojana (SAUBHAGYA)

Saubhagya scheme launched in October 2017, the objective of the scheme is to provide electrification to all rural households, encompassing Low Tension (LT) infrastructure up to 440 volts supplied under normal conditions, including Distribution Transformer (DTR), Poles, and free electricity connections. A total of Rs. 524 crores were sanctioned for electrifying 10.87 lakh households, while an additional Rs. 508 crores were allocated for enhancing infrastructure for Saubhagya households. The overall completion cost amounted to Rs. 883 crore, with contributions from the Government of India (Rs. 497 crore) and the Government of Odisha (Rs. 386 crore).

By December 2018, a significant progress was achieved, with 9.44 lakh households electrified through the grid, and an additional 0.14 lakh households electrified through off-grid solar solutions. Furthermore, the initiative led to the installation of 10,943 Distribution Transformers (DTRs), laying of 8,524 circuit kilometers (ckm) of LT lines, and 2,181 ckm of 11KV lines.

Overall, by December 2018, a total of 24.12 lakh households were connected under various electrification schemes.

6.4 MO BIDYUT

The scheme encompasses both urban and rural electrification efforts aimed at providing electricity to previously unelectrified areas or households. Taking proactive steps, the state government launched an online portal for scheme applications, inaugurated by the Honourable Chief Minister in October 2020. In that year alone, over 200,000 applications were received, resulting in the provision of 130,000 active connections within a year. More than 5600 consumers grievance is also addressed by the portal.

6.5 BHUBNESHWAR RE City Programme

The nodal agency proposed to designate Bhubaneshwar as a Renewable Energy (RE) city, seeking technical assistance from the German agency GIZ. Upon analysis, it was revealed that Bhubaneshwar's peak demand reached 300 MW, while the city currently hosts a 12 MW rooftop solar plant. This program aims to address the entirety of Bhubaneshwar's energy requirements through renewable sources, complemented by additional storage capacity to meet peak demands effectively.

7. Challenges in Energy Transition

7.1 Energy surplus state Odisha and RE mix ratio in electricity generation

Odisha, known for its rich reserves of coal and a strong network of thermal power plants, has traditionally maintained the status of an energy-surplus state. Its robust energy infrastructure has enabled consistent power generation to meet industrial and domestic demands. However, in alignment with national and global climate action goals to reduce carbon emissions, Odisha is now actively integrating renewable energy sources into its existing energy mix. This shift represents not just a transition, but a strategic transformation towards a cleaner, more sustainable, and resilient energy future that balances economic growth with environmental responsibility.

Despite this positive shift, the state’s dependence on thermal power remains high due to the presence of several energy-intensive industries. The increasing addition of renewable energy (RE) to the grid is exerting additional pressure on the electricity authorities, particularly in terms of managing generation, distribution, and grid stability. With Odisha already being a power-surplus state, the inclusion of more RE capacity further amplifies the available surplus power, presenting challenges related to optimal dispatch and efficient utilization of the total energy generated.

7.2 Categorization of RPOs

To enhance the penetration of renewable energy generation and improve Renewable Purchase Obligation (RPO) compliance in Odisha, it is essential to address the prevailing challenges.

Although the state has relatively modest RPO targets, DISCOMs continue to face difficulties in meeting them.

One of the key challenges is the categorization of RPO targets into separate components for solar and wind energy. This segmentation complicates compliance efforts for DISCOMs, particularly in a state like Odisha where the availability and development of specific renewable resources may be uneven.

7.3 Old Captive Power Plant and Carbon Emission

The government's restrictions on the establishment of new thermal captive power plants (CPPs) present a significant challenge in Odisha, where industries with high energy demands rely heavily on existing infrastructure. Despite the elevated carbon emissions from older thermal plants, energy-intensive industries are often compelled to depend on them due to the limited availability of viable alternatives.

This situation is further complicated by regulations prohibiting the development of new thermal plants, thereby restricting the state's ability to modernize its energy infrastructure. As a result, Odisha must navigate the complex task of balancing industrial energy needs with environmental sustainability. To address this, the modernization or replacement of existing CPPs should be prioritized based on their carbon emission levels, enabling a gradual transition to cleaner energy while safeguarding energy security and supporting continued economic growth.

7.4 Land Availability

Land availability poses a significant challenge to Odisha's efforts to expand its renewable energy (RE) capacity. According to the Odisha Economic Survey 2018–19, over 70% of the state's land is designated for forest and agricultural use, leaving limited flat terrain suitable for the installation of solar power plants.

This constraint underscores the need to explore alternative solutions such as canal-based and floating solar photovoltaic (PV) plants. Adopting such innovative approaches can help optimize land use, reduce potential conflicts over land allocation, and accelerate the development of renewable energy infrastructure—paving the way for a cleaner and more sustainable energy future in Odisha.

7.5 Not Mature RE technology

The government's reluctance to actively pursue renewable energy (RE) options in Odisha stems from a combination of factors, including the availability of surplus power from conventional sources and concerns regarding the maturity of RE technologies. The absence of well-established and proven renewable technologies, along with frequently changing policies for RE deployment, has created uncertainty, discouraging large-scale adoption in the state.

Additionally, technical challenges such as performance variability, intermittency, and the inability of current RE systems to meet peak demand consistently further hinder confidence in

renewable energy solutions. This complex scenario poses a significant barrier to Odisha's transition toward a more sustainable energy future. Addressing these concerns will require a stable policy framework, continued technological advancements, and strategic planning to ensure the reliable integration of RE into the state's energy mix.

7.6 Reliability of DISCOMs

The expanding energy mix and the integration of renewable energy (RE) into the grid have significant implications for the reliability of DISCOMs in Odisha. Disparities between distribution losses and aggregated technical and commercial losses among the state's DISCOMs highlight a persistent lack of efficiency and reliability in power distribution. These inefficiencies undermine the overall performance of the electricity sector and hinder progress toward achieving Odisha's energy transition goals.

To address these challenges, it is essential to strengthen the operational efficiency of DISCOMs through targeted infrastructure upgrades, improved grid management, and enhanced accountability mechanisms. By optimizing distribution networks and reducing losses, Odisha can ensure a more stable and resilient electricity supply, capable of supporting both current demands and future growth driven by renewable energy integration.

7.7 Green Job Opportunity & Employment of Unskilled Labour

Odisha's strong dependence on coal mining and conventional thermal power plants has deeply rooted the livelihoods of many workers in these sectors. While upskilling and transitioning educated workers to green jobs is a viable approach, the situation of unskilled and underprivileged workers—particularly from older generations—poses a significant challenge in the state's shift towards renewable energy (RE). The limited availability of alternative employment opportunities further intensifies their vulnerability during this transition.

To ensure a just and equitable energy transition, Odisha must adopt comprehensive strategies that go beyond reskilling. This includes developing inclusive employment pathways, offering targeted social support programs, and fostering community-based initiatives aimed at socio-economic empowerment. Such measures are essential to protect the interests of marginalized workers and ensure that the transition to a sustainable energy future does not leave anyone behind.

8. Recommendations

- **Expansion of Solar Energy Usage:** Recognizing the current energy mix of the state, there is a pressing need to enhance the utilization of solar energy for electricity production in the form of floating solar and canal solar plants.
- **Reduction of AT&C Cost:** Implementation of smart meters and the improvement of DISCOMs through privatization and granting them autonomy can lead to a reduction in Aggregate Technical and Commercial (AT&C) losses, thereby curbing electricity misuse.

- **Avoidance of Over-Reliance on Freebies:** Over-dependence on freebies such as free electricity should be minimized to encourage responsible consumption habits among consumers.
- **Small Hydropower Expansion and Pumped Hydro Storage:** Given the already developed state of Odisha's hydropower sector, further installation of large dams raises concerns such as tribal displacement and environmental degradation, including the emission of methane, a potent greenhouse gas. However, the expansion of small hydropower projects can contribute to clean energy production, while pumped hydro storage holds immense potential for meeting peak demand effectively.
- **Incentivizing Shift to Renewable Energy:** Priority sectors such as domestic, commercial, public lighting, agriculture, and irrigation should be incentivized to transition to renewable energy sources, particularly solar energy, to stimulate demand, reduce costs, and expand the market.
- **Removing the Categorization of RPO:** Given the comparable costs of solar and wind energy technologies, the categorization of Renewable Purchase Obligations (RPO) should be removed. Instead, a long-term RPO trajectory should be prescribed to encourage DISCOMs to enter into future Power Purchase Agreements (PPAs) aligned with RPO targets. This approach aims to foster a transparent electricity market and facilitate Odisha's transition towards a less carbon-intensive energy system.
- **Efforts to Improve DISCOMs' Reliability:** This includes investing in infrastructure upgrades, grid modernization, and adopting advanced technologies such as smart grids and automated distribution systems. Additionally, initiatives to reduce transmission and distribution losses, improve maintenance practices, and enhance outage management systems contribute significantly to improving reliability.
- **Inducement of Industries:** Industries involved in renewable energy production and generation should be encouraged through tax rebates to promote investment and development within the sector.
- **Focus on Skilled Manpower:** Odisha faces a shortage of skilled personnel trained in renewable energy technology installation and operations. The government should prioritize skill development initiatives, including programs to retrain and upgrade semi-skilled technicians and service providers, particularly in remote areas.
- **Implementation of Climate Budget:** Odisha's Climate Budget for 2020-21, based on a climate impact appraisal framework, is commendable as the first state to introduce a dedicated budget for climate change. However, it should include monitoring and verification indicators to track progress on priority actions, thereby enhancing transparency and boosting investor confidence.

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