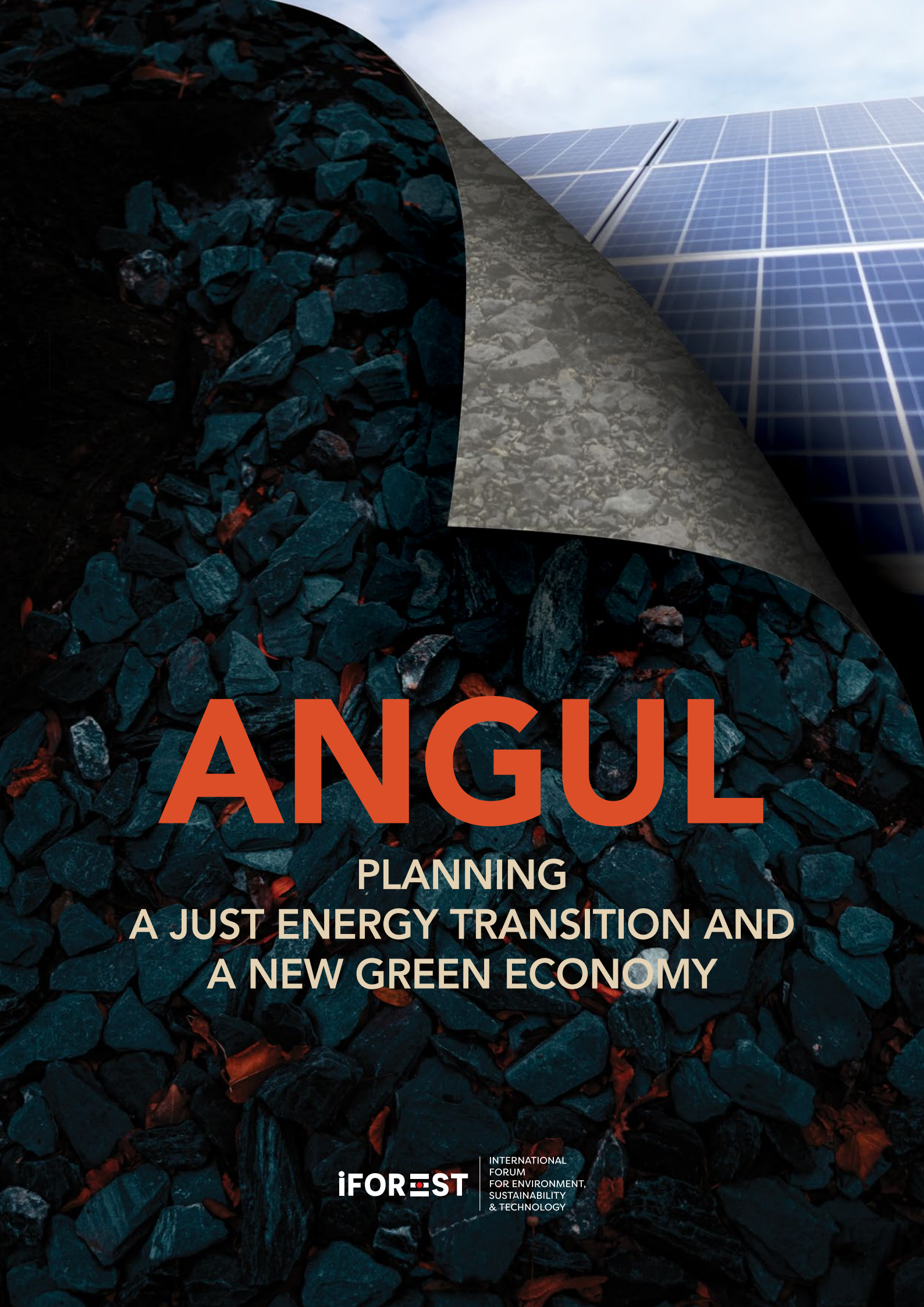

ANGUL

PLANNING A JUST ENERGY TRANSITION AND A NEW GREEN ECONOMY

iFOREST
INTERNATIONAL FORUM FOR ENVIRONMENT, SUSTAINABILITY & TECHNOLOGY

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& TECHNOLOGY

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List of abbreviations

AAY	Annapurna Antayodaya Yojana
APC	Agriculture Production Cluster
AUM	Asset Under Management
BAT	Best Available Technology
BAU	Business-as-Usual
BCM	Billion Cubic Metre
BESS	Battery Energy Storage Systems
BF	Blast Furnace
BOF	Basic Oxygen Furnace
BPL	Below Poverty Line
BSKY	Biju Swasthya Kalyan Yojana
BKKY	Biju Krushak Kalyan Yojana
CDQ	Coke Dry Quenching
CEA	Central Electricity Authority
CEPI	Comprehensive Environmental Pollution Index
CF	Community Forest (rights)
CFR	Community Forest Resource (rights)
CGST	Central Goods and Services Tax
CGWB	Central Ground Water Board
CHC	Community Health Centre
CIL	Coal India Limited
COP	Conference of Parties
CPA	Critically Polluted Area
CPCB	Central Pollution Control Board
CPS	Current Policy Scenario
CSO	Civil Society Organisation
CSR	Corporate Social Responsibility
CUF	Capacity Utilization Factor
DDT	Dividend Distribution Tax
DFI	Development Finance Institution
DLC	District Level Committee
DMF	District Mineral Foundation
DRI	Direct Reduction Iron
DST	Department of Science and Technology
EAF	Electric Arc Furnace
EC	Environmental Clearance
EMIL	Essel Mining and Industries Limited
EPF	Employees' Provident Fund
ESP	Electrostatic Precipitators
EV	Electric Vehicles
FGD	Focus Group Discussion
FPO	Farmer Producer Organisation
FRA	Forest Rights Act
GCV	Gross Calorific Value
GDP	Gross Domestic Product
GER	Gross Enrolment Ratio
GEDCOL	Green Energy Development Corporation of Odisha Limited
GHG	Greenhouse Gas
GoI	Government of India
GST	Goods and Services Tax
GW	Giga Watt
GWh	Gigawatt hours
HP	Horse Power
ICDS	Integrated Child Development Services
IDBI	Industrial Development Bank of India
IDCO	Odisha Industrial Infrastructure Development Corporation
IFR	Individual Forest Rights
IGCC	Integrated Coal Gasification Combined Cycle
IGST	Inter-state Goods and Services Tax
IMD	Indian Meteorological Department
INTUC	Indian National Trade Union Congress
IPHS	Indian Public Health Standards
IPICOL	Industrial Promotion and Investment Corporation of Odisha Limited
JITPL	Jindal India Thermal Power Limited
JSPL	Jindal Steel and Power Limited
KALIA	Krushak Assistance for Livelihood and Income Augmentation
kWh	Kilowatt hours
LCOE	Levelised Cost of Electricity
LPG	Liquefied Petroleum Gas
MCL	Mahanadi Coalfields Limited
MDO	Mine Developer and Operator
MoEFCC	Ministry of Environment, Forest and Climate Change
MoU	Memorandum of Understanding
MFP	Minor Forest Produce
MGNREGA	Mahatma Gandhi National Rural Employment Guarantee Act
MGNREGS	Mahatma Gandhi National Rural Employment Guarantee Scheme
MMT	Million Metric Tonnes
MMTPA	Million Metric Tonnes Per Annum
MPI	Multi-dimensional Poverty Index
MSME	Micro, Small and Medium Enterprises
MSP	Minimum Support Price
MUKTA	Mukhyamantri Karma Tatpara Abhiyan
MW	Mega Watt
NAAQS	National Ambient Air Quality Standards
NABARD	National Bank for Agriculture and Rural Development
NAC	Notified Area Council
NACP	National Clean Air Programme

NALCO	National Aluminium Company Limited
NER	Net Enrolment Ratio
NFSA	National Food Security Act
NISE	National Institute of Solar Energy
NITI	National Institution for Transforming India
NMET	National Mineral Exploration Trust
NRLM	National Rural Livelihood Mission
NTFP	Non-Timber Forest Product
NTPC	National Thermal Power Corporation
NULM	National Urban Livelihood Mission
NZ-2050	Net-Zero 2050 Scenario
OB	Over Burden
OBC	Other Backward Class
OC	Open Cast
ODOP	One District One Product
OMC	Odisha Mineral Corporation
ORMAS	Odisha Rural Development and Marketing Society
OSEB	Odisha State Electricity Board
PCC	Pulverized Coal Combustion
PHC	Public Health Centre
PM	Particulate Matter
PMJAY	Pradhan Mantri Jan Arogya Yojana
PMKKKY	Pradhan Mantri Khanij Kshetra Kalyan Yojana
PMKUSUM	Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan Yojana
PNG	Piped Natural Gas
PRI	Panchayati Raj Institution
PSU	Public Sector Undertaking
PV	Photo Voltaic
PVTG	Particularly Vulnerable Tribal Group
PWS	Piped Water Supply
RE	Renewable Energy
ROM	Run of Mine
RTI	Right to Information
SC	Scheduled Caste
SCCL	Singareni Collieries Company Limited
SDG	Sustainable Development Goal
SECC	Socio-Economic Caste Census
SECL	South-Eastern Coalfields Limited
SEZ	Special Economic Zone
SGST	State Goods and Services Tax
SHG	Self-Help Group
SIDBI	Small Industries Development Bank of India
SPCB	State Pollution Control Board
ST	Scheduled Tribe
STP	Sewage Treatment Plant
STPS	Super Thermal Power Station
tCO2e	Metric Tons of Carbon Dioxide Equivalent
TLF	Talcher Fertiliser Limited
TPP	Thermal Power Plant
TPS	Thermal Power Station
TRT	Top Pressure Recovery Turbine
UG	Under Ground
UNDP	United Nations Development Programme
UNFCCC	United Nations Framework Convention on Climate Change
UPHC	Urban Public Health Centre
US$	United States Dollar
USEPA	United States Environmental Protection Agency
VAT	Value Added Tax
VRS	Voluntary Retirement Scheme

SUMMARY FOR STAKEHOLDERS

Angul is the epicenter of Odisha's coal mining and industrial economy which is expected to grow significantly over the next 10 years. However, the state is also highly vulnerable to climate change impacts. Ushering a green industrialisation along with coal transition, therefore, lies at the core of planning a just transition.

The study on just transition for Angul was undertaken to evaluate how Odisha's largest coal mining and industrial district can strategically plan for a just energy transition and simultaneously build a green economy in the coming decades.

A. Key observations

1. Coal mining and coal-based industries are growing in Angul; coal production will peak in the next 10 years.

Angul is currently India's third largest coal producing district, accounting for over 12% of the total production. In 2020-21, coal production of 96.7 million metric tonnes (MMT) was recorded from nine mines - eight opencast (OC) and one underground (UG).

The industrial landscape of the district is also highly coal-dependent. There are four thermal power plants (TPPs), including two captive plants, with combined capacity of 6.2 gigawatts (GW). Additionally, one 1.3 GW ultra-supercritical TPP is in the pipeline. Besides, there is an integrated steel plant of 6 million metric tonnes per annum (MMTPA) production capacity (with a plan to increase production to 25 MMTPA), an aluminium smelter and a planned aluminium park, a fertilizer plant, and several medium and small-scale industries.

Overall, coal mining along with the industrial sectors account for nearly 61% of the district's gross domestic product (GDP). The service sector has a share of 26%; the agriculture and the forestry sectors combined have a share of 9%.

Coal production is expected to increase steeply over the next 10 years, with expansion of existing mines and opening of new mines. If all the proposed mines come into production, the district's coal production will peak at 308.8 MMT in 2033 – more than three times the current production. The contribution of coal mining and coal-based industries to the district's GDP will, therefore, increase further.

2. 29% of all workers – approximately 168,000 workers – are directly employed in coal mining, coal-based industries, and coal transport sectors; 69% of them are informal. Total number of workers engaged in coal mining and coal-dependent industries will at least double in the next 10 years, a large share of them will be contractual and informal workers.

One in three workers in the district are currently engaged in the coal industry (coal mining, coal washeries and coal transport) and coal-based industries (TPPs, steel and aluminium). The workforce exhibits a high proportion of informality. About 69% of the workers are informal.

The share of contractual and informal workers is going to increase significantly in the next 10 years as coal production capacity will increase nearly three times, with proportionate increase in worker demand. A significant part of the increased production will be met by engaging mine development operators (MDO) and contractors through 'fixed term employment' contracts. The proportion of informality will also increase considering simultaneous rise of odd-jobs in the coal economy.

The steel, aluminium and ancillary industries will also have a huge worker demand with planned expansions in the coming years. These industries will engage contractual and informal workers as well.

3. Under the current policy scenario (CPS), coal production will start reducing only from 2040 onwards, and will be phased out by 2070. In an ambitious Net Zero-2050 (NZ-2050) scenario, in which production will have to be phased out by 2050 to meet 1.5°C climate goals, 75% of new coal mines have a high risk of becoming stranded assets.

In CPS, which assumes that the operational and upcoming coal mines will continue to produce as per their existing mining plan and will have a full operational life without much disruption, the last mine in Angul can be closed in 2070. There will be only one forced closure and 240 MMT of production will be foregone.

However, under an ambitious NZ-2050 scenario, about 75% of the new coal mines, that will commence operation by 2030, will have to forego 30%-60% of their lifetime coal production.

Figure 1: Coal mine closure schedule under CPS

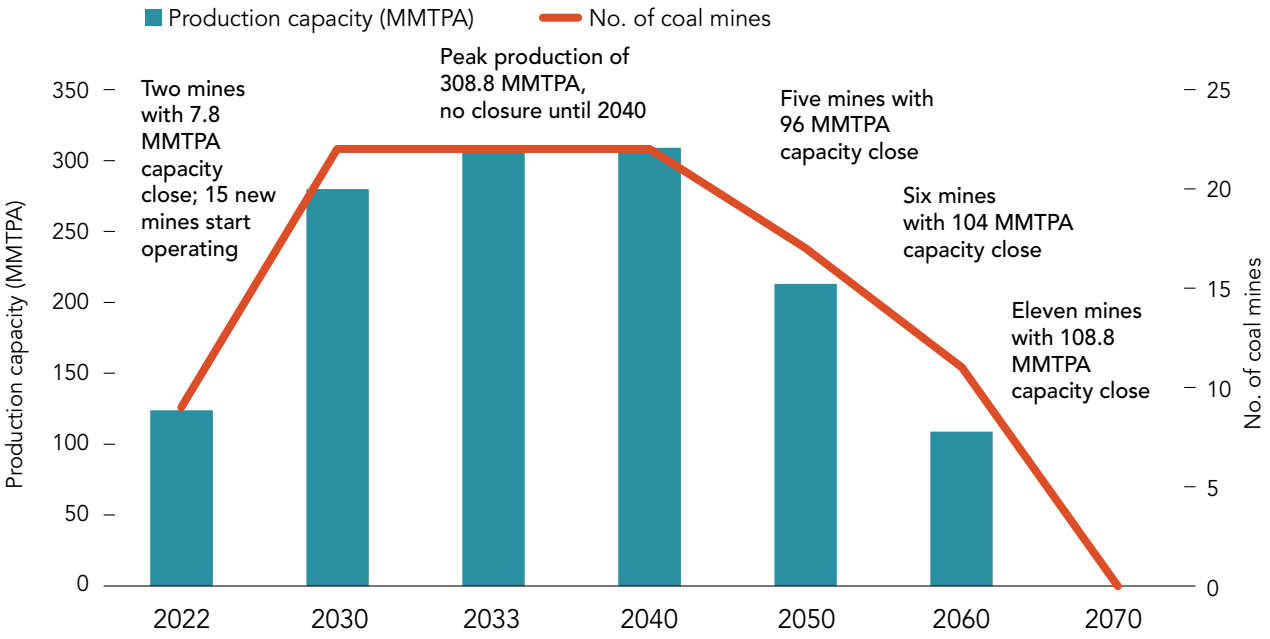
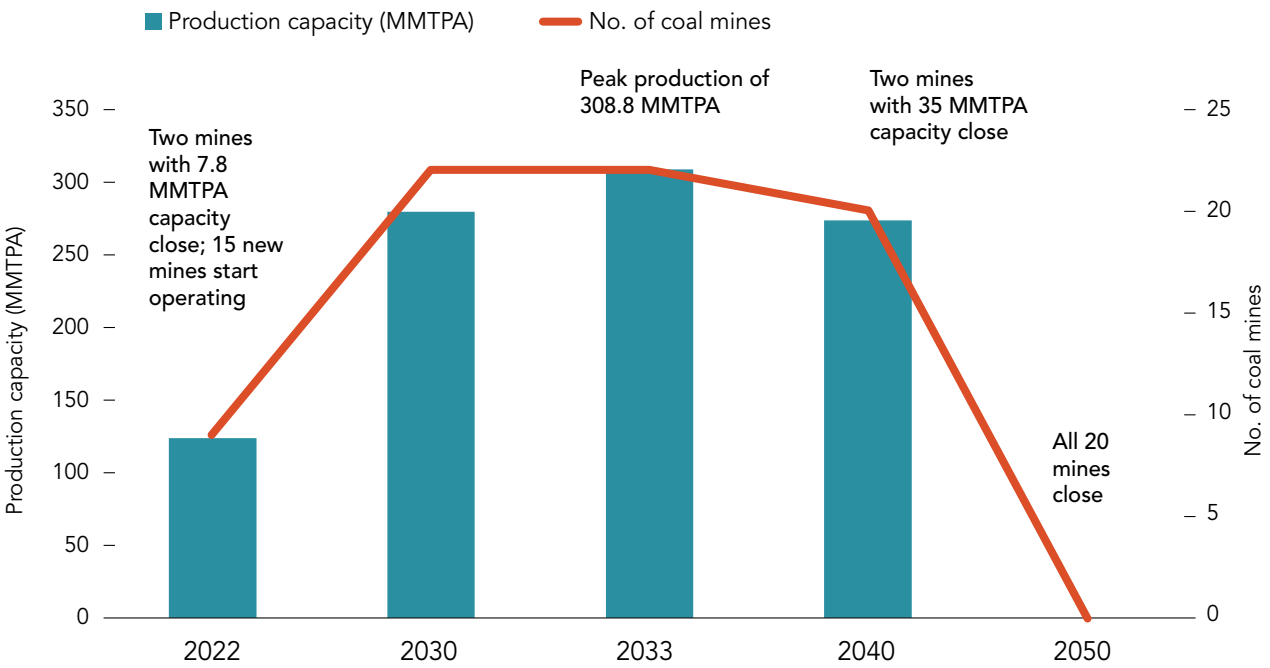


Figure 2: Coal mine closure schedule under NZ-2050



4. Several coal-based thermal power units will start closing after 2025 due to age and their inability to meet environmental norms. If no new power plants are constructed apart from those in the pipeline, in both CPS and NZ-2050 scenarios, coal-based power production can be phased out by 2050.

Closure of coal-based power plants in Angul will start this decade. Five captive-power units with a combined capacity of 600 megawatts (MW) are already aged between 33-36 years, and will struggle to meet the new emission standards. While, 30% of the installed capacity (6.2 GW) are currently below 10 years of age, by 2050 all the TPP units can be retired as they will be older than 35 years. Under NZ-2050, only the upcoming ultra-supercritical TPP will face an early closure.

Figure 3: Power plant closure schedule under CPS

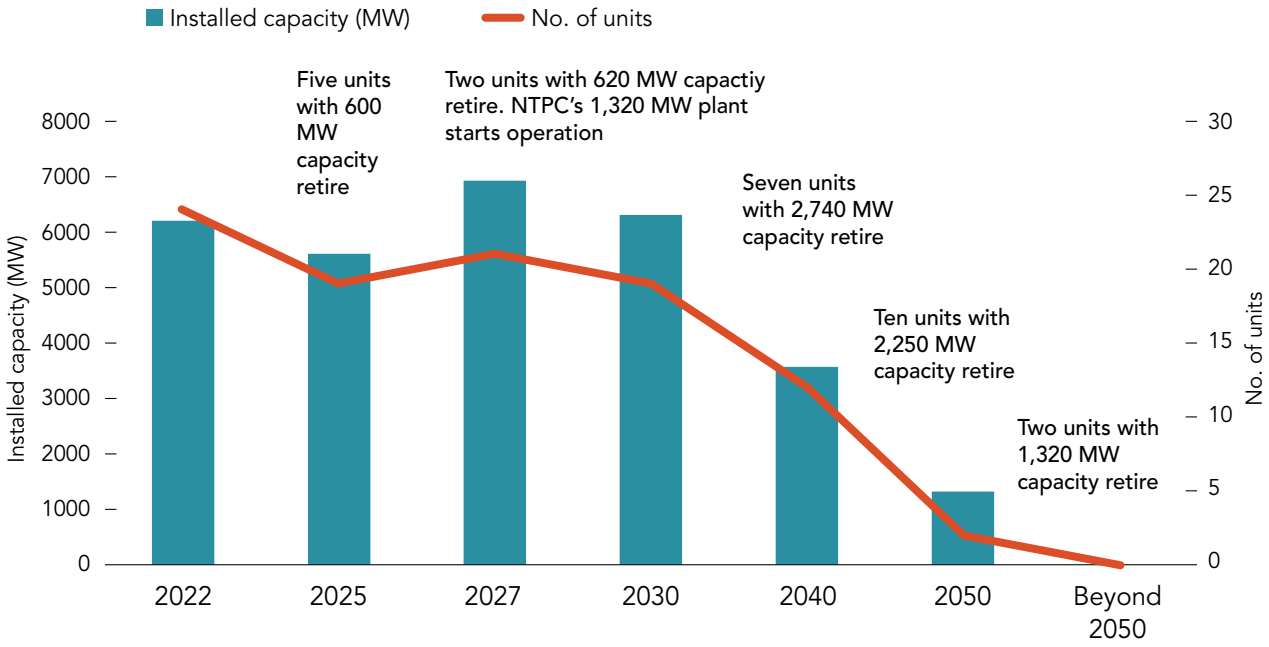
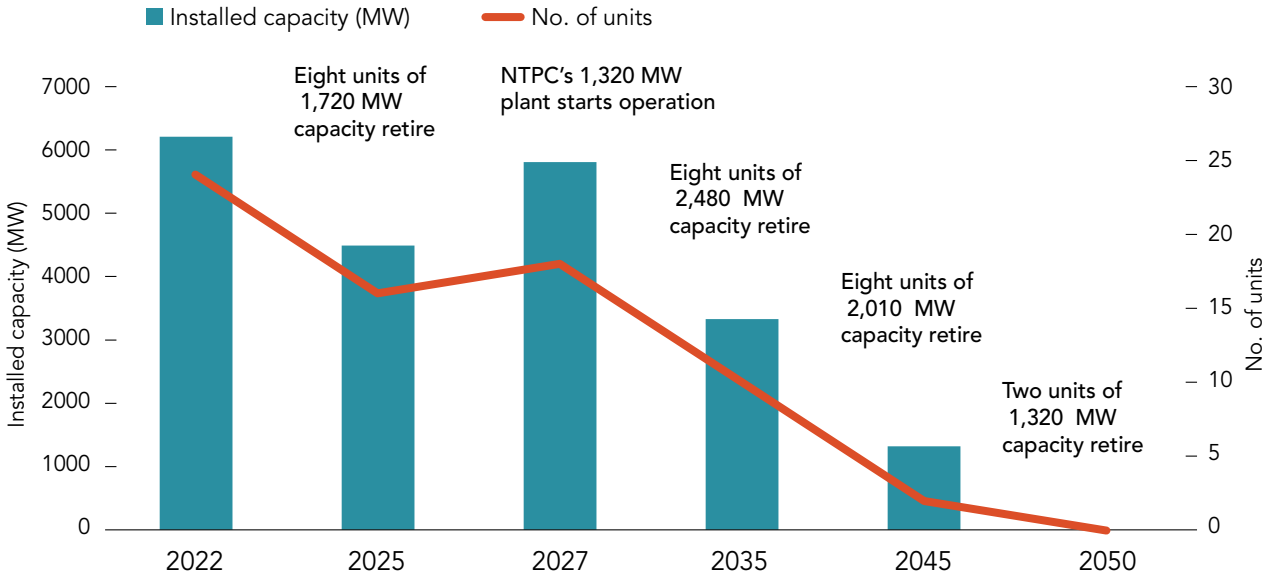


Figure 4: Power plant closure schedule under NZ-2050



5. Investments in coal-based power generation risk becoming stranded assets, as renewable-based electricity along with storage is likely to be cheaper than coal post 2030.

Thermal power plants in Angul produce some of the cheapest electricity in the country. The generation cost of electricity currently ranges from ₹2.65 to ₹2.95 per kilowatt-hour (kWh). Cheap coal and coal-based power is driving the coal industry in the district. New TPPs for the utilities and captive power plants for the aluminium refinery and steel plants are in the pipeline presuming availability of cheap coal in the coming years. However, the economics of electricity generation from coal vis-à-vis renewables will dramatically change in the next 10 years.

Modelling undertaken by iFOREST to compare the levelized cost of electricity (LCOE) from various energy technologies shows that, presently solar photovoltaic (PV) is the cheapest source of energy in Angul during the day time; even cheaper than pithead captive power plants.

The analysis shows that by 2025, the LCOE for Solar PV with 25% battery energy storage systems (BESS) will be ₹4.3/kWh, compared to ₹4.2/kWh for a pithead super-critical TPP. In 2030, the cheapest source of electricity will be from solar PV with storage. The LCOE for a solar PV plant with 50% BESS will be ₹4.8/kWh, as compared to ₹4.9/kWh for super-critical and ₹5.6/kWh for Integrated Coal Gasification Combined Cycle (IGCC) plants.

This essentially suggests that there is a limited window to invest in coal-based TPPs. After that, renewables with storage will outcompete coal-based power. This will also have major repercussions for coal demand from Angul. Therefore, coal mining in the district should be planned keeping in mind the projected demand from coal-consuming sectors, such as, coal-based power. Else, there will be risk of stranded assets in the coal mining sector due to lack of demand.

Table 1: Levelized Cost of Electricity (₹/kWh)

Technology	2022	2025	2030
Super-critical TPP	3.6	4.2	4.9
IGCC power plant	4.2	4.9	5.6
Solar PV	3.1	2.9	2.7
Solar PV + 25% BESS	4.7	4.3	3.8
Solar PV + 50% BESS	6.3	5.7	4.8

6. Pollution is a major concern in Angul-Talcher coal belt.

The Angul-Talcher industrial cluster is classified as a 'critically polluted area' by the Central Pollution Control Board. Large-scale industrial activities in the district have been contributing to the pollution of air and water, among which coal mining activities, and emissions and discharges from the TPPs are major ones.

Talcher and Angul municipalities are also among the 132 'non-attainment' cities as per the National Clean Air Program (NCAP). Three river stretches flowing along Angul and Talcher are among the most severely polluted river stretches of the country.

Mining and industrial expansion will exacerbate the situation if adequate safeguards for pollution mitigation, waste management and material circularity are not enforced. Besides, upcoming mines will lead to diversion of additional 3,000 hectares of forestland, which also has implications for the local environment.

B. Planning a Just Transition

1. Angul must use its coal to power a green economy.

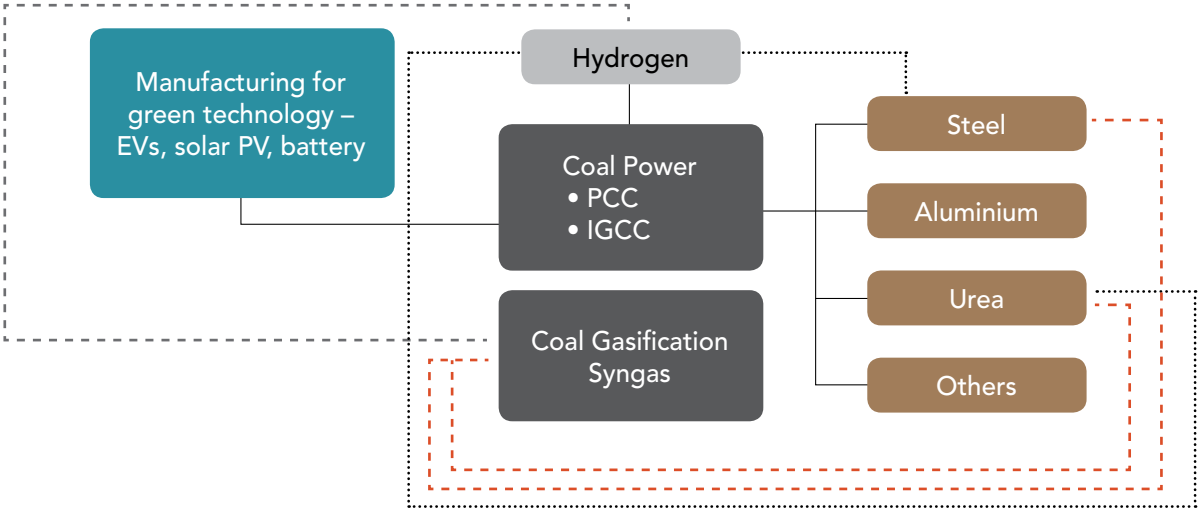
There is an enormous opportunity to build a green industrial economy by using cheap coal over the next 10 years. The green industrial transition can be planned in two phases - a 'Brown Phase' and a 'Green Phase'.

In the Brown Phase (the next 10-15 years), the focus should be to build the backbone of the green industry using coal in the most environmentally responsible manner. Angul can maximise the potential of its coal resources, using it for power generation through super-critical and ultra-supercritical TPPs, and production of grey hydrogen through coal gasification.

Electricity generated through such technologies can be used to build the green manufacturing sector which is energy intensive. This will include, manufacturing of electric vehicles (EVs), solar PVs and battery for storage, which will also boost domestic manufacturing of high-value products and support the 'Make in India' initiative. The grey hydrogen will be used to build the base for producing green steel and green urea.

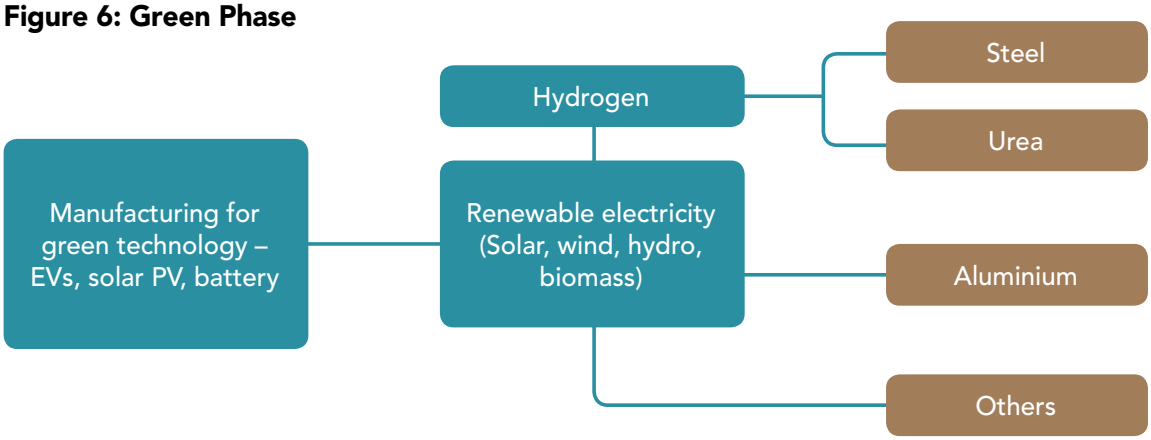
The phase will also involve incentivising investments to exploit the RE potential of the district and increase its share in the energy mix, as Angul has about 10.8 GW of solar potential.

Figure 5: Brown Phase



Post 2035, industries in Angul must decisively move to a Green Phase, with the focus to shift to RE, green industrial processes, and maximising material circularity. This will be aided by availability of cost-competitive RE-based electricity (with storage), green hydrogen, technological advancements, and an established ecosystem for supporting these industries and ancillary processes.

Figure 6: Green Phase



In this phase, the steel industry should move to production of green steel by utilising green hydrogen. Similar transformation should happen with green urea. In addition, material circularity in the sector should be improved through better utilisation of high-quality scrap in Electric Arc Furnace (EAF). In India, EAF-based steel already accounts for 29% of steel production, which the expanding steel industry in Angul and Odisha should build upon. For the aluminium sector, there should a shift to use RE-based electricity and the use of aluminium scrap, to reduce carbon footprint.

2. Pollution mitigation, environmental remediation, and circular economy practices will be essential to support sustainable growth.

Mining and industrial expansion will exacerbate environmental pollution and resource degradation, if adequate safeguards are not enforced. At the same time, environmental and carbon footprint of the extractive and manufacturing industries must be minimised through responsible mining (green mining) and environmental practices.

To ensure responsible environmental practices, scientific closure of coal mines, through planning for ecological restoration, remediation and repurposing of land will be required. Industrial pollution standards must be made stringent to ensure that the pollution is within the carrying capacity of the local airshed, water bodies and land. Reuse, recycling, and safe disposal of waste, especially fly ash, slag and other wastes will be equally important. Overall, supporting circular economy practices will be essential through legislative and non-legislative measures. Else, the economy will become highly unsustainable.

3. Repurposing of mining and industrial land will be crucial for environmental sustainability, industrial development, and economic diversification.

In Angul, about 33,000 hectares of land can be available for repurposing over the next three to four decades following closure of coal mines and TPPs. Over 93% of the land will be available from coal mine closures.

Besides restoration of green covers, a significant proportion of this land will be primed for investments in various economic activities that can help to diversify the economy, augment clean energy production and generate local employment. Considering the land availability in the district, some of the potential investments include, installation of solar PVs, development of industrial and food parks, fisheries, and tourism. Ensuring repurposing of mining and industrial land will also prevent the need to divert agriculture and forest land for greenfield development.

4. Angul will not experience major job loss till 2040. In fact, there will be a significant increase in coal-dependent jobs over the next 10 years. To meet the skill requirements of both the brown and green economy, significant investments in skilling programmes and technical education are necessary.

Unlike the old coal mining districts, where coal mines closures will lead to significant job losses in the next 10-15 years, Angul will experience increase in coal-related jobs to meet the requirement of three-fold increase in coal production.

Job loss is not a challenge in the existing coal mines and power plants as well. The operational mines and power plants of the public sector undertakings—Mahanadi Coalfields Limited (MCL) and NTPC Limited—have an aging workforce. About 61% of employees of MCL engaged in Angul mines are already above 40 years of age; their retirement can be made co-terminus with mine closures. About 70% of the employees in power plants operated by NTPC Limited are also above the age of 40 years. For many of them the retirement can be co-terminus with the plant closure; the rest can be shifted to the new plant. Securing pension, therefore, is the key issue for the departmental employees.

For the informal and contractual workers, skilling is the key requirement. Currently, about 69% of the workers in the coal mining and coal-based industries are informal. Their low skill levels have compromised their ability to secure dignified jobs and better wages. The current hiring practices indicate that the share of low-waged contractual and informal workers in the coal industry is going to increase significantly. These workers need to be skilled to secure better paying and dignified jobs.

There will also be a huge demand for skilled workers for building the economy, both during the Green Phase and the Brown Phase. New skills will be required to develop the RE sector, green manufacturing, green industrial expansion, and associated infrastructure development in the coming years. Deployment of massive skilling and reskilling programmes through government and industry support will be necessary to have a prepared workforce for these industries. Simultaneously, investments in education, as well as vocational and skill training institutes will be required to prepare the workforce for future jobs.

Overall, Angul can continue to generate high quality jobs and build a sustainable economy, if the district plans the industrial and labour transition together. With no major coal closures happening until 2040, and simultaneously prospects of green industrial growth (including in steel, aluminium, fertilizer, small and medium enterprises, and others that the region might attract), a timely intervention will help create good jobs in the district.

5. Ensuring safety net for contractual and informal workers will be essential through regulatory reforms.

Considering the trend of hiring of the PSUs, engagement of MDOs, and providing 'fixed term employment' contracts to workers, the workforce going ahead will be increasingly contractual in nature. The involvement of contractors and sub-contractors will also increase informality in the industrial sectors.

Therefore, ensuring wage security and safety net for the contractual and informal workers will be a key aspect. The existing provisions of the labour and industrial laws are not suitable to address the work security, wage, and compensation aspects, that will be a key issue for just transition and considering the nature of the future workforce. Reform in industrial and labour laws will be necessary to improve terms of engagement, retrenchment, compensations, etc. In the new economy, workers must be engaged through long-term contracts to ensure job security and entitlement of rights.

Besides, ensuring gender equality must be a focus of the new economy. As per the workforce assessment study undertaken by iFOREST, currently only 5% of women within the working age group are workers, while the corresponding proportion for men is 76%. The women also suffer from comparatively poor educational status, which undermines their ability to secure a a well-paying job.

6. Responsible social and environmental investments will be important for building community resilience and ensuring environmental justice.

Angul has better development indicators and infrastructure as compared to many other coal districts of India. However, investments in social infrastructure will be necessary to overcome the developmental gaps, particularly in the rural areas where 80% of the district's population resides. This will include clean piped water supply to all households, improving healthcare access, increasing the use of clean cooking fuel, and improving health indicators of women and children.

A key focus of social infrastructure investments should be to build community resilience in face of an energy transition. Better infrastructure will also help to build local support for a just transition.

Environmental remediation and pollution mitigation will be important for a critically polluted area like Angul-Talcher. Legacy pollution issues related to extraction, processing, and combustion of coal, from which the local community, particularly the poor and disadvantaged, has suffered need to be addressed while planning a new economy.

7. Angul has significant resources for implementing a just transition. Nearly ₹3 trillion can be available for supporting just transition through coal cess and District Mineral Foundation funds under accelerated climate action scenario.

Massive financial resources will be necessary for implementing just transition measures in Angul. This must be leveraged by optimising coal mining related funds, fiscal support of the government, private financing, and international support.

The public revenue that the government will earn from coal mining through coal cess (currently subsumed under the GST compensation cess) and the District Mineral Foundation (DMF) funds can be the seed money to facilitate the just transition process starting this decade. The purpose of these funds is also aligned with the goal of a clean environment, supporting clean energy and ensuring public good and social welfare.

A decadal assessment of potential funds available combining coal cess and DMF shows that over ₹1.9 trillion (US $24 billion) can be available for such purposes over the next 20 years (even under NZ-2050 the funds remain nearly equal). This is the most crucial period for the government to plan a clean energy transition and a just transition to meet India's net zero emission reduction target. Even with an accelerated coal phase-down by 2050 (under NZ-2050 scenario) nearly ₹3 trillion (US$ 38 billion) will be potentially available to support just transition.

Table 2: Estimated direct finance for just transition in Angul

Sources of Financing	2022-2030		2031-2040		2041-2050		2051-60		2061-70		Total	
	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050
DMF (₹ billion)	53	53	87.2	81.7	72.6	52.6	33.9	0	12.8	0	259.5	187.3
Coal cess (₹ billion)	594.7	594.7	1212.4	1,160.4	1,078.4	890	640.8	0	243.5	0	3,769.8	2,645.1
Total direct finance for just transition (₹ billion)	**647.7**	**647.7**	**1,299.6**	**1,242.1**	**1,151**	**942.6**	**674.7**	**0**	**256.3**	**0**	**4,029.3**	**2,832.4**

8. Deep stakeholder engagement will be necessary to build consensus for a just transition and ensure inclusive development.

Just transition planning in a major coal mining and industrial district like Angul must be inclusive and bottom-up. Considering that coal has been central to the region for nearly a century, the social acceptance of a coal transition and understanding of opportunities in the new economy will be crucial for implementing just transition measures. Having the support and confidence of the local community and various stakeholders will also be essential to support a four-decade transition process.

Developing an extensive stakeholder engagement and a participatory planning process, therefore, will be fundamental for a just transition. It is also an effective way of assessing the needs and aspirations of the local community and plan interventions accordingly for inclusive development.

C. Policy considerations

1. Just transition in Angul will be a time-consuming process; policy deliberation and planning must start now.

Achieving an industrial decarbonisation and a just transition for Angul will be a time-consuming process given the scale of coal mining, industrial operations, dependence of the local economy, and revenue flow for the government. A phase-wise planning will be necessary considering the timeframe of coal mine and TPP closures, and corresponding growth in green industries. A concrete cross-sectoral decarbonisation strategy, that also ensures inclusive growth, will be required to facilitate a just transition.

2. Conscious decision needs to be taken on capping coal production considering risks of stranded assets.

Investments in coal mining and coal-based power plants risk losing market value due to a number of factors, such as falling RE costs, technological disruptions and breakthroughs in industrial processes, government policies on clean energy, climate change and environmental pollution, and consumer choices for clean energy and sustainable materials. Therefore, investments without considering these factors have a huge risk of turning into stranded assets.

For Angul's energy, industrial and economic planning, these need to be factored in. While there will be untapped coal resources, a conscious decision needs to be taken on a coal production cap through co-operative decision making between the state and the central government.

3. Reform in mining and land-related regulations are required to ensure repurposing.

The current guidelines pertaining to closure of coal mines do not provide for repurposing of mining land. At present, post-closure land use is largely limited to plantations, because most of the mines have been opened by diverting forest land. Once mines are closed, the land will be transferred to the forest department again. This precludes the scope of utilising the land for developing new low-carbon industries. For new industries, virgin forest land and agricultural land will have to be diverted. However, such practice is not good for the economy or the environment.

To allow repurposing of mining land, comprehensive regulatory reform will be required. This will include revisions in mining, forest and relevant land-related laws.

4. Odisha Climate Change Action Plan needs to integrate just transition provisions.

The State Climate Change Action Plan needs to integrate principles of just transition to enhance climate change action. The next plan, which will be promulgated soon (as the current plan ends in 2023) need to include the following:

- Reclamation and repurposing of coal mining and industrial land and infrastructure to optimise environmental and economic benefits;
- Restructuring of the economy and industrial activities to support low-carbon development in the coal-dependent districts;
- Reskilling and skilling the workforce to prepare for the new green economy and build local employment opportunities in the green economy;
- Revenue substitution plan for the state and local government(s) aligning with the state's industrial and economic policy; and,
- Responsible social and environmental investments to improve development outcomes, alleviate poverty, create better living standards and quality of life, and build local resilience.

5. Development of a comprehensive renewable energy and green industrial policy will be required for the state.

The Government of Odisha has several policies which can aid growth of the RE sector and help to develop green manufacturing industries. However, these policies are currently fragmented and need to be consolidated to create a comprehensive policy framework.

It will, therefore, be important for the state government to develop a comprehensive policy for green energy and green industrialisation. This will support ease of doing business, boost economic growth and employment, and support a just transition.

6. Odisha will need a state-level just transition policy and plan.

Odisha is a highly coal-dependent state and is also vulnerable to the climate crisis. Therefore, a comprehensive state-level just transition policy and plan will be required to provide a framework for just transition and to build a new green economy in the coal districts. The policy should provide guidance for an integrated approach on economic, industrial, energy and labour decisions, that can facilitate just transition.

7. Formulation of a national just transition policy will support states like Odisha on inclusive climate action.

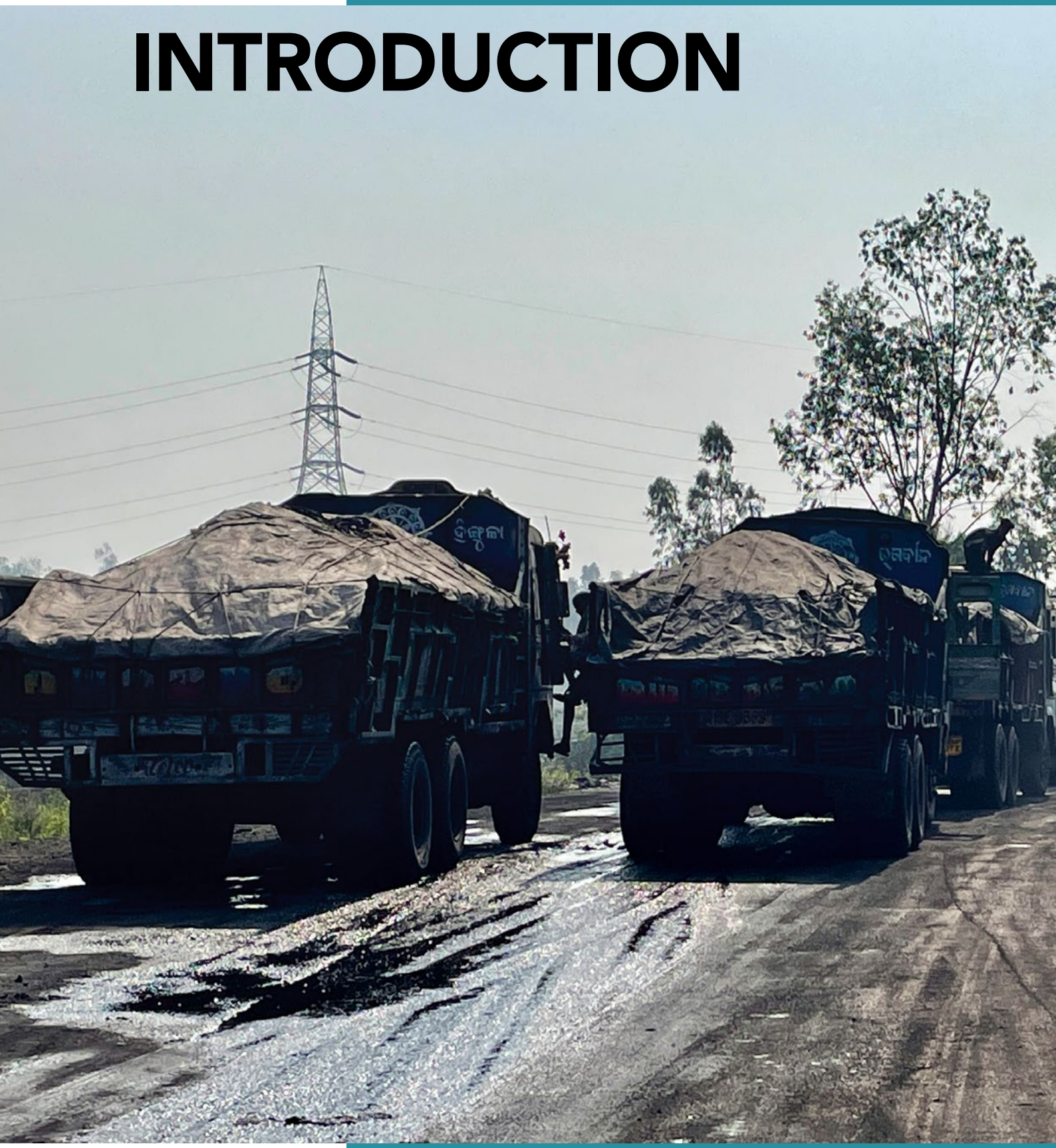
The formulation of a national policy will support a well coordinated and inclusive climate change action to achieve India's climate goals and the net zero emission target by 2070. With respect to just transition, the focus should be on:

- Low-carbon industrial and economic growth, with a specific focus on coal-dependent states.
- Economic diversification in fossil fuel dependent districts and states.
- Job creation in the renewable sector and green industries.
- Strengthening worker protection during the transition and in the low-carbon economy.
- Building community resilience.
- Equitable financing to ensure distributive justice.

Angul offers critical insights for the state government and India to start deliberation on a comprehensive just energy transition policy. This will be instrumental in shaping investment plans and governance mechanism in the coming years to support an equitable climate change action.

CHAPTER 1

INTRODUCTION



Chinmayi Shalya/iFOREST

- *Angul is currently India's third largest coal producing district, and is being considered as a key one for meeting India's 1,448 MMT coal demand by 2030.*
- *Coal-dependent industries dominate the district's industrial landscape, including thermal power, steel, aluminium, fertilizer and MSMEs.*
- *A deep decarbonisation strategy will be necessary to support just transition in the district, as well as to meet India's climate change goals.*
- *The study relies on survey of 467 households and stakeholder consultations to evaluate the coal dependence of people, and their aspirations in a green economy.*
- *The study provides important insights on technology, policy and financial support that will be necessary to facilitate a just transition.*

1.1 Background

The Government of India (GoI), in May 2022, released the latest projection of India's coal demand till 2030. As per the projection, the total coal demand in India by the end of this decade will increase to 1,448 million metric tonnes (MMT), from the current demand of 980 MMT. Over 71% of the demand is related to the power sector, and the rest for other industrial and economic activities. The government aims to meet this demand completely through domestic supply.[1]

While coal demand is projected to increase in the next decade considering the growing energy needs of the country, the government has also set important targets and measures to increase the share of renewable energy (RE) sources for electricity generation and decarbonise the industrial sectors reliant on coal. The GoI's announcement of installing 500 gigawatts (GW) of RE by 2030 and meeting 50% of the country's electricity requirement through renewables by the same timeframe is a testament to this.[2] At the same time, there is a growing support for use of non-conventional fuels, such as green hydrogen, for industrial sectors to support deep decarbonisation and achieve India's net zero emission targets by 2070. The Green Hydrogen Policy notified by the government in February 2022 is a significant step in this regard.[3]

What these scenarios are essentially suggesting is that, while the country is wary of the increasing coal demand till the end of this decade, there is also a clear recognition of the need to decarbonise our energy systems. India's competitive edge in RE production and the policy support for augmenting non-conventional fuel use in the industrial sectors certainly provide the right impetus for this.

The national ambition for decarbonisation over the next three to four decades is not only aimed at dealing with the climate crisis, but also towards building a new economy that is sustainable, prosperous and ensures energy security. However, to ensure that the new economy benefits all, the decarbonisation pathway must also be a just pathway.

The question of ensuring a just decarbonisation pathway, therefore, will not be a technological exercise only. It will require an in-depth socio-economic evaluation of India's coal districts. The variations in the coal economy and the political economy context of various coal states and districts exhibit unique challenges and opportunities of a just transition. An understanding based on experiences of some of the country's classic coal districts that exemplify diversity will also be important in guiding the formulation of just transition policies and governance mechanisms in the coming years.

1.2 Objective and scope

In 2020 and 2021, the International Forum for Environment, Sustainability and Technology (iFOREST) undertook two in-depth studies on just transition in Jharkhand (Ramgarh district)[4] and Chhattisgarh (Korba district)[5], respectively. The studies in two of India's classic coal districts brought out unique issues of a just transition. In Ramgarh, where coal is nearly a story of the past now with a steady decline in production and the increasing number of mines closing, challenges of a just transition are imminent. The district's informal coal economy, with a large number of coal gatherers and sellers and informal workers, alongside its poor development indicators, clearly underscored that just transition for such districts must be planned as a broad-based socio-economic intervention. In contrast, the study of the Korba district exhibited what a just transition planning should entail for India's biggest coal producer with three of Asia's largest coal mines. The district's large coal production (from just three mines) on the one hand, and poverty, underdevelopment, and poor opportunities in other sectors on the other provided the opportunity to understand how just transition must be planned for such districts in the coming years.

The current study of Angul district of Odisha is a progression of the earlier two studies. Angul is not just India's third-largest coal producer currently, it is also an industrialised district. Most operational industries are coal-dependent and drive the district's economy. At the same time, Angul is being considered among the key districts to meet India's projected coal demand by 2030. Large-scale industrial expansion is also being planned simultaneously.

However, to avoid any unplanned disruptions and to ensure long-term prosperity, Angul must start planning for the coal transition and building a new green economy. The district being located in Odisha, which is one of India's most vulnerable states to the impacts of climate change, raises questions about the sustainability of coal dependence over a long period of time.

The Angul study adds significant value to just transition deliberations in the country in two respects. First, it provides an understanding of how India's largest coal mining and industrial districts, which are currently upscaling coal production, can strategically plan for a just transition coupled with a decarbonisation strategy. Second, it gives a clear signal for the need of policies which will be necessary to ensure a decarbonisation pathway to meet the net zero emissions target of 2070 and respond to the climate crisis. Besides, the study also offers an understanding of the collaborative support that will be necessary from the state government, the central government, as well as the international community to support such transition.

1.3 Study approach

The study is based on a mixed-method approach, including both primary and secondary research. The primary research includes the following components:

- Household survey covering 467 households in Angul district.
- Focus group discussions (FGDs) with relevant stakeholders.
- Individual interviews conducted with key actors, including public representatives, state and district officials, industry, and union leaders.

The primary survey is designed to get an understanding of the household coal dependence and other relevant socio-economic characteristics, along with a detailed assessment of the worker profile of the district. It seeks to answer some of the questions that are central in the understanding of the scope and potential of just transition in the Angul. These include:

- Dependence of the district on coal mining and allied sectors for income, amenities, and social welfare.
- Dependence of the district on various other sectors such as agriculture, fisheries, and forestry.
- Occupational and economic profile of workers with a focus on informality in mining and coal-dependent sectors.
- The potential impact of coal mine and power plant closure on income and livelihood opportunities.
- The opportunities of planning a just transition in the district and for the people.

The secondary research involves literature review, analysis of government and industry data, scholarly articles, and research papers. The objective of the secondary research is to compliment the analysis of the primary survey, and evaluate prospects and strategies for just transition planning and development of a green economy in the district. It forms the basis for the understanding of the following key aspects:

- Overall district profile, demographic characteristics, development status, income opportunities, and environmental pollution.
- Coal mining, coal-based power and industrial scenario within the district.
- Key economic sectors – primary, secondary, and tertiary – and the opportunities and issues therein.
- Scope for maximising RE potential, economic diversification and green industry development, revenue substitution and finances to support a just transition.
- Need for interventions to ensure environmental and distributive justice.

Evaluation of the primary and secondary data and information forms the basis of the proposal of a district just transition plan. The proposal includes a comprehensive framework for determining a strategic timeline of coal mine and coal-based power plant closure, economic diversification and green industrial transition measures, required labour support, an assessment of the economic implication of a coal transition and the opportunities for financing, and the role of various actors to support the transition process.

Sample distribution

A total of 467 households were selected for the primary survey. The sample size was determined by considering the estimated district population (as of 2021) and taking a 95% confidence level and a 2% confidence interval for a statistically significant representation, and ensuring precision of observation. The households for the primary survey were chosen through a process of stratified random sampling to minimise the possibility of clustering and selection bias.

The sampling points were spread across three spatial strata, which included both urban and rural areas within the eight blocks of the Angul district. The stratification ensured the coverage of highest to lowest degrees of dependence on coal and allied activities.[6]

- Within 0-3 kilometre (km) radius from the mine (or cluster of mines area) and plant area that is considered to have the highest dependence on coal mining and coal-related sectors.
- Within 3-10 km radius from the mines or plant area that has moderate dependence on coal mining and coal-related sectors.
- Beyond 10 km radius, which can be presumed as the strata with the least dependence on coal mining and coal-related sectors.

The spatial categorisation is guided by the delineation of directly and indirectly mining-affected areas (and thus where the impacts of such industries are most pronounced), as considered by the Government of Odisha.[7] As per this, a radius of 10 km from mines or cluster of mines is considered to be the area which has the most direct impact of mining and related activities.

In each stratum of the sampling, a specific number of both urban and rural households were chosen considering the population density, demography, such as proportion of rural and urban population in the areas, and the caste distribution. For example, a relatively higher number of sample households were chosen within the 0-3 km radius of the mines and thermal power plants (TPPs), due to the population density in the area. Also, a higher number of urban households were selected within this radius due to the urban nature of the region and the concentration of industrial jobs. In contrast, largely rural households have been selected in the beyond 10 km radius, where the region is largely agrarian and forested.

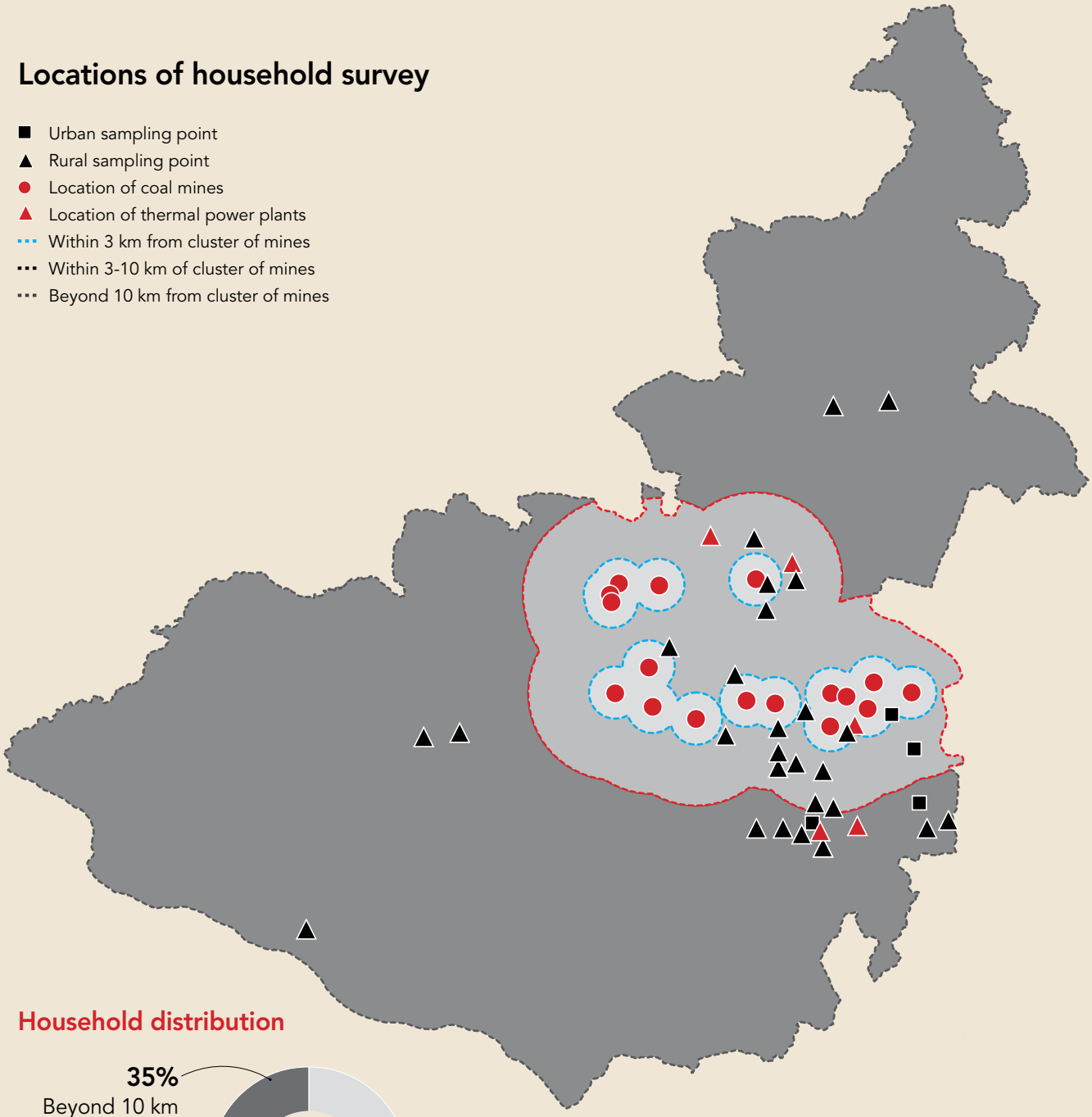
A special focus has been given to the caste representation in the district to ensure that all caste groups are represented as per the overall district demographics.

In order to capture the coal transport sector, which is largely informal, and involve workers who are migrants and scattered across localities, a "purposive sampling" was done.[8] Specific sampling locations were selected to ensure that the target group was captured based on ground truthing. For this, locations within the Angul-Talcher mining and industrial area were considered, which has a concentration of transportation sector workers.

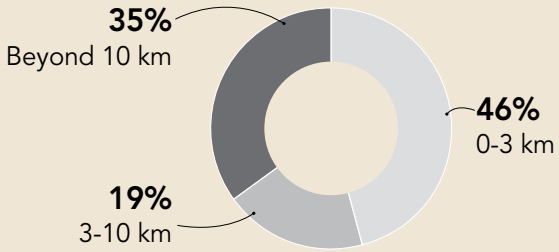
Chinmayi Shalya/iFOREST

Locations of household survey

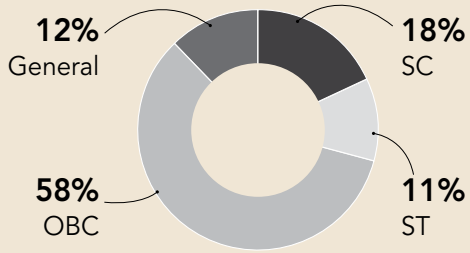
- Urban sampling point
- Rural sampling point
- Location of coal mines
- Location of thermal power plants
- Within 3 km from cluster of mines
- Within 3-10 km of cluster of mines
- Beyond 10 km from cluster of mines

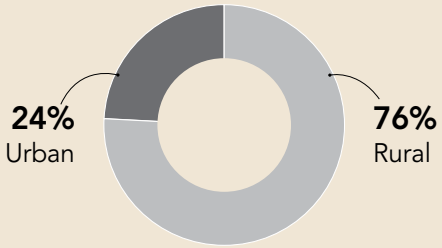


Household distribution



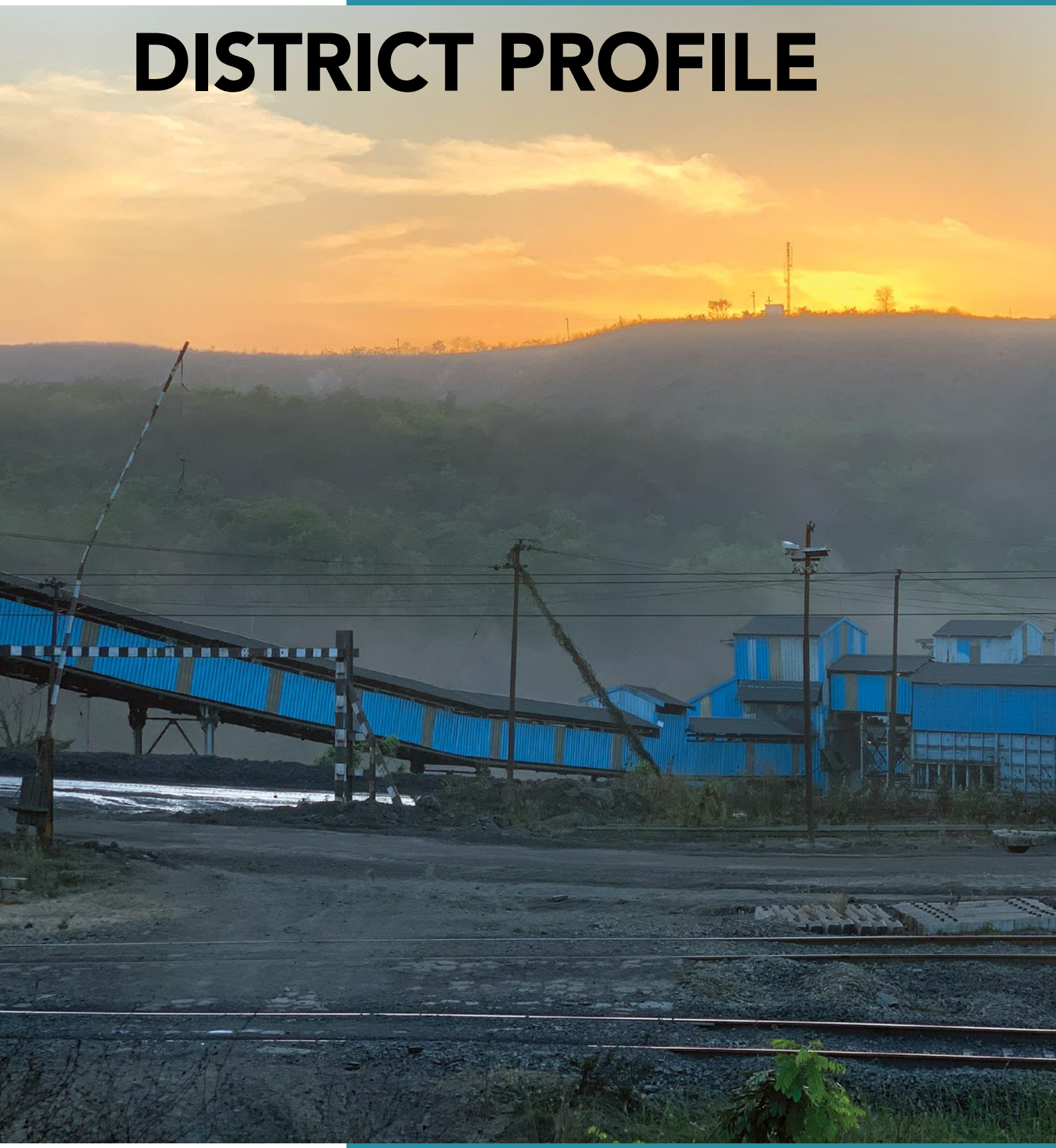
Demographic mix





CHAPTER 2

DISTRICT PROFILE



Deeksha Pande/iFOREST

- *Angul is home to the biggest coalfield in India – Talcher coalfields – which has 52,550 MMT of coal resources.*
- *Mining and quarrying, along with the industrial sectors, account for nearly 61% of Angul's GDP.*
- *While 40% of the geographical area is under agriculture and another 45% under forest, the collective contribution of these sectors to the district GDP is 9%.*
- *The agricultural community remains highly vulnerable to climate change impacts as agriculture is largely rain-fed.*
- *Angul-Talcher industrial cluster is a critically polluted area and faces tremendous environmental pressures due to air, water and soil pollution.*

2.1 Administrative profile

Angul district was carved out in 1993 from the undivided Dhenkanal district. It shares boundaries with Cuttack and Dhenkanal districts in the East, Sambalpur and Deogarh in the West and Sundargarh and Keonjhar in the South.[1]

The district has eight administrative blocks or *tehsils* – Angul, Talcher, Chhendipada, Kaniha, Banarpal, Pallahara, Kishorenagar and Athamallik. There are 1,871 villages and 225 *gram panchayats* spread across the eight blocks.[2] The urban local bodies in Angul include two municipalities – Angul and Talcher – and one notified area council (NAC) – Athamallik.[3]

The Brahmani river (along with its tributaries Tikira, Samakoi, Singrajhor and Nandira) is the major river with 19% of its basin falling in Angul. The Mahanadi river also cuts through a 22-kilometer (km) gorge, with about 3% of its basin falling in the district.

Map 1: Administrative map of Angul district

Source: Adapted from District Irrigation Plan, Angul, 2015-2020

2.2 Land use land cover

Spread across an area of 637,499 hectares (ha), Angul is 11th in terms of area, occupying about 4% of Odisha's total geographical area. The biggest proportion of the district's geographical area (45%) is under forest, followed by 40% area that falls under agriculture, as net sown.[4]

About 6% of the area is categorised as wasteland, which includes scrubland, waterlogged or marshy land, land affected by salinity/alkalinity, shifting cultivation area, scrub forest, degraded pastures, etc.[5] Besides, 7.4% of the area falls under the "other uses" category, which is largely attributable to coal mining and industrial areas in the district. In fact, Talcher, where most of the coal mines are located, has the highest proportion (27.3%) of the area under other uses.[6]

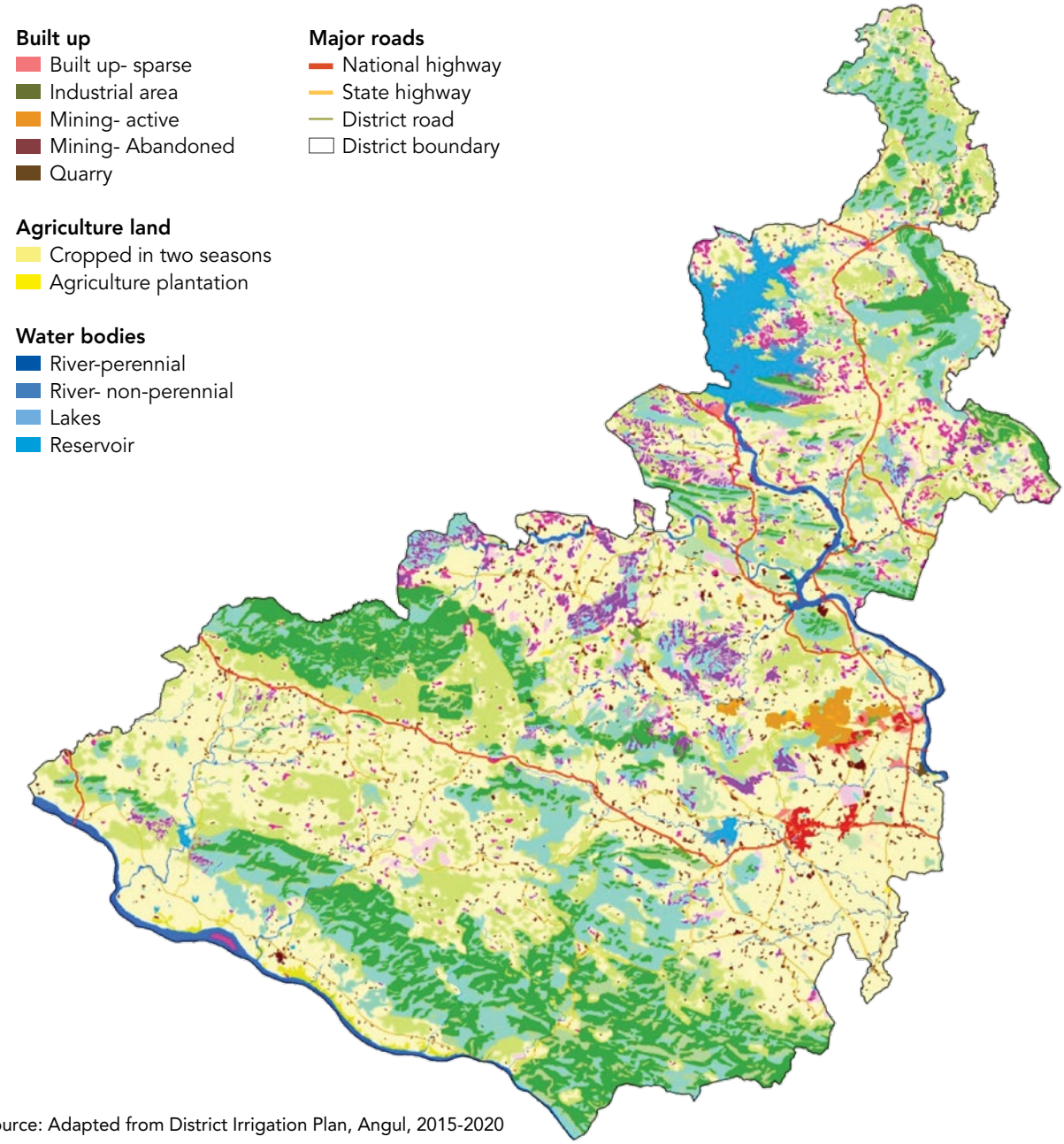
Table 1: Block-wise land use land cover

Block	Geographical area (ha)	Net sown area (%)	Area under forest (%)	Area under wasteland (%)	Area under other uses (%)
Angul	112,257.7	30.5	65.2	1.3	3
Athamallik	102,995.4	42.6	48.5	2.2	2.2
Banarpal	35,119.4	76.6	4.7	3.2	14.4
Chhendipada	86,051.6	46.1	37.2	11	5.1
Kaniha	71,144.4	37.1	39.2	12.4	10.5
Kishorenagar	84,049.1	43.3	52.6	1.2	2.4
Pallahara	117,395.2	31.6	45.8	10.1	12.4
Talcher	28,487.2	52.9	14.7	4.5	27.3
Total	**637,499.9**	**40.7**	**45**	**5.9**	**7.4**

Source: District Irrigation Plan, Angul, 2015-2020

Odisha Millet Mission

Map 2: Land use land cover



Source: Adapted from District Irrigation Plan, Angul, 2015-2020

2.3 Demography

As per the Economic Survey of the Government of Odisha (2021-2022), Angul's population is estimated to be nearly 1.4 million. About 81% of the district's population is rural, with the urban population being largely concentrated in Talcher, Angul and Banarpal blocks. About 17% of the population belongs to the Scheduled Tribe (ST) category, largely residing in the district's most forested and rural blocks – Athamallik, Pallahara and Kishorenagar.

Angul is overall sparsely populated except for the urban agglomerations. The population density of the district is 223 persons/sq. km., which is far less than Odisha's (270 persons/sq. km.) and the India average (423 persons/sq. km).

Table 2: Demographic distribution

Parameters	2021
Total population	1,396,000
Male population (%)	51
Female population (%)	49
Rural population (%)	81
Urban population (%)	19
SC population (%)	21
ST population (%)	17
Total no. of households	324,651
Population density (persons/sq.km)	223

Source: Census of India, 2011; Odisha Economic Survey 2020-21.
Note: Male, female, SC and ST population has been calculated assuming that the proportion of each demographic factor in the district's total population has remained as in 2011.

Table 3: Block-wise demographic distribution

Block	Total population	Rural (%)	Urban (%)	SC (%)	ST (%)
Talcher (including Talcher municipality)	201,075	53	47	18.6	8.1
Chhendipada	182,759	100	0	21.5	10.7
Kaniha	156,847	93	7	21.5	8.4
Banarpal	229,574	76	24	20.7	7.3
Angul (including Angul municipality)	230,769	79	21	17.9	9.2
Kishorenagar	118,172	100	0	14.9	20.1
Pallahara	142,267	96	4	15.4	39.2
Athamallik (including Athamallik NAC)	134,644	90	10	17.5	22.3

Note: Block-wise population has been calculated assuming that the proportion of each block's population, including the SC and ST population, in the district's total population has remained the same as in 2011; Urban and rural population share has been calculated against the overall urban projection for 2021 as per the Odisha Economic Survey, 2021-22, assuming that the proportion of the urban population in the blocks has remained the same.

2.4 Economic sectors

The secondary sector – comprising manufacturing, electricity, gas and water supply, and construction – has the largest share in Angul's gross domestic product (GDP), accounting for nearly 43% of the contribution. This is followed by the primary and tertiary sectors.[7]

However, as a standalone sector, the manufacturing sector has the highest contribution to the district's GDP, which is about 32%. This is largely due to the presence of large-scale aluminium and steel industries, and thermal power plants operational in the district (*Refer to Chapter 3*). The mining and quarrying sector, dominated by coal, is the second-largest sector contributing to 21.6% of the overall GDP. Collectively, mining and quarrying, along with the industrial sectors, account for nearly 61% of the district's GDP.[8]

Though more than 80% of the district's area is under agriculture and forests, the economic contribution of these sectors remain low due to the suboptimal utilisation of potential.

Table 4: Share of economic sectors in the district GDP

Sector	Share in district GDP (%)
Primary sector	**31.1**
Agriculture	7.4
Forestry	1.6
Fishery	0.5
Mining and Quarrying	21.6
Secondary sector	**42.8**
Manufacturing	32.1
Electricity, Gas and Water supply	7.2
Construction	3.6
Tertiary sector	**26.1**

Source: Directorate of Economics and Statistics, Odisha. GDP reference year 2011-12.

2.4.1 Primary sector

Mining and agriculture are the two key economic activities of the primary sector outlined in the section. Given the vast geographical area under forest, the status of forestry has also been discussed.

Coal mining

Angul is home to the biggest coalfield in the country – Talcher coalfields – which has 52,550 million metric tonnes (MMT) of coal resources.[9] The coalfields are spread largely across the Talcher block and to some extent in the Chhendipada and Kaniha blocks.

Given its large resources, Angul remains one of the top coal producers in the country. In 2021-22, it accounted for nearly 12.5% of the total coal produced (96.7 MMT) in the country, making it India's third-largest coal-producing district after Korba (Chhattisgarh) and Singrauli (Madhya Pradesh).[10]

Nine mines – one underground (UG) and eight open cast (OC) – are currently operational in the district. Besides, seven upcoming coal mines (including three captive) and eight allocated blocks are expected to commence operation in the next five to seven years.[11] (*Refer to Chapter 3*).

Agriculture

About 40% of Angul's geographical area is net sown, indicating that cultivation is a key activity among the locals, for self-consumption as well as commercial purposes. The highest share of the net sown area is spread across the rural blocks of Athamallik (17%), Chhendipada (15%), Kishorenagar (14%), and Pallahara (14%).[12]

Paddy is the main crop cultivated and Angul falls in the top-five districts in Odisha having a high paddy yield of more than 4,600 kg/ha.[13] Apart from paddy, maize and legume crops such as urad, gram, groundnuts, etc., are also cultivated widely.[14] An estimated 53% of the district's workers depend on cultivation either as cultivators or as agricultural labourers.[15]

Table 5: Crop production

Crop	Season	Area (ha)	Production (t)	Yield (t/ha)
Rice	Summer, autumn and winter	62,060	192,900	3.1
Arhar	Summer and autumn	9,250	9,570	1
Coriander	Winter	3,400	2,620	0.7
Dry chillies	Summer, autumn and winter	4,630	5,930	1.2
Garlic	Winter	4,070	11,670	2.8
Onion	Winter	4,950	65,930	13.3
Other pulses	Winter	5,050	2,460	0.4
Sweet potato	Summer, autumn and winter	980	9,090	9.2
Ginger	Summer and autumn	460	6,160	13.3
Potato	Winter	394	4,990	12.6
Groundnut	Summer and autumn	1,253	2,654	2.1
Sugarcane	Winter	6	351	58.5
Others	Different seasons	4,019	9,480	

Source: Ministry of Agriculture and Farmers' Welfare, 2019

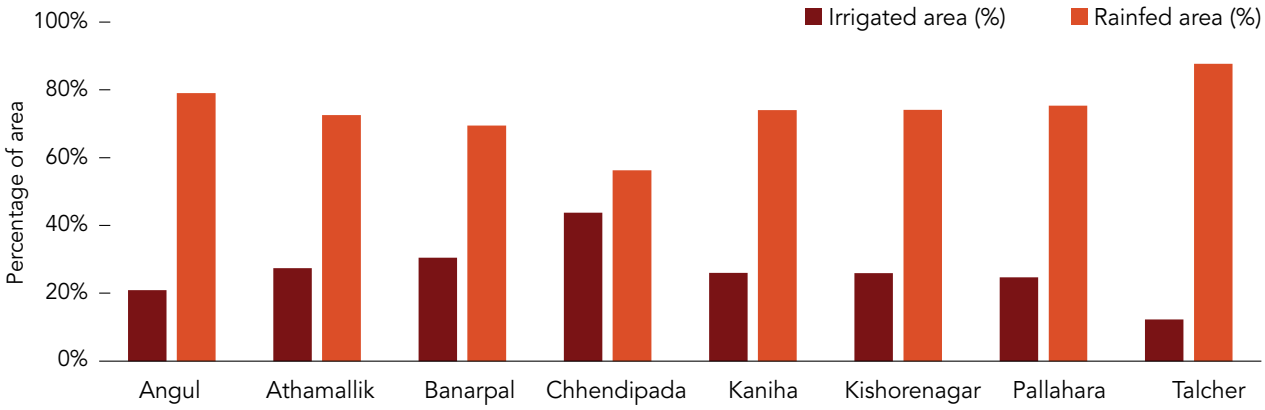
The district also has a significant horticulture potential. Horticultural crops and plantations cover 22,635 ha (about 9%) of the district's net sown area.[16] The crops include vegetables (such as mushrooms, tomato, brinjal, cabbage, etc.), fruits (mango, aonla, litchi, banana, guavas, etc.), flowers (marigold, gerbera, gladioli and rose), and spices (coriander, turmeric, etc.).[17] About 98% of this area is spread in five blocks – Angul, Athamallik, Chhendipada, Pallahara and Kishorenagar – which also are the non-mining blocks.[18]

While Angul produces crops all year round, the high reliance on rain-fed agriculture makes the district vulnerable to crop failures in case of extreme weather events, such as drought. Of the total net sown area, only 26% is currently irrigated.[19]

Despite the presence of surface water bodies in the district, such as Brahmani and Mahanadi river basins, the potential has not been utilised optimally. As per interactions with the district agriculture department, even the existing irrigation potential is plagued by poor maintenance of the schemes, rendering them defunct.[20] The depletion of the ground water table due to industrial activities, particularly in Angul and Talcher blocks, has compounded the problem by affecting groundwater availability to complement micro-irrigation schemes.[21]

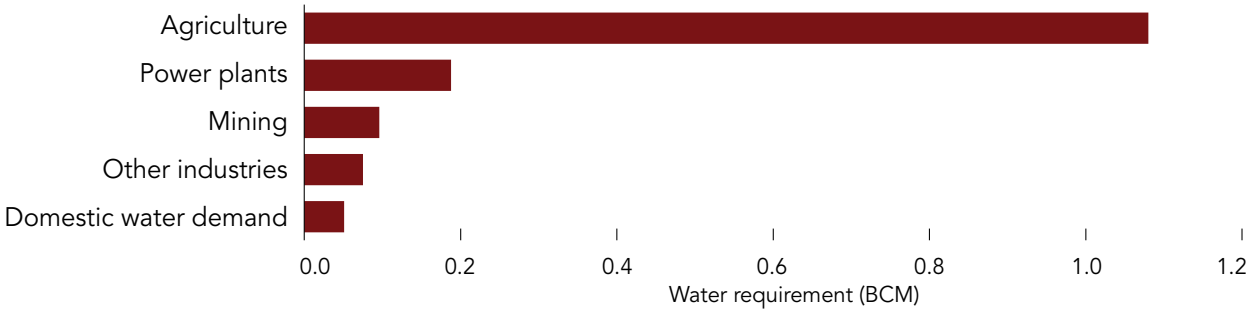
Rainwater harvesting is being seen as a potential option to recharge the dwindling ground water table in Angul district. In 2021, Angul municipality received a grant of ₹5 million (US$ 0.6 million) for digging 200 pits at different locations within the municipality.[22]

Figure 1: Block wise irrigated and rainfed area



Source: District Irrigation Plan, 2015-20

Figure 2: Water demand for agriculture and other sectors



Note: Domestic water demand has been calculated keeping projected population for 2021 and a daily water requirement of 100 liters per day; For water demand for agriculture, a demand of 400 mm has been assumed for total gross cropped area round the year; for coal mining about 1 m^3/tonne has been considered; for power plants maximum demand of 5 m^3/MWh has been considered and for other industries demand has been considered as 40% of power plants, as per Indian average.

Besides, the small size of landholdings has also undermined the income potential from the agriculture sector. Among the 50% of rural households with agricultural landholdings, most are marginal. As the analysis of the landholding data shows, nearly 86% are marginal, that is, below one hectare, and another 11% are small. This makes agriculture largely self-subsisting, with limited and low income from commercial sales.[23]

Table 6: Proportion of rural households with landholdings

Block	Households with landholdings (%)
Talcher	25
Chhendipada	71.7
Kaniha	49.2
Banarpal	41.9
Angul	36.4
Kishorenagar	63
Pallahara	48.9
Athamallik	69

Source: Socio-economic caste census, 2011

Table 7: Agricultural landholding size

Size of landholding	No. of landholdings	Proportion of landholdings (%)
Below 0.5 hectare	87,539	58.8
0.5-1 hectare	40,169	27
Total marginal	**127,708**	**85.8**
1-2 hectare	15,970	10.7
Total small	**15,970**	**10.7**
2-3 hectare	3,718	2.5
3-4 hectare	551	0.3
Total semi-medium	**4,269**	**2.8**
4-5 hectare	529	0.3
5-7.5 hectare	161	0.1
7.5-10 hectare	47	0.03
Total medium	**737**	**0.5**
10-20 hectare	54	0.04
20 hectare and above	29	0.02
Total	**148,767**	**100**

Source: Agricultural Census, 2015-16

Angul is also vulnerable to weather disruptions. It falls in the "moderate damage risk zone" of winds and cyclones in Odisha which leads to crop damage. Rainfall deficit is also a looming concern. In 2020-21, Angul faced 40% of rainfall deficit as per the Indian Meteorological Department (IMD).[24] These factors also affects agricultural productivity and rural income.

Overall, agriculture potential in the district is high, but poor penetration of irrigation, small holdings and periodic droughts affect the productivity and limits the scope of building economies of scale around it. This is can be improved through rainwater harvesting, investing in solar-based irrigation and collectivising farmers for production and incentivising climate resilient crops.

Forest

As discussed earlier, about 286,875 ha of area in Angul is forested, which is nearly 45% of the district's geographical area. The forest is divided into three main forest divisions – Angul, Athamallik and Satkosia. Some parts of the Pallahara block also fall under the Deogarh forest division.[25] Apart from these, there is Kenduleaf forest division which falls between Angul and the neighbouring districts, to oversee tendu leaf (*Diospyros melanoxylon*) collection and management. About 33% (96,387 ha) of the forest area falling in the Satkosia division is classified as a tiger reserve.[26]

Four blocks – Angul, Athamalik, Pallahara and Kishorenagar – account for 77% of the area under forests. These blocks are also the rural and non-mining blocks.

The forest area in Angul is categorised as dry to moist deciduous.[27] While sal, teak and bamboo are found prominently, one can also find patches of mixed forests having all these varieties together.

Apart from wood and bamboo, 93 recognised varieties of non-timber forest produce (NTFPs), including *tendu* leaves, *mahua* flowers and seeds (*Madhuca indica*), siali leaves and seeds, lodha, *harra behera* (*Tamarindus indica*), tamarind, honey, gooseberries, *bel* (*Aegle marmelos*), etc., are also found in the forests of Angul. These are used for making medicinal, edible, and various other commercial products.

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The economy around NTFPs in the district is largely concentrated around the collection and selling of *tendu* leaves. About 44,300 people were engaged in *tendu* leaf collection and ₹15 million (US$ 187,787) was disbursed as wages for *tendu* collection in the year 2020-21.[28]

While locals collect other NTFPs, they sell very small quantity of raw produce for additional income to complement agriculture.[29] The NTFP potential in the district is underutilised due to the lack of training among the locals for value addition processes such as moisture reduction and de-seeding of produce. The absence of processing and storage facilities, and lack of collectivisation for sale to traders are other issues.[30] In Angul, the produce is largely collected for self-consumption.

Additionally, the district also has *tasar* silk potential as it is suited for Asan and Arjun trees, which are the host trees for rearing silkworms. The tribal population in Pallahara, Kishorenagar and Athamallik blocks are engaged in *tasar* rearing around the forest fringes.[31] However, there is no *tasar* reeling or processing centre in the district currently.[32] The government only procures the cocoons from the locals.

For forest potential development, joint forest management (JFM) activities are being promoted. JFM is a programme under the National Forest Policy of 1988, where the "state forest departments support local forest-dwelling and forest fringe communities to protect and manage forests and share the costs and benefits from the forests with them."[33] So far, the Athamallik and Angul blocks have been identified under the JFM programme as one of the project areas. In Athamallik, the project is being funded by Japan International Cooperation Agency (JICA) and it is being executed through the Odisha Forestry Sector Development Society with the goal of promoting sustainable livelihoods and community development through sustainable forest management. According to the information procured at district level, around 249 *Vana Samrakshana Samities* (VSS) have been created and 255 local self-help groups (SHGs) have been mobilised for work on NTFPs alone in the Athamallik division. The project will go on until 2027.[34] However, there is wide consensus among independent experts that the way JFM activities are carried out, they contribute very little towards livelihoods and community empowerment due to the lack of forest rights being granted to the communities, insufficiency of funds and little or no compensation for forest land loss from mining activities.[35]

Angul falls among the non-tribal sub-plan districts, which means that it is not covered under the funding and facilities accorded to the tribal districts for the development of NTFPs. Hence, the development of forest potential does not have the necessary policy support, and market mechanisms for value addition. Also, there is an absence of a nodal department to oversee the development of NTFPs. The lack of a clear policy mandate and a well-structured mechanism around it has limited the potential of income from NTPFs in the district and its commercialisation.

Additionally, the harnessing of the forest potential is also affected by the poor settlement of forest rights in the region. One of the important rights recognised under the Forest Rights Act (FRA, 2006) is community forest resource (CFR) rights which allows independent communities to manage their forests for sustainable use. No CFR claim has been settled in Angul so far.

Poor facilities and no legal rights granted to dwellers for the collection of NTFPs have been identified by the district itself as a big deterrent in optimal harnessing of the forest potential in the district.[36]

Table 8: Block-wise area under forest

Block	Geographical area (ha)	Area under forest (ha)	Area under forest (%)
Angul	112,257.7	73,176.3	65.2
Athamallik	102,995.4	49,976.4	48.5
Banarpal	35,119.4	1,643.3	4.7
Chhendipada	86,051.6	32,012	37.2
Kaniha	71,144.4	27,920	39.2
Kishorenagar	84,049.1	44,194.5	52.6
Pallahara	117,395.2	53,824.5	45.8
Talcher	28,487.2	4,187.2	14.7
Total	**637,499.9**	**286,934.4**	**45**

Source: District Irrigation Plan, 2015-2020

Table 9: Status of settlement of forest rights

Claims	IFR	CF rights	CFR rights
Claims filed at gram sabha level	8,960	547	53
Claims recommended by the sub divisional level committee (SDLC) to District Level Committee (DLC)	3,452		
Claims approved by DLC and title deeds distributed	2,823	28	0
Forest land for which titles distributed (ha)	723.53	124.85	0

Source: SC and ST development, Minorities and Backward Classes Welfare Department, Odisha, December 2021

2.4.2 Secondary sector

The economy of Angul is dominated by the manufacturing sector, much of which is due to the availability of coal and other raw materials in the state.

Angul is a coal-based thermal power hub of the state, with 43% of Odisha's total installed capacity. The biggest operator in the district is National Thermal Power Corporation (NTPC) Limited, the central government PSU.

Currently there are four coal-based thermal power plants (two grid connected and two captive) with a combined capacity of 6.2 gigawatt (GW). There are a several heavy industries operational in the district. The National Aluminium Company Limited (NALCO) operates an aluminium smelter of 0.4 million metric tonne per annum (MMTPA) production capacity. There is also an integrated steel plant of 6 MMTPA capacity operated by Jindal Steel and Power Limited (JSPL).

The district is experiencing further industrial expansion given the availability of resources, well-developed infrastructure in urban and industrial areas, and connectivity with the state capital. For example, the integrated steel plant operated by JSPL is slated for an expansion to 25 MMTPA capacity. Additionally, the district has received approval from the state government for an aluminium park. The project will be provided budgetary assistance of ₹4.3 billion and is expected to be completed within the next three years.[37] As part of its industrial vision, the district is also inviting investments for ancillary and downstream industries around steel and aluminium.[38]

Besides the heavy industries, there are three industrial estates in the district where more than 3,500 micro, small and medium enterprises (MSMEs) are concentrated. Two of these estates – Talcher and Kangula – are located in the Talcher block and one – Angul – is located in the Angul block. The largest number of MSMEs in the district are in the repair and servicing sector, indicating high vehicular movement, particularly of heavy vehicles such as trucks. The district also has a concentration of food processing, engineering and metal industries.

As per the officials of the Industrial Promotion and Investment Corporation of Odisha (IPICOL), Angul is also in the process of setting up an MSME park, for which an area of 21 ha has been earmarked.[39] The MSME sector is a growing opportunity in Angul district. In terms of MSME registrations, there has been a 36% increase in the number of registered MSME units from 2018 to 2019.[40]

Table 10: Industrial estates

Name	Total land (ha)	Land allotted (ha)
Angul Industrial Estate	90.9	4.8
Talcher Industrial Estate	28.8	15.3
Kangula Industrial Estate	2	1.2

Source: District Industry Centre, Angul

Table 11: Large scale industry

Company	Industry	Block
NALCO	Aluminium smelter and TPP	Angul
NTPC Limited	TPP	Kaniha
MCL	Coal	Talcher and Kaniha
JSPL	Steel and TPP	Angul
Ganesh Sponge Pvt. Ltd.	Sponge iron	Angul

Source: District Industry Centre, Angul

Table 12: Category of MSME

Category	No. of units
Food and allied	337
Chemical and allied	21
Electrical and electronics	5
Engineering and metal based	315
Forest and wood based	37
Glass and ceramics	118
Livestock and leather	1
Paper and paper product	40
Rubber and plastics	17
Textiles	67
Miscellaneous manufacturing	173
Repairing and servicing	2,452
Total	**3,583**

Source: Industrial Profile of Angul District, 2017-18

2.5 Employment and income

According to Census 2011, 41.3% of the population of the district are workers, which is less than Odisha's average of 48.3%. The agriculture sector employs about 53% of total workers, which include agriculture labourers (32.7%) and cultivators (20.4%). Overall, 58.7% of people in the district are 'non-workers', including people of all age-groups. Specifically considering the working age-group of 15-59 years, the work participation in the district is still poor, as 43% people are non-workers.

Table 13: Categories of workers

Category	Proportion of total workers	Proportion of total population
Main workers	60.3	24.9
Marginal workers	39.7	16.4
Total workers	**100**	**41.3**
Cultivators	20.4	8.4
Agricultural labour	32.7	13.5
Workers in household industry	6.7	2.8
Other workers	40.2	16.6
Non workers		**58.7**

Source: Census of India, 2011

The district's unemployment rate, which takes into account the population actively seeking work, stands at 12.4%, significantly higher than Odisha's unemployment rate of 7.1%. Unemployment in the district has further increased in the past two years as evident from the work demand Mahatma Gandhi National Rural Employment Guarantee Scheme (MGNREGS) – India's biggest rural job guarantee programme which provides at least 100 days of employment. The scheme relies on work demanded by people.

The data shows that job demand under MGNREGS more than doubled in 2020-21 and there was only a marginal reduction in the following year. The increase in demand also coincides with the Covid-19 pandemic, which saw many migrant workers returning home, and many others looking for jobs due to the closure of local industries during the lockdown. While the demand increased, the proportion of households that were provided with work reduced during this period.

Table 14: Unemployment rate

Unemployment rate (%) (2017-18)	Total	Rural	Urban	Male	Female
Angul	12.4	11.7	17.8	11.5	25.6
Odisha	7.1	6.9	8.3	7.3	6.2

Source: Angul District Handbook; Data for 2017-18

Table 15: Demand for work under MGNREGS

Year	Households demanded employment	Households provided work	Households provided work (%)
2017-18	54,066	50,773	93.9
2018-19	48,488	44,858	92.5
2019-20	45,101	42,473	94.1
2020-21	112,805	94,980	84.1
2021-22	97,013	84,850	87.4

Source: MGNREGS MIS extracted in February, 2022.

Income levels in the district, however, vary between urban and rural areas. While no clear estimates are available, primary survey findings suggest that urban areas are better off in terms of income earned and the high-income households are concentrated in the urban regions close to mines and TPPs *(Refer to Chapter 4)*. Poverty estimates available for the rural areas suggest that the below poverty line population in the rural areas of the district is about 22%.[41] In about 83% of households, the highest earning member earns less than ₹5,000 (US$ 62) per month.[42]

2.6 Environmental pollution

Angul-Talcher industrial cluster is classified a critically polluted by the Central Pollution Control Board (CPCB). As per the latest available data, the industrial cluster has a Comprehensive Environmental Pollution Index (CEPI) of 72.8 (aggregate CEPI scores of 70 and above is deemed "critically polluted").[43] The CEPI score assesses air, water and land pollution and provides a composite index. In Angul-Talcher cluster, air and water quality is categorised as "critical". The critically polluted area of the Angul-Talcher cluster spreads over an area of about 35,000 ha, covering parts of Angul and Dhenkanal districts.

Large-scale industrial activities in the district have been contributing to the pollution of air and water. Coal mining activities and coal-based power plant operations are the two most significant ones. Government records for pollution monitoring stations near the coalfields in Talcher and industrial areas of Angul show that air pollution is in critical category in both of these areas.[44] Besides, there are a number of other industrial operations that contribute to pollution in the district. Overall, in Angul, there are 69 red category industries, 94 orange category industries, and 17 green category industries.[45]

A major factor is the poor regulatory compliance of these industries with respect to pollution control measures. As observed by the CPCB, most industrial set-ups using boilers or furnaces have installed air pollution control systems like electrostatic precipitators (ESPs), cyclones and scrubbers, etc., but their operation and use is a major concern.[46]

Overall, air pollution remains a critical issue, particularly for the urban population in Angul and Talcher. Both Talcher and Angul municipalities are among the 132 "non-attainment" cities as per the National Ambient Air Quality Standards (NAAQS), and under the National Clean Air Program (NCAP).[47]

Besides air pollution, the other major problem is related to the pollution of rivers (surface water bodies), that flow through the district. Three river stretches (Nandirajhor, Kusumi and Banguru Nallah) flowing along Angul and Talcher are among the most severely polluted river stretches of the country as identified by the CPCB (2018). Besides, the Mahanadi river, which has a 22 km stretch in Angul, also remains severely polluted.[48]

Various industrial activities in the Angul-Talcher industrial area are a significant cause for surface water pollution. One of the key pollution sources identified by scientific studies include industrial effluent discharges. Besides, surface runoff from mining areas is another major concern.[49]

The groundwater in the district is not universally polluted and most testing sites show water quality within the permissible limits for drinking and irrigation.[50] However, higher than permissible levels of fluoride (above 1.5 mg/l), nitrate (above 45 mg/l) and iron (above 1 mg/l) have been recorded in parts of the district.[51] In particular, high fluoride levels have been recorded in a areas close to the NALCO aluminium smelter, likely due to percolation of fluoride contaminated effluents.[52]

Additionally, fly ash management is a key challenge for the district. As per data of the Central Electricity Authority (CEA) of fly ash utilisation for the year 2020-21, two out of four TPPs in the district (run by Jindal Steel and Power Limited, and Jindal India Thermal Power Limited) utilises 55% of the ash generated. The

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TPPs operated by the PSUs, the Talcher Kaniha STPS and NALCO captive power plant, recorded a better utilisation of over 70%.[53] However, none of these plants meet the requirement now stipulated by the Ministry of Environment, Forest and Climate Change (MoEF&CC).

The notification of the MoEF&CC of December 2021, has mandated a 100% utilisation of fly ash by all TPPs generated during that year. It further specifies that in no case the utilisation shall fall below 80% (even for the first year since the notification), and the TPPs must achieve average ash utilisation of 100% in a three years cycle. The problem of legacy ash generation and non-compliance has also been addressed in the notification. It has been specified that the unutilised accumulated ash (legacy ash), which is stored prior to the current notification, must be progressively utilised by the TPPs, and utilisation must be completed over the next 10 years. In all cases, "eco-friendly" utilisation of the ash is required, including use for brick making, cement production, filling up of mine voids, construction of shoreline protection structures in the coastal districts, etc. [54]

For TPPs in Angul, legacy fly ash utilisation will be a key issue for the private sector operated TPPs. For the PSU run plants too, the ash utilisation must meet the target. A key consideration for utilisation is filling up mine voids, a proposition which is also of interest to the mining industry. While this can help to fulfil obligations of fly ash utilisation and mine closure, from a just transition perspective it is important to consider the land repurposing opportunity of the mining land once voids are filled with fly ash.

Overall, considering the scale of industrial operations in Angul, environmental management and compliance will remain a key issue. These aspects must be an integral component of the industrial expansion plans. At the same time, the capacity of the authorities involved in monitoring of environmental compliance must be strengthened to ensure compliance. Finally, the district must make every effort to move to green industrial practices in the coming years and function within the principles of a circular economy.

CHAPTER 3

THE COAL ECONOMY

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- *Angul accounts for 12.5% of India's and 56% of Odisha's total coal production.*
- *Coal production will peak at 308 MMTPA in 2033 with planned expansion of current mines and new mines commencing operation.*
- *MCL, the largest PSU operational in the district is the most profitable subsidiary of CIL.*
- *Angul is also a key producer of coal-based thermal power with an installed capacity of 6,210 MW, including captive plants.*
- *Nearly 88% of coal produced in the district is used for consumption by coal-based power plants in Odisha and other states.*

3.1 Overview

Coal mining in Angul has a history of more than 100 years, starting with the opening of Handidua colliery by M/s Villiers in 1921. In the following decades, more underground (UG) operations started in the district (then part of undivided Dhenkanal), such as Talcher colliery, Deulbera and Nandira, which were operated by the railway companies owned by the Government of India.[1] In 1960, the first open cast (OC) mine – south Balanda – became operational in Angul and was run by the National Coal Development Corporation Ltd. (NCDC), the erstwhile arm of Coal India Limited (CIL).[2]

With the nationalisation of coal in India in 1973, all mines in the district came under CIL.[3] As CIL established its subsidiaries, coal mines in Angul were first operated by South Eastern Coalfields Ltd. (SECL), before Mahanadi Coalfields Limited (MCL) was formed as the eighth and the last subsidiary of CIL in 1992. After that, all coal mines came under its ambit.[4] Around the same time, in 1993, Angul was also separated from Dhenkanal.[5]

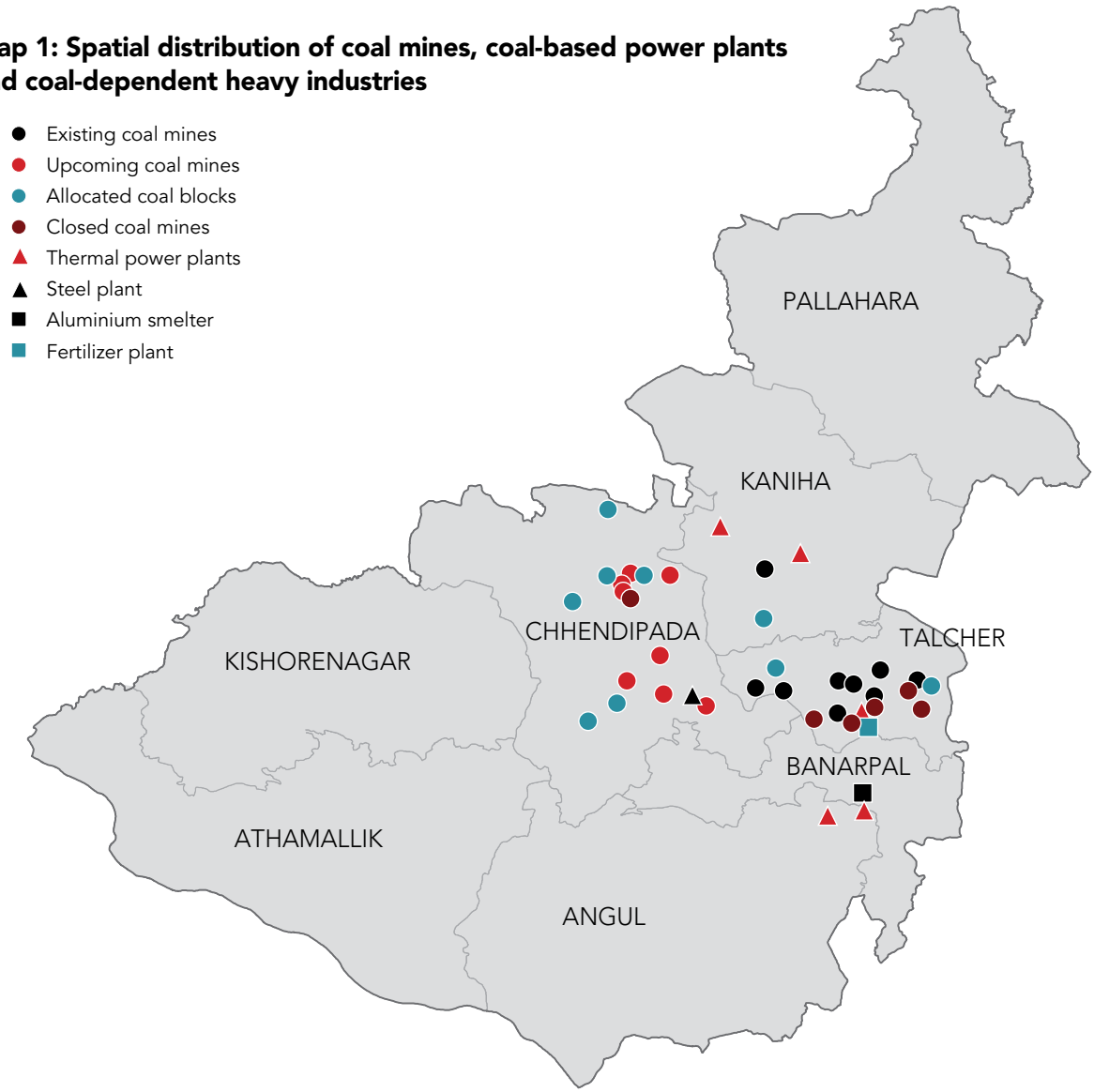
Currently, Angul is the third-largest coal-producing district of India accounting for about 12.5% of the total coal produced in the country (96.7 MMT in 2021-2022). Evidently, the district is Odisha's largest coal producer, accounting for more than half (56%) of the state's total production, followed by Jharsuguda (41.4 MMT) and Sundargarh (33 MMT) districts.[6] It also has a large concentration of CIL's top producing mines. Out of the 37 mines that account for 70% of CIL's production, eight are located in Angul.[7]

The abundance of coal has also led to the establishment of various coal-based industries in the district. The key ones include power plants, aluminium smelter, integrated steel plant, fertilizer plant, etc. Besides, the coal produced in Angul is transported to various districts of Odisha and to other states. As per company information, in 2021-22, about 52% of the coal produced was dispatched within Odisha, about 21% to Andhra Pradesh and 18% to Tamil Nadu. Additionally, West Bengal, Karnataka, Chhattisgarh and Punjab also source coal from the district. Nearly 88% of the coal dispatched was used for coal-based thermal power plants (TPP), including captive plants.[8] The remaining was consumed by sponge iron, aluminium, steel and paper industries.

This chapter provides an overview and assessment of the status of coal mining activities, and coal-based industries in the Angul district, including those that are planned in the near future.

Courtesy: NALCO, Angul

Map 1: Spatial distribution of coal mines, coal-based power plants and coal-dependent heavy industries



3.2 Coal mining

Angul is home to India's biggest coalfield, Talcher coalfield, which has 62% of Odisha's and 24% of India's total coal resources.[9] The name is eponymous with the Talcher block, where most of the coal mines in the district are currently located.

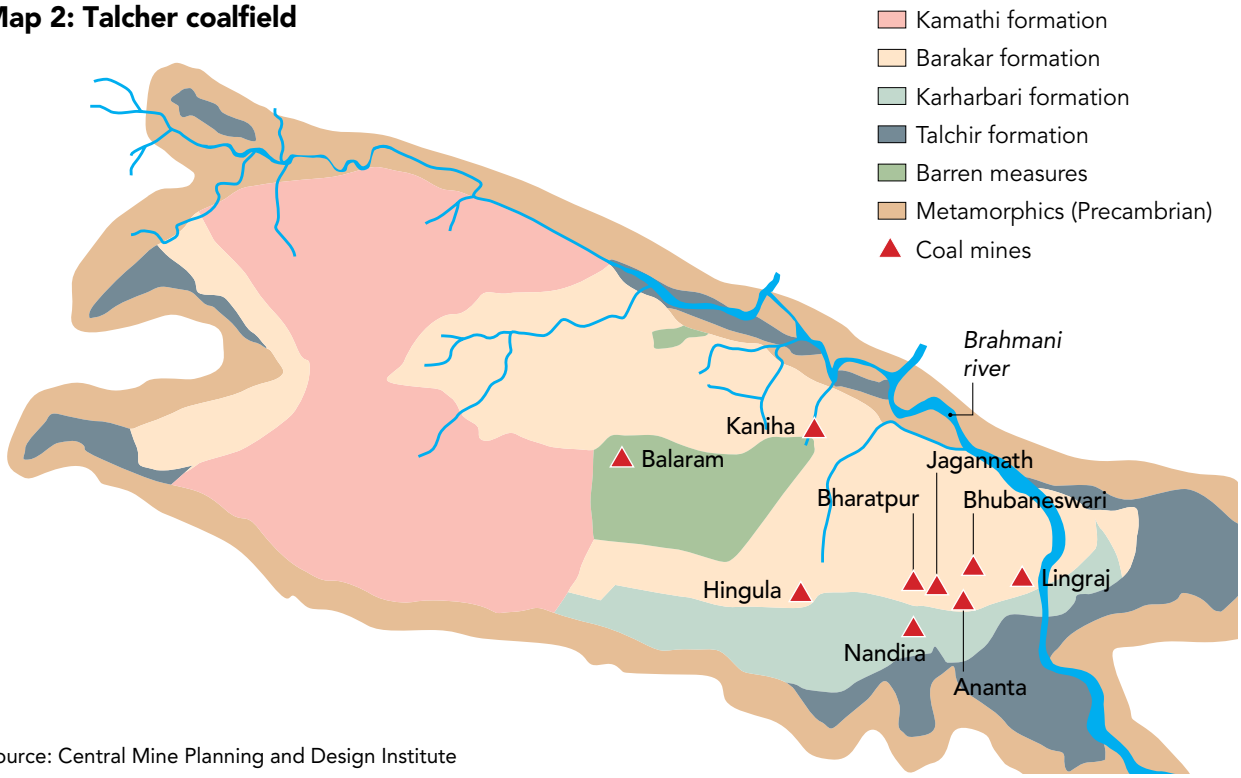
Angul produced 96.7 MMT of coal in 2021-22, up from 88.7 MMT in the preceding year.[10] This production came from nine mines, of which eight are OC operations, and only one is an UG operation. All mines are operated by the publicly-owned MCL. The operation of one mine, Bhubaneswari, has been outsourced to the private-run Essel Mining & Industries Limited (EMIL), a mine developer and operator (MDO) company, which is an arm of the Aditya Birla Group.

Table 1: Coal resources in Angul

Coal reserves	Proved (MMT)	Indicated (MMT)	Inferred (MMT)	Total (MMT)
India	163,460.8	150,391.9	30,168	344,020.8
Odisha	40,871.7	36,067.1	7,713.1	84,652
Angul (Talcher coalfields)	25,515.8	22,931.8	4,102.5	52,550.3
Proportion of Odisha's coal resources in Talcher coalfields (%)	**64**	**63.6**	**53**	**62**

Source: Indian Minerals Yearbook, 2020, Indian Bureau of Mines.

Map 2: Talcher coalfield



Source: Central Mine Planning and Design Institute

Table 2: Operational coal mines

Name of mine	Block	Operation type	Public/ Private	Capacity (MMTPA)	Production (MMT) (2021-22)	Area (ha)
Nandira	Talcher	UG	Public	0.3	0.08	370
Jagannath	Talcher	OC	Public	7.5	7	553.9
Bharatpur	Talcher	OC	Public	20	9.2	927.4
Balaram	Talcher	OC	Public	8	6.5	1,309
Ananta	Talcher	OC	Public	15	13.6	1,419.8
Lingaraj	Talcher	OC	Public	16	14.5	1,493.2
Kaniha	Kaniha	OC	Public	14	10.1	718
Hingula	Talcher	OC	Public	15	7.7	1,870
Bhubaneswari	Talcher	OC	Public	28	28	638.3
Total				**123.8**	**96.7**	**9,299.6**

Source: Area and capacity from the recent Environment Clearance letters of respective coal mines; Operational mines, production from Mahanadi Coalfields Limited, March 2022

Coal mining in Angul is set for further expansion, both in terms of capacity enhancement of current projects as well as new mining projects. Capacity expansion is currently proposed for three mines, namely, Balaram (15 MMTPA), Bhubaneswari (50 MMTPA) and Kaniha (30 MMTPA).[11]

Further, seven projects are upcoming, including commercial and captive mines. Besides MCL, the operators of these projects include Singareni Collieries Company Limited (SCCL), which is owned by the Ministry of Energy, Government of Telangana, EMIL, Vedanta, NTPC Limited, NALCO, etc.[12]

In addition, many coal blocks in Angul have been allotted by the Government of India (GoI), on which work is yet to begin.[13] For instance, Utkal B1 and B2 have been allotted to Jindal Steel and Power Limited (JSPL), Chandrabila block to Tamil Nadu Generation and Distribution Corporation Limited, New Patrapara to SCCL,

Mandakini to Karnataka Power Corporation Limited, Surapal, Nuapara to Andhra Pradesh Power Generation Company Limited, and Baitarni West and Brahmani to Odisha Mineral Corporation (OMC).[14] Considering the expansion in capacity of existing mines and new mines (included allocated coal blocks), the coal production in Angul is slated to go up to 308.8 MMTPA by 2033.[15]

Table 3: Upcoming coal mines

Name of mine	Block	Operation type	Operated by	Production capacity (MMTPA)	Area (ha)
Naini	Chhendipada	OC	Singareni Collieries Company Limited (SCCL)	10	912.8
Radhikapur East	Chhendipada	OC	Essel Mining & Industries Limited (EMIL), Mines and Mineral Resources Limited (EMMRL)	5	1,030
Subhadra	Talcher	OC	MCL	25	1,145
Radhikapur West (Captive)	Chhendipada	OC/UG	Vedanta Limited	6 (5.3 OC;0.7 UG)	1,048
Mandakini B (Captive)	Talcher	OC	NTPC	20	2,073
Utkal D, E (Captive)	Chhendipada	OC	NALCO	4	843
Balabhadra	Talcher	OC	MCL	10	523.6

Source: District Mines Department; Area and production capacity from respective mines' pre-feasibility and environment clearance reports.

Table 4: Coal blocks allotted

Coal blocks allotted	Block	Capacity (MMTPA)	Extractable reserve (MMT)	Allottee
Utkal B1 and B2	Chhendipada	8	173.5	Jindal Steel and Power Limited (JSPL)
Chandrabila	Kaniha	6	200	Tamil Nadu Generation and Distribution Corporation Limited
New Patrapara	Chhendipada	20	1,042	Singareni Collieries Company Limited (SCCL)
Mandakini	Kaniha	7.5	287.8	Karnataka Power Corporation Limited
Surapal, Nuapara	Chhendipada	6	200	Andhra Pradesh Power Generation Company Limited
Baitarni West	Chhendipada	15	468.2	Odisha Mineral Corporation
Brahmani	Talcher	2	58.9	Odisha Mineral Development Corporation
Utkal C	Chhendipada	3.37	123.8	Gujarat State Electricity Corporation Limited

Source: Provisional Coal Statistics, 2020-21, MSTC e-commerce portal, Ministry of Coal. For blocks where the peak capacity was not provided, a mine life of 33 years was assumed for the calculation, based on Ministry of Coal guidelines.[17]

Besides the operational and upcoming mines, the district currently has six closed mines, of which five are UG. All the mines have been closed after the exhaustion of coal reserves. MCL has been trying to reopen the Chhendipada mine. However, the project is currently stalled due to local protests.[16]

Table 5: Closed mines

Name of mine	Block	Operation type	Lease area (ha)	Temporarily/permanently closed
Deulbera Colliery	Talcher	UG	954.1	Permanently closed
Handidhua Colliery	Talcher	UG	553.6	Permanently closed
South Balanda	Talcher	OC	1,208.7	Permanently closed
Talcher Colliery	Talcher	UG	1,140	Temporarily closed
Chhendipada	Chhendipada	OC	24.3	Temporarily closed
Natraj	Talcher	UG	483.2	Temporarily closed

Source: Mahanadi Coalfields Limited, 2022

3.2.1 Spatial distribution

Coal mines in Angul – including operational and closed mines – are spread across an area of nearly 13,662 ha, which is over 2% of the district's geographical area. This will further go up to 5% of the total area if the upcoming mines, allotted blocks and expansion of current mines is considered.

Currently, mining activity is concentrated in the Talcher block, which has eight out of the nine operational coal mines. One mine is located in the Kaniha block. Almost all the closed mines (five out of six) are also located in Talcher. The mining area (considering operational and closed mines) nearly covered 12,920.6 ha in Talcher, which is 45.3% of the block's geographical area. The future expansions are largely planned in the neighbouring Chhendipada block.

3.2.2 Financial status

Among all the CIL subsidiaries, MCL is the highest profit-making arm, recording a net profit (after tax) of ₹68.7 billion (US$ 860 million) in 2020-21.[18] In Angul, except for Nandira, which is an UG and low producing mine, all the OC mines are profitable operations. The cost of per tonne coal production in these mines is low, particularly for Lingaraj, Kaniha, Bhubaneswari, which are among the relatively newer operations.

Table 6: Financial status of operational coal mines

Name of mine	Grade of coal	Cost of per tonne coal production (₹/tonne)	Financial performance
Nandira	G8	26,450	Unprofitable
Jagannath	G12	590	Profitable
Bharatpur	G13	710	Profitable
Balaram	G13	700	Profitable
Ananta	G12	670	Profitable
Lingaraj	G13	450	Profitable
Kaniha	G14	460	Profitable
Hingula	G14	730	Profitable
Bhubaneswari	G12	300	Profitable

Source: Mahanadi Coalfields Limited, 2021-22; Coal India Limited, 2020.

3.2.3 Revenue contribution

The coal produced in Angul contributes significantly to the government exchequer through direct and indirect taxes. In 2020-21, MCL's overall contribution to the central and the state government exchequer stood at ₹106 billion (US$ 1.3 billion) .[19]

While there is no clear distinction available on the quantum of revenue that is contributed by the district, it can be assumed that since Angul accounts for 57% of the MCL's production, a nearly equivalent proportion of the revenue contribution comes from the district under various components.

For example, in 2020-2021, the district contributed nearly ₹9,100 million (US$ 114 million) in royalty, against production of about 88.7 MMT of coal.[20] Further, as per the information provided by the district administration, coal mining operations in Angul contribute nearly ₹4 billion (US$ 50 million) annually to the District Mineral Foundation (DMF) funds (depending on the production).[21]

Besides taxes and revenues, the funds generated from Corporate Social Responsibility (CSR) initiative is another contribution that is made by the company towards various welfare activities in the district.[22] In 2020-21, the total fund outlay under CSR was ₹450 million (US$ 5.6 million), which was used to support welfare activities, including water supply, construction and repair of schools and the development of a medical college and hospital at Talcher.[23]

Table 7: MCL's contribution to government exchequer

Heads	2020-21 (₹ billion)
Royalty	16.2
NMET	0.36
DMF	5.4
Goods and service tax	4.6
GST compensation cess	57.5
Income tax	22.5
Dividend distribution tax	0
Total	**106.6**

Source: Annual report, 2020-21, Mahanadi Coalfields Limited

3.3 Coal-based thermal power plants

Angul is the biggest coal-based power producer in Odisha, with 4,200 MW of installed grid-connected capacity and 2,010 MW of captive capacity. The combined capacity (6,210 MW) of grid-connected and captive power accounts for nearly 43% of the state's total installed capacity.[24] The coal consumption of all operational TPPs was 29.2 MMT in 2020-21, nearly 30% of the total coal produced in Angul.

NTPC Limited is the largest power producer in the district, with an installed capacity of 3,000 MW. The other big TPP, of 1,200 MW, is run by the private company Jindal India Thermal Power Limited (JITPL).

The two captive plants are related to the two largest coal-dependent heavy industries in the district. The captive TPP operated by the National Aluminium Company (NALCO), a public sector undertaking, is for its aluminium smelter plant, and the other operated by privately-owned JSPL is part of its integrated steel plant.

The installed capacity is set to increase in the coming years as NTPC Limited is further setting up a 1,320 MW capacity ultra-supercritical TPP (two units of 660 MW each) in Talcher. The upcoming TPP will be Phase 3 of the Talcher Thermal Power Station (TPS).[25] Additionally, NALCO will be developing a 1,400 MW feeder captive TPP by 2027-28.[26]

Spatially, the grid-connected TPPs are in Talcher (the core mining block) and Kaniha (which is adjacent to Talcher). The captive TPPs are in Angul block within the NALCO aluminium smelter plant and the JSPL steel plant premises.

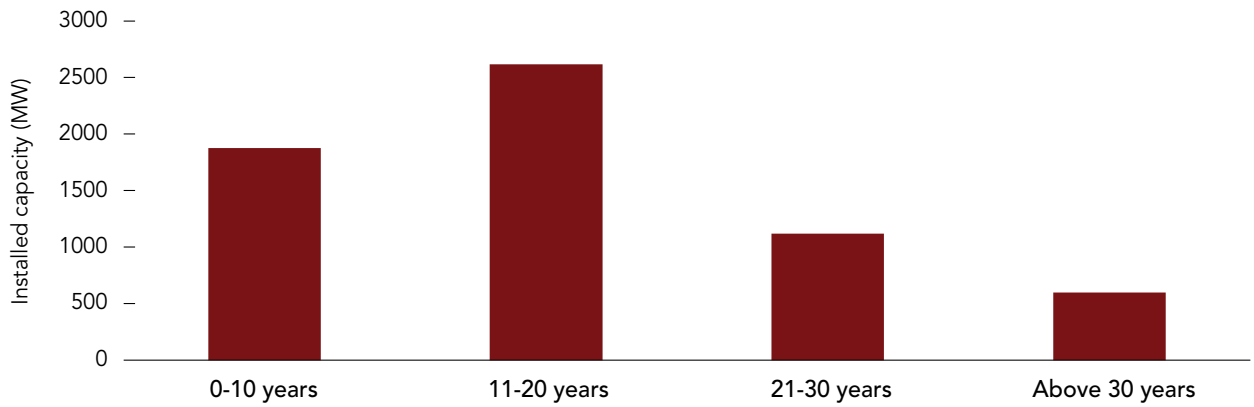
Table 8: Operational TPPs

Owner	Name of TPP	Unit no.	Installed capacity (MW)	Net generation (GWh) 2019-20	Coal consumption (million tonnes) 2020-21	Area (ha)
NTPC	Talcher Kaniha STPS	1	500	21,897.1	16.6	1,502.1
		2	500			
		3	500			
		4	500			
		5	500			
		6	500			
JITPL	Derang TPP	1	600	5,936.3	4.3	384.5
		2	600			
JSPL	Angul TPP (Captive)	1	135	2,667.8	2.2	Located within the steel plant premises
		2	135			
		3	135			
		4	135			
		5	135			
		6	135			
NALCO	NALCO TPP (Captive)	1	120	7,066.2	6.1	Located within the aluminium plant premises
		2	120			
		3	120			
		4	120			
		5	120			
		6	120			
		7	120			
		8	120			
		9	120			
		10	120			
Total (including captive)		**24**	**6,210**	**37,567.4**	**29.2**	

Source: Central Electricity Authority, list of thermal power plants in India, 2021; Central Electricity Authority, Report on fly ash generation at coal and lignite thermal power plants and its utilization in the country, 2020-21.

In terms of age, Angul has a younger fleet of TPPs, including its captive TPPs. Units related to about 30% of the installed capacity are below 10 years of age (as of 2022), and 42% are between 11 and 20 years. The older units (above 20 years) largely belong to the Talcher Kaniha Super Thermal Power Station (STPS) and NALCO captive TPP, accounting for 27% of the capacity.

Figure 1: Age profile of TPPs



Source: Central Electricity Authority, 2021; Jindal Steel and Power Limited environment compliance report, 2015, NALCO office, Angul

3.4 Coal washeries

Angul has three coal-washeries with a cumulative processing capacity of 15.7 MMPTA. All the washeries are privately owned and are located in the Talcher block.

There are two upcoming coal washeries of 18 MMTPA processing capacity. Among them, a 10 MMTPA capacity washery will be operated by MCL, and the other one of 8 MMTPA capacity will be a part of the upcoming Naini coal mine project, operated by SCCL.[27]

Table 9: Coal washeries

Name of washery	Operated by	Capacity (MMTPA)
Talcher ACB washery	Aryan Coal Beneficiation (India) Ltd.	9.5
Talcher Aryan washery	Aryan Energy Pvt. Ltd	2.3
Talcher GCM washery	Global Coal & Mining Pvt. Ltd	4
Upcoming		
Jagannath coal washery	Mahanadi Coalfields Limited	10
Naini coal washery	Singareni Collieries Company Limited	8

Source: Provisional Coal Statistics. Coal Controller's Organization, 2020-21

3.5 Coal transportation

Coal transport by road is a key sector closely allied with coal mining and coal demand. While MCL transports about 77% coal through the railways, trucks remain a key mode of transportation within the district and the state.[28] In 2020-21, of the 136.6 MMT of coal (including annual production and stock), 37.5 MMT was dispatched through trucks.[29]

In Angul, however, transportation through the railways is 66%, while 34% is dispatched through trucks. The truck transport business is privately run. In Angul, about 7,000 trucks from within the district are involved in the transportation of coal. Additionally, there are many others that come from other parts of the state as well (*Refer to Chapter 4*).

Table 10: MCL's mode of coal dispatch

Coal off-take 2020-21	Total	Rail	Road	Merry Go Round (MGR)
Volume (MMT)	136.3	90.18	37.5	8.9
Proportion (%)		66	27.4	6.5

Source: Mahanadi Coalfields Limited, annual reports and accounts, 2020-21

3.6 Other coal dependent industries

The presence of minerals such as coal, iron ore and bauxite in Odisha has created an ecosystem of industries, co-dependent on each other for raw material and operations. The large-scale industries in Angul are steel and aluminium. Apart for these, fly ash brick manufacturing has grown as a small-scale industry around the coal-based TPPs.

3.6.1 Steel and Aluminium

Angul has one large integrated steel plant with a capacity of 6 MMTPA operated by JSPL. It is one of the largest steel plants in Odisha. The company is further securing necessary permits to increase the production capacity by more than four times (25.2 MMTPA) by 2027, making it the "world's largest single location steel plant".[30] The proposal has already been cleared by a high-level clearance authority in the state, and is awaiting environment clearance from the Ministry of Environment, Forest and Climate Change (MoEFCC).[31] The company has also acquired Utkal B1 and B2 coal blocks in Chhendipada for captive use for its existing TPPs.[32]

Additionally, there is one operational sponge iron unit in the district with a capacity of 0.09 MMTPA. The integrated steel plant, as well as the sponge iron units are all located in the Angul block.[33]

Besides steel, the district also has an aluminium smelter of 0.4 MMTPA capacity located in the Angul block. NALCO also owns captive coal blocks – Utkal D and E – in Chhendipada block and is in the process of developing 2 MMTPA mines in each of the blocks for its use.

3.6.2 Fly ash brick

There are 85 registered fly ash units spread across various blocks. The units are an outcome of the mandate to use fly ash generated by the TPPs, as directed by the MoEFCC. The largest number of units are concentrated in the Angul block, followed by Athamallik and Talcher.

Table 11: Fly ash brick units

Block	No. of units
Angul	38
Athamallik	16
Banarpal	3
Chhendipada	4
Kaniha	3
Kishorenagar	0
Pallahara	7
Talcher	14
Total	**85**

Source: District Industry Centre, Angul

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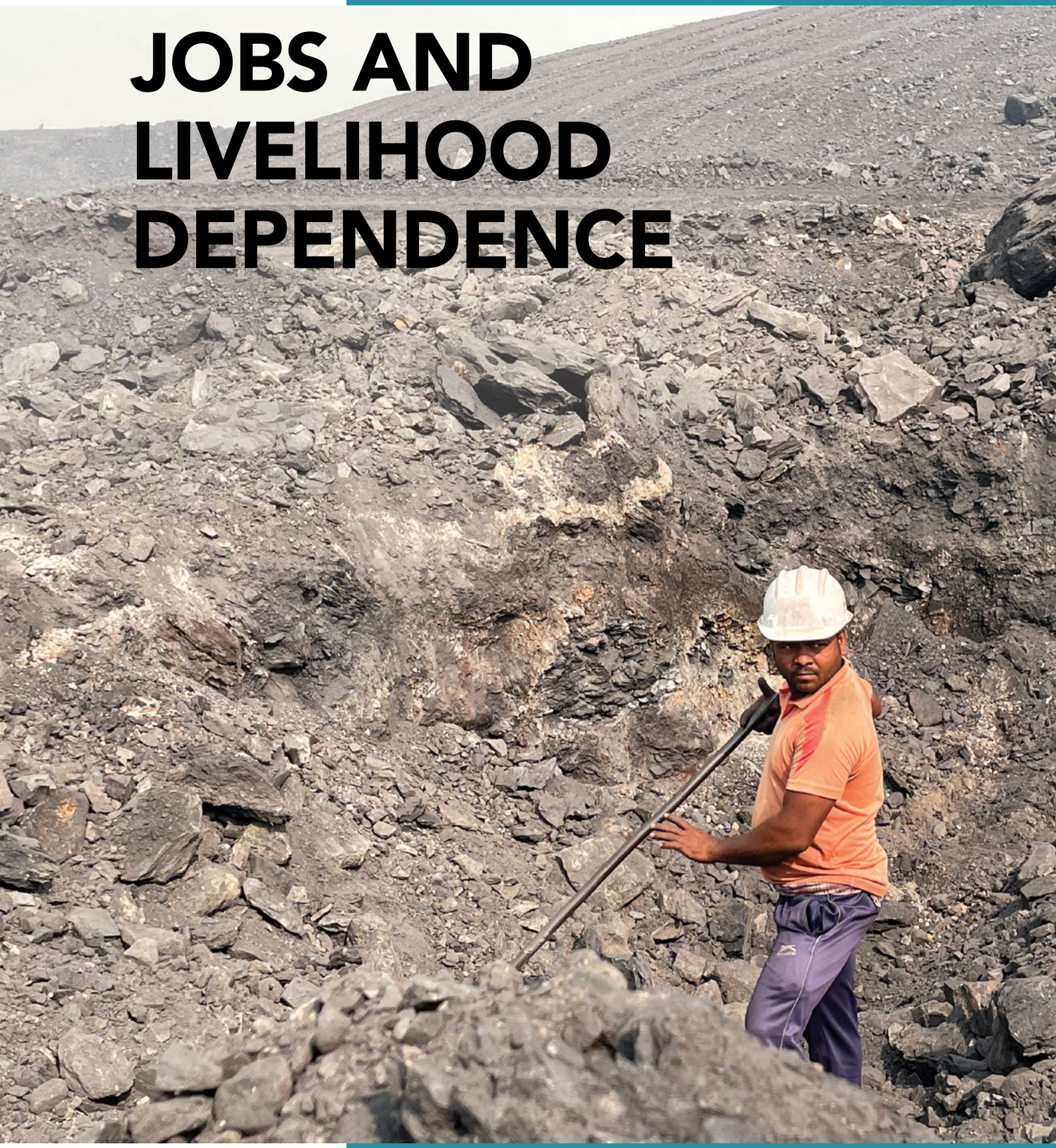
Overall, the industrial landscape of Angul remain highly dependent on coal and coal-based electricity. The cost per tonne of coal production by MCL being one of the lowest in the country is further supporting expansion of industries in the region. However, going ahead the carbon and environmental footprint of mining and industrial activities must be internalised. Green mining practices must become a norm until a complete coal transition is achieved, and simultaneous measures must be adopted for industrial decarbonisation (*Refer to Chapter 6*). The next 20 to 30 years will be crucial for this.

CHAPTER 4

JOBS AND LIVELIHOOD DEPENDENCE



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- *Over 29% of workers within the working age group are employed in the coal industry, coal-based power plants, and other coal dependent heavy industries, such as steel and aluminium.*
- *Collectively, about 69% of workers engaged in the coal industry and other coal-dependent sectors are informal. The largest informality is in road-based coal transport.*
- *The proportion of contractual and informal workers will grow significantly due to increasing engagement of MDOs and sub-contractors in coal production and related work.*
- *There is also a large proportion of coal-induced economic activities, such as servicing and repairing, retail businesses, etc. More than 18% workers depend on these.*
- *The rural economy is dependent on agriculture, which constitutes the primary income source of over 15% households.*

4.1 Overview

In the coal industry, the scale of economic dependence is often under-represented in the official employment numbers, which only capture the formal workforce, and leave out the informal workers. To understand the extent of dependence on coal, the primary survey considered two aspects:

- Household dependence for primary income; and,
- Workers' dependence, which includes all working members captured in the surveyed sample.

This section provides an assessment of the overall livelihood dependence on various sectors in Angul, and analyses the number of workers reliant on the coal industry and other heavy industries which are coal-dependent.

4.2 Household income dependence

The dependence of households for income on the coal industry has been assessed considering three key parameters:

- Dependence on a particular sector as a source of primary income;
- Spatial distribution of households as per the primary income source; and,
- Income distribution.

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4.2.1 Primary source of income

Coal mining and coal-based industries collectively are the biggest source of primary income in the district. About 30% of households are dependent on the coal industry (coal mining, coal washeries, coal transport), coal-based TPPs and aluminium and steel plants as their primary income source.

However, a sector-wise assessment of the survey results shows that:

- Agriculture is the single-largest sector as a source of primary income, with over 15% of the households being dependent on it.
- Reliance on retail businesses is also high with about 13% of the households deriving primary income from it .
- For another 13% of the households, miscellaneous casual labour work at factories, shops, local vegetable markets, etc., is a primary source of income.
- Coal mining (and the limited number of coal washeries) remain the primary income source for about 11% of the households. Additionally, 10% of the households depend on coal transport.
- Coal-based TPPs are a primary income source for 5% of the households, steel for 3% and aluminium of 1%.
- Additionally, 8% of the households derive income from labour work in the construction sector.

While Angul has a significant proportion of the district's geographical area under forests, no households reported forest-based livelihood as primary income source (*Box: Dependence on forest*)

Figure 1: Sector-wise household dependence for primary income

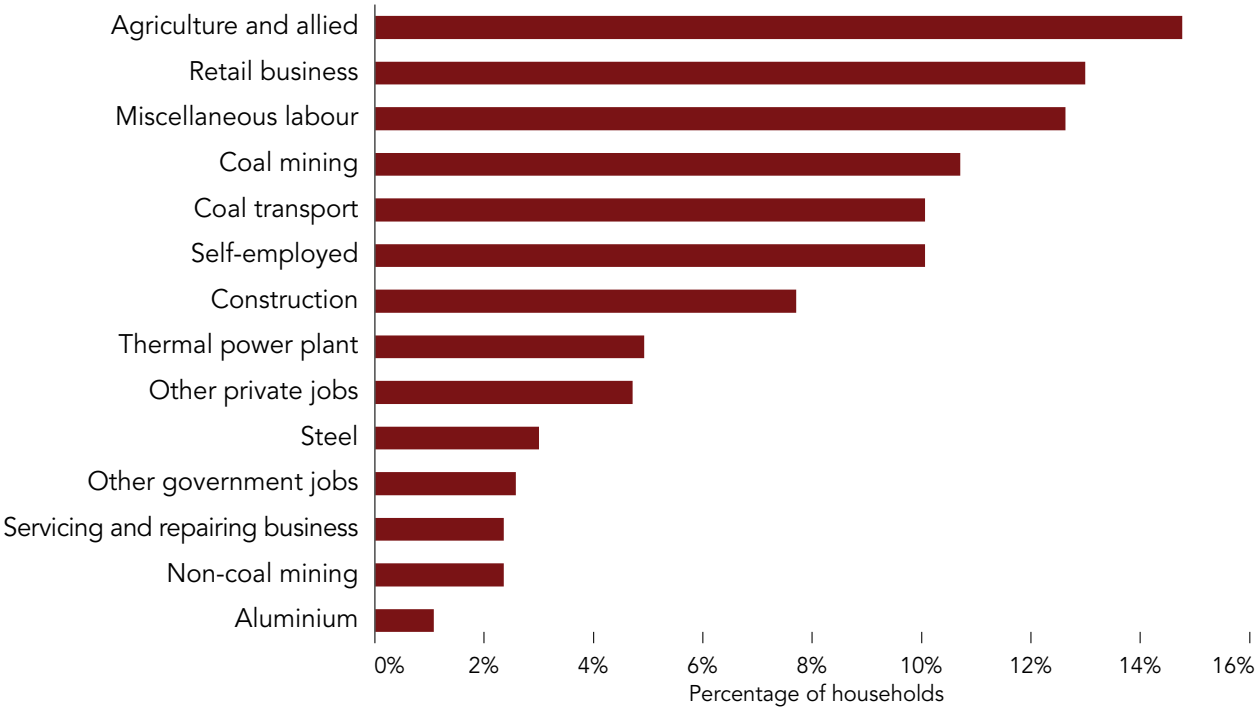
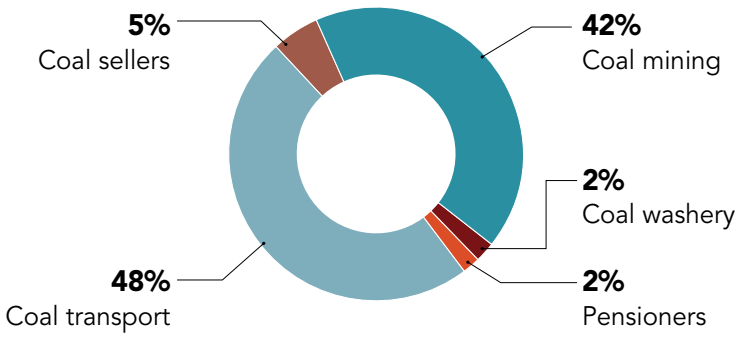


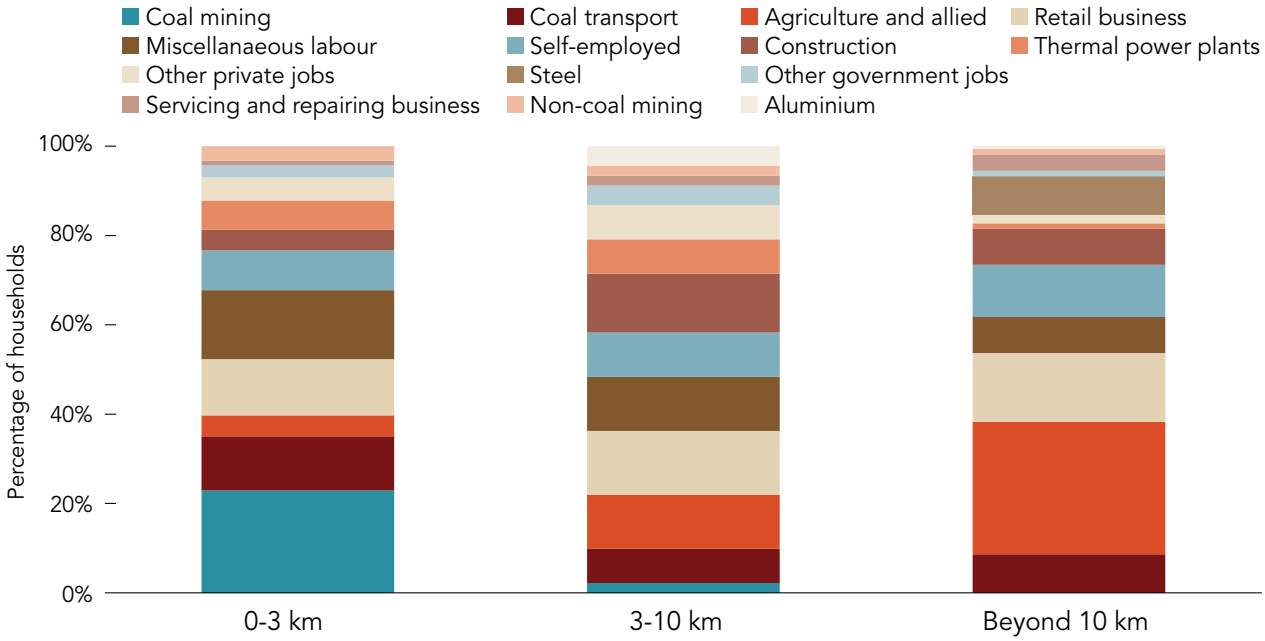
Figure 2: Distribution of households dependent on coal industry for primary income



In terms of spatial distribution, households dependent on various industrial activities (including coal mining and TPPs), businesses, and other government and private jobs are highly concentrated within a certain radius around the coal mines. The results show that:

- All households dependent on coal mining, and 91% of the households dependent on TPPs are concentrated within a 0-10 km radius of the mine clusters. This includes a large part of Talcher and the Kaniha blocks where most of the mines and power plants are located.
- Households dependent on other industries and businesses are also highly concentrated within this 10 km radius. The only exception is with respect to the households dependent on the steel industry, considering the location of the steel plant in Angul block, which is located at a significant distance from the mining area.
- Majority of the households (77%) dependent on casual labour work in various industrial activities, as well as construction, were also found to be residing within this 10-km radius, given the opportunity of work.
- Beyond 10 km of the mining and industrial clusters, households are largely dependent on agriculture. Over 70% of the households dependent on agriculture reside in rural parts of the district, particularly in the Kishorenagar, Pallahara, Athamallik and Angul blocks.

Figure 3: Spatial distribution of households based on primary income



4.2.2 Income status

The income analysis shows low income levels among a significant proportion of households. Some of the key findings are:

- About 43% of the households have a monthly income below ₹10,000 (US$ 125). Overall, more than 77% of the households have a monthly income below ₹20,000 (US$ 250).
- Only about 11% of the households have an average monthly income above ₹40,000 (US$ 500).
- Only 1% of the households have income above ₹100,000 (US$ 1,250) per month.[1]
- While the high-income households are concentrated within a 10-km radius, the low-income households are spread across the district. These include households dependent on various industries, casual labour, agriculture, etc.

Dependence on forest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About 45% of Angul's geographical area is under forest, which offers a big opportunity for creating livelihood opportunities based on forest products. While households in the district are involved in collection of forest produce, and some of them also derive income from it, no household has specified it as a primary source of income during the survey. This is because forest products have very little market support, and is a small seasonal addition to the household income in rural areas.

The survey findings show that:

- While about 14% of the households are involved in the collection and processing of forest produce, it is not a primary source of income for any of them.
- Most of them derive their primary income through miscellaneous labour work, agriculture-related activities, and as informal workers in the coal industry.
- Over 54% of the households having some income from forest produce are concentrated in Athamallik, Pallahara and Kishorenagar blocks, which are completely rural and forested.

An analysis of the earnings from forest products shows that:

- Only 51% of the households involved in the collection and processing of forest produce derive an income from it. However, all these households earn below ₹5,000 (US$ 62) in the season (which is on an average three months).
- About 32% of the households did not specify any income. They are largely involved in an informal barter-based system of exchange of goods
- About 23% of the households reported only self-consumption. One of the most consumed products by them is bamboo, which is used for building houses

Overall, *tendu* leaves *(Diaspyros melanoxylon)* are the most common forest produce that provide for seasonal earnings. Out of the households deriving an income from forest produce, 40% are engaged in *tendu* collection and processing. This is because *tendu* is the only forest produce procured by the state government in an organised manner. The others are engaged in the collection of *mahua* flowers, *sal* leaves, wild mushrooms, mangoes, etc., and selling it in the local village market.

Primary income source of forest-dependent households

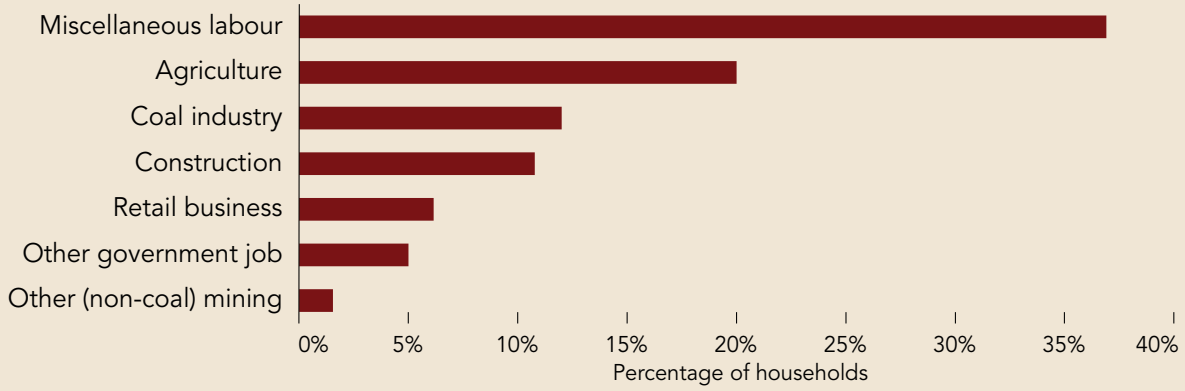
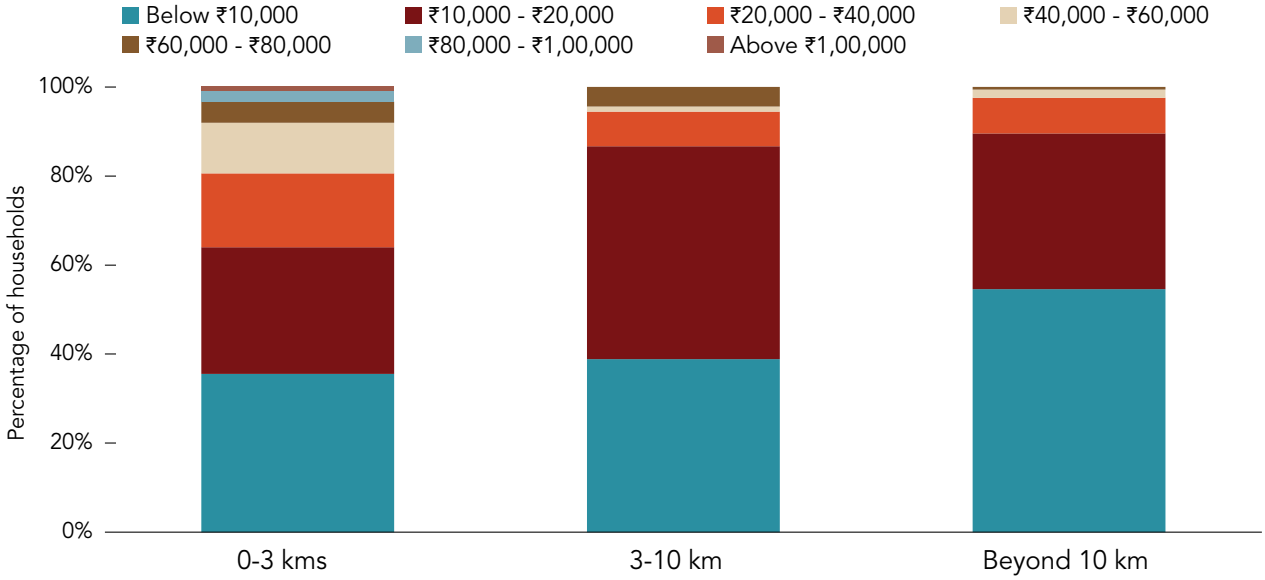


Figure 4: Spatial distribution of households and primary income source



The spatial disparity also shows that better income opportunities are highly concentrated in the district, largely in the small urban parts. The other areas are rural and agrarian and have a higher proportion of people with low incomes.

4.3 Worker profile

The worker profile has been assessed considering the people falling within the working age group of 15-59 years covered through the survey.

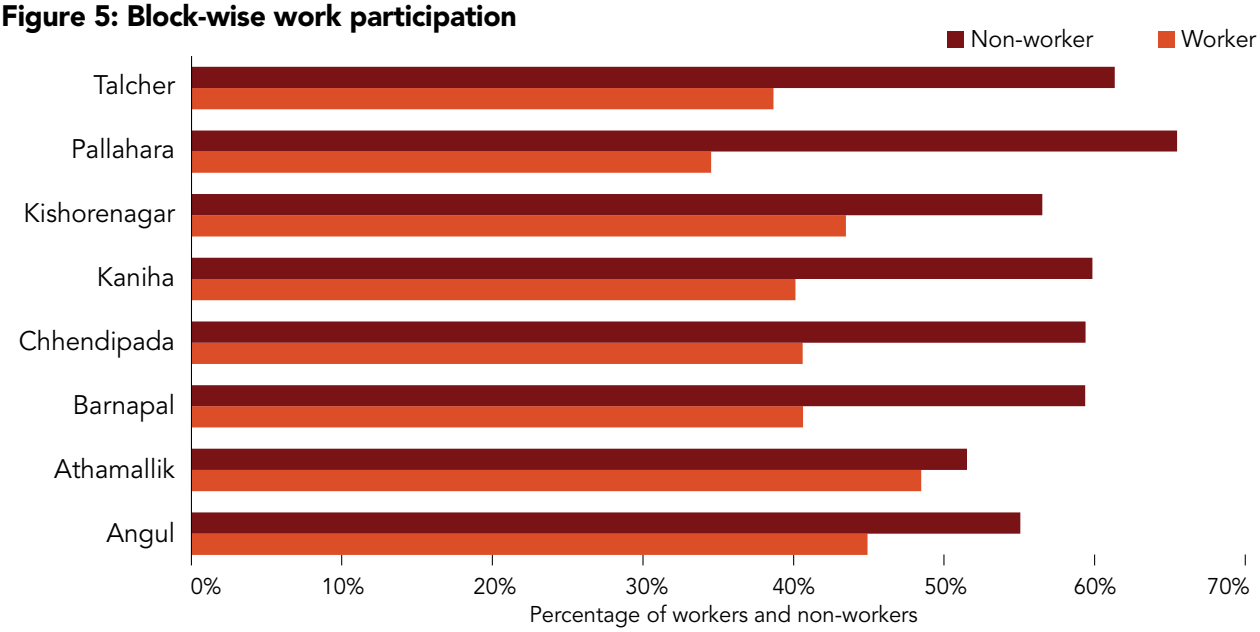
4.3.1 Work participation

Work participation in Angul is poor, as the number of non-workers is high across all the blocks. The results show that:

- About 41% of people are workers and 59% are non-workers.
- More than 50% of people across all the blocks are non-workers.
- The participation is even poorer among women. Only 5% of women are workers, compared to 76% of men
- Talcher, where most coal mines and the biggest TPPs are located, has among the highest proportion (61.3%) of non-workers. However, this is partially attributable to the fact that many high-income households have only one member working, as opposed to low-income households. Also, many people in the block have lost their agricultural land to coal mining, in lieu of which only one household member has been provided with a job.

The overall work participation is similar to the Census 2011 data for Angul, which estimated 41% of workers in the district across all ages, and 43% in the working-age group. These include both main and marginal workers.[2]

Figure 5: Block-wise work participation

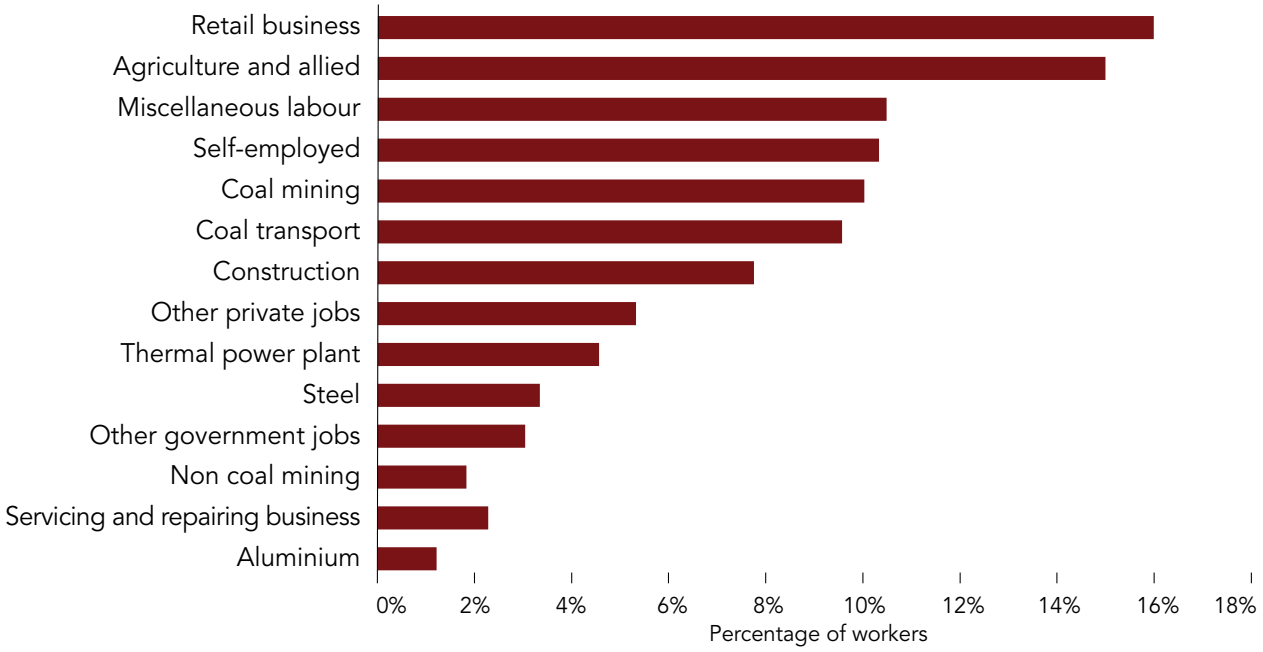


4.3.2 Worker distribution

Worker distribution across sectors reflects the trends observed at the household level. An assessment of the worker distribution shows:

- The highest proportion of workers are employed in the agriculture sector (15%). Besides, a similar proportion of workers are also engaged in various retail businesses , including their own businesses.
- Miscellaneous causal labour work employs 10% of workers; another 8% are employed as construction workers.
- Coal mining (including coal washeries, coal gatherers and sellers) employs 10% of workers; and a near equal (9.6%) proportion is employed in coal transportation.
- Thermal power plant employs 5% of the total workers.
- Steel and Aluminium, the two other coal-based industries, employ 3% and 1% of the workers, respectively.
- Collectively, coal mining and coal-dependent industries employ about 29% of the workers in Angul.

Figure 6: Worker distribution in different sectors



4.4 Coal industry and power plant workforce

The workers of the coal industry and the coal-based TPPs have been further assessed on the basis of their terms of engagement – formal and informal. The classification criterion for each of these is based on the definition provided by the Labour Bureau of India (2015).[3]

Table 1: Categorisation of formal and informal workers

Category	Description
Formal workers	Workers with salary and benefits working with coal, power and other coal-based industries, also referred to as departmental workers.
	Workers with salary and limited benefits working with private contractors of coal mining, power and other coal-based companies.
Informal workers	Workers working in coal mining, power, coal transport and other coal-based industries, without any employment and social security benefits provided by the employers and are unorganised.

4.4.1 Coal industry

This section assesses the formal and informal workers engaged in coal mining, coal transport, and coal washeries. The three have been considered together as coal industry since coal washing and coal transportation is intricately related to coal mining. Besides, a considerable number of people living near the mines also earn a living by gathering and selling coal and have been considered to be directly dependent on coal mining.

Coal mining

- Nearly 62% of the workers engaged directly in coal mining related activities is estimated as informal workers. Most of them are casual labourers engaged in various activities, such as cleaning, overseeing conveyor belts, moving small equipment, etc.
- The proportion of formal workers (including departmental and contractual workers) is about 38%.

As per latest (2021-2022) official estimates of Mahanadi Coalfields Limited (MCL), there are a total of about 20,531 workers engaged in various mining-related activities in Angul. Among them, 10,673 are departmental employees. Nearly equal number (9,858) of people are engaged through contracts by the company for a variety of jobs including mines management-related jobs, civil works in colonies and other MCL facilities, etc. They collectively constitute the formal workforce.

Extrapolating the proportion of workers engaged in coal mining (not including coal washeries) as per the primary survey, it can be estimated that about 33,271 people are employed in coal mining as informal workers. Overall, coal mining employs a total of about 53,802 people, formally and informally.

Table 2: Formal employment in coal mines

Name of mine	Departmental manpower	Contractual manpower	Total
Lingaraj	1,833	1,671	3,504
Bhubaneshwari	680	2,021	2,701
Hingula	1,279	1,263	2,542
Ananta	1,261	1,838	3,099
Bharatpur	2,160	1,168	3,328
Jagannath	943	466	1,409
Balaram	1,417	602	2,019
Kaniha	431	803	1,234
Nandira	669	26	695
Total	**10,673**	**9,858**	**20,531**

Source: Mahanadi Coalfields Limited, 2022

Table 3: Estimated total employment in coal mines

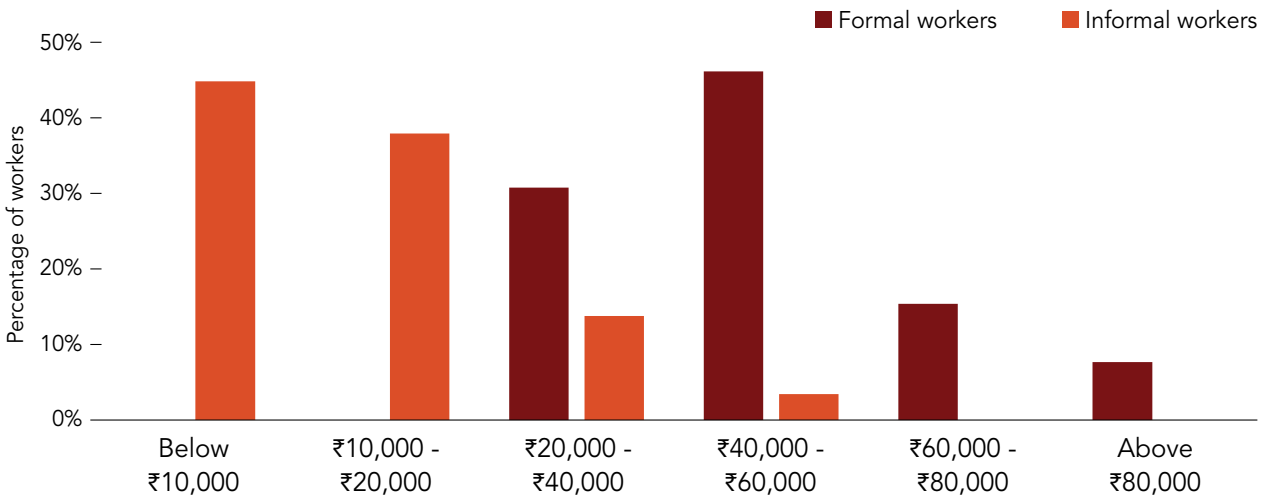
Employment type	No. of workers
Departmental	10,673
Contractual	9,858
Informal	33,271
Total coal mining	**53,802**

Note: Number of informal workers have been estimated based on the extrapolated worker numbers from the primary survey findings with respect to the district worker population. From the total workers estimated to be engaged in coal mines, the number of formal workers were deducted to arrive at the informal workforce.

An analysis of the income distribution shows a marked disparity between the formal and informal workers, where the former are better paid across type of jobs and education levels.

- Nearly 70% of formal workers earn above ₹40,000 (US$ 500) per month. The remaining earn between ₹20,000 and ₹40,000 (US$ 250-500), largely towards the higher side of the income bracket.
- In contrast, over 45% of the informal workers earn below ₹10,000 (US$ 125) per month.

Figure 7: Income distribution of formal and informal coal workers



Coal transport

The highest proportion of informality in the coal industry exists in the coal transportation sector, especially by road. While no official estimate is available on the worker number , as per the All Odisha Truck Association, the umbrella body of truck operators in Odisha (including in Talcher), about 26,900 people (including truck business owners, drivers, helpers, coal levelers etc.) are engaged in coal transportation by road.

However, this estimate is likely to be conservative. Ground interactions suggest that the number of workers engaged in such activities is higher, as there is a fleeting population who are engaged as 'helpers' to support various activities related to coal movement.

Extrapolating the proportion of workers engaged in the sector from the primary survey, it can be estimated that about 54,947 workers are involved in coal transportation activities.

Coal gatherers and sellers

At early hours in the morning, the roads leading to the coal mines of Talcher are lined by *cyclewallahs* carrying sacks of coal on the bicycles. The coal is being carried for selling in the local market which fetch these people a living. As per the primary survey, about 0.7% workers are engaged in coal gathering and selling. Extrapolating this proportion to the district's working population, it can be estimated that about 4,007 people derive an income by gathering and selling coal.

In Angul, the dependence on coal as fuel is nearly 40% as per the primary survey. A considerable proportion of it is procured from the coal sellers, particularly by poor households and local eateries. Each seller sells about 60 kilogram (kg) of coal on a day which fetches him an earning of ₹400 (US$ 5). Their monthly income from such activity is about ₹4,800 (US$ 60), as on an average they sell coal in the local market three days a week.

All the coal gatherers and sellers interviewed for this study reported low levels of education completion, largely until elementary school (Class VII). Lack of education and skills were cited as key reasons for the occupation. Also, since coal as a fuel is cheaper than LPG connections and refills, market demand has also sustained this informal coal economy.

Srestha Banerjee/iFOREST

Coal washeries

Three privately-owned coal washeries are currently operational in Angul. These washeries employ about 672 people formally. Further, by extrapolating primary survey observations, it can be estimated that about 2,762 workers are engaged in the washeries informally. Combining formal and informal workers, the coal washeries in Angul employ nearly 3,434 people.

Table 4: Employment in coal washeries

Name of washery	Operated by	Capacity (MTPA)	Workers
Talcher ACB washery	Aryan Coal Beneficiation (India) Ltd.	9.5	*416
Talcher Aryan washery	Aryan Energy Pvt. Ltd	2.3	81
Talcher GCM washery	Global Coal & Mining Pvt. Ltd	4	175
Total		**15.8**	**672**

Source: Provisional Coal Statistics, Coal Controller's Office, 2020-21; workers as per EC letters.(*) An employment factor approach is used for Talcher coal washery worker calculation.

4.4.2 Coal-based thermal power plants

The worker assessment of the TPPs show that:

- About 43% of the TPP workers are formal, and 57% of the workers is estimated as informal.
- Informality was found to be higher among the workers engaged in privately-operated TPPs.

As per the official labour data provided by NTPC Limited and NALCO, and estimates drawn for the privately-owned TPPs applying an employment factor approach, it can be derived that more than 12,300 people are employed at the power plants in the Angul district. About 73% of them are engaged through contracts.

By extrapolating the workers data from the household survey, it can be estimated that about 16,310 people are employed as informal workers. Overall, combining the primary survey estimates and the official data, about 28,618 people are estimated to be employed in coal-based TPPs.

Table 5: Formal employment in TPPs

Name of TPP	Departmental manpower	Contractual manpower	Total manpower
Talcher Kaniha STPS	917	3,200	4,117
NALCO captive TPP	868	2,207	3,075
Derang TPP	868	2,207	3,075
Angul captive TPP	583	1,458	2,041
Total	**3,236**	**9,072**	**12,308**

Source: NTPC Kaniha, NALCO RTI, Manpower for Derang and Angul TPP has been assessed at 0.72 persons per MW for formal and 1.8 persons per MW for contractual, based on NALCO worker data

Table 6: Estimated total employment in TPPs

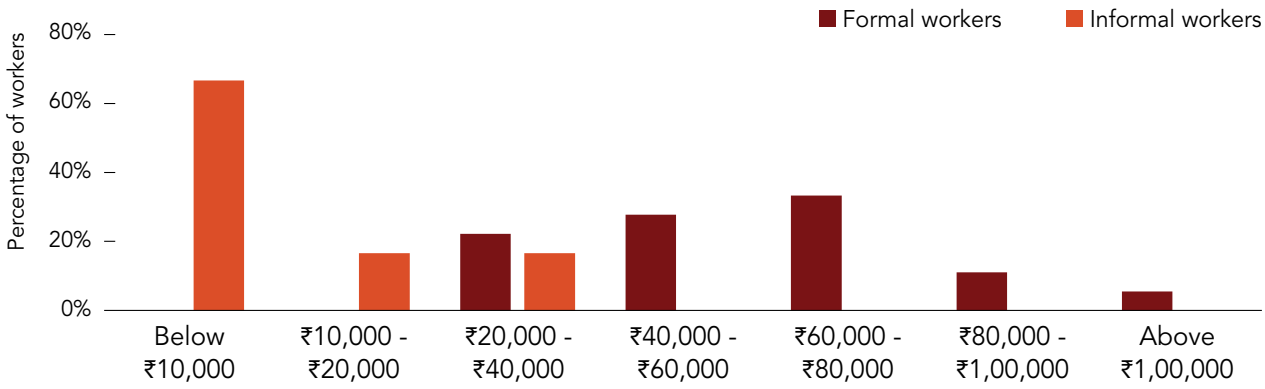
Employment type	No. of workers
Departmental	3,236
Contractual	9,072
Informal	16,310
Total	**28,618**

Note: Number of informal workers calculated based on the extrapolated worker numbers from the primary survey findings with respect to the district worker population. From the total workers estimated to be engaged in coal-based TPPs, the number of formal workers were deducted to arrive at the informal workforce.

In terms of income, formal TPP workers are better paid, similar to the observations for coal mining activities. Also, there is a significant difference between income levels of formal and informal workers in TPPs as well. The results show that:

- About 78% of formal workers earn above ₹40,000 (US$ 500) per month.
- Nearly 17% of workers reported salaries above ₹80,000 (US$ 1,000), and 6% reported monthly earnings above ₹100,000 (US$ 1,250).
- In contrast, 67% of the informal TPP workers earn below ₹10,000 (US$ 125) per month.

Figure 8: Income distribution of formal and informal TPP workers



4.4.3 Fly ash brick units

Angul has 85 fly ash brick units spread across all the blocks. The primary survey could not capture the fly ash unit workers, as many of them are migrant and seasonal labour from adjacent districts. The workers, are typically provided a room for stay within the unit premises, as observed during ground interactions.

With respect to the number of workers, as per the Angul Fly Ash Owners' Association, each of the operational units employ about 12 people on an average, making the total up to at least 1,020 workers.[4]

Table 7: Employment in fly ash brick units

Block	No. of fly ash units	No. of people employed
Angul	38	456
Athamallik	16	192
Banarpal	3	36
Chhendipada	4	48
Kaniha	3	36
Kishorenagar	0	0
Pallahara	7	84
Talcher	14	168
Total	**85**	**1,020**

Source: District Industry Centre, Angul; workers calculated at 12 per unit as per estimates provided by the Fly Ash Factory Owners' Association, Angul

4.4.4 Steel and aluminium

About 81% workers in the steel and aluminium industries are formal and the remaining 19% are informal. The proportion of informal workers are observed to be low, as both the integrated steel plant and the aluminium smelter are highly mechanised operations.

Official estimates of the companies suggest that about 18,717 people are formally employed in these industrial operations. Of these, about 12,000 workers are employed at the JSPL integrated steel plant.[5] Another 6,717 at NALCO's aluminium smelter plant.

Extrapolating the workers' number from the primary survey, it can be estimated that the two industries collectively employ about 4,177 people informally as well. Overall, about 22,894 people are employed in the steel and aluminium industry.

4.4.5 Total direct dependence on coal

The data, as extrapolated from the primary survey, along with official data shared by the companies, it can be estimated that about 168,721 people depend on the coal industry, coal-based TPPs, fly ash brick units, steel and aluminium industry, and on gathering and selling coal, for an income. A high proportion of these workers are contractual and informal. Collectively, about 69% of workers engaged in the coal industry and other coal-dependent sectors are informal. workers.

The number of coal-dependent workers will increase significantly in the next 10 years considering the growth in coal production and simultaneous expansion in the steel and aluminium industries, For instance, for the coal industry alone, it can be estimated that the workforce will increase at least two times (considering production efficiency), as production increases from 96.7 MMTPA at present to over 300 MMTPA. Similarly for the steel industry, an expansion in capacity from current 6 MMTPA to nearly 25.2 MMTPA will entail significant increase in the number of workers.

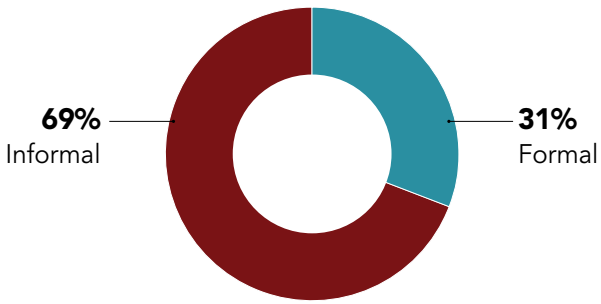
A large proportion of the future workforce will be contractual as the industries are shifting towards fixed-term contracts for a large proportion of workers who will be newly engaged. Besides, a significant proportion of the coal production will met by engaged Mine Development Operators (MDO). As per information of MCL, nearly 28% of the coal production in Angul in the coming years will be met by engaging MDOs. Simultaneously, the number of informal workers will also increase for several odd-jobs that these industrial activities will require.

Therefore, for planning a just transition in Angul, it will be important to take into consideration the support mechanisms that will be required for this large number of contractual and informal workers, and to ensure that they are appropriately absorbed in the new economy through decent income and safety nets.

Table 8: Total direct dependence on coal and coal-based industries

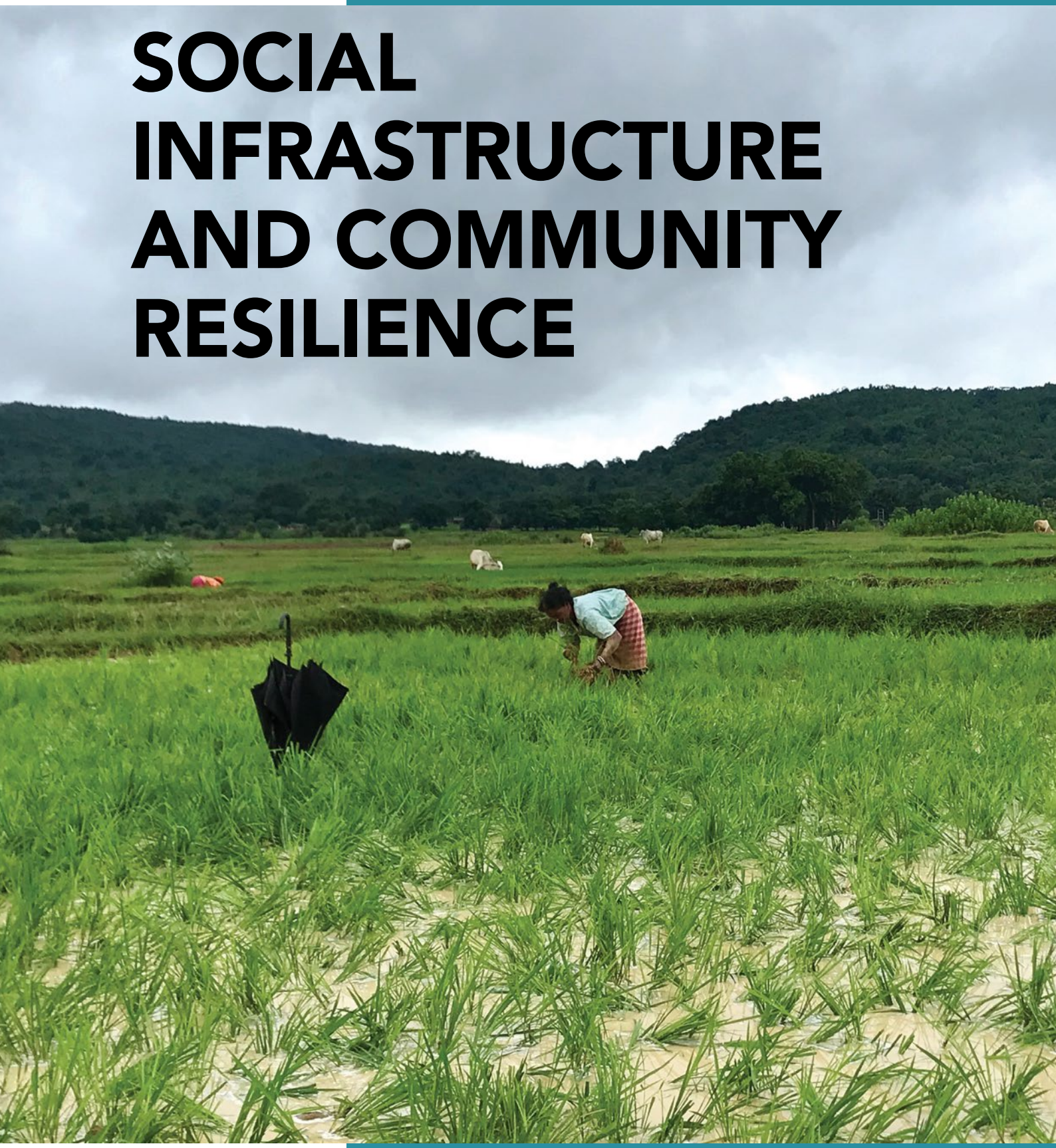
Category	Total	Formal	Informal
Coal mining	53,802	20,531	33,271
Coal transport	54,947	0	54,947
Coal washery	3,434	672	2,762
Coal gatherers and sellers	4,007	0	4,007
Coal based TPP	28,618	12,308	16,310
Fly ash brick units	1,020	0	1,020
Steel and aluminium	22,894	18,717	4,177
Total	**168,721**	**52,228**	**116,493**

Figure 9: Proportion of formal and informal workers in coal and coal-based industries



CHAPTER 5

SOCIAL INFRASTRUCTURE AND COMMUNITY RESILIENCE



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- *About 24.5% of Angul's population is multidimensionally poor, which is at par with the India average of 25%.*
- *Healthcare infrastructure is better in urban areas with availability of both public and private facilities and those supported by the company; in rural areas the infrastructure needs attention to fulfill IPHS norms.*
- *Education investments are necessary for higher secondary levels, colleges, and vocational institutes to improve scope of income.*
- *33% households rely on coal as a primary cooking fuel source due to its cheap availability in the local market.*
- *The district remains vulnerable to climate impacts; droughts, erratic rainfall, and heat-island effects are some of the key concerns that can jeopardise its growth potential.*

5.1 Overview

Energy transition will entail major socio-economic disruptions in districts like Angul. Researchers and public policy analysts have shown that communities with better social infrastructure are better prepared to respond to transition challenges and adapt to them.[1] Therefore, evaluating the prospects of a just transition for Angul and planning it, necessitates an understanding of the status of social infrastructure in the district.

The closure of coal mines in the coming decades can also affect the access of people to healthcare and education facilities, and other public amenities, that have been developed or supported in these regions by the coal companies. Therefore, besides evaluation of the status of social infrastructure, it is important to understand the direct dependence of the local community on the infrastructure and services provided by the coal mining and power companies, so that necessary measures can be taken.

5.2 Social infrastructure

The access to social infrastructure has been analysed considering the following key indicators:

- Healthcare;
- Education; and,
- Basic amenities such as drinking water, electricity, cooking fuel.

The results of the primary survey have been considered to determine the access with respect to these indicators. For an understanding of the status of social infrastructure, corresponding government and industry data have been further considered.

The index developed by the United Nations Development Programme (UNDP) and the National Institution for Transforming India (NITI) Aayog, a GoI think tank, shows that about a quarter (24.5%) of Angul's population is multidimensionally poor.[2] Though better than many big coal districts in India, there remains much to be addressed.

5.2.1 Healthcare

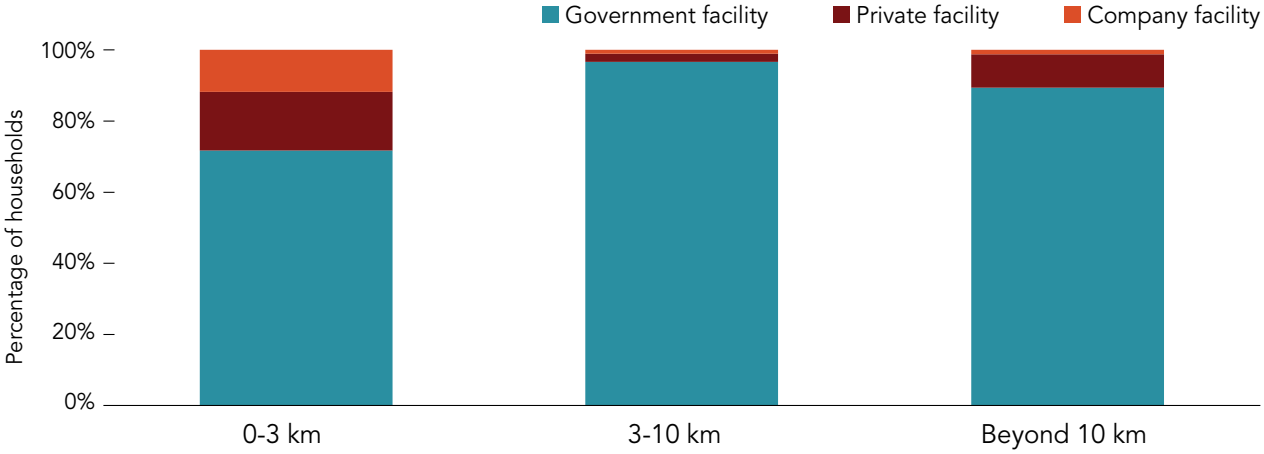
Healthcare access and dependence for healthcare on coal mining and power companies has been evaluated based on two key indicators:

- Type of healthcare facilities primarily used by the respondents; and,
- Health insurance coverage.

Healthcare facilities

- About 83% of the households rely primarily on government facilities for healthcare. These households are spread across the three radii considered.
- Only 11% of the households reported dependence on private healthcare and about 6% of households reported availing on company's healthcare facilities.
- The dependence on private healthcare is concentrated in 0-3 km and beyond 10 km radius, that is, in the peri-urban areas in the Talcher and Angul blocks.
- Household dependence on company facilities is entirely concentrated within 0-3 kms radius and include households with permanent/departmental coal and TPP company employees. At least 61% of these households have one formal worker employed in coal mining and another 11% in TPPs. The remaining are employed in other government and private jobs.
- Lack of doctors, long waiting time and lack of testing facilities were the top reasons for preference for private facilities, indicating the government healthcare facilities, although cheaper, are not adequately equipped for service delivery.

Figure 1: Type of healthcare facilities accessed



The public healthcare infrastructure and resources in Angul have been evaluated against the minimum stipulated requirement as per the Indian Public Health Standards (IPHS) under the government's National Health Mission (NHM).

As per the IPHS norms, there should be at least one primary health centre (PHC) per 30,000 people and one community health centre (CHC) per 120,000 people in rural areas.[3] A district is also supposed to have a district hospital and sub-district hospitals depending on the population. Considering that nearly 81% of Angul's population lives in rural areas, the IPHS standards set for such pockets ,therefore, constitute a benchmark to evaluate the status of healthcare access for a majority of the district's population.

As per the information obtained from the district officials, there is a deficit in the number of PHCs and CHCs as compared to the population. In many blocks, particularly in Chhendipada, Banarpal, Angul, Kaniha and Kishorenagar, the PHCs are functioning beyond their capacity. The CHCs in Banarpal, Chhendipada and Kaniha blocks are facing a similar problem.

Access to these facilities is also a challenge. Only 17% of the villages have a PHC located within a 5 km radius, while only 5% of villages have access to a CHC within a 10 km radius.[4] However, the district also has three sub-district hospitals, which in some areas, off-set the burden of the PHCs and CHCs, suggest ground interactions.

Table 1: Status of primary healthcare facilities

Block	No. of PHC	No. of people served per PHC	PHC serving over IPHS standards	No. of CHC	No. of people served per CHC	CHCs serving over IPHS standards
Angul	5	37,173	1	1	185,867	1.5
Athamallik	3	41,182	1	1	123,545	1
Banarpal	4	58,514	2	1	234,056	2
Chhendipada	4	46,582	2	2	93,164	Adequate
Kaniha	4	39,978	1	1	159,910	1.3
Pallahara	5	29,009	Adequate	1	145,045	1.2
Kishorenagar	3	40,160	1	1	120,479	1
Talcher	3	36,217	1	1	108,651	Adequate
Tertiary healthcare						
Angul – District hospital	1					
Talcher – Sub district hospital	1					
Athamallik – Sub district hospital	1					
Pallahara – Sub district hospital	1					

Source: District Planning and Statistics Department, 2022
Note: The data provided was consolidated and has been benchmarked against the IPHS norms for calculation of deficits.

According to the data obtained from the district health department, there is a deficit of medical staff in primary healthcare facilities, including doctors and nurses. For instance, Talcher, the core mining block, has a 30% deficit of doctors for primary healthcare facilities. Neighbouring Kaniha and Chhendipada bocks have an average of 55% shortage. The shortage of staff nurses is about 70% in most blocks.

While there are 27 private healthcare facilities in the district, healthcare access continue to be a challenge, particularly for people in rural areas. Most of the private clinics (17) are located in the urban areas of Talcher and Angul blocks.[5]

Mahanadi Coalfields Limited (MCL) also operates several hospitals and dispensaries in the Angul district located around the urban conglomerations and colonies. Currently, there are 11 such facilities, especially in the mines area.[6] There are also additional facilities which are upcoming. These include, the Nehru Shatabdi central hospital and a medical college-cum-hospital in Talcher. For the Talcher hospital, while the capital cost will be borne by MCL, the state government will be responsible for the operational costs.[7] Additionally, NTPC Limited runs a hospital near its TPP premises in Kaniha. There is also the Employees State Insurance Corporation (ESIC) hospital run by the Ministry of Labour and Employment, Government of India) for government employees (including contractual workers of the PSUs).

Health insurance

The biggest health insurance scheme in Angul is the Biju Swasthya Kalyan Yojana (BSKY). The state scheme provides a health cover of ₹500,000 (US$ 6,200) per household, and additional ₹500,000 for women of the family after the exhaustion of the initial limit. The beneficiaries can avail of the insurance through government facilities as well as private facilities empanelled by the government. The scheme covers all households irrespective of their income brackets.[8] In Angul, about 0.3 million households are covered by the scheme, which constitutes about 84% households of the district.[9]

With respect to availing health insurance coverage, the survey results show that:

- About 79% of the households have health insurance coverage provided by the government. These included households that availed benefits under the BKSY as well as the Biju Krushak Kalyan Yojana (BKKY), which is a scheme introduced by the government of Odisha in 2013 to provide health insurance to farmers and their families in various hospitals in the state.
- About 17% of the households had company-sponsored insurance. These households had at least one working member employed as a formal worker in a government or private company.
- The departmental employees of the coal and power companies largely avail company provided insurance.

The assessment of the health sector overall suggest that in the urban areas, the healthcare infrastructure is decent. The availability of private facilities, and hospitals and clinics particularly developed and supported by the PSUs, along with health insurance coverage provided by the companies and the government, has helped the people to avail decent healthcare services. However, the rural healthcare infrastructure and access still remains a challenge. A particular concern is with the primary healthcare infrastructure and resources, which is the first point of contact for these people on a day-to-day basis. Therefore, investments will be necessary to augment the rural healthcare access, that will also lead to overall improvement of development indicators of the district as per the sustainable development goals.

5.2.2 Education

The evaluation of education access considers three key parameters:

- Level of education, which is ascertained through the status of the primary earner's education level;
- Enrolment in schools; and,
- Status of education facilties.

Level of education

The overall level of education in Angul is low. The analysis of the primary survey shows that:

- Only 24% of the surveyed people (considering all members of the surveyed households) have completed secondary education (till class X).

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- The proportion of people who completed higher secondary school (class XII) is only 10%, and those who completed graduation (or higher degrees) are 9%.
- About 13% of the people are illiterate.

School enrolment

Government data with respect to educational status of children currently studying shows that the net enrolment ratio (NER) in schools is nearly 100% at the elementary levels (Class VIII). However, it drops by 12.8 points by higher secondary level, indicating dropouts.

The enrolment scenario in Angul is, however, better as compared to other coal mining districts.[10] Enrolment at the higher secondary level can further be improved through enhancing coverage of secondary and higher secondary schools.

Table 2: Net enrolment ratio

Block	NER (%)		
	Elementary level (Class VIII)	Secondary level (Class X)	Higher secondary (Class XII)
Angul	100	96.6	78.7
Athamallik	98.7	97.4	76
Banarpal	100	97.9	82.5
Chhendipada	98.6	96.3	88.4
Kaniha	100	98.9	82
Kishorenagar	98.7	95.5	81.3
Pallahara	98.3	95.2	79.3
Talcher	100	98.8	88.9
Angul municipality	100	100	100
Athamallik NAC	99.2	100	94
Talcher municipality	100	94.4	95.7
Total	**99.4**	**97.2**	**86.6**

Source: District Education Department, 2022

Education facilities

The survey findings show a preference for government education facilities in Angul for children's education. The analysis shows:

- More than 73% of the households rely on government schools for their children. Such preference is discernible both in urban and rural areas.
- About 26% of the households rely on private schools for their children. However, in the urbanised areas, the proportion of households sending their children to private schools is higher. The highest proportion was observed in Talcher (40%), the most urbanised block in the district.

The reliance on government schools is due to the low number of private schools as well as access to subsidised education. Official data shows that there are only 246 private schools in Angul, as opposed to 1,759 government schools. The private schools are concentrated around the urban areas or PSU townships.[11] The number of schools are further limited when those offering secondary and higher secondary education are considered. Only 16% of the schools provide secondary and higher secondary education.[12]

Overall, while the educational level among the current workforce is poor, there is better school enrolment among the current students. However, there is still a need to improve education beyond the secondary level in Angul. This is not only important for improving education indicators, but also for creating a workforce of the future. The district's industrial potential and opportunities in service sector, will require a large number of educated and skilled workforce in the coming years. Beside schools, investments will also be necessary to improve opportunities of college education, and vocational and technical training.

Figure 2: Type of educational facilities accessed

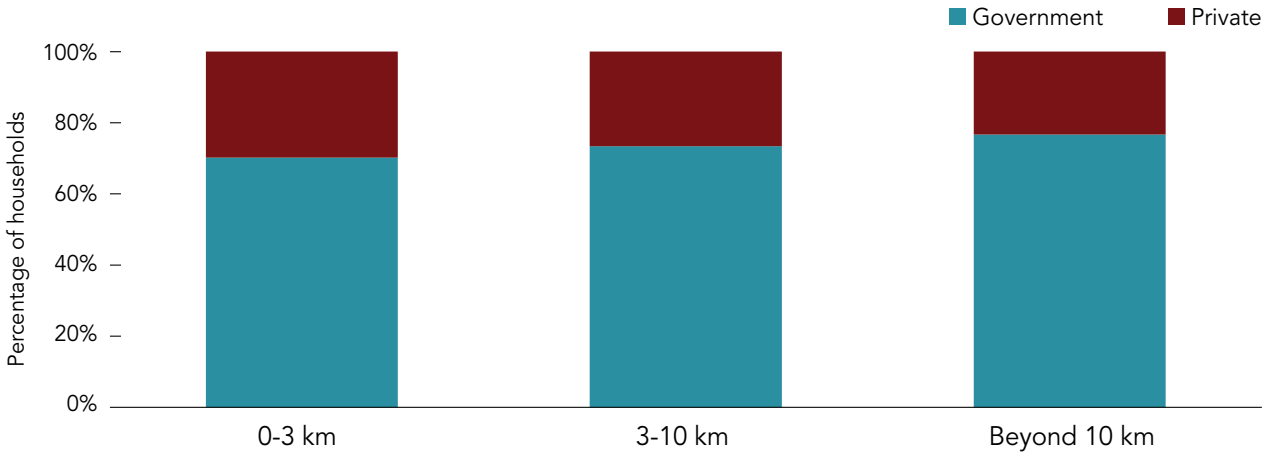


Table 3: Various levels of schools

Block	Primary	Elementary	Secondary	Higher secondary
Angul	158	81	48	10
Athamallik	142	87	27	5
Banarpal	104	81	34	7
Chhendipada	135	78	35	6
Kaniha	109	85	42	6
Kishorenagar	112	81	24	3
Pallahara	160	102	35	2
Talcher	84	73	37	7
Total	**1,004**	**668**	**282**	**46**

Source: District Statistics and Planning Department, 2021. Includes private schools

5.2.3 Access to basic amenities

Three key amenities – drinking water, cooking fuel and electricity – have been analysed to understand the access to basic amenities in Angul. The key observations are outlined below.

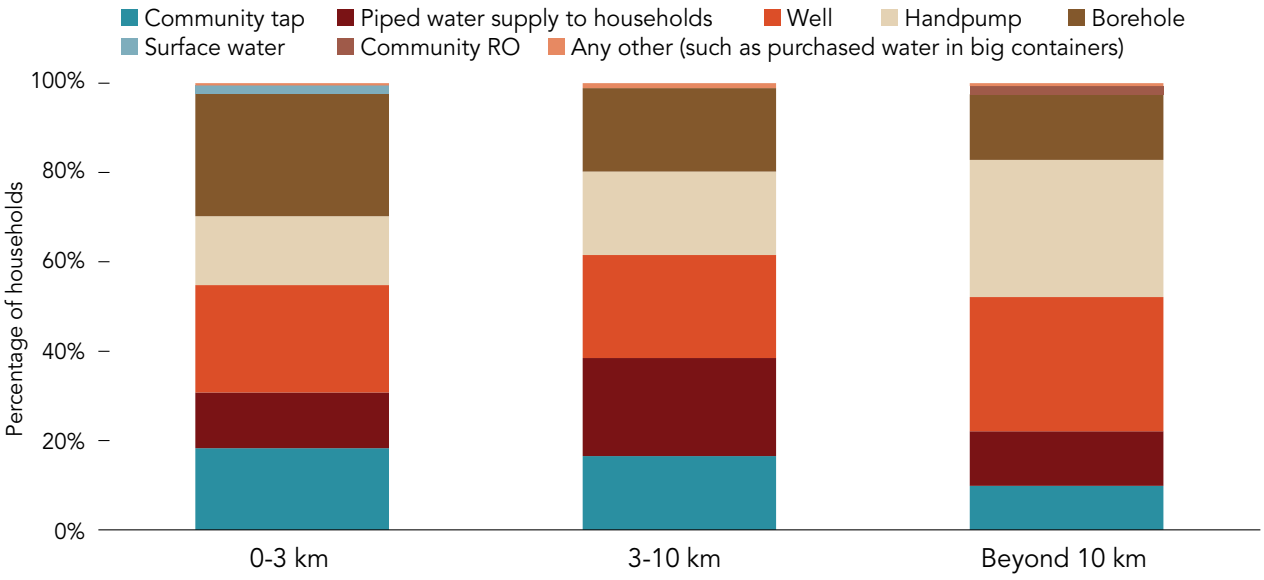
Drinking water

Access to clean drinking water in Angul is poor. The survey results show that:

- About 69% of the households source water from wells, handpumps and boreholes for potable purposes.
- About 29% of the households have access to piped water supply. However, nearly 50% of this is through community taps.
- The proportion of people sourcing drinking water from open wells and handpumps is comparatively higher in areas beyond a 10 km radius.

The official data, however, shows much wider coverage among rural households. About 59% of the rural households in the district have access to piped water supply.[13] The discrepancy in the reporting can be attributable to the fact that many piped water projects are not functioning or have maintenance issues, as observed during ground interactions. In such cases, people are reluctant to pay for the repair or maintenance and continue to rely on other sources.[14]

Figure 3: Access to clean drinking water



Cooking fuel

Most households in Angul use coal and firewood as the primary sources of cooking fuel given the easy and cheap availability of these resources.

- Overall, 33% of the households depend on coal as a primary source of fuel; another 34% use firewood.
- The use of fuel varies spatially. Nearly 48% of the households within the 10 km radius use coal as a primary fuel. Locally, many people are involved in gathering and selling of coal for use as fuel.
- Households using coal (about 60%) primarily buy it from the local market. Around 14% source it directly. The remaining use both sources for procurement.
- Beyond 10 km radius, firewood is the main cooking fuel for most (66%) households.
- The use of liquefied petroleum gas (LPG) cylinders is around 20% among households living in vicinity and also beyond 10 km radius from the mines.

The National Family Health Survey also shows similar trends in the use of clean cooking fuel in the district. As per the NFHS-5, only 24% of the households use clean cooking fuel.[15]

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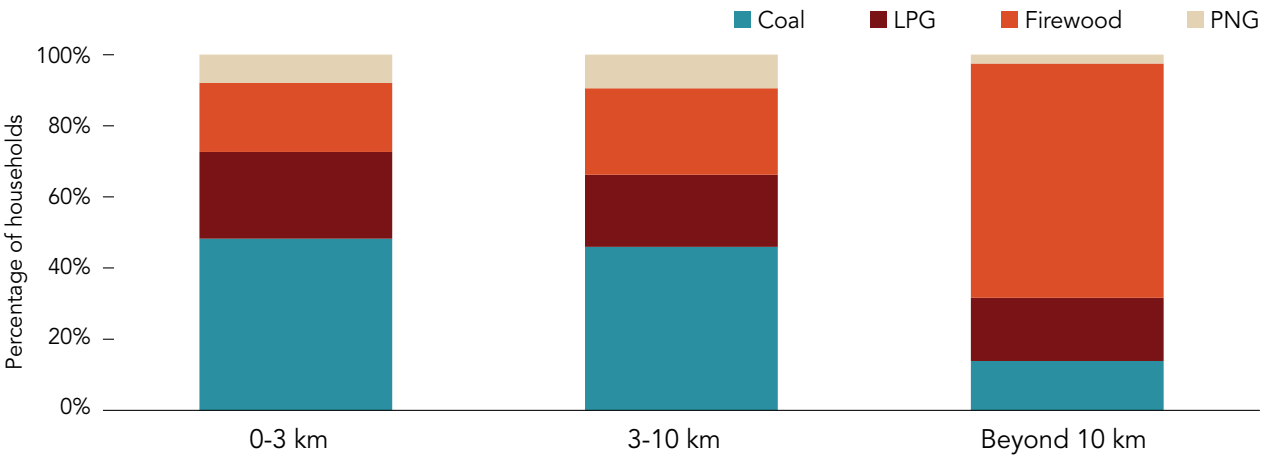
Figure 4: Primary fuel used by households



Electricity

Most households in Angul reported having electricity coverage. The survey results show that:

- 93% of the households have electricity coverage; about 7% reported no coverage.
- All of the households surveyed are connected with grid power. No solar or alternate sources of electricity were reported to be supplying power in these households.
- However, the reliability of the power supply is challenging. On an average, households reported having 10 to 12 hours of electricity per day.

The Pradhan Mantri Sahaj Bijli Har Ghar Yojana, the central government scheme for electrification, shows that Angul is 100% electrified.[16]

5.3 Assets

Two parameters have been considered for asset evaluation of households in Angul. These are:

- House ownership; and,
- Land ownership.

5.3.1 Housing

House ownership has been evaluated considering the ownership status as well as the type of houses owned. The analysis shows that:

- About 95% of the respondents owned the house they are living in.
- However, only 45% own a *pucca* house (permanent structures made of durable material).
- About 44% of the respondents own mixed type house, for example those where either the wall, or roof is made of permanent material, but the rest is temporary such as mud, grass, thatch, wood, etc.[17]
- The rest live in *kuccha* houses (entirely made of temporary material such mud, bamboo, etc.)

5.3.2 Land ownership

Land ownership in the district is evaluated in terms of the landholding as well as the kind and size of the holding. The analysis shows that:

- 61% of the households in Angul own land. Of these, 67% of households own agricultural land.
- Nearly 90% of the landholdings are below one hectare (ha) and hence are marginal.

The findings of the primary survey align with the secondary data for agriculture landholdings, which shows that about 86% of the agricultural landholdings in the district are marginal (*Refer to Chapter 2*).

Overall, it can be concluded that while a significant proportion of people in Angul own houses, the type of housing needs further attention considering the climate vulnerability of the state. This make pucca houses essential for people in both urban and rural areas. In fact, the SDG specifies a target of having no *kuchha* houses by 2030. With respect to landholding, the high proportion of households with marginal landholding indicate low economic security.

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5.4 District resilience assessment

The socio-economic conditions of a district, along with its infrastructure, are crucial determinants for the ability of the local community to adjust to any disruptions, such as the energy transition. Considering the various socio-economic and environmental parameters of Angul as analysed in the previous chapters (*Chapter 2 and 3*), and the social and physical infrastructure, the resilience of the district is evaluated. The assessment takes into account the indicators as considered by the Department of Science and Technology (DST) of the Government of India (GoI) to evaluate district climate vulnerability, along with other pertinent ones that require attention in the district's context.[18]

Table 4: Resilience assessment

Category	Criteria	Indicators	Status	Inference on resilience
Socio-economic	Poverty	i. Percentage of Below Poverty Line (BPL) population. ii. Percentage of households having monthly income of highest- earning members less than ₹5,000/- in the rural area.	i. About 22% of the population are BPL, which is better than India average of 32.5%. ii. As per the primary survey, only 8% of the rural households surveyed in Angul have monthly income of the highest-earning members less than ₹5,000 (US$ 62).	Moderate
	Deprivation	i. Percentage of multidimensionally poor people.	24.5% of the population is multidimensionally poor, which is at par with India average of 25%. However, this is much below the 2030 SDG target of 13.95%.	Moderate
Agriculture	Landholding	i. Proportion of marginal and small landholders.	Approximately 86% of the agriculture landholdings in the district are marginal, less than one hectare, indicating low adaptive capacity within the agriculture sector.	Poor
	Rainfed agriculture	i. Proportion of rainfed agriculture.	74% of the net sown area in Angul is rainfed. Makes the district highly vulnerable to crop failure.	Poor
	Horticulture	i. Proportion of net sown area under horticulture.	i. 22,635 ha (about 9%) of the district's net sown area is under horticulture. ii. The district is also promoting horticulture through the Horticulture Development Programme 2021.[19]	Low (potential for further development)
Infrastructure	Healthcare infrastructure	i. Healthcare facilities and resources. ii. Access to healthcare facilities and resources and reliance.	i. Healthcare infrastructure and resources in the urban areas is decent with a combination of government clinics and hospitals, private facilities and industry supported healthcare infrastructure. ii. Considerable deficit in public healthcare infrastructure and access particularly in the rural areas. Except Pallahara, in no other blocks PHCs fulfill the IPHS requirement. iii. In the primary healthcare facilities, there is also about 70% shortage of staff nurse and 30% shortage of doctors.	Moderate to good

Category	Criteria	Indicators	Status	Inference on resilience
Infrastructure	Education	i. Educational infrastructure. ii. Enrolment and completion. iii. Female literacy.	i. Enrolment rates up to secondary level is good, which is approximately 97%. ii. Number of government schools offering higher secondary education are limited. iii. Female literacy is 60.6%, which is lower than the India average of 70.3%.[20]	Moderate (potential for focus on females)
	Access to clean drinking water	Percentage of households with improved drinking water source (piped water supply).	i. About 59% of the households have piped water supply as per district data. ii. Due to mining and industrial activities, the Talcher-Angul region also have serious concerns of water pollution.	Poor
	Road and railway network	Access and connectivity.	i. The district has widespread road network, four national highways and the Sambhalpur-Khurda railway line. ii. Well-connected to the capital, Bhubaneshwar. Savitri Jindal airport is a public-private airstrip, owned and managed by Jindal Steel and Power Limited.	Good
Workforce	Labour participation in work	i. Proportion of non-workers. ii. Proportion of women participation in workforce. iii. Worker distribution.	i. According to the primary survey, 41% of the people within the working age group (15 to 59 years) are workers, and the rest are non-workers. ii. Of the total people in the working age, only 5% are women, indicating a high gender disparity in workforce. iii. As per the survey, the highest proportion of workers are engaged in retail (16%) and agriculture (15%). Miscellaneous labour also accounts for 11% of the workforce. iv. About 20% workers are employed in the coal industry (which includes coal mining, washeries, coal gatherers and sellers,road-based coal transport).	Poor
Income	Income shares from natural resources	i. Output and income from agriculture, livestock and fishery. ii. Income from forest products/resources.	i. As per the primary survey, 54% of the agriculture dependent households earn less than ₹10,000 (US$ 125) per month. ii. 49% of the respondents engaged in animal husbandry earn less than ₹5,000 (US$ 62) per month. Most of the respondents used livestock for self-consumption. iii. Forest-based livelihood is not the primary source of income for most people. Majority of the households having an earning from forest products, earn less than ₹5,000 (US$ 62) per month.	Very poor
Income	Dependence on coal for earnings	District GDP dependence	About 61% of the district GDP is dependent on coal mining and coal-based industries.	Very poor

The resilience assessment of Angul brings out the key sensitivities and vulnerabilities of the district with respect to climate change and its adaptive capacity. Overall, it can be concluded that despite having better development indicators as compared to many other coal districts of India, such as with respect to healthcare infrastructure, education, etc., there are three key factors which undermines the district's resilience and increases its vulnerability. These include, the high dependence of the district GDP on coal mining and coal-dependent industries, the high share of marginal land holdings among the agricultural community and dependence on rain-fed agriculture, and the significantly high proportion of non-workers among the working age group. There is also a high proportion of informal workers in various sectors of the economy, including in the coal industry, which undermines the capacity of the local community to adapt to any unforeseen events.

However, the district's economic potential and availability of resources, good infrastructure, and the focus of the state government to enhance climate adaptation and mitigation measures, provide significant opportunities to build resilience through economic diversification and investments in green industries. Simultaneously, intervention will also be necessary to augment social infrastructure, particularly in the rural areas, develop an educated and skilled workforce, and ensure gender equality in education and workforce participation.

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Climate vulnerability

Angul was among the districts affected by cyclone Fani that hit Odisha in 2019. While the biggest impacts of the cyclone were felt in the coastal belt, Angul, despite being an inland district, was identified as a "red" category region. Although no loss to human life was reported, the rural population suffered heavy losses from crop damage. The houses of the poor were also affected.[21]

While Angul is identified to have "moderate damage" risk from cyclones,[22] the increasing intensity and frequency of storms and cyclones in the state due to climate change impacts, potentially increases its risk. The recent experience of cyclone Fani, and earlier of cyclone Phalin in 2013, are wake-up calls.[23]

The rainfall pattern has also become erratic in recent years which has increased the risk of droughts in the district. In 2020-21, Angul faced 40% rainfall deficit as per the Indian Meteorological Department (IMD).[24] This has made the rural economy particularly vulnerable, which is highly dependent on rain-fed agriculture. Of the total net sown area, only 26% is currently irrigated.[25]

The district is also suffering from worsening heat conditions in the summer months due to growing urbanisation and industrial activities. The Odisha Climate Change Action Plan 2018-2023, has identified the Angul-Talcher industrial belt as a heat island. The plan notes that high temperatures are likely to affect the infrastructure (including railways) cause health hazards such as heat strokes, and reduce working hours and worker productivity among people.[26]

Therefore, the industrial growth of Angul needs to consider the district's climate vulnerability. Coal-based TPPs and manufacturing industries, particularly steel, are among the highest contributors of GHG emissions in India as well as globally.[27] Within Odisha too, industry, transport and energy sectors are the biggest contributors to the GHG emissions, many of which are located in Angul.[28] Therefore adopting a low-carbon pathway is a necessity for the district to ensure long-term prosperity and the well-being of the local community.

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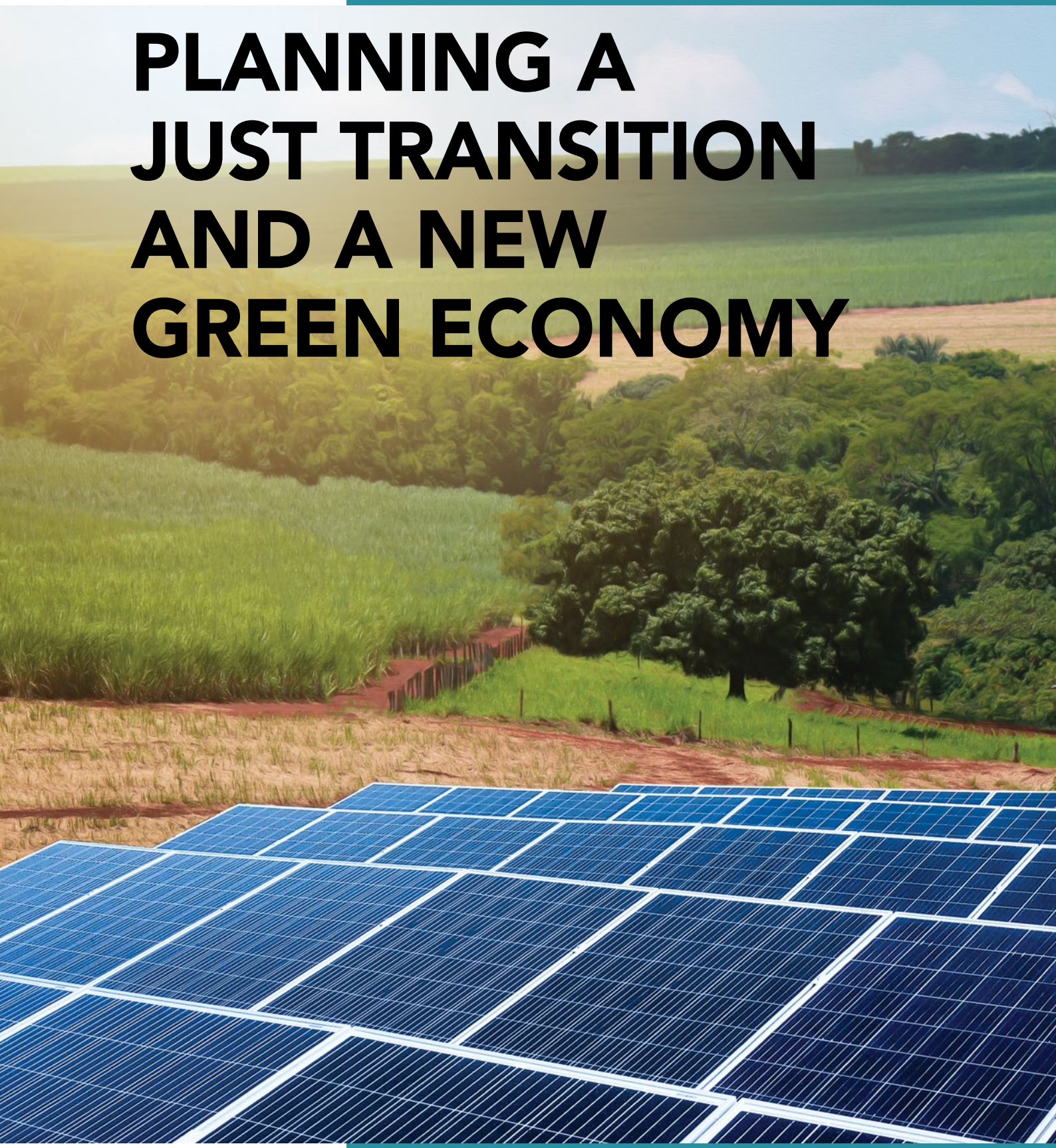
CHAPTER 6

PLANNING A JUST TRANSITION AND A NEW GREEN ECONOMY



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- *Major coal mine closures will only start after 2040 in Angul. 75% of new mines have a risk of becoming stranded assets under an accelerated closure scenario by 2050 to meet 1.5°C climate goals.*
- *Coal-based power plants will start experiencing closures this decade, particularly captive plants.*
- *About 33,000 ha of land will be available from closure of coal mines and power plants, of which 93% is from coal mining. Land repurposing will be crucial for economic diversification and green industry development.*
- *Transitioning from a coal-dependent brown economy to a renewable-centered green economy should be the focus of economic diversification and industrial planning.*
- *Nearly ₹3 trillion can be available from coal cess and DMF to support just transition even under an accelerated closure scenario by 2050.*

6.1 Context

Minimising the impact of coal phase-down (and phase-out) on livelihoods and the local economy is central to just transition planning. There is also a growing recognition that just transition planning should be intricately related to long-term industrial decarbonisation, where considerations of climate, environment, resource, innovation and justice are well coordinated.[1]

To ensure a just transition, a deliberative and strategic approach is necessary. Such approach should take into account the timeframe of phasing down coal mining activities and coal-based power production, initiating a system-wide transition process in the coal-dependent industrial sectors, planning economic diversification, building stakeholder engagement, labour support, provisions for revenue substitution, and securing the necessary funds and resources for a just transition.

iFOREST has developed a framework and a matrix for just transition planning, which has been used to plan a just transition for Angul. Eight key aspects have been considered for developing the plan. These include:

i. An inclusive planning and execution mechanism;
ii. Determining the timeframe for a just transition considering a phased closure of coal mines and coal-based power plants;
iii. Repurposing of land and infrastructure;
iv. Planning economic diversification and green industrial transition;
v. Skilling and reskilling of the workforce and providing worker assistance;
vi. Responsible social and environmental investments;
vii. Securing finances for just transition; and,
viii. Engaging PSUs and private industries.

Angul offers a distinct case with regard to the phasing down of coal mining activities in the coming years, as it is currently in the throes of coal mine expansion. Mahanadi Coalfields Ltd. (MCL) has one of the largest and the cheapest coal deposits in the country, which will allow the district to produce cheap coal-based power over the next 15 years.[2] The district is also planning expansion of coal-based heavy industries such as steel and aluminium.

However, the business-as-usual situation can barely continue considering the climate crisis and India's net zero emission targets. Besides, Odisha is one of the most vulnerable states to climate change impacts. Therefore, a coal transition is inevitable for the district. The transition must be planned as a system-wide process to minimise economic and social disruption, and reduce environmental and climate externalities. In fact, Angul should utilise its fossil fuel wealth judiciously to build a strong backbone to support a green economy of the future.

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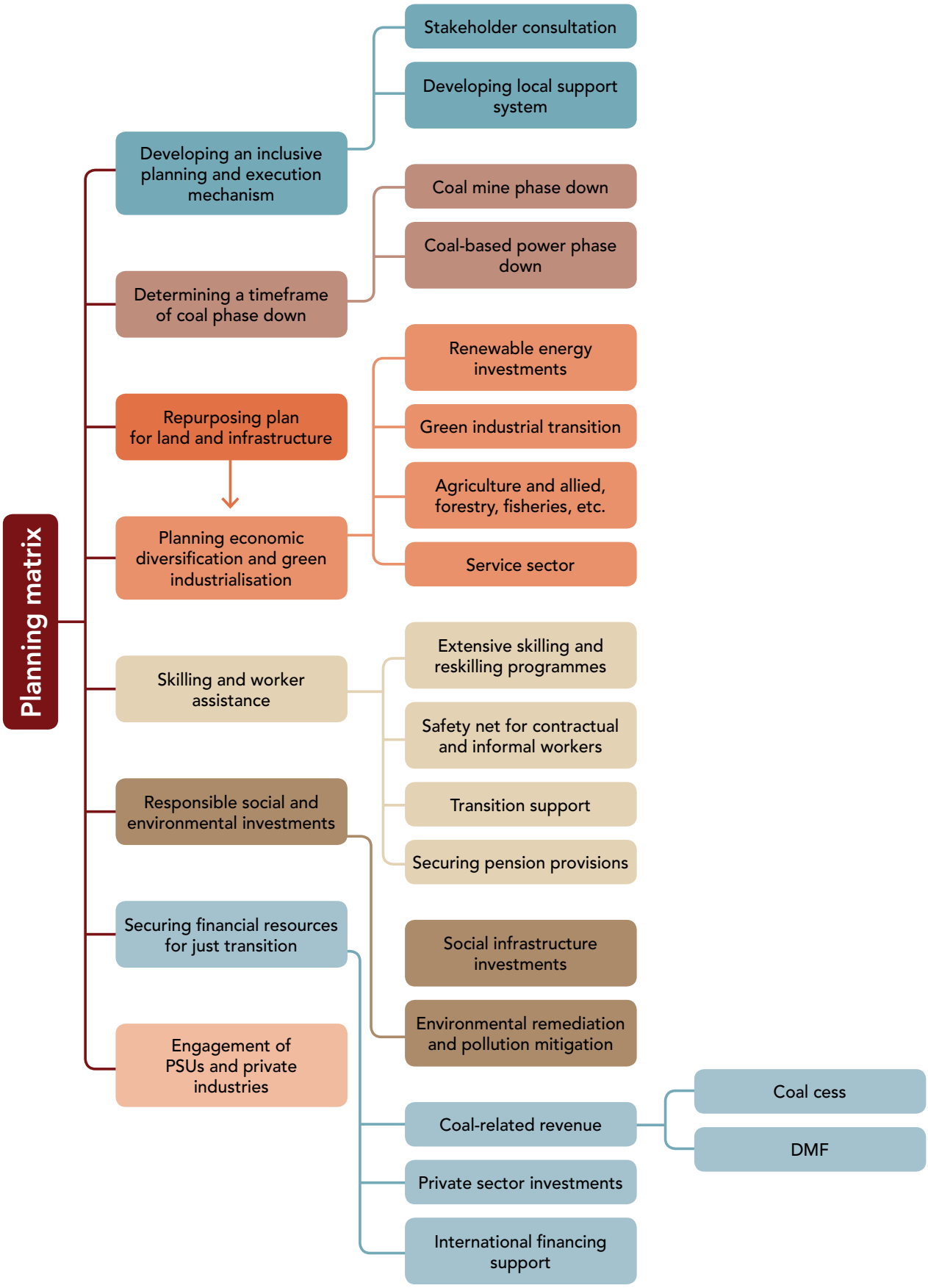
Figure 1: Planning matrix for just transition



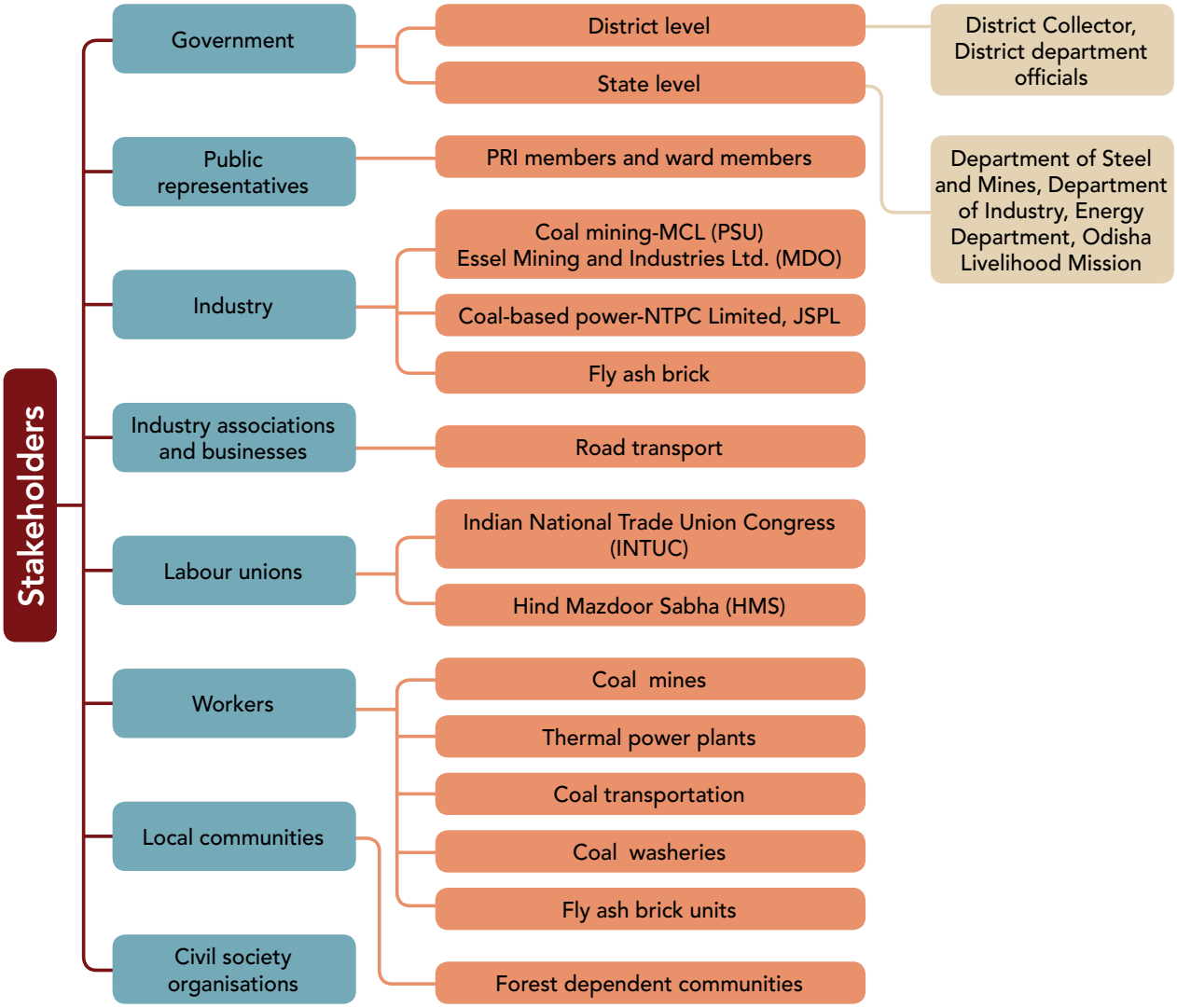
6.2 Inclusive planning mechanism

The need to adopt an inclusive approach for just transition planning has been underscored by various governments and commissions appointed by them, stakeholder groups such as labour unions, environmental and climate justice groups, as well as multilateral institutions.[3] There are three main reasons for this. First, developing inclusive mechanisms for planning and execution is essential to build a broad-based support for it. Second, a top-down approach will hinder the social acceptance of a just transition, which is essential for its success. Third, for the transition plans and investments to be effective, assessing the needs and aspirations of people is crucial, which can only be ensured through inclusive planning and decision-making systems.

To develop an inclusive plan and understand pertinent transition-related issues from all perspectives, focus group discussions (FGDs) and interviews were conducted with various stakeholder groups in Angul and at the state-level in Bhubaneshwar (the state capital). The FGDs were particularly held with various workers, local communities, representatives of panchayati raj institutions (PRI), ward members and civil society organisations (CSOs) working in the area. During the study period (March to May 2022) interviews were also conducted with various stakeholders as well as with the state and district officials, industry, labour union members, etc., to capture the prospects of just transition planning for the district.

The responses bring out the diversity of opinions of various stakeholders on how a coal transition and a just transition can be managed in the district considering challenges of jobs and livelihood security, economic opportunities, and support inclusive development (*Box: Stakeholder perception*).

Figure 2: Stakeholder engagement matrix



Stakeholder perception

Chandan Kumar Naik

Coal mining in Angul is nearly a century old. Over the years, many generations have earned their living from coal as the number of mines in the region expanded. The mining activity, so far, has been largely concentrated in the Talcher block and is considered an integral part of the economy by the local community.

The century-long entrenchment of coal mining in the local social and economic system has generated a sense of perpetuity about it. None of the stakeholders are able to visualise Talcher, and even Angul district, without coal and coal-based industries in the future. Most people feel that a coal phase-out will not happen within their lifetime, and they hope that their children would, by then, be better educated for non-coal jobs in other industries and the service sector.

However, the state government and the industry officials are more pragmatic about the future. The key industrial players, such as NTPC Limited and JSPL, are diversifying their business portfolio and also investing in cleaner fuel sources in their operations. The state administration is exploring the possibility of setting up green hydrogen and renewable energy plants. The state's Climate Action Plan (2018), also clearly mentions the need for augmentation of renewable energy (RE) based electricity and low-carbon industrial development.

Based on responses as captured through FGDs and interviews, this section highlights the perception of various stakeholders about coal transition under four key thematic areas:

- Job and income substitution needs for workers in the coal industry;
- Economic diversification;
- Opportunities for the district; and,
- Environmental and climate concerns.

Job and income substitution

Labour unions

- Open dialogue on coal transition between unions and the PSUs and the discussion on the timeline.
- Undertake age assessment of the workers (including contractual workers) at various phase-out stages to understand the required skilling and reskilling needs, compensations, etc.
- Provide income support to all workers while they are undergoing training for new jobs.
- Provide pension support and option of a voluntary retirement scheme (VRS) for employees above the age of 45 years if they do not wish to be reskilled for the new industry.
- Ensure a centralised/state-level wage structure for all workers if the new industries are not PSUs.
- Ensure investments in education and skill training based on the industry vision for the future.

Informal coal mine workers

- Create requirement for industrial jobs.
- Provide training to ensure that an alternative income can be secured.
- Institute a formal contract and payment system, rather than the daily wages one.

Contractual mine workers

- Focus on local job creation to avoid migration.
- Ensure monitoring of contractors for full wage payment.
- Ensure income support as per the current income and healthcare benefits.
- Training for new jobs by an upcoming industry or the government with better wages.

Departmental TPP workers

- Ensure compensation and provision of benefits such as pension and healthcare.
- Provide skill training for a new industry if the PSUs are diversifying within Angul or adjoining districts/states.

Coal transport workers

- Establish industries which would require transportation.
- Provide skill training options for mechanical and technical jobs with placement assurance.
- Provide financial support to encourage entrepreneurial activities.

Coal washery workers

- Provide local job opportunities closer to the villages.
- Provide skill training to small businesses and the retail industry.
- Provide assistance to landless people.

Fly ash brick workers

- Identify industries that can absorb low-skilled labour.
- Provide education completion options with income support.
- Ensure provision of better accommodation, regular incomes to avoid frequent out-migration.

PRI representatives and ward members

- Ensure creation of industry jobs and stable income for the youth.
- Ensure amenities like water, healthcare, and education are provided by the government or continue to be provided by the PSUs in places close to mines and TPPs.
- Ensure education for children to guarantee better and well-paid jobs for them in the future industries.
- Focus on improving income opportunities of villages, many of whom are engaged as labourers in the industries.

Economic diversification

Labour unions

- Focus on setting up diverse industries to replace the coal industry.
- Ensure diversification of PSUs into other businesses, including energy, but in the same region.
- Focus on bringing other private industrial investments to Angul.
- Focus on developing other parts of the district equally to reduce the dependence on Talcher.

Coal transport association

- Provide economic opportunities in Talcher to offset for any income loss in the coming years.
- Ensure maintaining industries in the region that will require goods to be transported by road.

PRI representatives and ward members

- Focus on developing local livelihood through agriculture and livestock-based industries across the district.
- Plan for economic activities across the district to ensure better livelihoods for all, avoid a concentrated focus.
- Involve local representatives and self-help groups (SHG) to plan around the resources, provide better funds for livelihood programmes.
- Develop micro, small and medium enterprises (MSME) or industries that can create sufficient jobs and also ensure that revenue inflow is not affected.

CSOs

- Develop local businesses and industries around agriculture and allied sectors.
- Build the potential of forest products through proper policy and market support.
- Strengthen SHG network to improve women income, which is a challenge near the coal mining areas.

Chinmayi Shalya/iFOREST

Opportunities for the district

District administration and officials

- Focus on eco-restoration and land repurposing for improving environmental status and economic opportunities.
- Develop organic farming clusters in rural blocks to strengthen the local economy in a sustainable manner.
- Develop infrastructure of the district and continue ongoing urban area development.
- Ensure availability of resources, such as water, electricity, trained human resource, for industry by partnering with skill training agencies such as the Central Institute of Petrochemicals Engineering & Technology.

State-level officials

- Augment infrastructure and connectivity by road, railway and ports.
- Shift industrial focus on Angul with regard to steel and aluminium industry and develop downstream industries.
- Develop clean fuel avenues such as hydrogen plants, renewable energy plants.
- Develop industries for green energy such as EV manufacturing, solar cell manufacturing, etc. to make Odisha a manufacturing hub.
- Ensure coal cess utilisation (on negotiation) for developing alternative clean energy industry in the coal districts.
- Augment potential of horticulture, fisheries, and off-farm livelihoods.
- Develop eco-retreats and boost tourism in and around the district.
- Provide policy support and incentives.

Industry (PSUs and private)

- Ensure availability of land for various activities such as fisheries, hydro power, solar energy, eco-park, etc. after the closure of coal mines.
- Improve connectivity of the region to ensure its proximity to the state capital and ensure availability of human resources.
- Explore potential for coal gasification as one plant is already operational at the JSPL integrated steel plant.
- Ensure gas-based production of power through coal-bed methane.

Civil society organizations

- Ensure availability of labour, providing skill training.
- Identify industrial land that can be reused when coal mines will be closing down.
- Strengthen network of Civil Society Organisations (CSOs) that can provide knowledge, capacity building and implementation support.

Environmental and climate concerns

Formal coal mine workers

- Heavy air pollution around mining areas due movement of trucks, emission from the TPPs.
- Air pollution in villages and municipal area due to coal burning.
- Rise in temperature over the years.

Coal transport workers

- Air pollution and prevalence of breathing issues among people.
- Water crisis in villages close to the mines.
- Erratic rainfall in the past years.

PRIs and ward members

- Air pollution due to TPPs, coal mining activities and heavy road transport of coal.
- Water contamination due to industrial discharg from TPPs, aluminium smelter.
- Water stress in Talcher due to coal mining, affecting irrigation for crops.
- Spells of drought over the years due to consistent and increasing industrial activity.
- Fear of erratic rainfall and drought which will affect livelihood.

Chinmayi Shalya/iFOREST

6.3 Timeframe for just transition

Determining the timeframe for phasing down (and phasing out) coal mining activities and coal-based power production is one of the most crucial steps for just transition planning. A well-defined timeframe can guide phased action on closure of mines and thermal power plants (TPPs) with least socio-economic disruption. At the same time, it will also ensure that timely measures are taken for economic diversification and revenue substitution, necessary labour support is provided, the required physical and social infrastructure are developed, and finances are secured from public and private sources, as well as from multilateral and international institutions.

The timeframe for the closure of coal mines and TPPs has been considered under two scenarios — the Current Policy Scenario (CPS) and the Net Zero-2050 Scenario (NZ-2050) — to evaluate the prospects of a just transition under existing government policies, and accelerated measures for climate action.

Policy scenarios

Current Policy Scenario

The Current Policy Scenario (CPS) is based on existing government policies and plans. For coal mines, it assumes that the existing and upcoming mines can be closed following completion of their respective operational life. For coal-based power plants, it assumes a closure timeline considering the operational life of the plant as 35 years, 10 years more than the 'design life' stipulated by the Central Electricity Authority. The scenario aligns with India's target of achieving net zero by 2070.

Net Zero-2050 Scenario

The Net Zero-2050 Scenario (NZ-2050) considers how India can meet a net zero emission target by 2050, towards meeting 1.5°C climate goals. The scenario assumes a stiffer but achievable pathway for phasing down coal-based power and non-coking coal production. The scenario considers the need for a contingency planning in response to expected technological advancements in non-conventional energy sources and their cost-competitiveness, which is likely to stimulate a change in policy as well.

6.3.1 Coal mine phase-down and closure

Angul currently has a coal production capacity of 123.8 million metric tonnes per annum (MMTPA), as per normative capacity estimates. The actual production recorded in 2021-22 was 96.7 MMT.[4]

The district will experience a significant expansion in coal production over the next decade. By 2030, there will be 22 operational mines (including the existing mines, the upcoming mines that have received a clearance or awaiting final approvals, and the allocated coal blocks) with total production capacity of 279.7 MMTPA. The production will peak in 2033 at 308.8 MMT. The estimates of the study are in line with the projections of the Ministry of Coal, where it is estimated that coal production from Talcher coalfields will be about 300 MMT by 2030.[5]

Given the scale of coal production, the two scenarios – CPS and NZ-2050 – have considered four key assumptions to develop the phase down schedule:

- For the upcoming mines, the start year of 2027 has been assumed.[6]
- For the allocated blocks, the start year of 2030 has been assumed.
- For the allocated blocks, where no mining plan is available, the mine life of 33 years has been considered. This is typically regarded as the duration by which a mine has recovered its cost of investment and extracted most of the coal.[7]
- In NZ-2050, the life of the existing mines has been capped at 50 years.

a. Current Policy Scenario (CPS)

Coal mine closure under CPS can be planned in four phases. The sequence of closures has been determined based on three key assumptions:

- Since all mines, except one underground (UG) mine, in Angul are profit making, the existing mines would continue to produce as per their estimated mineable reserves and corresponding mine life.
- The production will increase in the coming years as per planned expansions.
- All upcoming mines and allocated coal blocks would complete their life as per the available mineable reserves.

Taking these into consideration, coal phase down under CPS can start during this decade and continue until 2070. The sequence of closures is outlined below.

Phase I – By 2030: Two coal mines – one UG and one opencast (OC)– can be closed down. The UG mine, Nandira has been operating for more than 50 years, is low producing and unprofitable. Jagannath, the OC mine, will also exhaust its mineable reserves.

Between 2030 and 2040: No mine will close during this period. There will be an increase in coal production until 2033 when production will reach a peak at 308.8 MMTPA. The peak is assumed considering all mines will be operating optimally.

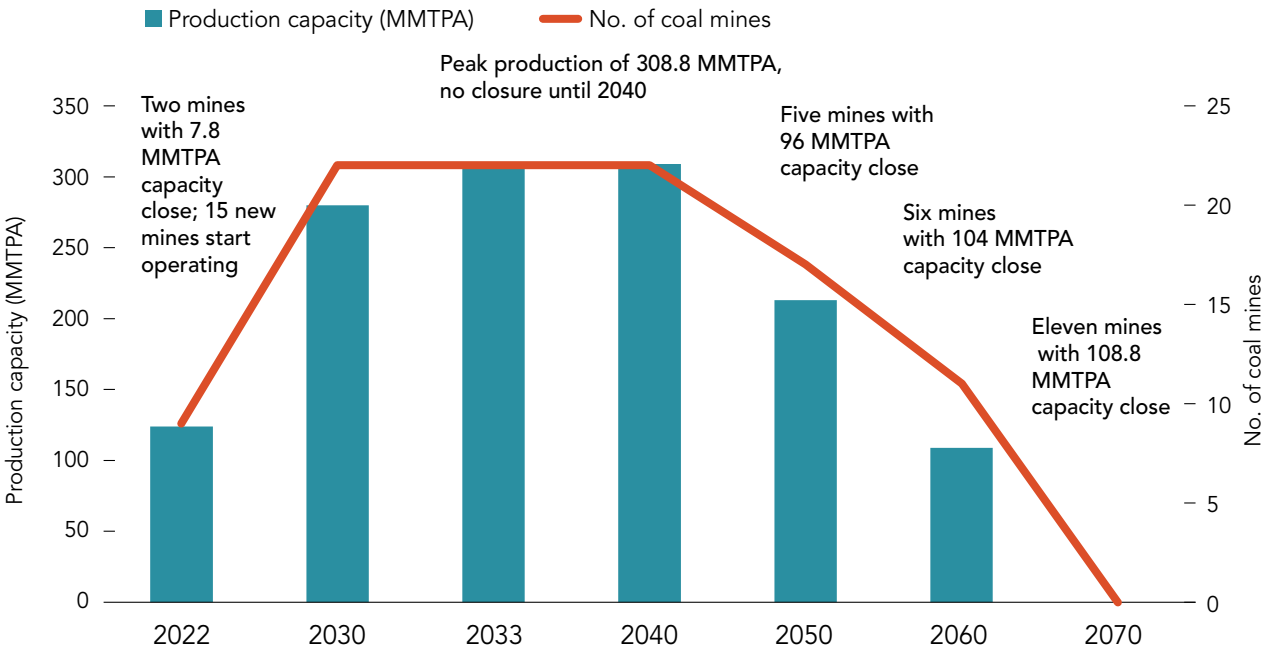
Phase II – Between 2040 and 2050: During this phase, five mines will reach the end of their life and can be closed. These include, Lingaraj, Ananta, Bhubaneswari, Radhikapur East and Balabhadra. Of these, the first three are existing mines, and the remaining two are upcoming. With these closures, there will be a reduction of about 96 MMTPA of production capacity.

Phase III – Between 2050 and 2060: Six coal mines, with a cumulative production capacity of 104 MMTPA can be closed in this phase. These include, Bharatpur, Kaniha and Hingula which are currently operational, and Utkal B1 and B2, Radhikapur West and Subhadra, which are upcoming.

Phase IV – Between 2060 and 2070: The remaining 11 mines, with a cumulative production capacity of 108.8 MMTPA can be closed during this decade. All of these, except Balaram, are new mines.

As per the CPS, the closure of most mines will start after 2040. The maximum number of closures will happen after 2060, assuming that all the allocated coal blocks will actually come into production. As per the industry observation, the final decision on their operations will be taken around 2030 considering the energy requirement of the country.

Figure 3: Coal mine closure schedule under CPS



b. Net Zero-2050 Scenario (NZ-2050)

Coal mine closures under NZ-2050 can be planned in three phases, assuming that the last mine will close by 2050 following an accelerated closure. Within this timeframe, three key assumptions have been considered:

- A maximum of 50 years of operation for the existing coal mines, based on their start year.
- All upcoming and allocated mines will operate for their full estimated mine life if the closure under the CPS precedes 2050.
- For those with year of closure under the CPS beyond 2050, a forced closure will be required to meet the NZ-2050 timeline.

In terms of a decadal scenario, a large number of mines (total 20) will close between 2040-2050. The sequence of closures is outlined below.

Phase I – By 2030: This phase will be the same as CPS, where two mines – one OC and one UG – will close.

Between 2030 and 2035: In this phase, there will be an increase in coal production in the same manner as under CPS. By 2033, production will reach a peak of 308.8 MMT with 22 mines operating optimally.

Phase II – Between 2035 and 2040: During this period, two mines – Ananta and Bharatpur – will close after completion of 50 years of operation, leading to a reduction in 35 MMTPA production capacity.

Phase III – Between 2040 and 2050: All 20 remaining coal mines will close at various stages during this period leading to a complete closure of mining activities.

In NZ-2050, most of the coal mines will have to close within a short time span of 10 years – between 2040 and 2050. A large number of new mines which will start operation after 2027 will not be able to complete their design life and will have to leave 30%-50% of the reserves unextracted. In fact, estimates show that 75% of the new mines have a risk of becoming stranded assets under the accelerated closure scenario to meet 1.5°C climate goals. This raises serious doubts about the practicality of opening these mines, particularly the allocated blocks, given the climate targets as well as the prospects of RE.

Overall, in the CPS, only about 240 MMT of coal production would be foregone, due to forced closure of one mine, which has life cycle beyond 2070. In NZ-2050, however, about 3,051 MMT of coal production will be foregone, largely from the upcoming mines and allocated blocks.

Figure 4: Coal mine closure schedule under NZ-2050

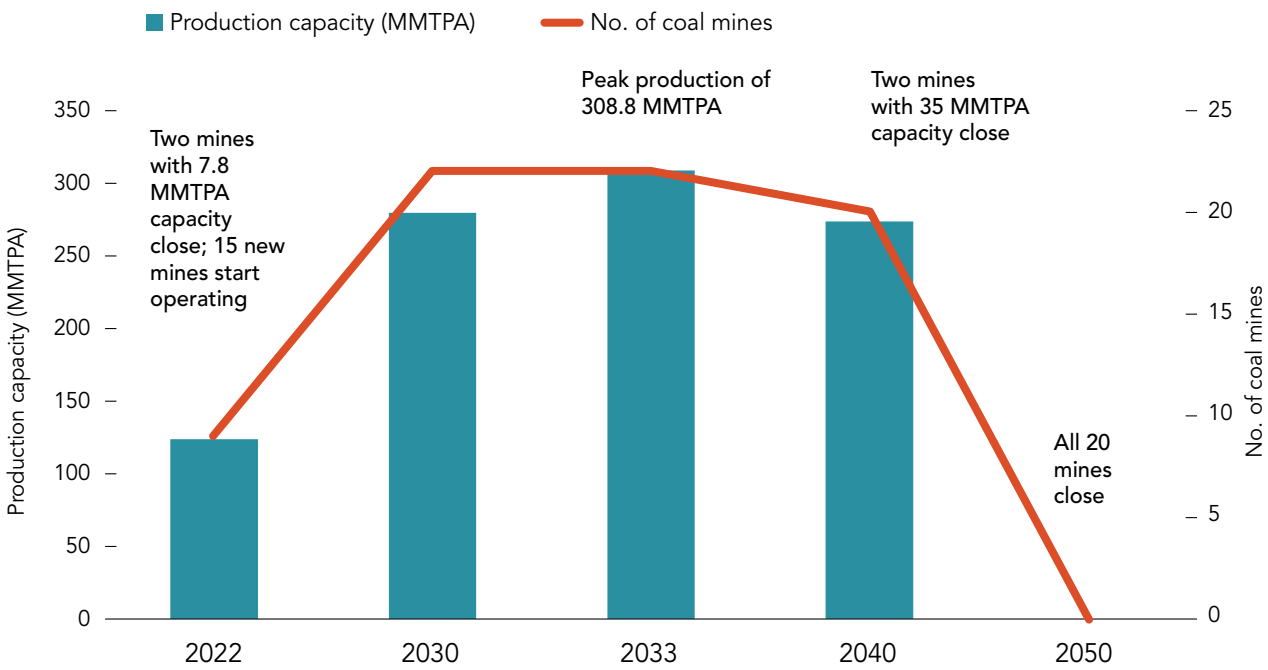


Table 1: Coal mine closure year under CPS and NZ-2050

Name of mine	Block	Operation type	Production capacity (MMTPA)	Production, 2021-22 (MMT)	Mineable reserves as on 2022 (MMT)	Estimated remaining life of mine in 2022 (years)	Years in operation (as on 2022)	Year of closure under CPS	Year of closure under NZ-2050
Nandira	Talcher	UG	0.33	0.08	9.38	28	52	2025	2025
Jagannath	Talcher	OC	7.5	7.03	55.98	7	51	2030	2030
Lingaraj	Talcher	OC	16	14.46	321.5	20	31	2042	2041
Ananta	Talcher	OC	15	13.58	366.7	24	34	2046	2038
Bhubaneswari	Talcher	OC	28 50 (planned expansion)	28	1,201.4	24	15	2046	2046
Radhikapur East*	Chhendipada	OC	5	-	110.8	22	Still to start	2049	2049
Balabhadra*	Talcher	OC	10	-	229	23	Still to start	2050	2050
Utkal B1 and B2**	Chhendipada	-	8	-	173.5	21	Still to start	2051	2050
Bharatpur	Talcher	OC	20	9.2	593.7	30	37	2052	2035
Kaniha/Gopalji Kaniha	Kaniha	OC	14 30 (planned expansion	10.1	951	32	20	2054	2050
Radhikapur (West)*	Chhendipada	OC and UG	5.3	-	166.7	28	Still to start	2055	2050
Hingula	Talcher	OC	15	7.7	513.9	34	24	2056	2048
Subhadra*	Talcher	OC	25	-	791	32	Still to start	2059	2050
Baitarni West**	Chhendipada	-	15	-	468.3	31	Still to start	2061	2050
Mandakini B*	Talcher	OC	20	-	691.1	35	Still to start	2062	2050
Chandrabila**	Kaniha	-	6.1	-	200	33	Still to start	2063	2050
Surapal-Nuapara**	Chhendipada	-	6.1	-	200	33	Still to start	2063	2050
Brahmani**	Talcher	-	1.8	-	58.9	33	Still to start	2063	2050
Naini	Chhendipada	OC	10	-	378.6	38	Still to start	2065	2050
Utkal D&E*	Chhendipada	OC	4	-	159.5	40	Still to start	2067	2050
Utkal C**	Chhendipada	-	3.4	-	123.8	37	Still to start	2067	2050
Mandakini**	Talcher	-	7.5	-	287.8	38	Still to start	2068	2050
Balaram	Talcher	OC	8 15 (planned expansion)	6.53	721	48	31	2070	2041
New Patrapara**	Chhendipada	-	20	-	1,042	52	Still to start	2082	2050

(*) Assumed year of starting operations is 2027; (**) assumed year of starting operations is 2030. For Chandrabila, Surapal- Nuapara and Brahmani, life of mine was not available at the time of the study. Hence a mine life of 33 years has been assumed. The operation type could not be provided for the allocated blocks as they are still under the process of development. Production for 2021-22 is available only for the currently operational mines. (-) indicates information not available.

Table 2: Proportion of coal production foregone by upcoming and allotted mines under NZ-2050

Name of mine	Block	Operation type	Mineable reserves (MMT)	Proportion of production foregone (%)
Radhikapur East	Chhendipada	OC	110.8	Will exact all reserves
Balabhadra	Talcher	OC	229	Will exact all reserves
Utkal B1 and B2	Chhendipada	-	173.5	Will exact all reserves
Radhikapur (West)	Chhendipada	OC and UG	166.7	Will exact all reserves
Subhadra	Talcher	OC	791	30
Baitarni West	Chhendipada	-	468.3	35
Mandakini B	Talcher	OC	691.1	35
Chandrabila	Kaniha	-	200	40
Surapal-Nuapara	Chhendipada	-	200	40
Brahmani	Talcher	-	58.9	40
Naini	Chhendipada	OC	378.6	40
Utkal D and E	Chhendipada	OC	159.5	45
Utkal C	Chhendipada	-	123.8	45
Mandakini	Talcher	-	287.8	50
New Patrapara	Chhendipada	-	1,042	60

(-) indicates information not available

Table 3: Decadal coal production foregone under CPS and NZ-2050

Decade	Cumulative production in CPS (MMT)	Cumulative production in NZ-2050 (MMT)
2022-2030	1,487	1,487
2031-2040	3,031	2,901
2041-2050	2,696	2,225
2051-2060	1,602	0
2061-2070	609	0
Total production	**9,425**	**6,613**
Production forgone	**240***	**3,051.8**

*New Patrapara is the only coal mine whose life is up to 2082 and will have to be closed by 2070

6.3.2 Coal-based thermal power plant phase-down and closure

The timeframe for the closure of the TPPs also takes into consideration the CPS and the NZ-2050 scenarios. Two key assumptions have been considered for the scenarios:

- The CPS considers the operational life of the plant as 35 years, which is 10 years more than the 'design life' stipulated by the Central Electricity Authority.[8]
- The NZ-2050 considers the operational life of the plants as 25 years, same as the design life.

Additionally, both scenarios consider the ability of the plants to meet environmental norms as recommended by the CEA under the National Electricity Plan (2018).

The closure timeframe of the TPPs has been determined taking into consideration the operational units (both grid connected and captive) and the upcoming ultra-supercritical TPP in Talcher. The Government of Odisha is also not considering any expansion of coal-based TPPs for grid-connected power. As per government information, only co-generation TPPs will be allowed for captive power production in the coming years.[9]

a. Current Policy Scenario (CPS)

The CPS assumes that a TPP will operate until a maximum of 35 years, which is 10 years above the standard design life of the plant. This scenario offers the flexibility of extended operations of TPP for power generation beyond the 25 year design life. The TPP closure under CPS can be achieved in five phases as outlined below.

Phase I – By 2025: In this phase, plants which are already above or nearing 35 years of operation can be closed. Considering this, five units of NALCO's captive power plant will retire, leading to a capacity reduction in 600 MW.

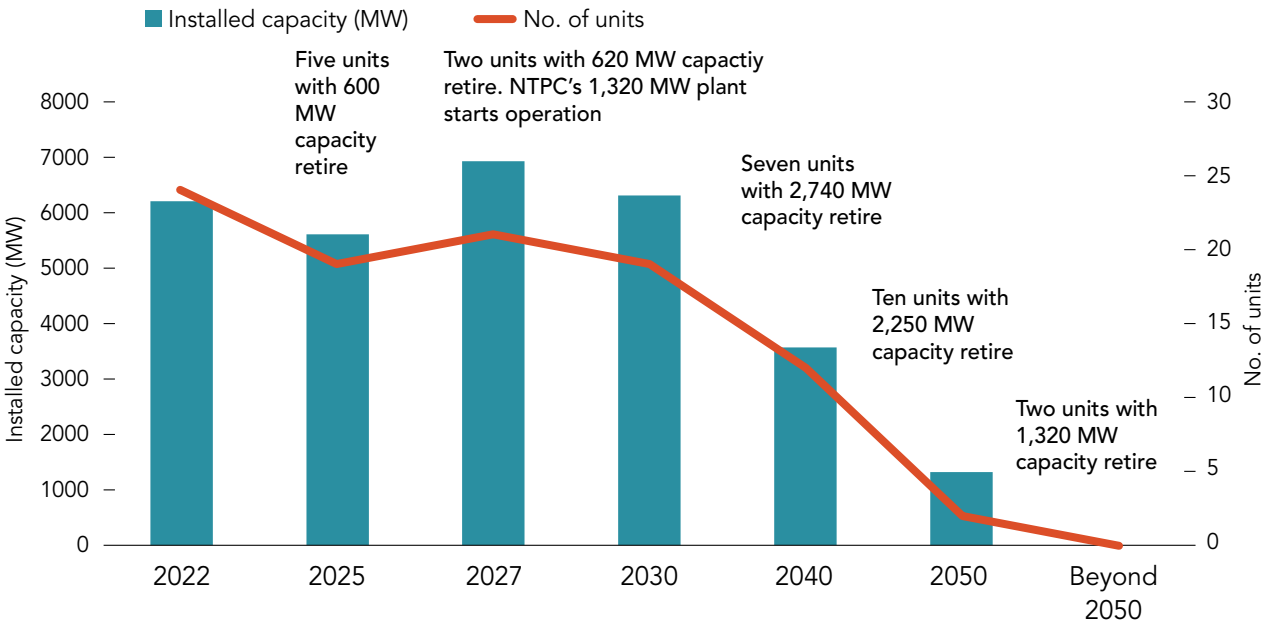
Phase II – Between 2025 and 2030: This phase is characterised by both addition in capacity as well as phase out of some of the existing capacity. In 2027, the Talcher ultra-supercritical plant of 1,320 MW (2 units of 660 MW capacity each), will start operation. On the other hand, two units, one each of Talcher Kaniha STPS and NALCO TPP will retire.

Phase III – Between 2030 and 2040: During this phase, five additional units of Talcher Kaniha STPS and two units of NALCO TPP will retire. This will lead to a 2,740 MW capacity reduction.

Phase IV – Between 2040 and 2050: In this phase, all units of Derang TPP, and JSPL's Angul captive TPP will retire. Additionally, the remining two units of NALCO TPP will also retire. This phase will mark the retirement of all existing TPPs with a 2,250 MW capacity reduction.

Phase V – Beyond 2050: Post 2050, only the upcoming Talcher ultra-supercritical TPP will be operational. As per the 35 year life cycle, both units of the plant will retire by 2062.

Figure 5: Power plant closure schedule under CPS



b. Net Zero – 2050 (NZ-2050)

The NZ-2050 scenario has been determined considering 25 years as the design life of a TPP. For TPPs which are more than 25 years old, a uniform retirement year of 2025 has been considered. The TPP closure under NZ-2050 can be achieved in four phases as outlined below.

Phase I – By 2025: In this phase, eight units – six of NALCO TPP and two of Talcher Kaniha STPS – will retire. These units have already completed 25 years of operation. The closure of these units will lead to a reduction of 1,720 MW capacity.

Phase II – Between 2025 and 2035: In this phase, in 2027, Talcher ultra-supercritical TPP will start operation adding 1,320 MW to the installed capacity. At the same time, eight units, with a cumulative capacity of 2,480 MW will retire. These include each of the remaining four units of Talcher Kaniha STPS and NALCO TPP.

Courtesy: Jindal Steel and Power Limited, Angul

Phase III – Between 2035 and 2045: Additional eight units will retire in this phase. These include all units of JITPL's Derang TPP and JSPL's Angul captive TPP, accounting for 2,010 MW of capacity reduction.

Phase IV – Between 2045 and 2050: In the final phase, the two units of Talcher ultra-supercritical TPP will retire. These units, with a cumulative capacity of 1,320 MW, will undergo early closure to meet the NZ-2050 timeline.

Overall, there will be no forced closure of TPPs in Angul under CPS, if no new power plants come up. Even under NZ-2050, only the Talcher ultra-supercritical TPP will face an early closure.

Figure 6: Power plant closure schedule under NZ-2050

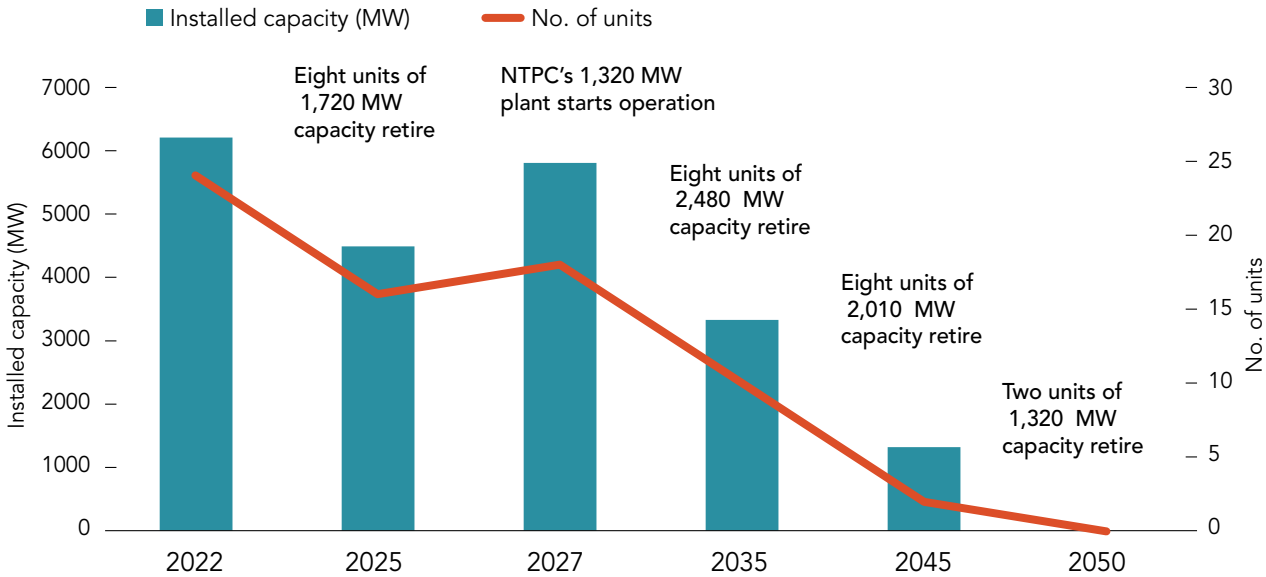


Table 4: Coal-based TPP closure year under CPS and NZ-2050

Company	Name of TPP	Block	Units to be retired	Installed capacity (MW)	Year of commissioning	Current age (years)	Year of retirement under CPS	Year of retirement under NZ-2050
NTPC Limited	Talcher Kaniha STPS	Kaniha	1	500	1995	27	2030	2025
			2	500	1996	26	2031	2025
			3	500	2003	19	2038	2028
			4	500	2003	19	2038	2028
			5	500	2004	18	2039	2029
			6	500	2005	17	2040	2030
JITPL	Derang TPP	Kaniha	1	600	2014	8	2049	2039
			2	600	2015	7	2050	2040
JSPL	Angul TPP (Captive)	Angul	1	135	2011	11	2046	2036
			2	135	2012	10	2047	2037
			3	135	2012	10	2047	2037
			4	135	2012	10	2047	2037
			5	135	2013	9	2048	2038
			6	135	2013	9	2048	2038
NALCO	NALCO TPP (Captive)	Angul	1	120	1986	36	2025	2025
			2	120	1987	35	2025	2025
			3	120	1987	35	2025	2025
			4	120	1988	34	2025	2025
			5	120	1989	33	2025	2025
			6	120	1994	28	2029	2025
			7	120	2002	20	2037	2027
			8	120	2004	18	2039	2029
			9	120	2009	13	2044	2034
			10	120	2010	12	2045	2035
NTPC	Talcher ultra-supercritical (upcoming)	Talcher	1	660	2027	0	2062	2050
			2	660	2027	0	2062	2050

Contractual worker unrest at closed Talcher (old) thermal power plant

It has almost been a year in March 2022, but the contractual workers are at a sit-in protest outside the Talcher (old) TPP in Angul. The 460 MW TPP operated by the NTPC Limited was closed last year after being in operation for since 1967 (with the last unit set-up in 1984). An official statement by company stated the reason of closure as end of the life of the TPP. The demand of the workers is to re-employ them.

At the time of its retirement, the TPP employed 1,400 contractual and about 570 departmental workers as per information shared by company officials. After the closure, some of the departmental employees were shifted to the Talcher Kaniha TPP operated by NTPC Limited in Angul. The transfer of others is on hold until the new TPP—Talcher Phase III ultra-supercritical plant— comes up, which NTPC is now in the process of setting up in the same premises.

However, the contracts of 875 contractual workers were terminated with the closure of the plant. The remining contractual workers were retained to maintain the premises. Interactions with the retrenched workers suggest that most of them are the sole earning members in their family, who are now struggling to find work. There is also an inter-generational dependence, as parents (mostly fathers) were employed in the plant, which was initially commissioned by the Odisha State Electric Board (OSEB). The second-generation was employed in the facility after NTPC took over the operations from OSEB in 1995.

Considering the work contract, the company, has no obligation to provide alternative employment in the event of a closure. However, due to the stability of income and a long-term dependence on the TPP, the workers are demanding for alternate employment and compensation considering it to be a "moral obligation" of the company. The labour unions – workers's union and NTPC men's Congress – who usually confine themselves to the causes of the departmental employees, filed a petition in the Odisha High Court against the loss of employment. As per the latest status the matter remains sub judice. The workers are trying to ensure that they get re-employed hopefully in the upcoming Talcher Phase III ultra-supercritical TPP.

The closure of the TPP and the ensuing worker crisis demonstrates the local turbulence among the labour in the case of closure of a TPP without a just transition plan. Going ahead, therefore, it becomes an imperative to plan a just transition as operations of coal-based TPPs coal mines gradually phase down. For contractual and informal workers this will also entail reform in the industry and labour laws, such as the Industrial Disputes Act of 1947 and the Contract Labour (Regulation and Abolition Act) of 1970, that pertains to the terms of employment (including retrenchment) of the industry workers.

Chinmayi Shalya/iFOREST

6.4 Repurposing of land and infrastructure

Land is a crucial requirement for industrial development and economic diversification. Repurposing of land available with coal mines and TPPs will be an essential component of just transition planning. Global studies suggest that repurposing of mining and industrial land has been a key factor for local employment generation and supporting economic transitions.[10]

However, the laws and regulations pertaining to closure of mining and industrial land in India do not have provisions for land repurposing. For coal mines, the guidelines are only confined to technical and biological reclamation of the mining land.[11] For TPPs, there is no regulatory provision either. So far, the absence of this has led to poor utilisation of land available with mines and TPPs after cessation of their operations. What is worse is that it has led to creation of large tracts of abandoned brownfield areas. However, repurposing must be considered as an integral component of closure of coal mines and TPPs going ahead, through necessary regulatory reforms.

At the same time repurposing of infrastructure developed by the coal mining and power companies will also be important. In large coal mining districts like Angul, many of these infrastructures are being used by employees and their families who are working in these companies. In the event of just transition when coal mines and power plants will close down progressively, the facilities maintained by these companies, particularly the public sector undertakings (PSUs) can become assets for use of the local community. This can also complement the social infrastructure investments that will be necessary for a just transition.

6.4.1 Current practices of post closure land use

An analysis of the proposed post closure land use for the OC mines in Angul show that it largely involves plantation activities. On an average, at least 60% of the available land area for most mines (and in few cases as high as 80%) is identified for plantations. Besides, about 15% of the area is kept as waterbody. For rest of the land, no specific use is outlined, and it is noted as built-up and undisturbed areas.

Considering the land that will become available in Angul in the coming decades from the closure of the coal mines, a framework needs to be developed for mine land repurposing which will be an integral part of mine closure planning. Considering that such land is of prime value, with already established infrastructure around it, the focus of land repurposing should be optimising economic returns through sustainable investments.

Table 5: Current post closure land use plan

Name of mine	Total area (ha)	Plantation (%)	Water body (%)	Undisturbed (%)	Built up area/ public use (%)	Quarry bottom/ quarry slope/dip side slope (%)	Agriculture land/grass land (%)
Bharatpur	1,556.9	80	3	1.4	3	12.5	0
Ananta	1,663.4	50	1.9	18	16.2	13.9	0
Lingaraj	1,493.2	21.8	16.5	0	37.4	0	24.2
Kaniha	718	54	0	0	22.7	23.3	0
Hingula	1,869.9	70.8	3.4	8	11	6.8	0
Bhubaneswari	787.9	71.7	3.9	0	17.3	7.1	0
Balaram	2,558.1	51.8	25.7	20.8	0	1.6	0
Jagannath	553.9	49.4	41.1	5.9	0	0	3.6
Subhadra	1,111.9	79.5	3.2	11.8	5.5	0	0
Naini*	912.8	2.1	12.1	0	0	0	0
Mandakini	2,078	37.6	15.5	14.8	0	32.1	0
Utkal D & E	885.2	69.5	17.2	6.1	0	0	7.1
Radhikapur east	1,029.9	68.7	9.7	21.6	0	0	0

Source: EC and EIA reports of coal mines. (*) The remaining area for Naini was marked as forestland which is to be returned. Hence, it is not reflected in the proportions for land use plan.

6.4.2 Land repurposing potential

In Angul, about 33,000 ha of land can be available for repurposing over the next three to four decades following closure of coal mines and TPPs. Over 93% of this land will be available from coal mine closures.

The repurposing potential of land has been analysed with respect to the OC coal mines. At the time of this research, information of post closure land use as envisaged by the mining companies was available for 13 mines (including expansion of current mines and the upcoming projects). The total land available with these mines is 17,219 ha.

As per the assessment, post mining land use can be broadly classified into four categories:

i. Disturbed land comprising backfilled mine pits (excavations) and external OB dumps;
ii. Waterbody, including void;
iii. Undisturbed land comprising of safety zones, project boundaries, etc.; and,
iv. Land for infrastructure.

Considering the aforementioned categories, and the suitability of the land for various activities, the potential investments and activities in the repurposed land has been identified. The uses proposed are also assumed to be suitable for creating substantial employment in the district, as well as help build a sustainable and diverse economy.

There are particularly three economic activities that can happen in the repurposed land, which will also help the district to prepare for a green energy and industrial transition, while creating jobs. These include:

i. Installations of solar PV;
ii. Development of industrial parks and food parks; and,
iii. Development of fisheries and tourism.

For example, one of the most suitable uses of external overburden (OB) dump area will be for setting up solar PV. Additionally, the excavated area can also be considered for such purposes. There is in fact a huge momentum in the global North to encourage RE development in mine sites, brownfields, etc. The United State Environmental Protection Agency (US EPA) in fact has launched an initiative in 2021 named 'RE-Powering America's Land' with such focus.[12]

Similarly, the undisturbed areas are most suitable for developing industrial parks and manufacturing zones, including for solar manufacturing, green MSMEs, etc. to create jobs and build a green economy.

The Ministry of Coal last year (October 2021), has started deliberating on repurposing of coal mining land. The Ministry has recognised the need for developing a comprehensive mine closure framework that will ensure both environmental reclamation and land repurposing, with a focus on people and communities. The government has also emphasised that this should be aligned with the principles of just transition (*Refer to Section on Green mining*).[13]

Table 6: Mine-wise post closure land availability

Name of mine	Excavation area (compacted mine quarry area) (ha)	Water body (ha)	External OB dump (ha)	Safety zone (ha)	Other un-disturbed land (ha)	Rationalisa-tion of project boundary (ha)	Infrastruc-ture (ha)	Total (ha)*
Ananta	936	32	10.8	41.2	298.9	6.9	337.6	1,663.4
Bharatpur	1,091.3	242.7	49.5	11.7	78.5	0	83.2	1,556.9
Bhubaneswari	411.3	31	94	83.2	0	0	168.5	787.9
Hingula	1,345	64.2	0	34.4	149.9	19.8	256.4	1,870
Jagannath	249.3	227.4	36.5	0	32.6	0	8.2	553.9
Kaniha	363	0	172	0	163	0	20	718
Lingaraj	292.1	246.7	256	110.6	442.3	10.4	135	1,493
Balaram	1,241.0	699.7	11.4		532.9	14	59.2	2,558.1
Subhadra	845.9	35.4	33.1	11.8			185.6	1,111.9
Naini	602	176.9		45.9			87.9	912.8
Mandakini	1,022		724	307			25	2,078
Utkal D & E	391.4		364.8				129	885.2
Radhikapur east	502		116	57			354.9	1,030
Total	**9,292.7**	**1,756**	**1,868**	**702.7**	**1,698**	**51.1**	**1,850.5**	**17,219**

Source: EC and EIA letters of respective coal mines.
(*) For some mines, the total area considered for post-mining land use is higher than the mine lease area. This is due to the fact that residential and rehabilitation colonies have been included in the post-mining land use, which are not part of the mine lease area.

Table 7: Potential investments and activities on repurposed land

Type of land	Category	Land availability by 2030 (ha)	Land availability by 2050 (ha)	Land availability by 2060 (ha)	Land availability post 2060 (ha)	Total (ha)	Potential use
Disturbed area	Excavation	249.3	2,109.4	3,645.6	3,256.4	**9,292.7**	Solar PV, horticulture, agriculture, eco-tourism, bio diversity parks
	External OB dump	36.5	476.8	254.6	1,100.2	**1,868**	Solar PV
Water body	Water body	227.4	309.7	342.3	876.6	**1,756**	Pisciculture
Undisturbed area	Safety zone	0	291.9	57.9	352.9	**702.7**	Industrial parks for various industries including solar manufacturing, green MSMEs, food parks, special economic zones
	Other undisturbed land	32.6	741.2	391.3	532.9	**1,698**	
	Rationalization of project boundary	0	17.4	19.8	14	**51.1**	
Land for infrastructure	Land for infrastructure	8.2	996	545.3	301.1	**1,850.5**	Affordable housing, hospitals, training centres, etc.
Total		**553.9**	**4,942.4**	**5,256.8**	**6,434.1**	**17,219**	

6.5 Economic diversification and green industrialisation

Coal mining and coal-dependent industries constitute the backbone of Angul's economy. The industrial expansion that the district is envisioning in the near future is also coal-dependent. The availability of low-cost coal, power, and water resources has positioned Angul (and the adjoining Dhenkanal district) as one of the top industrial regions of the state.[14]

For Angul, the process of transitioning away from coal and building a green economy will take two to three decades. However, it is important to start planning for it now.

Considering aspects of job creation, revenue substitution, and a growing economic trajectory, manufacturing, which has currently the largest share in the district gross domestic product (GDP), will continue to be an important contributor to the economy. However, efforts will have to be made so that the focus shifts from coal-based industries to green industries such as hydrogen for steel, biofuels, renewable energy, etc. The key interventions for economic diversification will involve:

- Investments in RE to maximise current potential.
- Using coal in the next decade to develop technologies and materials that can support a RE transition (battery, solar wafer manufacturing facilities to boost the solar value chain, etc.).
- Development of low-carbon/green industries.
- Boosting non-mining components of the primary sector – agriculture, forestry and fisheries.
- Improving income opportunities in the service sector.

6.5.1 Investments in renewable energy

The development of clean energy through investments in renewable energy would be crucial for Angul to diversify its energy mix and create new industry around it. This section assesses the potential of renewable energy (RE) in the district in the coming years, which also has a bearing on green manufacturing.

Angul's solar energy generation potential can be estimated considering potential for solar on rooftop, utilisation of wasteland, floating solar in waterbodies, and reclaimed mining land in the coming years.

One of the significant potentials for Angul lies with utilising the wasteland area. Currently over 37,612 ha of land area is classified as wasteland in Angul. When calculated considering the existing methodology of the National Institute of Solar Energy which nationally considers availability of 3% of the wasteland for such projects, the solar potential on wasteland can be estimated to be about 0.6 GW.[15] However, this assumption is overly conservative for a district-level estimation. A reasonable estimation for solar potential on wasteland, if considered as 10% of the total wasteland area, the generation potential becomes about 1.9 GW.

Additionally, the presence of dams and reservoirs in the district provide an opportunity for floating solar. Of the three existing dams, two – Rengali and Derjang – can be utilised for floating solar as their reservoir area is above 400 ha.[16] Considering 30% of the mean submerged area of the reservoirs as potential for floating solar, the estimated potential is 3.3 GW.

The potential for floating solar in Rengali is also recognised by the state government. The NHPC Limited, one of India's largest hydropower companies, has signed an agreement with the Green Energy Development Corporation of Odisha Ltd. (GEDCOL) in January 2022, for the development of 500 MW floating solar projects on different water bodies in Odisha. In the first phase, the reservoir of the Rengali hydroelectric project has been considered for installing 300 MW of floating solar.[17]

Finally, reclaimed and repurposed land following closure of OC mines in the district in the coming decades also provides opportunity for increasing the district's solar potential. An assessment of mine land availability post closure for OC mines in Angul suggest that nearly 11,212 ha of land area can be available for such purposes. This land area includes repurposed excavated area (flat land) and external OB dump area. The solar potential on the land is nearly 5.6 GW. This transition however would require a clear policy vision and schemes to support the transition.

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Table 8: Estimated land and water-based solar potential

Land use	Estimated area (ha)	Potential (MW)
Reclaimed mining land (External OB area)	1,868	934
Reclaimed mining land (Excavated area)	9,293	4,646
Wasteland	3,852	1,925
Floating solar	66,480	3,300
Total potential		**10,805**

Besides land and water based solar potential, the district also holds significant potential for roof-top solar. Various public and private buildings in urban agglomerations in Angul and Talcher, and also some in the rural areas can be harnessed for such installations. Considering existing residential buildings, commercial facilities such as shops and hotels, schools, medical facilities, factories and workshops, etc., the total solar rooftop potential can be estimated to be 26 MW. Increasing the potential for solar roof-top will also help to augment reliable energy access, particularly in rural parts of the district.

The rural economy of Angul can also benefit from solarization of the agricultural value chain. About 41% of the land area in Angul is currently being cultivated, but 74% (192,002 ha) of this is rainfed. A large proportion of the rainfed agricultural land area can be brought under irrigation through solar water pumps. A majority of these would be micro solar pumps of less than one horsepower (HP), as 85% of the land holdings in the district are marginal landholdings (below one ha).

Solar water pumps are already being widely deployed in Odisha under Central and state schemes such as the Pradhan Mantri Kisan Urja Suraksha evam Utthaan Mahabhiyan) (PM KUSUM) scheme and the Sourajalanidhi Scheme.[18] As of latest estimates, about 9,599 pumps have been installed in the state.[19]

Overall, renewable potential as estimated for Angul, particularly considering solar power-based energy, is an opportunity for diversifying job potential in the district, as well as help to improve developmental outcomes.

Coal vs. Solar power: The economics of energy production in Angul

Major investments in the energy sector will happen in Angul over the next 10 years. The district is ramping-up its coal production to 280 MMT by 2030 (and over 308 MMT by 2033, when it reaches the peak). New thermal power plants (TPP) for utilities and captive power plants for the aluminium refinery and steel plants are in the pipeline. All these investments are premised on the availability of cheap coal in Angul. But is coal the cheapest source of electricity? What is the economics of electricity generation from coal today and in the next 10 to 15 years? What is the economics of solar power and storage in Angul? To answer these questions, a modelling exercise was undertaken by iFOREST to compare the levelized cost of electricity (LCOE) from conventional energy technologies, next generation technologies and renewables. The following technologies were compared in the model:

- Super-critical TPP;
- Integrated Coal Gasification Combined Cycle (IGCC) power plant;
- Solar PV plant;
- Solar PV with 25% storage in lithium-ion battery; and,
- Solar PV with 50% storage in lithium-ion battery.

Assumptions for calculating LCOE

A set of financial and technical parameters have been considered for calculating LCOE from various technologies.

The financial parameters and the capital and fuel cost have been kept similar for all the technologies for the purpose of comparison. In reality, however, the parameters are different for different energy sources. While solar projects are able to attract foreign investments at a much lower cost of capital compared to the domestic cost, coal projects are now relying on domestic sources. Therefore, return expectations of investors for solar projects are lower than that from coal projects. In other words, the cost of solar projects is being over-estimated in this modeling exercise.

Financial parameters

Particulars	Normative parameters
Debt : Equity ratio	70:30
Return on equity	14%
Interest on loan	10%
Working capital	i. 1% of capital cost for solar PV ii. 1% of capital cost for battery storage iii. 10% of capital cost for super-critical TPP iv. 10% of capital cost for IGCC
Interest on working capital	10%
Rate of depreciation	5.28%; maximum depreciation of 90%
Loan duration	13 years for all; 10 years for battery storage
Increase in cost of fuel	3% per annum
Operations and maintenance (O&M) cost	i. 1% of capital cost for solar PV ii. 1% of capital cost for battery storage iii. 2.5% of capital cost for super-critical TPP iv. 2.5% of capital cost for IGCC
Increase in O&M cost	5% per annum
Discount rate	8.3%

Capital and fuel cost

Technology	Capital and fuel cost
Super-critical TPP	₹85 million /MW in 2022, increasing at 3% per annum
IGCC Plant	₹106.25 /MW in 2022, increasing at 3% per annum
Solar PV	₹35 million/MW in 2022; ₹32.5 million in 2025; ₹30 million in 2030
Lithium-ion battery	₹11.25 million /MWh in 2022; ₹9.75 million /MWh in 2025; ₹7.5 million/MWh in 2030
Rate of depreciation	5.28%; maximum depreciation of 90%
Loan duration	13 years for all; 10 years for battery storage
Increase in fuel cost	3% per annum
Increase in O&M cost	5% per annum
Cost of coal	₹1,500 /MMT in 2022 for pithead power plant, increasing at 3% per annum

The technical parameters considered for determining the LCOE are provided below.

Technical parameters

Particulars	Normative Parameters
Nominal capacity	i. 100 MW Peak (MWp) and above for solar PV ii. 100 MWh and above for Lithium-ion battery iii. 660 MW for super-critical TPP iv. 618 MW for IGCC
Capacity Utilization Factor (CUF)	i. 22% for solar PV ii. 90% for battery storage (depth of discharge) iii. 85% for super-critical TPP iv. 85% for IGCC
Availability factor	i. 90% for solar PV ii. 100% for battery storage iii. 90% for super-critical TPP iv. 90% for IGCC
Plant life	25 years for all except storage; battery storage 10 years
Gross Calorific Value (GCV) of coal (MCL average)	3,315 Kcal/kg
Station heat rate	i. 2,250 Kcal/kWh for super-critical TPP ii. 2,100 Kcal/kWh for IGCC
Auxiliary power consumption	i. 0.25% for solar PV ii. 0.25% for battery storage iii. 6.5% for super-critical TPP iv. 15% for IGCC

Results

The results of the modelling study show that the cheapest source of electricity in Angul during day time is Solar PV. Compared to the LCOE of ₹3.6/kWh for a super-critical TPP, the LCOE for a solar PV plant is ₹3.1/kWh in 2022. Solar PV with storage and IGCC are both more expensive in 2022.

However, from 2025 onwards, solar PV with storage starts becoming competitive with conventional technologies. In 2025, the LCOE for Solar PV with 25% battery energy storage systems (BESS) is ₹4.3/kWh,

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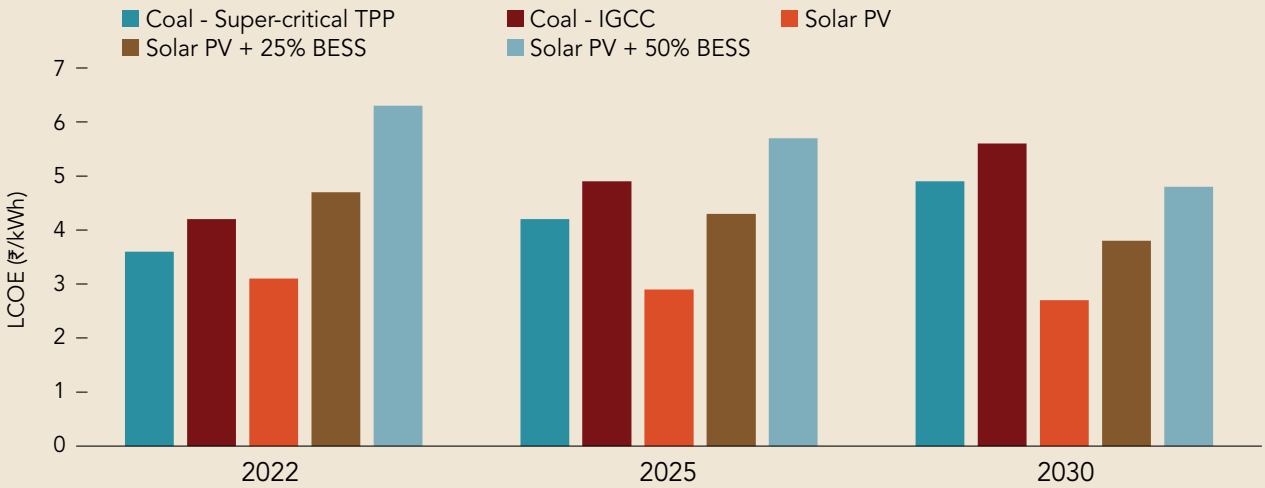
compared to ₹4.2/kWh for a super-critical TPP. In 2030, the cheapest source of electricity will be from solar PV with storage. In the reference year, the LCOE for a solar PV plant with 50% BESS is ₹4.8/kWh, as compared to ₹4.9/kWh for super-critical TPP, and ₹5.6/kWh for IGCC.

The results clearly indicate that there is a limited window – till 2030— to invest in coal-based TPPs. After that, the investments will not be viable. This will also have a major repercussion on coal demand from Angul. Therefore, coal mining in the district should be planned keeping in mind the projected demand from the coal-consuming sectors, such as, coal-based power. Else, there will be risk of stranded assets in the coal mining sector due to lack of demand.

Levelized Cost of Electricity (₹/kWh)

Technology	2022	2025	2030
Super-critical TPP	3.6	4.2	4.9
IGCC power plant	4.2	4.9	5.6
Solar PV	3.1	2.9	2.7
Solar PV + 25% BESS	4.7	4.3	3.8
Solar PV + 50% BESS	6.3	5.7	4.8



6.5.2 Green industrial transition

Angul offers major locational and resource advantage for the development of a green industrial sector. The district is located about 126 kms from the state capital and is connected through 228 km of national and 198.3 km of state highway. The district is also well connected by rail and has 12 railway stations.[20]

With respect to resources, the district is endowed with coal, and is estimated to produce over 300 MMTPA by the next 10 years.[21] The cost of electricity is also one of the cheapest in the country.[22] At the same time there is abundance of raw materials in the neighbouring districts, such as iron ore, bauxite, etc., which had led to scaling-up of heavy industries, such as steel and aluminium. Jindal Steel and Power Limited (JSPL) is expanding its steel production capacity from 6.0 MMTPA to 25.2 MMPTA. The company has also secured the bids for Utkal B1 and Utkal B2 coal blocks. The National Aluminium Company Limited (NALCO) is also expanding its operations and has secured coal blocks Utkal D and E. The fertilizer unit of the Fertilizer Corporation of India Limited (FCIL) in Talcher is being revived by the Talcher Fertilizers Limited (TFL). Using coal gasification technology, the will produce about 1.26 MMTPA of urea.[23]

While industrial growth is important for the economy of the district and the state government, it is extremely important to ensure that climate change and environmental considerations are internalised in the industrial planning. Therefore, the industrial growth should be based on the use of clean energy sources and modern technologies. In essence, Angul should plan a transition from a brown economy to a green economy. The transition should also be planned adhering to the principles of a just transition, ensuring better wages and secure employment.[24]

a. Phase-wise industrial transition scenario

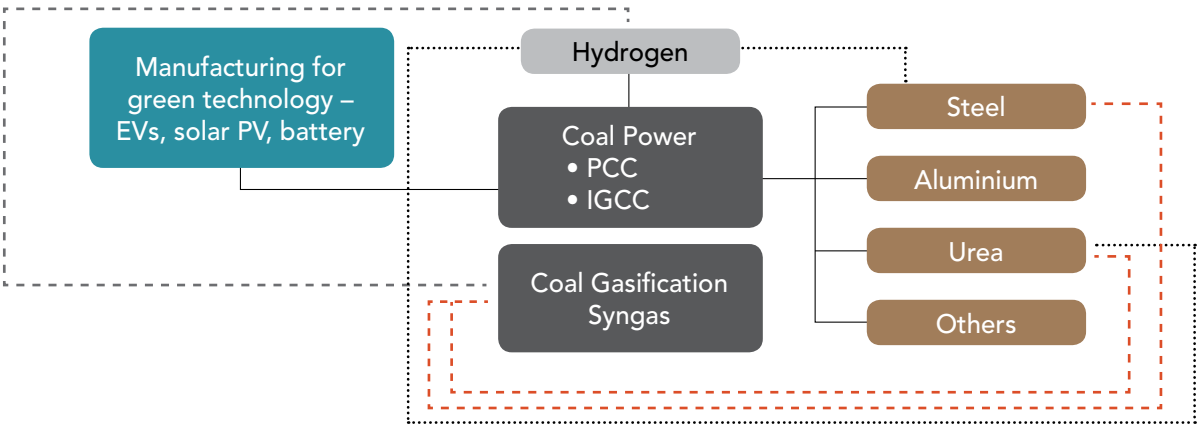
For an industrial transition in Angul, a two-phase approach is outlined below. This includes, a 'Brown Phase' and a 'Green Phase'. The approaches take into consideration the opportunities of new technologies, market viability, and the opportunity costs for the environment and the climate.

Brown Phase

The Brown Phase is a transition phase for the district to move into green industries. This intermediary phase is proposed taking into account four key considerations:

- Over the next 10-15 years, Angul can maximise the potential of its coal resources, using it for power generation through super-critical TPPs and IGCC technology. These processes can be further used to produce 'grey hydrogen' for use in industries.
- Simultaneously, there should be an effort to diversify the industrial sector for manufacturing of equipment to support the growth of RE and green technology, such as solar PV and battery production.
- Well defined policies must be formulated and investments should be ensured, to exploit the RE potential of the district and increase it's share in the energy mix.
- Ensure minimal environmental and carbon footprint of the extractive and manufacturing industries, through responsible mining practices (green mining), maximising the use of non-conventional fuels, and operating on the principles of a circular economy.

Figure 7: Brown Phase

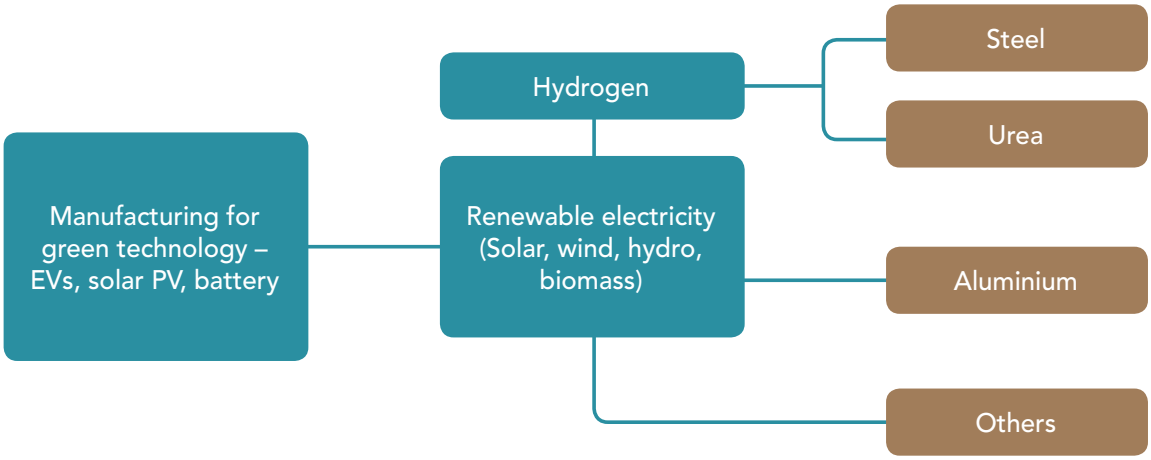


Green Phase

Post 2035, Angul must decisively move towards a green industrial phase. This phase should be aided by, and build on the following opportunities:

- Growing scale and cost competitiveness of RE.
- The technological advancements and their cost competitiveness to shift towards green industrial processes.
- Availability of green hydrogen and biofuels.
- Development of the required ecosystem, including the infrastructure, for supporting these industries and ancillary processes.

Figure 8: Green Phase



b. Key considerations of industrial transition

There is a 15–20-year window period for Angul to use coal economically and judiciously to build the pathway for a seamless transition to green industries. As the LCOE modelling shows, by 2030, RE coupled with battery storage technologies, will be the cheapest energy sources to produce electricity, and support the production of steel and other industrial products.

Also, till the time the transition happens, industrial activities must be practiced in an environmentally responsible manner and build on the principles of resource efficiency and circularity. If these are not ensured, the coal-based growth trajectory will have huge environmental and climate implications.

This section outlines six key considerations for industrial transition in Angul taking into account the abovementioned propositions.

Green mining

Coal mining has huge environmental and ecological impacts. These include, alteration of the natural landscape, deforestation and biodiversity loss, air and water pollution, soil erosion and contamination, land subsidence, fire hazards, etc. While these are regulated through various environmental regulations and guidelines, the approach remains fragmented.[25]

The Ministry of Coal, Government of India (GoI), last year (October 2021), had noted that the coal sector in India "is relatively new to the concept of systematic mine closure".[26] There are a large number of mines which are abandoned and poorly closed. The coal mine closure framework introduced in 2009 (and subsequently revised), also remains grossly inadequate in this regard. The existing regulatory framework largely focuses on aspects of technical closure (such as backfilling, stabilisation of mine pits and overburden dumps) and biological reclamation practices, largely involving plantations. Technical closure and plantations account for over 90% of the estimated closure costs for an OC mine. The closure practices however completely leave out environmental remediation of the mining-affected areas as well as mine land repurposing for productive economic use.

The Ministry, therefore, is considering to develop a comprehensive and robust mine closure framework emphasising on environmental reclamation and land repurposing, people and communities, and institutional mechanisms to ensure environmentally and socially responsible closure. The government has also emphasised that this should be aligned with the principles of just transition.

Going ahead, scientific mines management, environmental remediation and mine land reclamation and repurposing should be an integral part of the mining practices and closure plans.

Green equipment manufacturing to support renewable energy transition

The generation cost of electricity in Angul ranges from ₹2.65 to ₹2.95 per kWh at present, which is significantly cheaper as compared to many other parts of India.[27] The cheap cost of electricity is owing to the low basic sale price of coal for the coal grade available in Angul mines (G12 and G13 typically) as notified by CIL. As per the fixed base price, the average spot selling price of coal, is outlined below.[28] For captive mines, the cost is even lower.

Table 9: Average coal selling price per tonne

Industries	Basic sale price of MCL/ Cost of production for captive mines (₹/tonne)	Royalty (₹)	NMET (₹)	DMF (₹)	CGST (₹)	SGST (₹)	GST compensation cess* (₹)	Price with all taxes (₹)
For power utilities (including IPPs)	836	117	2.3	35.1	20.9	20.9	459.8	1,492.1
Sectors other than power utilities	1,000	140	2.8	42	25	25	550	1,784.8
Captive mines	600	117	2.3	35.1	20.9	20.9	459.8	1,256

Source: Based on CIL price notification, 2020, and considered respective taxes
(*) Considering MCL trend of payment of GST compensation cess which on an average is 11 times the State plus Central GST

Availability of cheap electricity in Angul can be beneficial for building and supporting the green industrial manufacturing sectors, such as solar PV, electric vehicle (EV), aluminium and batteries in this decade.

As pointed out by global experts, ensuring a transition to net zero will require diversifying the green manufacturing market and increasing production in countries where opportunity exists. Currently the market is highly concentrated in China. In China, as in many other parts of the world, green manufacturing is mostly reliant on coal. For example, 80% of the total energy used in solar PV manufacturing comes from electricity. Coal-based electricity has over 60% share of this. The electricity is primarily required for the production of polysilicon, ingots and wafers.[29]

China has been enjoying a competitive advantage in the market because of low-cost electricity available for such manufacturing. In the Chinese market, about 80% of the electricity required for polysilicon production is available at an average price of about US cents 7.5 per kWh, which is about ₹5.6 per kWh. This is considered as highly competitive as it is almost 30% below the global industrial price average.[30]

Angul can become a green equipment manufacturing hub in the coming years considering the determinants of the Chinese market. The district's coal production, low-cost of electricity and the supply of cost-competitive labour provides some of the key opportunities. In fact, even considering the LCOE from super-critical and IGCC power plants, electricity will be available at a rate of about ₹5 per kWh in the coming years. Therefore, if existing and upcoming (in the pipeline) power plants have surplus capacity, they can supply cheap electricity to build solar PV manufacturing facilities.

The Odisha State Industrial Policy (2015) already has some of the incentives (such as tax rebates, concessional land) to support this. The policy has been amended to incentivise 'new age industries' such as equipment for solar power generation, including, polysilicon, wafer ingots, solar cells, panels, modules, EV manufacturing, etc.[31]

Clean energy production and environmental management

Clean energy production in Angul will involve two key factors:

- Using coal-gasification to produce grey hydrogen in the immediate future and move on to green hydrogen; and,
- Using IGCC technology in future TPPs for power production.

i. Grey and green hydrogen

Coal produced in Angul can be harnessed through two key methods for producing 'grey hydrogen' as an intermediary fuel for the industrial sector until "green hydrogen" becomes commercially viable. The coal-based TPPs can directly produce hydrogen through electrolysis, taking advantage of cheap power in the district. The coal gasification plants can produce hydrogen from syngas. Hydrogen can be used as a reducing agent and fuel in the steel sector, where GHG emissions are hard to abate. Syngas/ grey hydrogen can also be used to produce other valuable products such as urea.

The GoI is planning to augment India's coal gasification potential as a transition approach to cleaner energy sources. The National Coal Gasification Mission promulgated by the Government in 2021, has set a target of achieving 100 MMT of coal gasification by 2030. Out of the 25 mines that the GoI is considering for coal gasification, eight are in Angul district. In fact, among all the mines that are being considered potentially for coal gasification, most are operated by MCL.[32] Angul's JSPL steel plant currently has a coal gasification plant with a capacity of 2,100 million normal cubic meter per year of syngas.[33] The upcoming ammonia and urea fertilizer unit of TFL in Angul has also proposed a coal gasification plant to produce syngas at 242,978 normal cubic meter per hour.[34]

However, as noted earlier, going ahead as RE becomes cheap and commercially viable, green hydrogen should become the energy source for producing steel, urea, etc.

ii. Clean Power

Apart from grey hydrogen, IGCC should be considered as the technology of choice for future TPPs. IGCC has advantage over all other technologies on pollution and GHG emissions. Particulate emissions, the biggest concern for conventional coal-based TPPs, are negligible in case of IGCC, and sulphur removal is much easier than conventional pulverized coal combustion (PCC).

Scientists at the National Energy Technology Laboratory of the US Department of Energy (2011) have noted that coal gasification uses more energy than conventional PCC. However, IGCC plants have a much higher overall efficiency than conventional plants. For example, a conventional PCC plant may have an efficiency of 33%, increasing to 37-38% for a super-critical pulverized coal (SCPC) plant, while an IGCC plant may have an efficiency of over 40%. Therefore, it is possible to demonstrate lower life-cycle GHG emissions from IGCC plants, compared to conventional PCC plants.[35]

At present IGCC plants are expensive and not always commercially viable. Therefore, technological advancements and policy incentives for making it cost competitive are necessary. Finally, carbon capture and storage (CCS) technologies need to be made cost competitive in the coming years to make coal gasification viable and ensure offsetting emissions.

With respect to coal-based TPPs, environmental performance will be a key issue. The use of advanced technology and compliance with environmental mandates for emissions control, and fly ash management, will be extremely important in the grey industrial phase.

Currently, Angul has four coal-based TPPs, two of which are captive. Of these, only one, Talcher Kaniha STPS has super-critical technology, while the others are subcritical plants. Given the lower operational efficiency of subcritical plants, as compared to super-critical plants,[36] their coal consumption and CO_2 emissions are much higher.

The TPPs also need to comply with pollution mitigation norms. For instance, the Ministry of Power requires flue gas desulfurization (FGD) systems to be installed which removes sulphur dioxide (SO_2) from flue gas

produced by boilers, furnaces, and other sources.[37] None of the non-captive TPPs in Angul have installed an FGD system so far. While Talcher STPS has awarded the bid for setting up FGD, Derang TPP has only floated the tender.[38]

Another aspect is of fly ash utilisation as generated by the TPPs. The Ministry of Environment, Forest and Climate Change (MoEF&CC) in December 2021, has mandated 100% utilisation of fly ash by using it in production of fly ash bricks and filling the mine voids, besides other specified 'eco-friendly' use..[39] None of the TPPs are currently utilising flyash as per the latest guideline. As per records of 2020-21, the Talcher STPS and NALCO TPP utilised more than 70% of the fly ash, while the JSPL and JITPL run TPPs recorded an average of 55% utilisation.[40]

However, following the 2021 notification, the utilisation is expected to improve. Besides, the upcoming Talcher TPP being an ultra super-critical unit, will have considerably less fly ash generation. The TPP would require about 6.9 MMT of coal annually for power generation and its fly ash will be disposed to fill the void of the Jagannath coal mine, which is nearing its end of life by 2030.[41] However, in all cases, monitoring and enforcement will be crucial to ensure compliance.

Table 10: Coal consumption and utilisation of fly ash by TPPs

Name of TPP	Coal consumed (MMTPA)	Fly ash generated (MMTPA)	Proportion of fly ash utilised (%)
Talcher Kaniha STPS	16.6	6.8	70.3
Derang TPP	4.3	1.7	58
JSPL captive TPP	2.2	0.9	53.8
NALCO captive TPP	6.1	2.9	75.7
Total	**29.2**	**12.3**	

Source: Central Electricity Authority, Report on fly ash generation at coal and lignite thermal power plants and its utilisation in the country, 2020-21.

Green steel

The steel industry is energy and resource intensive, a major share of which is coal. The sector accounts for 7% of global GHG emissions, making it the largest emitting industrial sector.[42] In 2019-20, steel along with sponge iron, accounted for over 10% of the total coal consumption in India. At the same time, the sector consumes about 70 Mtoe of energy per year, and coal accounts for 85% of the energy input. In 2019, direct CO_2 emission by the sector was about 250 Mt, which is nearly 10% of India's total energy system CO_2 emissions.[43] The bulk of carbon emissions originate from the reduction of iron ore, although subsequent steps in producing finished steel also have significant emissions.

The transition of the iron and steel sector will be extremely important for a system-wide transition in India for overall reduction in GHG emissions. Globally, the main technologies that are being considered for reducing emissions from steel production processes include- carbon capture, utilisation and storage (CCUS), hydrogen-based technologies, direct electrification and bioenergy.[44] Currently, coal-based blast furnace-basic oxygen furnace (BF-BOF) is the conventional method for reducing iron ore, and this is where most attention is focused for emission reduction potential.

It is expected that within the next 15-20 years, some of the more radical decarbonisation technologies, which are currently being demonstrated, would be commercially available. Among these, hydrogen-based production is particularly promising which involves the substitution of coal or natural gas as a reducing agent with hydrogen. Supported by India's RE advancements, if hydrogen is produced from emissions free electricity, the total emissions from the steel industry can be reduced by 94%. It is also further estimated that if hydrogen can be delivered at a cost of 2.5-3.5 US$/kg, it will be cost competitive with the BF-BOF route of steel production.[45]

The GoI in 2021 has introduced the Green Hydrogen/Green Ammonia policy to meet its climate target and incentivise the production of hydrogen through RE. The policy promotes a production of 5 million tonne (MT) per annum of green hydrogen by 2030, which can be used for steel and fertilizer sectors.[46]

In the intermediate years, the sector can also maximise its operational efficiency through investing in existing best available technologies (BAT). For instance, around 40% of blast furnaces in India are currently equipped with top-pressure recovery turbines (TRTs), and over 30% of coke ovens are equipped with coke dry quenching (CDQ), two examples of BAT. It is projected that under a Sustainable Development Scenario (SDS) the share of both of these can rise up to 70%. This, along with efforts of material efficiency, can contribute to considerable emission reductions.[47]

Table 11: Technological readiness of steel sector transition using hydrogen

Process	TRL*	Year available	Potential for emission reduction
Blast furnace: Electrolytic H2 blending	7	2025	Medium
DRI: Natural gas-based with high levels of electrolytic H2 blending	7	2030	High
DRI: Based solely on electrolytic H2	5	2030	Very high
Ancillary processes:H2 for high temperature heat	5	2025	High

Source: Adopted from IEA, 2020
(*) A scale used to assess where a technology is on its journey from initial idea to maturity; the IEA uses a scale with 11 increments which are grouped into six categories: Concept (TRL 1-3), Small prototype (TRL 4), Large prototype (TRL 5-6), Demonstration (TRL 7-8), Early adoption (TRL 9-10) and Mature (TRL 11)

Besides, Electric Arc Furnaces (EAF) are now in widespread use globally for making finished steel from steel scrap, accounting for 21% of global steel production.[48] Although they are not a direct substitute for conventional BF-BOF since they cannot reduce iron ore, they offer enormous emission reduction potential where a steady supply of scrap is available, and thus enhancing circularity. The direct CO_2 emissions from BF-BOF is 30 times more than EAF per tonne of steel produced.[49] Increasingly, EAF is combined with Direct Reduced Iron (DRI), which still results in significant emissions savings compared to conventional BF-BOF. This technology currently produces slightly less than 5% of steel globally.[50]

In India, EAF-based steel already accounts for 29% of steel production[51] but major potential for expansion exists if high quality steel scrap feedstock is guaranteed. There seems to be a growing momentum, with the Tata group, among others, announcing major EAF expansion plans.[52] Scaling up EAF can produce low-carbon emissions steel in the future as grid-based electricity moves to RE, and will also contribute to material circularity.

With a proposed expansion of the existing JSPL integrated steel plant from 6 MMTPA to 25.2 MMTPA, Angul's requirement to use coal to start with and move to green fuel is critical for decarbonization of the steel sector. In the current set up, the JSPL plant is already using syngas from coal to produce DRI[53] along with a coal-based captive TPP.

Green aluminium

The production of aluminium requires huge amounts of electricity and the growth of the aluminium industry is contingent on abundant supply of it. Since electricity generation is dominated by fossil fuels globally, the entire aluminium industry already contributes 2% of global CO_2 emissions.[54] Due to this reason, "green aluminium" investments are increasingly going to regions with abundant and cheap hydro power, such as in Canada.[55] Over the long term, aluminium production will have to move to zero-carbon electricity sources, as solar and wind, coupled with storage, become commercially viable and widespread.

Another important way of reducing emissions from aluminium is through using scrap as raw material instead of primary ore, as the scrap route uses only 5% of the energy.[56] Globally, only about a third of aluminium production is from scrap and the post-consumer scrap collection rate is estimated to be only about 70%.[57]

Angul currently has an aluminium smelter plant of 0.4 MMTPA production capacity. The transition in aluminium industry in Angul will also entail a phase-wise shift towards cleaner power sources. The district can also focus on scrap-based production to reduce costs and align with the principles of circular economy; This will also reduce emissions significantly.

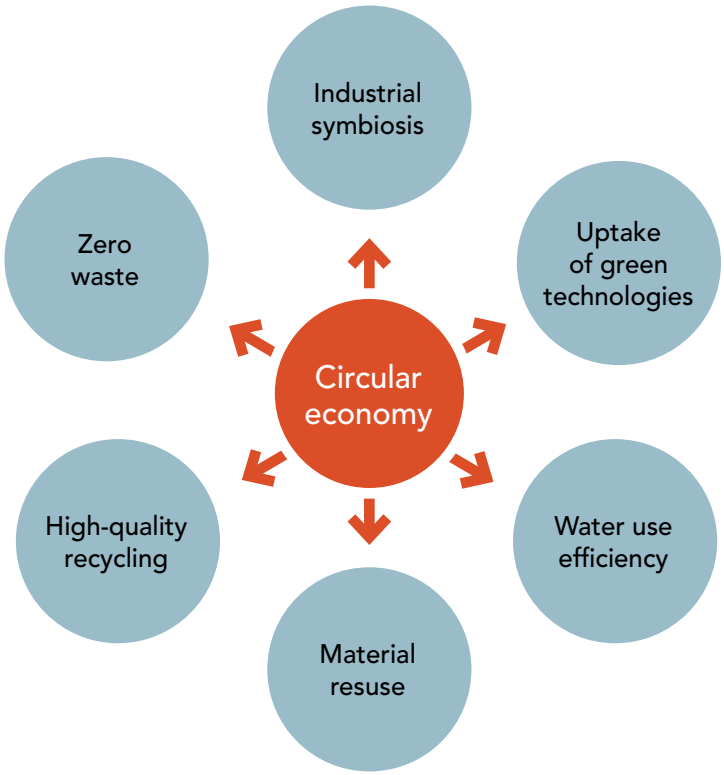
Notable steps towards moving to cleaner power sources have already started. In 2021, the mining conglomerate Vedanta Aluminium Limited procured two billion units of RE for consumption at its aluminium smelter in Jharsuguda, Odisha, from power exchanges. It helped the company cut down on GHG emissions at its smelter by more than 1.54 $MTCO_2e$.[58] Further, in May 2022, the company announced long-term sourcing of 380 MW RE for its aluminium smelters in Jharsuguda (1.6 MTPA) and Korba (0.57 MTPA).[59] The aluminium industry in Angul can follow this example and gradually move towards clean power over the next decades.

Ensuring a circular economy

The need for developing a circular economy is increasingly gaining momentum to deal with the challenges of resource scarcity, resource security, waste reduction and dealing with the climate crisis. The scale at which industrialisation in Angul is being envisaged, unless principles and practices of circularity are supported through legislative and non-legislative measures, the economy will become highly unsustainable.

A framework needs to be developed for Angul's industrial sector to move the economy from a linear to a circular model with a set of inter-related initiatives. The framework must be designed to improve circularity in production processes, product design, reduction of material and resource use, reduction of waste, and overall reduction of environmental and carbon footprint.[60]

Figure 9: Circular economy model for green industrialisation



Green industrialisation and developing a circular economy for Angul can only be supported through a comprehensive set of regulatory measures and institutional strengthening. The current regulations and policies are not sufficient to usher circularity in the economy. Therefore, a comprehensive circular economy policy is necessary to support an industrial transformation towards a low-carbon, resource-efficient economy that also enhances productivity, minimises environmental externalities, promotes economic and social co-benefits, and helps to achieve the net zero emission targets.

Policies to support industrial diversification and green economy – industrial plan section

The Government of Odisha has several policies which can aid growth of the RE sector and help to develop green manufacturing industries. However, these policies are currently fragmented and need to be consolidated to create a comprehensive green industrial policy. This will help to design implementation measures for green energy transition and sustainable industrialisation, as well as support ease of doing business.

Odisha State Industrial Policy, 2015

The state has an industrial policy to guide and attract investments. The policy was framed for the time period between 2015 and 2020, however, it is still active as amendments have been made to add more provisions through notifications. No separate industrial policy has been developed so far. Some of the key features of the industrial policy are:

- Attract large-scale investments in agro-processing, auto components, textiles, and ancillary downstream industry.
- Ensure the linkage of large-scale industries with MSMEs for downstream industry development.
- The Odisha Industrial Infrastructure Development Corporation (IDCO) is the key implementing agency.
- Land banks are created through the identification of government land, earmarking it, and transferring it to the IDCO for industrial development. The IDCO also assigns concessional rates for the land based on categorisation of areas.
- Use 10% of the land for large projects, with an upper limit of 300 acre (about 120 ha) earmarked for setting up ancillary and downstream industrial parks.

The policy highlights some priority sectors to incentivise investments and boost economy and job growth. Some of the key sectors with relevance to Angul are highlighted below.

Priority sectors as per the Industrial Policy

Agro and food processing	Handicraft, handloom, coir and leather products
Steel and aluminium ancillary and downstream industry	Information technology and IT-enabled services
Automobile and auto components	Pharmaceuticals
Plastics and polymers	Textile and apparel
Fly ash and blast furnace-based slag industries	Sea food processing
Petroleum, chemicals and petro-chemicals	Tourism and hospitality

The policy outlines fiscal incentives for various industries, largely focusing on the MSMEs. Those investing in priority sector industries have been provided the highest incentives. The key non-fiscal incentive is single-window clearance for industrial projects by the IDCO, to fast-track permits for the industry.

Subsidies granted for industrial development

Category	Scale of industry	Incentive/exemption
Land (exemption of payment of premium)	Micro and small	100% up to 5 acre
	Medium	75% up to 25 acre
	Large	50% up to 500 acre
	Priority sector	100% up to 100 acre ad 50% for balance area
Interest subsidy for five years	Micro	₹1 million
	Small	₹2 million
	Medium	₹4 million
	Non-MSME priority sector	₹10 million

Category	Scale of industry	Incentive/exemption
Stamp duty	Micro and small	75% of applicable stamp duty
	Medium	50% of applicable stamp duty
	Large	50% of applicable stamp duty
	Priority sector	100% exemption
	Land given by IDCO	No stamp duty
Value Added Tax reimbursement	New MSME	75% for the period of five years, limited to 100% cost of plant and machinery
	New priority sector	100% for a period of seven years, limited to 200% of cost of plant and machinery
	Existing MSME	75% for the period of five years, limited to 100% cost of plant and machinery over and above the installed capacity.
	Existing priority sector	100% for a period of seven years, limited to 200% of cost of plant and machinery, over and above the installed capacity

Additionally, the amendments to the policy add a list of "new age" sectors for incentives. These include EV manufacturing, non-conventional energy, electronics and telecommunication equipment manufacturing, textile, apparel, wearables and luggage, pharmaceuticals, etc.

These industries would be eligible for incentives including:

- Land from the IDCO land bank.
- 30% capital subsidy on actual investment in plant and machinery.
- Reimbursement of 100% net (full form) SGST for a period of 7-9 years limited to 200% of the cost of plant and machinery.
- Exemption from electricity duty for seven years.

Special Economic Zone (SEZ) policy

Odisha's SEZ policy of 2016 can be leveraged for dedicated investments in green energy enterprises. So far, Odisha has five SEZs, of which two are IT-based, two mineral-based and one aluminium manufacturer and exporter.

For Angul, the policy can help incentivise SEZs around solar equipment manufacturing, electric vehicles etc., which can build towards a green energy economy.

Electric Vehicle Policy

Odisha introduced its electric vehicle (EV) policy in 2021 to promote the use and manufacturing of EVs in the state. Some of the key incentives offered by the policy for the manufacturers include:

- SGST reimbursement.
- 25% capital reimbursement made in plant and machinery subject to an upper limit of ₹10 million for new MSMEs. The reimbursement is 30% with an upper limit of ₹12.5 million for micro and small units run by SC/ST/differently-abled people/women/technical degree holders.
- The state government is exploring the possibility for entering into a Memorandum of Understanding (MoU) with lithium cell manufacturers for a battery assembly plant in Odisha.
- Setting up a Centre of Excellence for training for various jobs in the sector.

The EV ambition of the state can be brought to Angul district given its proximity to the state capital, its focus on industrial growth and the availability of land, power and water.

6.5.3 Agriculture, forestry and fisheries

Boosting the primary sector, apart from mining, will be an important component of economic diversification measures. While more than 80% of the district's geographical area is under agricultural land and forests, the contributions of these sectors to the district GDP are about 7.4% and 1.6% respectively. Given the resource potential, these sectors can be developed for better economic opportunity and income gains of the rural population.

Agriculture

About 41% of Angul's geographical area is net sown and the soil and climatic conditions are suitable for a variety of high-value crops, such as paddy, legumes, oil seeds, etc. The district also has about 4% of its area under horticulture, which includes the cultivation of vegetables, particularly onions, fruits such as mangoes, and flowers (*Refer to Chapter 2*).

As per the 2020 estimates, about 26% of the district's net sown area is irrigated and the rest (74%) is rainfed. While the proportion of net sown area under irrigation is comparatively better than some of the top coal districts (where only 4 to 5% of net sown area is irrigated),[61] it is important to improve the district's irrigation potential by using sustainable technologies, such as solar pumps, considering the regions climate vulnerability.

Angul also has surface water bodies that are important for irrigation. The Rengali reservoir, built on the Brahmani river, is the major irrigation project in the district. There are three medium irrigation projects – Derjang, Manjore and Aunli – located in Angul, Athamallik and Chhendipada blocks, respectively.[62] There are also proposals in the pipeline, such as Kutulisingha Irrigation Project on the Mahanadi river for irrigation in Athamallik block and Hinjili dam for irrigation in Chhendipada and Kanhia blocks.[63] However, many of the current irrigation projects are not functioning efficiently due to poor equipment maintenance, and poor capacity of the old channels.[64]

The district's income from agriculture is also undermined by small landholdings. Nearly 95% of the landholdings in the district are marginal and small.

To improve the agricultural potential of the district, a number of measures, including improving groundwater availability through artificial recharge, using solar pumps, scaling up micro-irrigation to improve coverage, etc., are being considered.[65] Additionally, collectivisation of small and marginal farmers for commercial crops, introducing crops with low water demand, creating farmer producer groups, etc. are also considered to be important.[66]

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An entity named Angul Fresh Producer Company for marketing and retail of various food products such as rice, honey, spices, mangoes, and local artisanal products which are sold at various outlets, is already functional in Angul. The project is supported through the Odisha Rural Development and Marketing Society (ORMAS). The district also has an agri-mall which provides outlets for the procurement of agriculture equipment and other requirements.[67]

The district is also promoting organic agriculture clusters in the rural blocks, particularly targeting small and marginal farmers and the local youth. By 2023, an area of about 20-50 ha is targeted to be covered under organic farming. Angul also plans to develop small-scale industry around organic farming to promote off-farm livelihoods.[68]

Boosting agriculture sector

Advantages

- 41% of the geographical area is net sown. The district is largely agrarian and rural, hence necessary human resources and skill is available.
- Suitable for high-value crops.
- Potential for horticulture.
- Availability of surface water bodies for irrigation that includes the Brahmani River and its tributaries, the Mahanadi river basin.
- Good SHG network involved in the farm, livestock as well as non-farm commercial activities.
- About 100 existing agriculture credit societies.
- 53 producer groups operational and involved in a district-promoted producer company, setting a good precedent.

Drawbacks

- Only 50% of households own land.
- The size of landholdings is marginal (85%) and small (10.7%).
- A low number of FPOs. Only 15 FPOs registered in Angul involving 4,400 farmers.[69]
- Low irrigation coverage with only 26% of the net sown area irrigated.
- Poor maintenance of ongoing irrigation projects.
- Prone to cyclone and heavy winds, and rainfall deficits.
- No agro-processing and marketing industries. Only three existing marketing cooperatives.[70]

Interventions

- Strengthening the implementation of the Krushak Assistance for Livelihood and Income Augmentation (KALIA) scheme to provide loan assistance to small and marginal farmers, landless agricultural labourers, and sharecroppers.[71]
- Improving the reach of solar pumps for irrigation to small and marginal farmers through schemes such as the 'Kisan Urja Suraksha Evam Utthan Mahabhiyan' (KUSUM) Scheme.[72]
- Collectivising small and marginal farmers for commercial cultivation, providing end-to-end support to reach economies of scale through FPOs, local handholding, and training.
- Supporting packaging, grading, and transportation industries around agri produce.
- Improving storage, processing, and marketing facilities, particularly for horticultural produce.
- Improving water potential through groundwater recharge, integrated watershed development, soil and water conservation methods, arresting runoffs and simultaneously enhancing livelihood options through natural resource management.
- Improving the implementation of the Odisha Millet Mission to promote climate-resilient agriculture along with value addition and market linkages.
- Integrating schemes like Agriculture Production Cluster (APC) for farmer assistance in Angul.[73]

Forestry

Angul has 45% of the area under forest, which is endowed with 93 varieties of forest produce. However, due to the low potential utilisation and seasonal nature of the forest produce availability, forest-based livelihood is barely the primary income source for the locals. The resource, however, offers a significant potential for income generation not only through the collection and selling of forest produce but through the development of the processing industry. The status of forest-based livelihoods and potential has been assessed on the basis of official data, interactions with district officials, forest-dependent communities, and CSOs working on forest-based livelihoods.

Potential for forest-based livelihood

Advantages

- About 45% of the geographical area is under forest. Locals are used to the collection of forest produce for self-consumption and local sale.
- More than 90 varieties of forest produce suitable for food, medicinal and utility purposes.
- Forest suitability for tasar. The ST and SC population is already involved in *tasar* rearing.

Drawbacks

- Collection of produce largely for self-consumption.
- Lack of training for locals for small value addition for the preservation of products such as moisture reduction, deseeding, etc.
- Seasonal nature of produce availability.
- Lack of storage and processing centres.
- Limited market due to raw produce sale.
- No incentivisation of NTFP collection by the state government, except for *tendu* leaves.
- No reeling centre or processing units for *tasar* production.
- Overall, poor community mobilisation around forest resources.
- No community forest resource rights (CFR) rights granted.

Interventions

- Aggregating forest-dependent communities and building awareness on minimum support price (MSP) for forest produce.
- Providing training to people in local value addition.
- Providing processing units and facilities for value addition.
- Incentivising non-*tendu* NTFP collection and procurement.
- Providing end-to-end support, low-interest loans, creating cooperatives for storage, processing, packaging, and developing forward and backward linkages. ORMAS support to be extended to forest produce.
- Promoting private investments in forest-based small and micro industries for manufacturing of finished products.
- Promoting *tasar* rearing through plantations and providing end-to-end support to local rearers.
- Settlement of the CFR rights to manage and benefit from forests.

Fisheries

Water bodies, excluding minor and major irrigation projects, cover 2,495.7 ha of area in Angul. Additionally, there are reservoirs such as the Rengali, and gram panchayat tanks and ponds available for fisheries.

The district is ideal for fresh-water fish production and currently produces about 5,416 million tonnes (MT) of fish. As per the observations of the state and district officials, fish production in the district is currently low. There is an interim target to double the production. However, challenges remain with regards to ensuring water in water tanks during summer season, providing processing and marketing avenues to generate interest in fishing as an income generating sector, among others. Also, there is only one fish federation operational in Angul, which works near the Rengali reservoir.[74]

There are certain key interventions that can improve the scope of fisheries in Angul. These include using water bodies created under the MGNREGS for fishing activities, incentivising locals for commercial fishing, training and capacity building to maintain the water bodies for quality produce, setting up hatcheries and providing market linkage, etc.[75]

Agro-based industries and NTFP processing

The potential of the agriculture and forestry sectors can further be augmented through development of processing industries around agricultural products and NTFPs.

i. Agro processing

Agro-processing industry has been identified as a "priority industry" by the state government for investments and development as per the Industrial Policy 2015 as well as the Food Processing Policy 2016.[76] Development of agro-processing industries in the district will enable better farmer income as well as support off-farm livelihoods.

Some of the key government programmes are already enabling local resource enhancement. For instance, the central government's One District, One Product (ODOP) scheme identifies mango as a potential fruit crop for industrial and entrepreneurial support and employment generation. In addition, the availability of citrus fruits and other seasonal varieties, such as litchis, offers an advantage for food industry development.[77]

The Odisha government's Millet Mission is also incentivising millet production, processing, procurement and market linkage in various districts, including Angul. The value chain is supported through local SHGs and the creation of local FPOs.[78] Millets are not only climate resilient, but also require less water for cultivation.

The Food Processing Policy of the state government also incentivises setting up of Mega Food Parks, Sea Food Parks and State Food Parks in the districts. The policy offers financial assistance of up to 20% of the project cost, (excluding land), up to a limit of ₹150 million.[79]

Developing the agro-processing industry, however, would require collectivisation of farmers and their capacity building in farming methods. The presence of more than 21,000 operational SHGs in the district provides an important opportunity. The presence of local CSOs involved in livelihood generation offers the scope for handholding of local farmers and building their capacity.

ii. NTFP processing

Given the forest potential of Angul, NTFPs provide significant scope for the development of local NTFP processing industries. Angul has several high-value products such as honey, *sal* leaves, gooseberries, etc. which are collected locally by forest dwellers for personal use and for occasional sale in local village markets. The district also has silk production potential. The climate and soil type are suitable for *tasar* host trees and in some areas, locals living near the forest fringes are already rearing cocoons.

The potential of the forest produce, however, is underutilised due to the lack of organised collection of NTFPs, processing centres, storage, packaging, and marketing chain.[80]

In order to develop NTFP potential in Angul, some of the following interventions would be key[81]:

- Inventorisation and prioritisation of NTFPs to organise collection and processing and to optimise economic values.

- Development of value chains by aggregation, primary processing, grading, branding, and certification of the products.
- Undertaking conservation measures, including assisted natural regeneration, to prevent resource depletion after the development of industry around it.
- Capacity building for the rural and forest-dwelling communities, procurement agencies and officials of the forest department on various aspects of NTFP.

The expertise of ORMAS can be utilised as it provides access to the market linkage, technology transfer, thematic training, and skilling for wage employment.[82]

6.5.4 Income opportunities in the service sector

The share of the tertiary or service sector in Angul's GDP is nearly 26%. This can be largely attributed to the availability of various service sector jobs in Talcher and Angul block, particularly around the municipalities and industrial areas, where various kind of economic activities related to the service sector are concentrated.

The service sector in Angul needs to be further strengthened considering the opportunities of the future, and building on the district's potential.

Research around the world shows, the type of work and opportunities are rapidly changing in various economic sectors due to technological innovations and automation. It has been projected (2020), that in the next decade 50% of the jobs worldwide will be changed by automation.[83] Considering the changing nature of job opportunities, major investments in education, and development of technical and vocational institutes will be necessary to aid people's employability in the future labour market.[84] A skilled workforce with technical understanding will also be essential for supporting the green industrial transition in Angul.

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The industrial growth will also have a ripple effect on development of hospitality, telecom, and financial and legal services. Therefore, there is a huge potential for job creation for these services. An IDCO tower is already proposed in Angul, which will provide ready floor space for other service sector offices for telecom, financial services, transport and real estate offices.[85]

Angul also has a high potential for tourism with the presence of the Satkosia tiger reserve. There are many other scenic spots around water bodies in the Rengali dam catchment area and the Derjang irrigation project area in the Angul block. The district also has many religious and historically significant temple spots, which are frequented by the locals, such as the Hingula Devi temple in Talcher and Bulajhara, the home of the King of Talcher. These can be developed further through eco-tourism initiatives, which can also ensure conservation of these areas.

6.6 Skilling, reskilling, and workers assistance

Labour support is a key aspect of just transition planning for both formal and informal workers engaged in the coal industry and coal-based TPPs. As a phase-down (and eventually phase-out) happens, a significant proportion of workforce engaged in these sectors will need to be skilled and reskilled, and will require transition support. For formal workers, securing pension support will also be crucial.

6.6.1 Key factors of labour support

There are three important underlying factors that must be taken into consideration while planning for labour support. These include:

- Requirement of large number of skilled workers commensurate with mining and industrial expansion;
- Increase in the number of contractual and informal workers; and,
- Retirement of departmental employees.

Requirement of skilled workers

Over the next 10 years, coal production capacity in Angul is estimated to grow substantially, from current 123.8 MMTPA to about 308 MMTPA by 2033. Simultaneously large-scale industrial expansions are planned in sectors such as steel and aluminium. This will require a large number of skilled workers, as many of these expansions are being planned based on modern technologies. Besides, the green industrial transition that the district needs to plan for, will also be based on new-age technology. Therefore, in the coming years, a large number of skilled workers will be required for all of these sectors.

Increase in contractual and informal workers

A large share of the future workforce engaged in the mining, power, and other industrial sectors will be contractual and informal. Currently, contractual and informal workers account for about 80% of the workforce engaged in coal mining. For the coal-based TPPs, the proportion is equally high.

Considering the trend of hiring departmental employees by the PSUs in the past decade,[86] which is steadily decreasing, it can be assumed that the additional production will be largely met by engaging contractual workers and informal workers. In fact, for all industrial sectors contractual hiring will increase, as the GoI in March 2018 has allowed fixed term employment in all industrial sectors by amending the Industrial Employment (Standing Orders) Act, 1946 and various provisions towards the Industrial Employment (Standing Orders) Central Rules, 1946.[87]

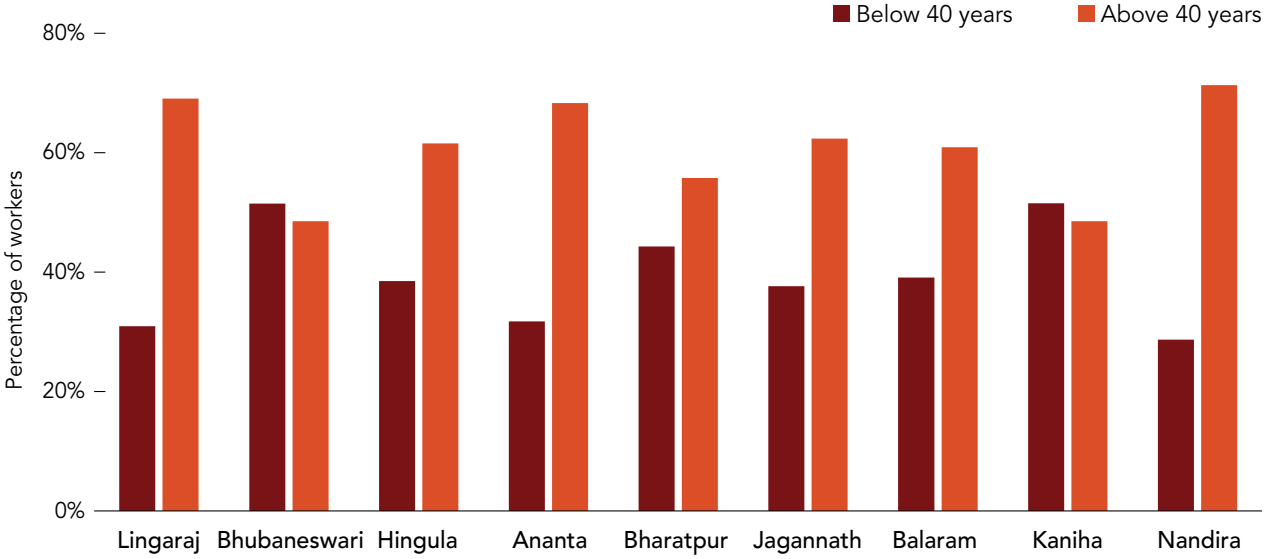
Large number of retirees

Finally, considering the current age-profile of the departmental employees and trend of future hiring, there will be a large number of people who will be retiring in the next three decades. Currently, about of 61% employees

(considering both executive and non-executives) engaged in the coal mining operations in the district fall within the 40-60 years age bracket. In the next three decades, about 88% of the current employees will retire.

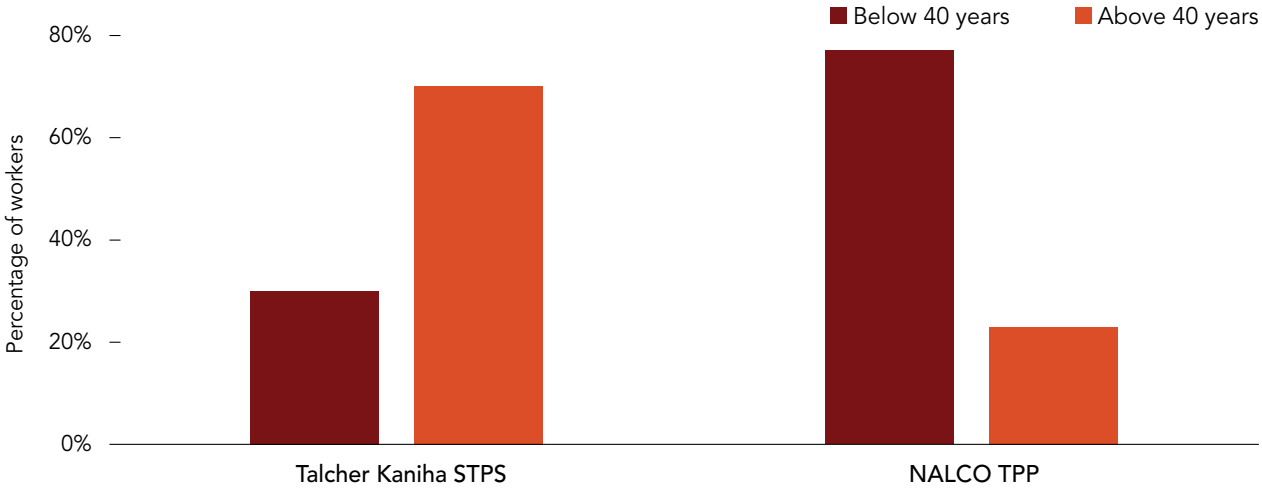
For the power sector too, the age profile of workers of NTPC Limited (Talcher Kaniha STPS) shows that about 70% workers are above the age of 40 years. However, for the captive power plants, such as for NALCO, only 23% of the workers/employees are above 40 years.

Figure 10: Age-wise distribution of departmental coal mining workers



Source: Mahanadi Coalfields Limited, 2022

Figure 11: Age-wise distribution of departmental TPP workers



Source: NTPC Limited, Talcher Kaniha STPS and NALCO as per RTI query dated March 2022

6.6.2 Intervention measures

The following set of interventions will be necessary for worker transition in the coming years through support of the central and state governments and the industry.

Extensive skilling and reskilling programme

There will be a huge demand for skilled workers in Angul in the coming years as industrial expansion happens. However, a large share of the current workforce engaged in the coal industry, coal-based TPPs, and other industrial activities are semi-skilled or unskilled. The poor skill and education level of these workers have also contributed to low earnings for most of the informal workers.

Table 12: Skill level of informal coal and TPP workers

Type of work	Skill level	Average daily wage (₹)
Miscellaneous casual labour	Unskilled	200-300
Cleaning	Unskilled	300
Coal loaders and unloaders	Unskilled	400
Helpers in coal transportation	Unskilled	300
Drivers in coal transportation	Semi-skilled/ Skilled	700
Security guards	Semi-skilled	700-750
Maintenance work	Semi-skilled	700
Machine operators	Semi-skilled/ Skilled	800-1,000

Considering the demand and the need for securing better wages for the workers, the following needs to be ensured:

- Mapping of education and skill levels of the workforce to evaluate their reskilling and skilling requirements in association with local civil society organisations (CSOs) and skilling partners, and commensurate to job requirement of the future.
- Deployment of massive skilling and reskilling programmes through government and industry support, with equal access to skill acquisition.
- Investments in vocational and technical institutes in the district and the state.
- Investments in quality education to create an educated and skilled workforce of the future.
- Engagement of informal workers in repurposing of existing infrastructure and development of new infrastructure through training and better wage support.

Safety net for contractual and informal workers

Ensuring wage security and safety net will be a key aspect for the contractual and informal workers who are currently engaged with various industries, and the proportion of which will steeply increase in the coming years.

The existing regulatory provisions barely provide any security for the contractual and informal workers and in fact, can be considered weak to support a fair labour transition.

For example, Contract Labour (Regulation and Abolition Act) of 1970, which pertains to determining social protection for workers, creates no obligation for the owners to provide workers alternative employment or reskill them.[88] The Industrial Disputes Act of 1947, that will be a crucial one for determining labour rights in the event of closure of industries, also has several limitations for ensuring security. The law essentially allows an industry to retrench workers by giving a three-month notice (in writing) indicating the reasons for retrenchment. The compensation to be provided in such event is equivalent to 15 days average pay for every completed year of 'continuous service or any part thereof in excess of six months'.[89]

Besides, short-term agreements have already been undermining the scope of contractual workers to benefit from what they are entitled to. A classic example in this regard is the Coal Mines Pension Scheme of 1998,

that entitles contract workers for a pension if a worker completes '10 years of pensionable service'.[90] However, given the short-term nature of contracts that typically these workers have, there is practically no claim of pension by such workers till date.

Therefore, for the energy transition to be just for the contractual and informal workers, subsequent reform in labour laws will be necessary, to improve wages, terms of engagement, terms of retrenchment and compensation, etc. At the same time, workers must be engaged through long-term contracts to ensure that they can avail the rights as provided by the regulations.

Transition support for workers

In the event of just transition, the informal workers and the low-paid contractual workers will need a short-term transition support. Such transition support will need to be provided in form of compensation to the workers during their training period, as well as in the form of placement support. Such transition support must be considered at least at the rate of minimum wage determined by the government, and for coal industry as per the rates of the High-Power Committee.

The state and central government schemes can also play a role in providing interim livelihood support to informal workers, including women. Some of the key existing schemes of the central government, which can be expanded and built upon, include the National Rural Livelihood Mission (NRLM) and the National Urban Livelihood Mission.[91] Additionally, Odisha also has state-level schemes for livelihood generation such as the Odisha Livelihood Mission (OLM), which works in tandem with the NRLM for gainful employment and poverty eradication.[92] The scheme is also linked to Mission Shakti, which supports entrepreneurial endeavours through local self-help groups. The state government had also initiated the Mukhyamantri Karma Tatapara Abhiyan (MUKTA) in 2021 as an urban employment scheme during the pandemic, which has now been extended.[93] Considering the concentration of coal mines in the Talcher block, which is also 47% urban, the scheme offers employment potential for the locals.

Securing pension for departmental employees

Pension is going to be a major financial liability of the PSUs that the industry and the government will need to consider in the event of a just transition. A trend analysis of past six years (since 2015) of CIL pension demand shows that pensioners with the coal PSUs have been increasing at the rate of 4% to 5% per year. Correspondingly, the disbursement of pension (outflow) has nearly doubled, from ₹22 billion in 2016-17, to nearly ₹43 billion in 2021-22.[94]

With a further aging workforce, securing pensions will be an important consideration for the departmental employees of the PSUs. The timeframe of coal mine closure suggest that most departmental employees of MCL can be retired in sync with closure of the coal mines. The contributory pension fund of Coal India Limited (CIL), should have adequate funds to support this. As per interviews with the industry, the fund has been running into deficits over the past years and efforts to revive are ongoing through various interventions.

Overall, coherent policies across labour, economic, education and training and social welfare will be necessary to ensure that the transition is just and creates better employment opportunities, wages and security.

Table 13: Pension requirements of existing departmental workers of PSUs

Sector	Company	Proportion of employees whose retirement can be synchronised with closure over three decades (%)
Coal mining	MCL	88
Coal-based thermal power	NTPC Limited	70
	NALCO	23

6.7 Responsible social and environmental investments

Just transition for India's coal districts is an opportunity for development intervention and to build resilience of the local community. This entails augmenting social and physical infrastructure to improve development indicators. Besides, for critically polluted mining and industrial areas, such as Angul-Talcher, investments for improving environmental conditions will also be equally important. In fact, ensuring environmental justice for the local community is a key imperative of just transition. This section outlines the key intervention requirements with respect to these.

6.7.1 Social infrastructure investments

Investments in social infrastructure and resources are necessary to achieve developmental goals while building a new economy. Such investments should also be planned to achieve long-term outcomes.

Angul has better development indicators and infrastructure as compared to many other coal districts of India. However, considering the existing gaps, some of the necessary interventions for the district have been identified. These particularly focus on women and child development, public health, education, access to clean drinking water and clean energy (cooking fuel). The proposed interventions are aligned with the achievement of sustainable development goals (SDG).

Table 14: Social infrastructure development for achieving SDG targets

Sector	Aligned SDG goals	National targets – 2030	Angul targets – 2023	Necessary interventions
Child development	SDG 2 – Zero hunger	i. Reduction of stunting to 6%. ii. Reduction of wasting to 1.9%. iii. Reducing percentage of pregnant women aged 15-49 years who are anaemic - 25.2%. iv. Maternal Mortality Ratio (per 100,000 live births) - 70. v. Percentage of children in the age group 9-11 months fully immunised – 100%.	i. Reduction of Infant Mortality Rate (per 1,000 live births) to 22. ii. Percentage of children in the age group 9-11 months fully immunised – 95%. iii. Percentage of women aged 15-49 years who are anaemic - 40%.	i. Improving diet under ICDS through collaboration with Odisha Millet Mission, introduction of protein foods such as eggs in meals. ii. Improve access and reach for healthcare and ante and pre-natal services through local volunteers, improving transportation, free check-ups, etc.
Public health	SDG 3 – Good health and well being	i. Under 5 mortality rate (per 1,000 live births) – 25. ii. Ensuring 45 physicians, nurses and midwives per 10,000 population.	i. Reduction of Under 5 mortality rate (per 1,000 live births) to 50. ii. Full compliance with IPHS norms for health centres staff and resources.	i. Increase the number of health facilities to meet IPHS norms. ii. Filling staff gap for health service delivery. Contractual health staff can be hired for short-term gap filling to meet the SDG 3 national target.

Sector	Aligned SDG goals	National targets – 2030	Angul targets – 2023	Necessary interventions
Education	SDG 4 – Quality education	i. Gross Enrolment Ratio (GER) in higher secondary (class 11-12) – 100%. ii. Percentage of schools with access to basic infrastructure (electricity, drinking water) – 100%.	i. Gross Enrolment Ratio (GER) in higher secondary (class 11-12) – 90%. ii. Percentage of schools with access to basic infrastructure (electricity, drinking water) – 100%.	i. Increase access to high school education and reducing dropouts through scaling up programmes like the 5 T High School Transformation. ii. Improve access and availability of vocational and skill training institutes to create a trained workforce.
Clean drinking water	SDG 6 – Clean water and sanitation	i. Percentage of rural population getting safe and adequate drinking water within premises through Piped Water Supply (PWS) – 100%. ii. Percentage of rural population having improved source of drinking water – 100%. iii. Percentage of industries (17 category of highly polluting industries/ grossly polluting/ red category of industries) complying with waste water treatment as per CPCB norms.	i. Percentage of rural population getting safe and adequate drinking water within premises through Piped Water Supply (PWS) – 100%.	i. Ensure safe drinking water through treated piped water supply to individual households. ii. Improve household piped water coverage to meet Jal Jeevan Mission target of tap water connection and supply to all households by 2040.
Clean cooking fuel	SDG 7 – Affordable and clean energy	i. Percentage of households electrified – 100%. ii. Percentage of LPG+PNG connection- 100%.		i. Ensure clean cooking fuel access to meet SDG #7 of 100% LPG and PNG connections so as to also improve the health of women and children and reduce indoor pollution. ii. Subsidise LPG refill, electric cooking for long-term behavior change.

There are some important development schemes and programmes of the government, which can be aligned to just transition goals with respect to improving social infrastructure and resources. One of the most important ones in this regard is the District Mineral Foundation (DMF) and the Pradhan Mantri Khanij Kshetra Kalyan Yojana (PMKKKY) aligned to it.[95] The objective of DMF and PMKKKY is to improve the lives and livelihoods

Chinmayi Shalya/iFOREST

of mining-affected areas and communities through well-planned investments in key sectors, such as drinking water, healthcare, education, livelihood, women and child development, sustainable environmental measures, etc. These are considered as priority issues on which at least 60% of the DMF funds must be used.[96]

Angul has a cumulative DMF accrual of nearly ₹18 billion (US$ 225 million) since DMF and PMKKKY came into effect in 2015. This money comes as a yearly contribution through mining companies (largely coal considering mining operations in the district). On an average, Angul receives about ₹4 billion (US$ 50 million) in DMF annually given the current scale of mining operations. The district so far has spent ₹12.2 billion (US$ 150 million) on various projects and schemes.[97]

Table 15: Sector-wise sanctioned projects through DMF in Angul

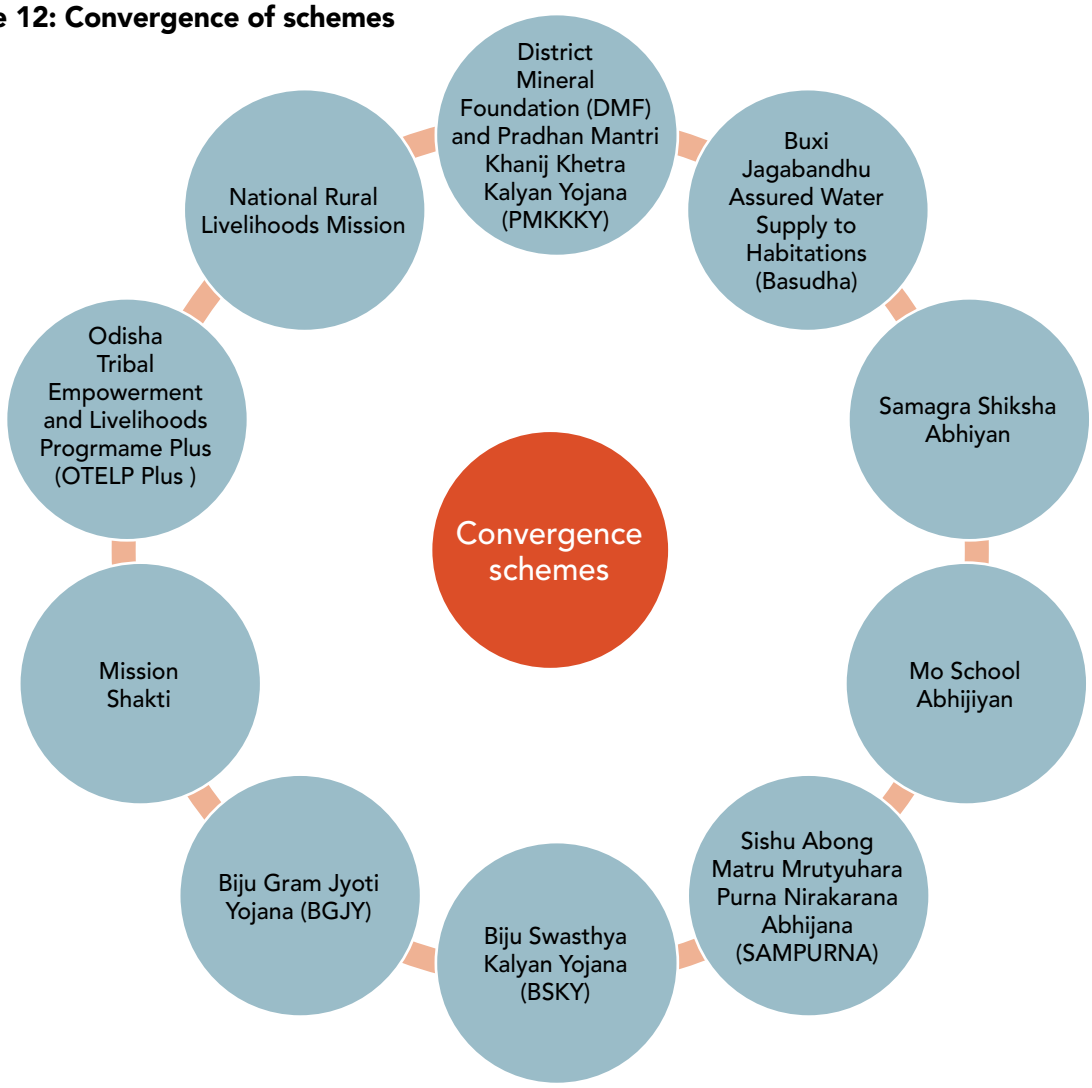
Sectors	Proportion of amount sanctioned (%)
Drinking water supply	57.7
Education	9.3
Health care	6.7
Livelihood support	5.4
Road connectivity	1.9
Welfare of women and children	1.7
Welfare of aged and disabled	1.2
Energy and watershed development	1.5
Irrigation	1.4
Skill development	1.0
Sanitation	0.5
Environmental preservation and pollution control	0.3
Afforestation	0.4
Physical infrastructure	10.7
Administrative expenses	0.3

Source: Programme Management Unit, District Mineral Foundation, Angul, 2021

Besides, the Government of Odisha under the State Sustainable Development Framework has identified various schemes that can cater to the achievement of SDGs. Convergence of many of these (also along with schemes of the central government) will help in better utilisation of the available resources to support various development interventions. Some of the schemes that can be considered in this regard include healthcare scheme such as the *Biju Swasthya Kalyan Yojana* (BSKY) launched in 2018, Mo School initiative launched in 2017 to improve educational infrastructure and outcomes, *Biju Gram Jyoti Yojana*, the rural electrification scheme to electrify villages/habitations having less than 100 population, and those not covered under the central schemes, Odisha Tribal Empowerment and Livelihoods Programme Plus to ensure livelihood and food security of tribal households are sustainably improved, and Buxi Jagabandhu Assured Water Supply to Habitations (Basudha) scheme to provide potable, safe drinking water to all, etc.[98]

The Planning and Convergence Department of the state government, which is responsible for co-ordinating the efforts of different development departments, can play a crucial role to facilitate necessary interventions, and aid just transition.

Figure 12: Convergence of schemes



6.7.2 Environmental remediation and pollution mitigation

The pollution burden of the Angul-Talcher mining and industrial area makes environmental remediation and pollution mitigation a key consideration of just transition planning. Besides, upcoming mines will lead to diversion of additional 3,000 ha of forestland, which also has implications for the local environment and community alienation. Therefore, responsible environmental practices will help to ensure environmental justice, and not just economic justice, in the event of just transition. The legacy pollution issues related to extraction,

processing, and combustion of coal, from which the local community, particularly the poor and disadvantaged has suffered need to be addressed while planning a new economy.[99]

For environmental remediation and pollution mitigation a mix of practices must be ensured through proper implementation of laws and regulations (including strengthening regulatory provisions through reforms), monitoring, and compliance. Some of the key aspects include:

- Scientific closure of coal mines (progressive and final), through proper planning and oversight, including ecological restoration of mining areas and repurposing of land for productive economic use.[100]
- Reclamation and redevelopment of industrial lands following appropriate remediation practices.[101]
- Disposal of industrial structures and assets during the decommissioning of TPPs through appropriate practices of waste management and safe practices of waste disposal, material recycling, ash management (including closure of fly ash ponds), among others.[102]
- Investments in remediation of land and water resources following proper scientific assessment.

Further, considering the expansion of mining and industrial activities in the district in the coming years, besides implementing pollution mitigation measures, reduction of material and resource use, and reuse of the same, must be ensured (*Refer to Section: Circular Economy*).

6.8 Financial resources for a just transition

A crucial aspect for just transition is mobilising financial resources. Global experiences show that the costs of implementing just transition measures are extremely significant, while they vary as per the size of the coal economy.

As per experiences of various countries[103,104,105] and regions,[106,107] the key costs associated with just transition include, costs for the scientific closure of coal mines and coal-based TPPs, disposal of physical assets, economic diversification, labour support, social welfare, and regional environmental remediation. Considering the quantum of financing necessary, just transition measures have been supported by public and private funds, as well as through international financial support.

For coal mining districts like Angul, massive financial support will be necessary to facilitate a just transition. This must be leveraged through optimising on coal mining related funds, fiscal support of the government, private financing, and international support.

6.8.1 Coal-related revenue

The central government, the state government and Angul earn a very significant amount of direct revenue from coal mining activities in the district. These include, the coal cess (currently subsumed in GST compensation cess) that goes to the Central exchequer, royalty which goes to the state government exchequer, and the DMF funds that directly come to the district (Refer to Chapter 3). At the peak coal production of 308.8 MMT in 2033, overall, about ₹176 billion (US$ 2.2 billion) in public revenue will be contributed by coal mines in Angul.

Table 16: Yearly revenue from coal at peak of production

Components	Revenue at peak coal production (₹ billion)
DMF	8.9
Royalty	43.6
Coal cess	123.5
Total	**176**

The public revenue that the government will earn from coal mining in the district will be very significant seed money to facilitate the just transition process starting this decade. The coal cess and the DMF funds hold particular significance in this regard, as the purpose of these funds are aligned with the goal of a clean environment, supporting clean energy and ensuring public good and social welfare.

The coal cess (currently subsumed in the GST compensation cess) in fact can be a game changer for facilitating a clean energy transition and accelerating climate change action for districts like Angul, and for Odisha. The cess levied at ₹400 per tonne of coal dispatch (US$ 5 per tonne) is potentially the largest direct source of green funds. While the compensation cess was supposed to come to an end in 2022, the GoI through a notification in June 2022 has extended the period for levying the cess until March 31, 2026.[108] However, this will be one of the most important policy decisions that the GoI needs to take in 2026, to allow the coal cess to support a energy transition aligning with its original purpose of promoting clean energy and environment.[109]

A decadal assessment of potential funds available for just transition in Angul, combining DMF and coal cess under the CPS and NZ-2050, shows that over ₹1.9 trillion (US$ 24 billion) can be available for such purposes over the next 20 years (even under NZ-2050 the funds remain nearly equal). This is the most crucial period for the GoI and the state government to plan a clean energy transition and a just transition to meet India's net zero emission reduction target. In fact, even with an accelerated coal phase-down by 2050 (under NZ-2050 scenario), nearly ₹3 trillion (US$ 38 billion) will be available to support just transition.

Table 17: Estimated direct finance for just transition

Sources of Financing	2022-2030		2031-2040		2041-2050		2051-60		2061-70		Total	
	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050	CPS	NZ-2050
DMF* (₹ billion)	53	53	87.2	81.7	72.6	52.6	33.9	0	12.8	0	259.5	187.3
Coal cess** (₹ billion)	594.7	594.7	1,212.4	1,160.4	1,078.4	890	640.8	0	243.5	0	3,769.8	2,645.1
Total direct finance for just transition (₹ billion)	**647.7**	**647.7**	**1,299.6**	**1,242.1**	**1,151**	**942.6**	**674.7**	**0**	**256.3**	**0**	**4,029.3**	**2,832.4**

*DMF is estimated at ₹42.4 per tonne of coal based on MCL's DMF contribution of ₹4.1 billion for the year 2021-22 when the annual production was 96.7 MMT and the contribution is 30% on the royalty. Royalty has been calculated as ₹141.3 per tonne of coal. For the upcoming coal mines, a 10% contribution on royalty has been taken; (**) Coal cess at ₹400 per tonne of dispatch (considered equal to production for projections). If, GST is considered since 2026, then ₹393.5 billion in GST will be available the decade between 2022-2030.

6.8.2 Leveraging private investment

While financial resources such as the coal cess and the DMF will be critical for supporting a just transition in Angul, the support of the private sector will be crucial. In fact, public finances can be used to attract private sector investments by making necessary investments in infrastructure and resources.

Besides, Development Finance Institutions (DFIs) can be critical for raising private investment through their financing, risk sharing and supporting activities. These include the national development banks, such as the Small Industries Development Bank of India (SIDBI) and Industrial Development Bank of India (IDBI), the State Finance Corporations and the State Industrial Development Corporations, among others.[110]

Overall, the public revenue coming through coal mining must be utilised optimally over the next 30 years to support a clean energy transition and a just transition. At the same time the government will need to develop a progressive revenue substitution plan to substitute the royalty and other direct and indirect taxes that is related to coal mining. Early on, measures of economic diversification and green industrialization are crucial for this. The proactive engagement of PSUs, government enterprises, private sector, as well as multilateral and international agencies will be necessary.

6.9 Engaging PSUs and private industry

The role of industries in just transition would be important considering their own plans to diversify. Angul has three major PSUs – MCL, NTPC Limited and NALCO, who can play a crucial role. All the three PSUs are also looking at diversifying into other sectors, which would be crucial for their own long-term sustainability, as well as for creating jobs in the region and for government revenue.

CIL has already set up two subsidiaries – CIL Solar PV and Navikarniya Urja Limited for manufacturing of solar value chain products and expansion of RE projects.[111] A subsidiary of MCL is also diversifying towards aluminium production and will set up a plant in Dhenkanal, which borders Angul as per the information provided by the industry and state government officials.[112] The aluminium smelter of MCL can use RE based electricity as is being done by Vedanta Aluminium Limited for their Jharsuguda and Angul smelters.

NTPC Limited has also established a wholly owned RE subsidiary in October 2020 called NTPC Renewable Energy Limited. The subsidiary has been developed to diversify the company's business portfolio and to 'build, own and operate' RE projects. The company further plans to have 60 GW capacity through RE sources constituting nearly 45% of its overall power generation capacity by 2032. So far, RE projects worth 1,365.4 MW capacity have been commissioned and projects worth 2,029.6 MW capacity are under implementation, as the company's own addition.[113]

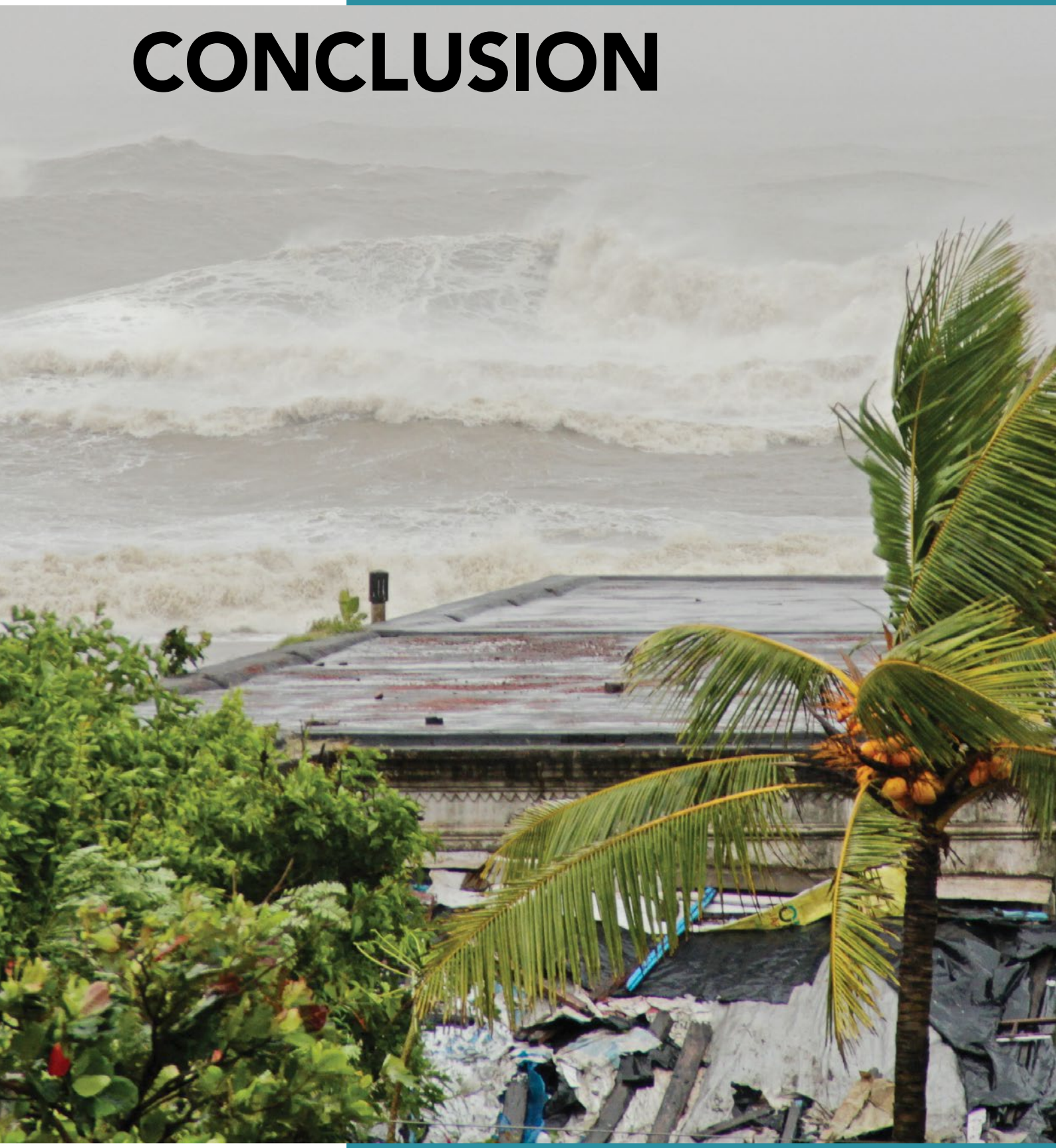
NALCO is also diversifying to RE sector by commissioning 198 MW wind power plant in four different places in Andhra Pradesh, Rajasthan and Maharashtra to reduce the company's carbon footprint.[114] The industry can plan investments in Angul on non-conventional energy sources, including using RE based electricity for the aluminium smelter.

Collectively, MCL, NTPC Limited, NALCO, and key private players, such as JSPL and Tata Steel, can be the leaders of economic diversification in Angul, support RE investments and help to build a green industrial hub for the new economy.

Overall, it can be concluded that just transition planning in Angul will require an integrated approach of strategically phasing down (and phasing out) coal mining activities and coal-based power production, implementing measures of economic diversification and green industrial transition to appropriately substitute revenue earnings of the government, create jobs, and build a prosperous economy that will have low environmental and carbon footprint. Such planning will require strong support of the state and the central government, as there will be requirement of regulatory reforms to support the process. An integrated green energy and industrial policy, aligned with climate change goals, needs to be developed to incentivise and support green investments and build a climate resilient and responsible future. Simultaneously, finances must be secured for enabling the transition through public and private investments, and the support of international agencies, while exploiting the potential of DMF funds and the coal cess in the coming years.

CHAPTER 7

CONCLUSION



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- *The growth trajectory of Angul based on coal mining and coal-dependent industries is counter-intuitive for Odisha, one of the most vulnerable states to climate change impacts.*
- *Coal mining should be planned keeping in mind the future coal demand from sectors, such as coal-based power due to growth in RE, and other industries where technologies are changing rapidly. Else, it faces the risk of stranded assets.*
- *Planning a just transition for Angul will be a central component of GHG and carbon footprint reduction strategy of Odisha.*
- *Just transition principles need to be integrated in the State Climate Change Action Plan to enhance climate action.*
- *Angul offers critical insights for Odisha and India to start deliberation on a comprehensive just energy transition policy.*

7.1 Introduction

Angul lies at the epicentre of Odisha's coal mining and industrial economy that is expected to grow significantly over the next 10 years. However, the state is also highly vulnerable to climate change impacts. It is impacted by extreme weather events, such as cyclones, heat waves, storm surges and frequent floods. Rainfall patterns in the state have been more erratic since the 1960s, with below-normal rainfall across all districts being recorded for most years. The normal 120 days of monsoon rain has reduced to 60-70 days. Besides, extreme rainfall days of over 200-250 millimetres/day have become more frequent. The state is also frequented by cyclones every year. Over 36% of the state's population lives in the nine most vulnerable cyclone districts. Cyclones, such as Phalin (2013), have also affected inland districts such as Angul. Besides, there are also heatwaves which are worst for industrial districts and areas. The Angul-Talcher area has been identified as a 'heat island' by the government.[1]

The economic growth trajectory based on coal mining and coal-dependent industries , therefore, is counter-intuitive for Odisha. As per observations of the state government, the state's rapidly growing economy and increasing urbanisation in several agglomerations pose a challenge for climate mitigation action. In fact, Odisha also has one of the highest per capita CO_2 emissions (4.41 tCO_2e, which is 2.3 times India's average for the same reference year)[2] and is among the top-five states in the country in terms of per capita coal consumption (117 kg per year for the reference year 2015).[3] The state government, therefore, recognises that a 'Comprehensive GHG and Carbon Footprint Reduction Strategy' must be developed for the state.[4]

Planning a just transition for Angul will be a central component of the GHG and carbon footprint reduction strategy of the state. While the district can optimise on its coal potential for building the green energy and industry backbone for Odisha, and also India, this should be considered as an intermediate phase to move to a green economy. Post 2030, the district must shift to a green economy through strategic planning for minimising environmental and carbon footprint, as well as building a climate-resilient future.

For this to happen, deliberations and planning must start now. Given the estimated coal production in the next 10 years, a clean energy transition for Angul will be a time-consuming process. Global transition experiences of large coal mining and coal-dependent industrial regions, such as the Ruhr of Germany, can be a telling example for Angul. For Ruhr, it took over 50 years to close down the last hard coal mine with least disruption in jobs and the local and regional economy. Considering Odisha's climate change vulnerability and India's net zero emission targets, districts like Angul have a much lesser timespan.

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The Ruhr experience

The coal mines in the Ruhr valley of Western Germany had been the bedrock since the time of the country's industrial revolution. Coal mining and the presence of heavy industries in the region, such as steel, made it the heart of the European Coal and Steel Community. It was also a major employer in the region. In 1957, considered the peak of the coal industry, it directly employed 607,300 people. However, in the following years, coal mining started becoming non-profitable in the region, and reliance on government subsidies increased to keep the industry viable. In 1968, through an agreement between the federal government, workers' unions and businesses, the mines were consolidated under a single mining corporation – the Ruhrkohle AG – and long-term plans started to be put in place to close the industry. By 2018, the last mine in Ruhr was closed down.[5]

What became unique about the complete closing down of coal mines in the region was that it did not lead to unemployment as typically suspected. Instead, the Ruhr experience showed how a well-coordinated effort of having proper policies, planning for economic diversification, collective engagement of workers, and support of social partners can help in the successful reshaping of the regional economy with no forced job losses.[6]

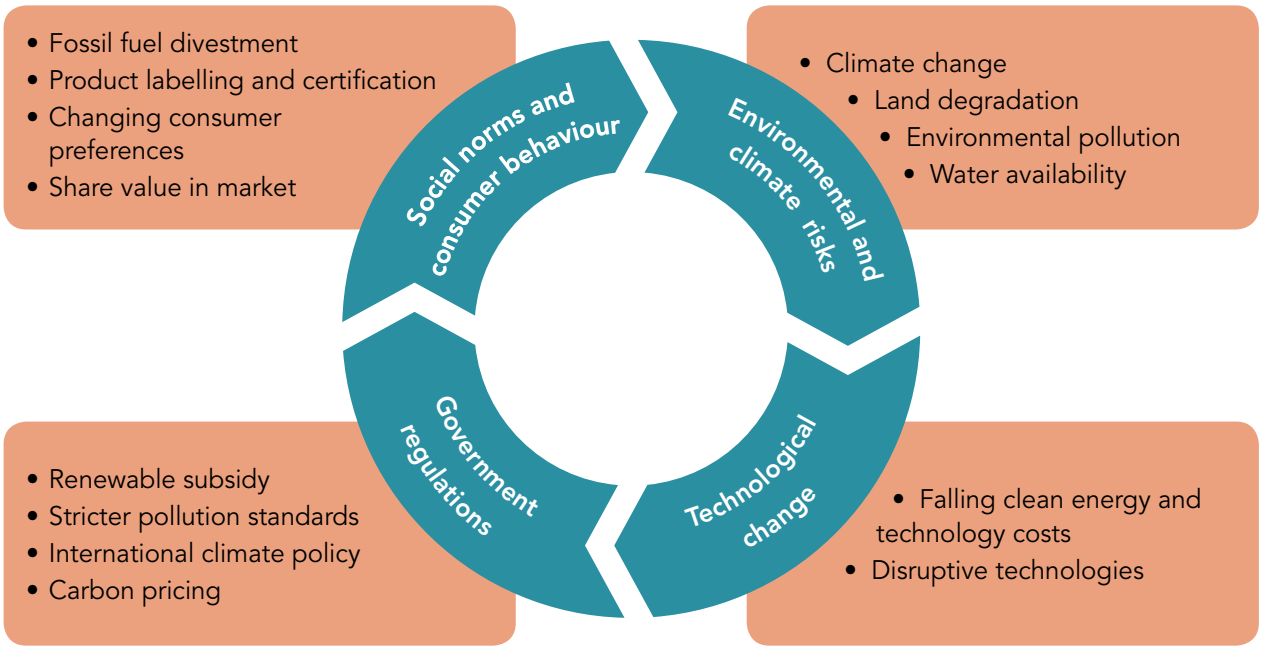
For transitioning the coal economy, a mix of policy and economic instruments were used. For instance, a comprehensive agreement was signed to guarantee a socially responsible approach to the restructuring process. The workers had a major role to facilitate this. The Government's Mining Codetermination Act (1951) gave the workers a voice equal to that of industrialists. At the same time, much emphasis was placed on retirement programmes, particularly early retirements. This was developed based on the transition payments system for coal industry employees that state legislators had introduced in 1972. For those who were not entitled to the transition payments system, a specific social compensation plan was created under the 'Agreement on the Closure of the Ruhr Coal Industry' by 31 December 2018.[7] The German government also passed the Hard Coal Financing Act in 2007 to phase-out hard coal mining subsidies in the country by 2018 and protect every worker older than 42 against unemployment. Besides, large-scale investments were made in infrastructure development, education, technology and innovation, vocational training, and re-skilling to support and improve employment opportunities.[8]

A number of macroeconomic policies were also introduced by the government. For example, in 1984 the industrial policy of the State of North-Rhine Westphalia was changed with a focus on environmental technology. This led to the growth of Ruhr as a centre of environmental technology research in Germany. The policy also encouraged suppliers of equipment to the coal mining, power generation and steel industries to invest in environmental technology and renewable energy systems. Today these activities make up for about two-thirds of their turnover.[9]

7.2 Internalising risk factors

Meeting decarbonisation goals have a bearing on planning and investing in coal mines and energy infrastructure. Investments in the fossil fuel industries are at risk of losing market value due to a number of factors. These include falling renewable energy (RE) costs in the future (RE-based electricity becoming cheaper than coal), unanticipated technological disruptions and breakthroughs in industrial processes, government policies on clean energy, climate change and environmental pollution, and global climate change policies to limit global warming to 1.5°C or 2°C, risks of investing in climate vulnerable areas, and conscious consumer behaviour. Therefore, investments with short-term vision risk becoming 'stranded', with a loss of value for investors.[10] In fact, studies of developed economies (the global North) show that stranded assets in the fossil-fuel sector are bearing heavily on investors.[11]

Figure 1: Risk model for fossil fuel investments



Due to such risk factors, investor sentiment is slowly changing globally. Investments in greener industries and technologies are growing. According to the latest estimates, over 100 (and growing) 'globally significant asset managers/owners' with Assets Under Management (AUM) over US$50 billion, and banks and insurers with AUM or loans outstanding larger than US$10 billion, have announced their divestment plans from coal mining and/or coal-based power plants.[12]

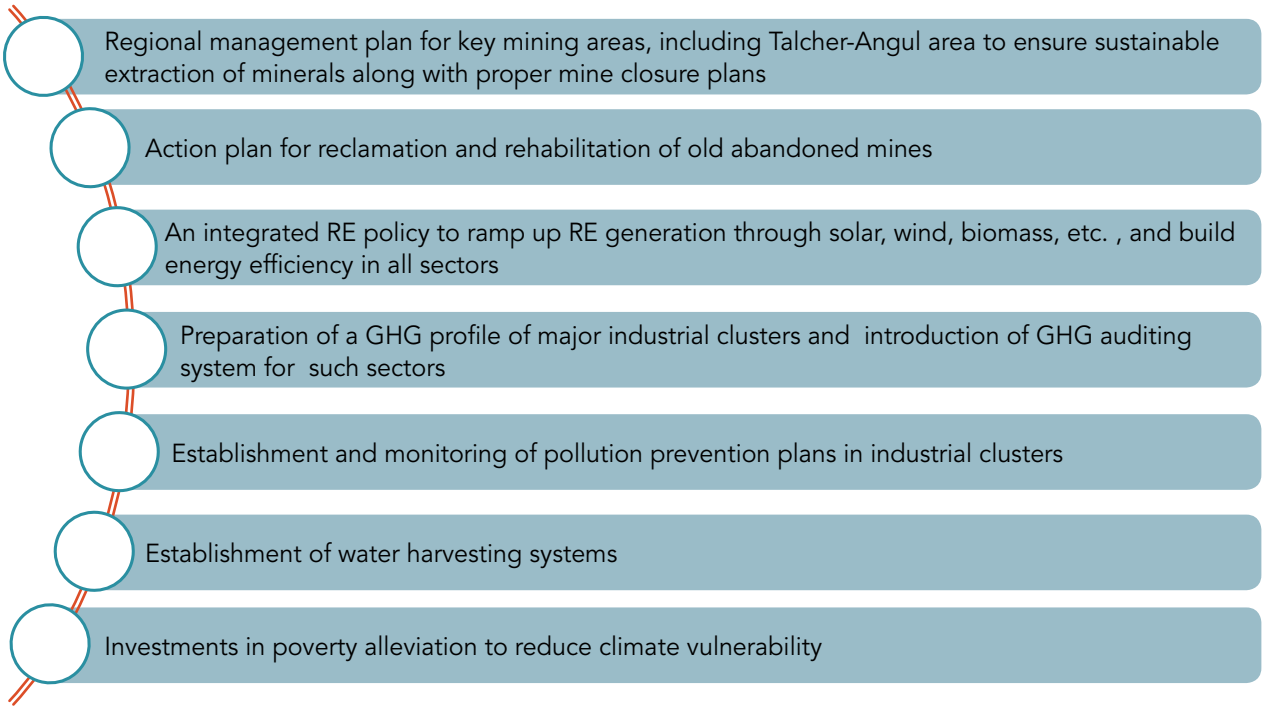
It is increasingly being recognised and accepted (even if grudgingly) that vast quantities of extractable fossil fuels will need to remain underground in order to stabilise the global climate. High emission and energy-intensive technologies based on fossil fuels must make way for less carbon-intensive technologies and practices.[13]

For Angul's energy, industrial and economic planning, such risks need to be factored in. While there will be untapped coal resources, a conscious decision will need to be taken on a coal production cap through a process of co-operative federalism between the state and the central government. Similarly, government, as well as the private sector and the international community will need to come together to improve the scope of green investments and support the development of green industries in the region, to help the district build an economy that will benefit all in the long run.

7.3 Building on Odisha Climate Change Action Plan to support just transition

Odisha has been one of the first states to formulate a State Climate Change Action Plan in 2010. The latest Climate Change Action Plan (2018-2023) has been outlined to address the climate crisis more comprehensively. The plan, which focuses on both climate change mitigation and adaptation strategies, has specifically laid an emphasis on responsible mining practices, including mine closure, renewable energy production, green industrialisation, and associated measures.

Figure 2: Components of Odisha Climate Change Action Plan to support just transition



The state action plan, therefore, provides an important opportunity to integrate principles of just transition to enhance climate change action and guide coal/fossil-fuel dependent districts to plan a clean energy transition that is comprehensive, multi-sectoral, time-bound, and inclusive. The focus of inclusion of such principles should also be to build an economy that is prosperous, secure, and better than the present.

Some of the key components of just transition that should be included in the State Climate Change Action Plan are:

- Reclamation and repurposing of coal mining and industrial land and infrastructure to optimise environmental and economic benefits;
- Restructuring of the economy and industrial activities to support low-carbon development in the coal-dependent districts;
- Reskilling and skilling the workforce to prepare for the new green economy and build local employment opportunities in the green economy;
- Revenue substitution plan for the state and local government(s) aligning with the state's industrial and economic policy; and,
- Responsible social and environmental investments to improve development outcomes, alleviate poverty, create better living standards and quality of life, and build local resilience.

An explicit inclusion of 'just transition' in the State Climate Change Action Plan will also help the government to seek finances for enhanced and accelerated climate action from the public and private sectors, as well as multilateral institutions and international agencies.

7.4 Cooperative federalism and international financing support

A just transition in a district like Angul will require a concerted effort of the state and central government, and support of the international community. While financial resources, such as the coal cess (in the coming years), District Mineral Foundation (DMF) funds, etc., can provide important seed support, considering the scale of the coal economy in the district and revenue implications for the states, much more ambitious, broad-based, and sustained financial support will be necessary.

Strong government support, from both the centre and the state, will be required to provide Angul the necessary financial incentives, support, and assurance to build a new economy. Besides, developed economies, bilateral and multilateral agencies and banks will need to support just transition financing, technical assistance programmes and capacity building measures in major coal districts like Angul. International support needs to be extended through various mechanisms including grants, concessional finance, investments, and risk sharing instruments, mobilising the private sector, etc.[14] The regional funding need shall have co-financing commitments from national governments aligned with national climate action commitments, as an assurance.

7.5 Policy reforms

For India's major coal districts like Angul, where coal reserves are plentiful, industrial growth is planned around the availability of cheap coal-based energy. Besides, there is a huge direct and indirect employment and economic dependence on coal. Therefore, a comprehensive set of reforms in laws and regulations will be necessary to support a just transition.

Emerging experiences of policy action from around the world show that governments (federal and state-level) are increasingly moving towards comprehensive climate and regulatory reforms that can ensure accelerated climate action through a combination of mechanisms.[15] These include, phasing down (and phasing out) fossil fuel dependence, growth in RE production and deployment, decarbonising industrial processes through the use of efficient technologies and zero-carbon fuels, creating employment in the green industries, and ensuring the protection of workers and the local community during the transition and in the new economy.[16]

In India, while there exist several legislations that can be considered relevant to support a green energy transition and climate change action, the laws and institutions pertaining to their implementation remain fragmented. Besides, the existing labour and industry laws, which have a central role in just transition, are barely suited to ensure the necessary support that must be provided to workers (and their families) in the event of an energy transition. There is also no law to ensure the repurposing of land and assets to maximise the economic value of these once coal mines and power plants close.

Therefore, India will need to start deliberation on a concrete cross-sectoral decarbonisation strategy and a set of comprehensive reforms to facilitate a just transition. In fact, it will be important for the country to consider the formulation of a national just transition policy, that can aid well coordinated and inclusive climate change action to achieve India's climate change goals and the net zero emission target by 2070. The focus of such reforms should be:

- Low-carbon industrial and economic growth, with a specific focus on coal-dependent states.
- Economic diversification in fossil fuel (in the immediate future coal) dependent districts and states.
- Job creation in the renewable sector and green industries.
- Strengthening worker protection during the transition and in the low-carbon economy.
- Building community resilience.
- Equitable financing to ensure distributive justice.

Besides a national-level policy, the Government of Odisha will also need to develop a comprehensive state-level just transition policy and plan to provide a framework for just transition and to build a new green economy in the coal districts. The policy should provide guidance for an integrated approach on economic, industrial, energy and labour decisions, that can facilitate just transition.

In conclusion, it can be said that Angul offers critical insights for the state government and India to start deliberation on a comprehensive just energy transition policy. This will be instrumental in shaping investment plans and governance mechanism(s) in the coming years to support equitable climate change action. This report provides an outline of the quantum of work that needs to be undertaken in the coming years, and the cooperation of various actors that will be necessary. Each of the elements of just transition planning as highlighted in the report, are substantial, and deserves deeper attention for implementing a just transition.

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