CARBON TRUST

Supporting a rapid, just and equitable transition away from coal

Frameworks and guidance to support a structured planning approach for a just coal-to-clean energy transition

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About the report

This report presents frameworks and guidance developed by the Carbon Trust that can be used to support a rapid, just, and equitable coal-to-clean energy transition. Specifically, the report outlines a 'Just Transition Planning Framework' (JTPF), and a 'Prioritisation Framework' for retiring or repurposing coal-fired power plants (CFPPs). Together, these two frameworks provide a structured approach for coal transition planning.

Odisha, a state in India, has been used as a case study to test the frameworks, given the size of the state's coal fleet and India's relevance in the global coal-to-clean energy transition challenge. This case study provides a high-level, practical example of the frameworks' application and demonstrates how the methodologies can be used to provide insights and recommendations to inform energy transitions.

The results of the case study could be helpful to Odisha's state government and support its long-term planning for a just energy transition, while also serving as guidance for other geographies. The case study only uses secondary data and is not informed by comprehensive stakeholder engagement. Findings are therefore intended as a starting point, which should be further developed through on-the-ground research to inform a thorough transition plan.

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Who we are

The Carbon Trust: The Carbon Trust is a global climate consultancy driven by the mission to accelerate the move to a decarbonised future. We partner with businesses, governments and financial institutions to drive positive climate action and are a core CATA partner.

TransitionZero: TransitionZero is a not-for-profit set up in 2020 to decarbonise energy systems by supporting global businesses and emerging market governments with open, granular and accessible data.

CATA: CATA is a first-of-its-kind platform focused on leveraging finance to accelerate the coal transition globally. CATA will empower local stakeholders in the coal transition field through delivering in-country technical assistance and operating a global centre of expertise.

The Carbon Trust's mission is to accelerate the move to a decarbonised future.

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Abbreviations

CCUS	Carbon capture, utilisation and storage
CEA	Central Electricity Authority
CFPPs	Coal-fired power plants
CIL	Coal India Limited
CSR	Corporate social responsibility
DER	Distributed energy resources
DFI	Direct foreign investment
DMF	District Mineral Fund
EV	Electric vehicle
FPV	Floating solar photovoltaic
FTE	Full-time equivalent
FY	Financial year
GDP	Gross domestic product
GEM	Global Energy Monitor
GVA	Gross value added
IEA	International Energy Agency
IPP	Independent power producer
MDB	Multilateral development banks
MT	Megatonnes
MW	Megawatt
MWh	Megawatt hour
NDC	Nationally determined contribution
NGO	Non-governmental organisation
OREP	Odisha Renewable Energy Policy
PPA	Power purchase agreement
PV	Solar photovoltaic
RPO	Renewable purchase obligation
tCO_2	Tonnes of carbon dioxide

EXECUTIVE SUMMARY

Globally, countries and regions are increasingly committing to Net Zero targets, driving accelerated transitions towards renewables and away from coal. To meet these ambitious and urgent climate objectives, the energy transition must happen at an unprecedented pace and scale. However, the transition is likely to give rise to complex trade-offs, with implications for workers, communities, the environment, and economies. It will be critical to manage energy transitions and coal asset closures in a 'just' manner that is socially, economically, and environmentally responsible, taking both positive and negative learnings from past international experiences of transitions to maximise the benefits and minimise the risks.

This report presents frameworks to support a rapid, yet just and equitable coal-to-clean energy transition globally. Specifically, the report outlines a Just Transition Planning Framework, and a Prioritisation Framework for retiring or repurposing coal-fired power plants (CFPPs). Together, the frameworks can support a structured approach to transition planning, with evaluation of assets for retirement and repurposing forming a crucial step in the management of and planning for the just transition.

The frameworks are then applied to a practical example to demonstrate their application and provide high-level insights to inform just transition planning. Odisha is used as a case study due to the size of its coal fleet and its relevance to India's Net Zero transition, as well as its ambitions to transition to more renewables in a rapid, yet fair and equitable manner, as set out in the state's recent renewable energy policy.[1] Given this push towards renewable energy generation, the results of the case study are intended to be complementary to the state government's efforts to support long-term planning for a just energy transition. The case study may also serve as guidance for other geographies to adapt the frameworks to address the energy transition challenges and opportunities specific to their local context and accelerate their own just energy transition.

Just Transition Planning Framework and policy solutions

Currently there is no universally agreed definition for the just transition, and application of the concept will vary across contexts and regions. In this report, we define a just transition based on the International Labour Organisation's (ILO) definition, as:

'A process for managing the transition to a decarbonised economy in a way that prioritises local, socioeconomic opportunities and decent livelihoods, and minimises risks to affected groups, including through inclusive, transparent, social dialogue, robust governance, and support for impacted workers and communities.'

The ILO emphasises that this concept is applicable not only to the energy sector, but to all economic sectors, geographies, and across scales. For the purposes of this report, we have applied the concept to the energy sector alone. The Just Transition Planning Framework (the JTPF) builds on this and a range of existing just transition frameworks and regional plans for application in the energy transition.[2, 3, 4, 5]

The proposed JTPF seeks to support the energy transition process by identifying how guiding principles and pillars can be applied across a range of contexts (see Figure 1). While the JTPF sets out the foundations, implementation must involve engagement with local actors and be informed by primary data on local conditions. This stakeholder engagement must be central to the transition and is integral to the JTPF.

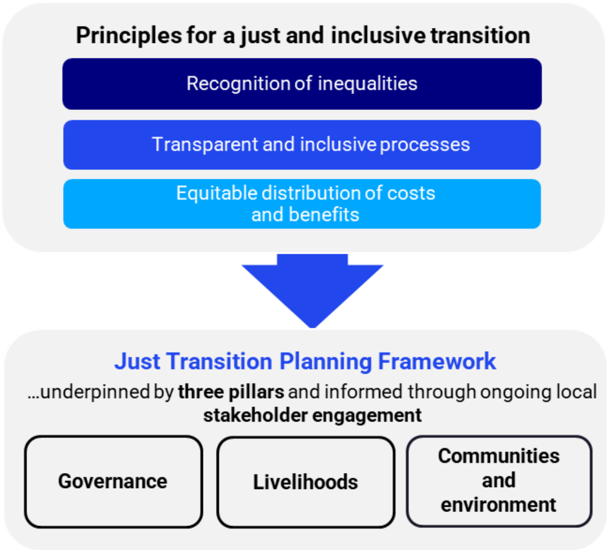


Figure 1. Principles and pillars for a just transition.

The JTPF is a structured step-by-step guide to planning as highlighted in Figure 1. The guidance is underpinned by three core principles: the recognition of socioeconomic inequalities, the need for transparent and inclusive processes for planning and decision-making, and the equitable distribution of costs and benefits that arise from a transition.

In applying these principles to the planning process, the JTPF emphasises the need to consider the following aspects, when planning for a just energy transition:

- Early, proactive, inclusive, and meaningful stakeholder engagement
- A place-based approach
- Robust, transparent governance structures
- Finance mechanisms leveraging a range of sources
- Regional revitalisation for economic resilience
- Financial, economic, and social support for workers and communities

The full JTPF can be found in Technical Appendix 1.

Prioritisation Framework approach

The Prioritisation Framework detailed in this study has been developed to support a high-level screening of a region's coal fleet, with the aim of assessing the suitability of CFPPs for repurposing or retirement. CFPPs are then ranked in order of highest to lowest priority over a given timeframe. The Prioritisation Framework developed for this study includes the following considerations:

- The different power generation objectives of captive and non-captive plants, and the role of coal in the region's future power generation mix to determine how critical CFPPs are to supporting energy security.
- The plant owner's perspective, where the cost of operations is expected to play a key role in their willingness to repurpose or retire a plant, and the potential cost of buyout in instances where the asset needs to change ownership to support its transition.
- The impact on communities and the environment, whereby social costs of air pollution and water stress, carbon intensity, accidents and fatalities are considered, as well as any positive benefits from the plant's operations, such as its contribution towards tax revenue, which is assumed to go towards improving the local community.
- The potential benefits of different types of repurposing options available, prioritising those that: (1) are least disruptive to energy security in the short-term, (2) support clean energy systems in the long-term, (3) have low implementation costs, (4) are least environmentally damaging, and (5) are least disruptive to the existing workforce and community.

Using the frameworks for effective planning

The JTPF presents a structured set of guidance materials that can be drawn upon to develop a place-based approach. It does not recommend a specific path to transition management but rather synthesises findings from emerging best practices. Similarly, the Prioritisation Framework is not intended to provide a definitive list of CFPPs which should be repurposed or retired. Instead, insights can be used to inform roadmaps, policies, and financial instruments needed to enable a transition from coal to renewables. The frameworks are intended as guides only. They must be tested further and applied in collaboration with policymakers and key energy sector stakeholders, using primary data, to provide useful insights for decision-making.

Planning for a just energy transition requires careful consideration of key contradictions and trade-offs. One such trade-off is the balance between ensuring a rapid transition while achieving just and equitable processes and outcomes, which can be resource and time intensive. Balancing environmental, health and efficiency considerations against the need for job security and workers' rights is complex but essential to build political support and ensure that workers and communities are protected during the transition. The frameworks outlined in the report can support the integration of these key considerations into any decisions that may accelerate a country's energy transition.

1. Introduction

1.1. Overview and context

Across the world, countries and regions are committing to Net Zero targets, driving accelerated transitions away from coal. In response to these ambitious climate objectives, alongside additional economic and policy drivers such as tightening air pollution regulations and the declining cost of renewable energy, key public sector actors and large industries are targeting the phase-out and retirement of old and inefficient coal-fired power plants (CFPPs).

Planning for and managing these transitions in a socially, economically, and environmentally responsible manner can help maximise the benefits of the transition while minimising its impacts and risks. Transitions present significant opportunities to create new, decent jobs, increase affordable energy access and develop resilient local economies. However, if transitions are poorly planned and managed, they risk resulting in worse outcomes for workers and communities. This can cause social and political resistance to decarbonisation efforts. A just energy transition planning approach can be used to mitigate these risks and take advantage of the opportunities. This report defines the just transition based on the International Labour Organisation's (ILO) definition, as:

'A process for managing the transition to a decarbonised economy in a way that prioritises local, socioeconomic opportunities and decent livelihoods, and minimises risks to affected groups, including through inclusive, transparent, social dialogue, robust governance, and support for impacted workers and communities.'

Since this report focuses on the transition away from coal, all references to the just transition refer specifically to the just energy transition. We recognise that there is a need to transition across a wide range of sectors to achieve global climate and environmental goals.

This report presents a starting point for policymakers and key energy sector stakeholders, including asset owners, to support the rapid, just, and equitable coal transition globally. Specifically, the report outlines a Just Transition Planning Framework (JTPF), and a Prioritisation Framework for retiring or repurposing CFPPs. The JTPF provides guidance to ensure that planning for the coal transition is fair and equitable for workers and communities. The Prioritisation Framework then provides a systematic approach for evaluating the suitability of CFPPs for retirement or repurposing based on a set of standardised criteria and the wider energy system context.

Together, these two frameworks provide a structured approach to support planning for a just coal-to-clean energy transition. By embedding just transition principles into decision-making for asset-level retirement, repurposing and the wider regional energy system transformation, policymakers can pursue decarbonisation goals in a socially responsible manner, maximise opportunities and minimise the risks.

Odisha, a state in India, has been used as a case study to apply the JTPF and Prioritisation Framework given the size of the state's coal fleet and the relevance of India in the global coal-to-clean energy transition challenge. Odisha's transition to clean energy will be crucial for India to meet its Net Zero by 2070 target. Home to a large proportion of India's coal mines and power plants, Odisha is one of India's largest coal-producing states. As such, it will be instrumental to the country's energy transition. After all, Odisha's government was one of the first states in the country to formulate a comprehensive climate change action plan, and has already set out a renewable energy policy to take advantage of the transition's opportunities and pursue a just and inclusive transition.[6, 7] This is also accompanied by budget allocated by the state government for Odisha's Renewable Energy Development Fund to accelerate renewable energy development. [8] This report therefore aims to align with the state's existing work, offering frameworks and guidance to support the policy's implementation.

The case study provides a practical example of the frameworks' application and demonstrates how the methodologies can inform other energy transitions in regions across the world. The frameworks are applied to identify opportunities, risks, potential assets for retirement and repurposing, and alternative livelihood options to support a just transition in Odisha. The results of the case study can build on the state's existing progress on renewable energy project development and also be helpful for Odisha's government in its long-term transition planning. The application of the frameworks in the context of Odisha also serves as an example for other geographies and can help inform their own just energy transition pathway. By adapting parameters such as worker demographics, livelihoods dependence on coal and future power generation plans, these geographies can be empowered to address the energy transition challenges and opportunities specific to their local context.

1.2. Report structure

The remaining sections of the report are structured as follows:

- **Section 2 sets out a Just Transition Planning Framework.** The JTPF provides guidance to support planning for an equitable transition from coal to clean energy for workers and communities.
- **Section 3 provides a practical example of the application of the JTPF.** Elements of the framework are applied to identify high-level opportunities, risks, and alternative livelihood options to support a just transition in Odisha.
- **Section 4 outlines the approach and methodology of a Prioritisation Framework to assess the suitability of coal-fired power plants for repurposing or early retirement.** The framework uses a set of standardised criteria and metrics to score and rank plants in the order of highest to lowest priority, integrating the wider energy system context in terms of its degree of readiness to transition away from coal.
- **Section 5 provides a practical example of the application of the Prioritisation Framework.** The framework is applied to Odisha's CFPP fleet to highlight potential candidates for repurposing or retirement.

1.3. Applications and limitations

This report synthesises emerging best practices on supporting a just transition and provides transparent and adaptable approaches to support regions in phasing down CFPPs. The frameworks presented in this report can be applied in any country or region looking to transition away from coal in a rapid yet just, and equitable manner.

Both frameworks have been designed for application at a range of scales. The JTPF has been developed for application at the sub-national level but can be used to support decision-making at other levels of government. The Prioritisation Framework can be applied to any coal fleet within a district, province, state, or country. For the purposes of this report, the term 'region' is used to reflect this.

Figure 2 below shows how the results of both frameworks can inform implementation plans for coal-to-clean energy transition policies, ultimately leading to the development of a CFPP retirement or repurposing action/investment plan, and a roadmap for the coal-to-clean transition.

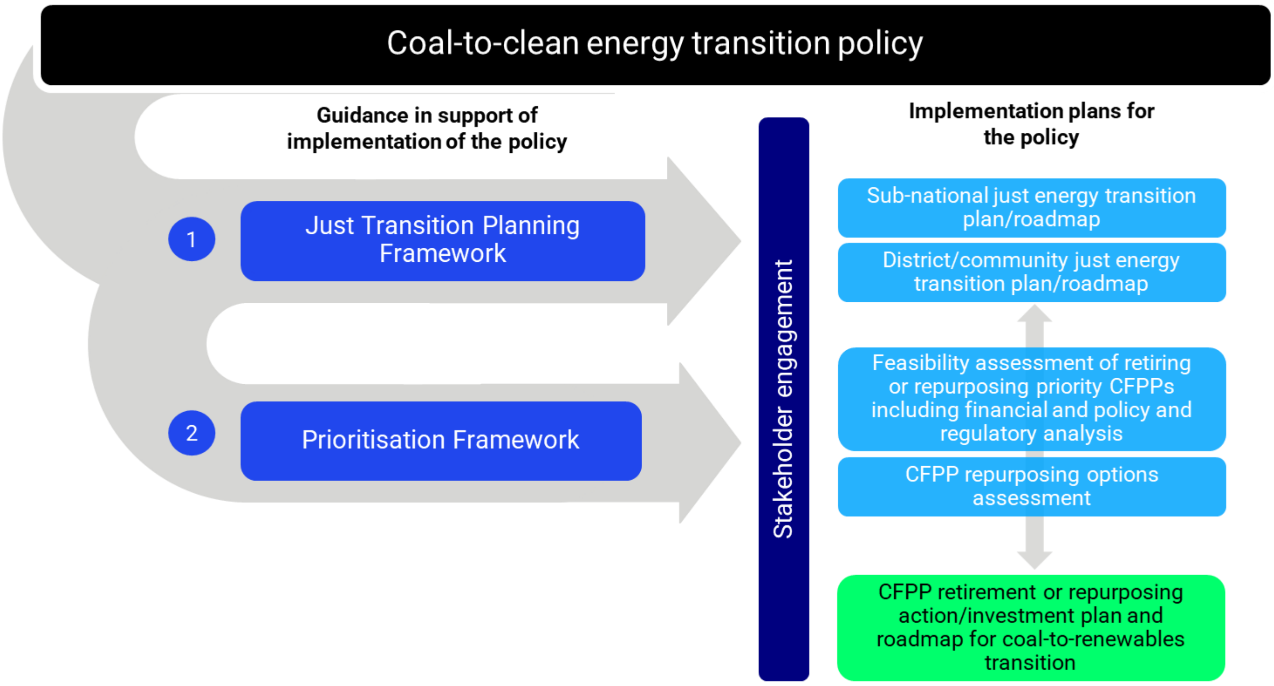


Figure 2. Use of the frameworks to support coal-to-clean energy transition policies.

There are limitations and trade-offs to both the JTPF and Prioritisation Framework that should inform their applications:

- While the JTPF builds on international frameworks and principles, it is not comprehensive and is intended to be used as a guide only. Just transition planning must be 'place-based' and thus be shaped by, and be appropriate to, the local context.
- The JTPF aims to be sufficiently high-level to be applied in a range of contexts, but this inevitably limits the depth of local factors that can be explored. For this reason, application of the JTPF must be in close collaboration with local stakeholders and use primary data.
- The JTPF has not been tested on the ground with local stakeholders. It is therefore expected that the JTPF should be further tested, updated, and adapted where necessary.
- The accuracy of the Prioritisation Framework's results is dependent on granular, latest available plant-level data alongside regional-level energy forecasts, which may not be easily accessible.
- While the Prioritisation Framework provides a valuable starting point for identifying potential candidates for repurposing or early retirement, practical considerations related to these options are beyond its intended scope. As such, it is necessary to conduct further analysis on the financials of CFPPs, the region's policy and regulatory environment, and the technical feasibility of repurposing options where applicable, to fully inform decision-making.
- The application of both the JTPF and Prioritisation Framework to Odisha uses publicly available data and modelling assumptions only and has not been developed or tested with local stakeholders. Since this is a significant limitation of the case study, the findings are intended as guidance only.

2. Just Transition Planning Framework

2.1. Introduction

The concept of a just transition is used to guide transitions to Net Zero across sectors, to understand and mitigate the risks and to ensure that the benefits are shared equitably. While definitions vary, the ILO's 'Just transition guidelines' provide an overview of key just transition principles, which have informed a number of frameworks and approaches and are used by government and industry as best practice.[9] Based on the ILO's definition, we define the just transition as described in Section 1.1.

The JTPF seeks to distil the positive and negative learnings from international transition experiences in the context of the energy transition as mentioned in Section 1. It builds on existing just transition frameworks to support ongoing and future just energy transitions.

2.1.1. Aims

The JTPF is a guide to support policymakers and key energy sector stakeholders to navigate the just energy transition planning process. It aims to:

- Support an understanding of the types and extent of socioeconomic risks and opportunities that may arise as part of an energy transition.
- Help policymakers consider the establishment of structures and means of governance to drive the just transition and facilitate social dialogue.
- Guide the development of policy and planning solutions to minimise these risks and enhance opportunities for impacted workers and communities.
- Identify relevant alternative livelihood opportunities for impacted workers and communities.

2.2. Summary of learnings from the literature

2.2.1. Socioeconomic impacts of energy transitions

The energy transition provides an opportunity to create green jobs, enhance affordable energy access, enable improved health and environmental outcomes, and build local economic resilience. However, there are also a range of context-specific risks to workers and communities which must be identified and managed to minimise adverse impacts and take advantage of the opportunities. Early, proactive planning and comprehensive support that is carefully managed and informed by a strong understanding of the likely impacts are essential for a just transition.

Jobs and livelihoods

Coal asset closures risk the jobs of those directly employed, as well as those dependent on indirect industries along the value chain, and informal workers. Rapid and poorly managed change poses a risk to the workers and communities whose livelihoods rely on coal assets and related industries, including those in power generation, coal mining, coal transport and steel manufacturing. In rural or isolated areas with high economic dependency on the coal industry, there may be limited alternative employment opportunities and available jobs might be of lower pay or quality and require a different skillset. Informal and contract workers are particularly vulnerable in the transition as they tend to have lower skillsets, reduced labour rights and no union representation.

Induced employment and pensioners in coal regions are also at risk from closures. Induced workers provide services to meet the consumption demands of coal workers, for example in local shops and restaurants.

Employees in these industries face unemployment if they lose customers.[10] Induced sector employees tend to be disproportionately women, and so the risk of livelihood loss in the induced sector can exacerbate inequalities faced by already vulnerable communities. Pensions are also a primary consideration as these are provided through either previous coal employers or the state, depending on the region and employer. As the number of existing workers declines, so does the funding available to provide pensions. This is exacerbated by the impacts of closures on regional and state tax revenues, reducing the funding available for social protection.

Investing in the diversification of the local economy away from coal and towards low carbon energy can provide alternative employment to workers impacted by the energy transition. Renewable energy developments such as wind or solar farms can provide alternative jobs, creating new direct employment opportunities. These industries can create long-term economic opportunities across the supply chain through manufacturing and downstream industries to supply key technologies and materials for renewable energy development. However, this is not a panacea. Employment opportunities in utility-scale renewable energy projects are generally concentrated in the early stages of project deployment rather than long-term operation and maintenance roles and local skills may be lacking to carry out these roles.[11, 12] This means workers may need to be trained and reskilled to take advantage of the employment opportunities. Additionally, not all renewable energy jobs will be in the same location as those lost, and may also be less unionised than the coal industry, with less secure jobs, lower pay, and poor working conditions. As such, policymakers and key energy sector stakeholders must consider investments in multiple sectors beyond large-scale renewable energy to enhance local economic opportunities for workers and communities, including manufacturing, services, or smaller-scale renewable energy projects.

Distributed energy resource (DER) projects can generate increased employment and value for local communities and support low carbon energy objectives. Focusing on the development of DER projects can bring important benefits because they tend to be more labour-intensive than utility-scale projects and provide more employment opportunities over the project's deployment cycle. In addition, these projects can also bring enhanced local benefits, including wealth creation, energy access and increased quality of life. This is particularly the case in rural or isolated areas.

Communities and environment

There are profound social and cultural implications of coal asset closures in communities where coal forms a core part of the local identity. Coal assets have served as generational employers and helped to develop a sense of community identity that is attached to coal as a culture in many regions.[13] Interviews and focus groups with residents from coal mining regions have revealed how the decline in coal has threatened their cultural identity and sense of community.[14, 15, 16] The long history of coal in a region can create a local cultural understanding and identification with the sector, which makes change difficult if this is not respected in the transition process.[17]

Coal asset closures can lead to loss of public finances and basic services in highly coal-dependent regions. There is a risk of government revenue loss, where taxation, royalties and other associated revenues from declining industries are not adequately replaced. This will, in turn, affect the provision of public services and can make it more challenging for the state to support workers and communities in the transition. Additionally, coal companies provide services directly to local communities, often compensating for the industry's impacts on local land, air, and water. The closure of coal assets could risk an abandonment of these services if management is not transferred effectively.

Renewable energy developments can drive economic activity in the region by providing funds through tax and royalties to replace those lost from the coal industry, although this will vary by region. Regional and national governments can raise revenue through land tax, property tax and royalties through solar photovoltaic (PV), wind and other renewable energy installations. In North Carolina, United States, for example, the state received almost $10.6 million in property taxes following solar PV installations, relative to half a million dollars on the same land prior to these installations.[18]

The expansion of renewable energy and DER can drive development, improve living conditions in rural areas and address distributional inequality in energy access.[19] Mini and micro grids and small-scale DER projects can help ensure that the benefits of clean energy reach rural areas and provide equitable energy access and employment opportunities. In Chhattisgarh, India, a regional government programme saw all public health centres — many of which previously had no reliable source of power — installed with solar PV systems and energy efficient appliances. The centres can now provide 24-hour healthcare and treat a greater number of patients.[20]

Community-owned and locally-driven green industries and renewable energy provide an opportunity to create local wealth and enhance economic opportunities. Large-scale renewable energy projects are often financed by multinational conglomerates and developed by large energy firms as they require significant amounts of capital and expertise.[21] This makes local ownership challenging and often local communities do not see the benefits of these new developments.[22] In some cases, the majority of the economic benefits will be felt by those who already own large amounts of land, reinforcing existing landowner advantages and inequalities within communities.[23] Local community renewable energy initiatives can address these distributional challenges. They are likely to reap greater regional benefits than non-resident investors and developers through tax revenues and will strengthen the local economy from salaries paid and spent in the region.[24]

The transition away from coal-based power generation may impact energy access and affordability. The distribution of costs and benefits of renewable energy generation will fall on different actors, depending on a region's energy market and policy framework. Subject to how the transition is managed, there is a risk that the cost may be felt most by taxpayers or electricity end-users.[25] In emerging economies, informal coal mining or coal gatherers provide household cooking fuel. Coal-bearing areas sometimes also receive free electricity from coal companies.[26] Nonetheless, analysis suggests that in the long-term, a comprehensive energy transition can ensure affordable energy access for consumers.[27, 28]

Closure of coal mines and plants can bring significant environmental and health benefits to local communities. Crucially, the transition presents an opportunity to address urgent air pollution challenges in coal mining regions, with significant health benefits to local populations. Reduced land conversion for coal mining alongside reinstatement of habitats and ecosystem services during restoration, bring ecological benefits, and environmental rehabilitation programmes can provide short-term employment opportunities.

The opportunities and risks of the energy transition will be context specific. Renewable energy alone may not provide sufficient employment and economic opportunities. It is therefore crucial to ensure that the necessary processes and structures are in place to fully understand and examine regional factors and the local economic context. The concept of a just transition provides a framework with which to do this, enabling an inclusive, locally-focused and informed transition to renewable energy.

2.2.2. Assessment of just transition approaches

The just transition concept was initially grounded in labour movements as a mechanism to empower and mobilise workers in carbon-intensive industries. Since then, it has expanded and incorporates the broader socioeconomic impacts of the transition and climate justice. The just transition concept has been increasingly used in academic and policy discourse to understand the socioeconomic implications of the low carbon transition. The ILO's just transition principles are widely recognised and cover the key elements common to many just transition frameworks. [29]

This section summarises key learnings from an assessment and analysis of international energy transition case studies which, in turn, inform the JTPF.

Understanding the context

Energy transitions are complex and context-specific, so an understanding of the local political and economic context should inform transition planning and implementation. Failure to understand the local context can exacerbate community resistance, create backlash, and limit the effectiveness of interventions. Mapping key stakeholders, their interest and influence, key drivers of the transition, regional industries and development goals, and the economic circumstances of a region will inform this understanding.[30] A detailed baseline assessment of the expected impacts and opportunities, carried out in collaboration with impacted communities, must therefore inform planning and implementation. Gathering data to inform the baseline assessment can also be an opportunity to engage with affected communities. Canada, for example, visited every affected community as part of its just transition process, which helped to build social support for the country's transition.[31]

Achieving social and political buy-in

Strong, transparent, and positive communication on the need for and opportunities of the just transition can support social and political buy-in.[32] Opportunities including new jobs, clean energy, regional diversification, and environmental rehabilitation can be emphasised, aligning communication with community values.

Achieving mutual agreement across stakeholders, including impacted communities, can avoid political and social pushback and identify transition objectives. In South Africa and Poland, perceived tensions between those aiming to speed up the transition and worker representatives protecting their livelihoods have created political roadblocks. Platforms for social dialogue established at regional and community levels can facilitate stakeholder discussions and enable mutual agreement on the objective of a just energy transition for the relevant community.[33]

Demonstrating clear, tangible benefits for affected communities early on can help to garner and maintain support for the transition. Indonesia's government used a positive narrative around development benefits to explain the need for fossil fuel subsidy reforms and reinvested the savings.[34] Clear demonstrations of the opportunities of the transition can support buy-in to enable the required long-term investment.

Stakeholder engagement and participatory planning processes

Collaboration between government, industry and workers is necessary for a successful just transition, but the mechanisms of communication, participation and decision-making must be inclusive and fair.[35] Participatory methods focusing on consensus through social dialogue must be carefully designed to ensure effective and meaningful engagement. In emerging economies — where many of the impacted workers will be informal and non-unionised — it can be difficult to mobilise this large proportion of the affected workforce and to identify official representatives to engage in planning discussions.[36, 37] Conflicting priorities and power imbalances must be carefully managed to ensure meaningful engagement from all stakeholders, particularly those who are marginalised and vulnerable. Here, strong and transparent governance structures can help facilitate inclusive planning.

A community-focused approach can enable a more successful transition. Core involvement of unions and the local community has been shown to enable better outcomes in terms of pay and conditions for new employment and legitimacy for the transition.[38] In Alberta, Canada, the state's community-focused just transition approach has mitigated pushback on the transition away from coal. In Germany, the government successfully identified key stakeholders, including the most underrepresented groups in fossil fuel communities, and engaged extensively with them to implement policies. This helped ensure that local communities remained invested in just transition programmes.[39]

The mechanisms of community involvement in just transition planning and implementation must be trusted and transparent. Stakeholder consultation and participation exercises are often run in parallel with formal decision-making processes. It is rarely specified how the former will impact the latter.[40] Participants must be able to see and trust that their contributions are informing decision-making.[41] Trusted community groups are well placed to maintain inclusive processes, facilitating engagements, and mediating between stakeholders.

Governance and funding

A just transition requires long-term funding and strong governance. In all cases, a just transition requires significant resources to provide the worker and community support necessary to avoid the socioeconomic risks of an energy transformation at such scale. Funding should be linked to a just transition plan or strategy to direct and distribute funds. Financing can come from both domestic and international sources, from the public sector and from companies. Emerging economies can seek international climate finance support to support climate justice objectives.

Dedicated institutional structures can oversee and drive the just transition, facilitate social dialogue and provide direction. Countries like Canada, the Czech Republic, Germany, Spain and South Africa have convened national taskforces or commissions to provide policy recommendations and estimate the financial implications of the transition. Strong oversight, cross-departmental collaboration and expert input from technical advisory committees can contribute to better management of the transition. Governance can build on existing institutions and structures or create new ones to drive the transition.

Support for workers and communities

Prioritising regional revitalisation and local wealth creation can support a more resilient, long-term low carbon economy. Economic diversification can support the creation of livelihoods and long-term economic resilience, in line with regional renewable energy, climate change and economic development plans. Retaining local wealth and economic opportunities can generate support for the transition and ensure communities see the benefits of the transition. Targeted support measures for workers and vulnerable communities should be embedded in broader objectives. For example, skills and training opportunities alongside compensation for workers are likely to be more effective in the long-term than compensation and helps support regional economic diversification.

Support measures can range from narrow, targeted, and short-term to broad, holistic, and long-term solutions. A range of interventions will be required to manage the just transition and can be anchored in regional objectives. For example, skills training can support wider economic diversification goals. Interventions should be informed by worker and community ambitions and preferences. The extent of interventions required will depend on the scale of the transition, existing economic opportunities and welfare support that is already available. A summary of policy solutions to support workers and communities is provided in Box 1 below.

BOX 1. Policy solutions for workers, communities and coal asset owners for a just transition.

Policy solutions range from narrow, targeted, and short-term to broad, holistic, and long-term solutions. A variety of intervention types will be required to manage the just transition. They can be implemented in a way which supports local wealth creation, embeds local benefits, and creates long-term resilience.

Narrow → Broad

		Compensation	Exemption from climate laws/regulations	Structural adjustment assistance	Holistic, adaptive support
Livelihoods	Workers	Redundancy benefits, early retirement package, pension 'bridging', unemployment insurance.	Indirectly felt from exemptions on asset owners.	Wage subsidies, training subsidies, relocation subsidies, job transfer schemes, expansion of existing industries, investment in new industry.	Comprehensive transition planning, counselling and other social services to workers and families, facilitating reemployment opportunities in line with needs, preferences.
Livelihoods	Asset owners	Lump sum payments, corporate tax cuts.	Delayed application of new laws, emission permits exemptions.	Conditional grants to update plants, R&D subsidies.	
Communities and environment	Adjacent communities	Revenue replacement grants for local governments.	Geographically-defined exemptions to new laws, geographically differentiated timelines for the implementation of new laws.	Place-based public investment in economic infrastructure, innovation, education and training, support for entrepreneurship.	Place-based investment in local public goods of a social, cultural or environmental nature.
Communities and environment	Consumers, households	Lump sum payments, tax reductions, increased transfer payments.	Certain consumers exempted from new laws, regulations.	Subsidies for home insulation, energy efficient appliances, solar panels.	Schemes to prevent household displacement.

Based on: Green, F (2018), Transition policy for climate change mitigation: Who, what, why and how? Crawford School of Public Policy, ANU, Canberra, p.1807 (anu.edu.au)

2.3. Just Transition Planning Framework

The JTPF builds on key frameworks, international case studies and learnings from just transition literature. The JTPF aims to distil these learnings into a practical, applicable, and adaptable planning approach for the energy transition. It can be used across geographies and scales for decision-making at the local, sub-national, and national level. The approach is intended as a guide to support just energy transition planning and emphasises the need for comprehensive stakeholder engagement and context-specific data gathering for it to be effective.

The full JTPF can be found in Technical Appendix 1. The following sections provide an overview of the key findings that inform the JTPF alongside a high-level summary of key principles and pillars. Figure 3 provides an overview of the JTPF's principles and pillars, which reflect the definition of the just transition adopted for the purposes of this report (see Section 2.1).

The JTPF is anchored in three principles common to just transition literature:

1. **Recognition of inequalities —** The process should involve the identification of both existing inequalities and those that may be created throughout the transition. Many inequalities may not be apparent until affected stakeholders are engaged, particularly for marginalised or vulnerable communities.

   The just transition process should aim to address and mitigate the exacerbation of existing inequalities, which may be characterised by economic status, gender, age, and other socioeconomic factors.

2. **Transparent, accountable and inclusive processes —** Inclusive, open, and honest planning and implementation processes can help build trust, ensure that all stakeholder perspectives are voiced, create accountability and drive ambition.

3. **Equitable distribution of costs and benefits —** There will be inevitable trade-offs and

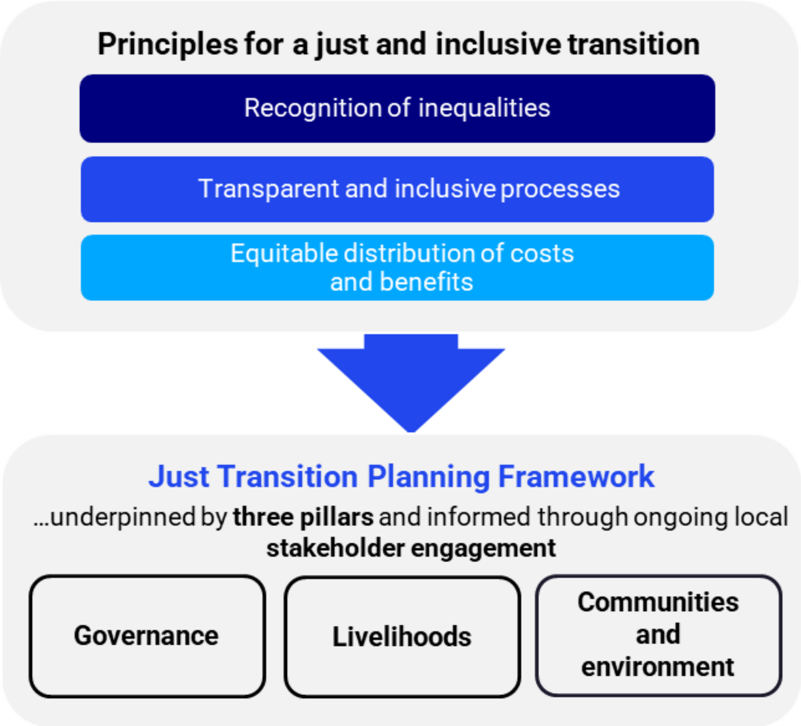


Figure 3. Principles for a just transition are embedded in the pillars of the Just Transition Planning Framework (Framework in Figure 4 below) and underpin the guidance materials contained therein.

compromises in the energy transition. The just transition must seek to share the costs and benefits as equitably as possible, ensuring that costs do not fall on those least able to bear them, and the benefits do not accrue unfairly to already powerful groups.

The JTPF is guided by these principles and is built around three pillars. Each pillar contains guidance to support decision-making.

1. **Governance —** Dedicated institutions, structures, and funding processes to drive and be accountable for the just transition.
2. **Livelihoods —** Supporting direct, indirect and induced workers, mitigating risks to livelihoods and enabling workers to transfer into new alternative livelihoods and/or other forms of support where possible.
3. **Communities and environment —** Mitigating social, economic, and environmental risks to the wider community, investing in diversifying and strengthening the local economy, investing in sociocultural projects and prioritising regional revitalisation.

Crucially, the transition must be planned for and implemented in close collaboration with local stakeholders. Early, proactive, inclusive dialogue is essential for a just transition. Starting the planning process too late or implementing reactive rather than proactive policies, can mean missing key opportunities to build support for the transition. It can also build resilience to the transition's negative consequences on communities. Further, inclusive social dialogue will support a more thorough understanding of the scale and scope of the risks likely to be faced in the transition, including the degree of vulnerability, distribution of impacts, and community characteristics, which can inform more effective support measures.

Figure 4 provides an overview of the JTPF. Just transition planning should encompass not only a transition away from inefficient, high carbon emitting assets and industries, but also seek to enhance community resilience and regional revitalisation through sustainable economic development and diversification, and investments in sociocultural and human capital. The 'asset transition(s)' in Figure 4 forms a component of and sits within the broader local, sustainable economic development, which encompasses the wider regional transition.

Each pillar cuts across these different levels of the just transition. The outlined processes are relevant to both asset and regional-level

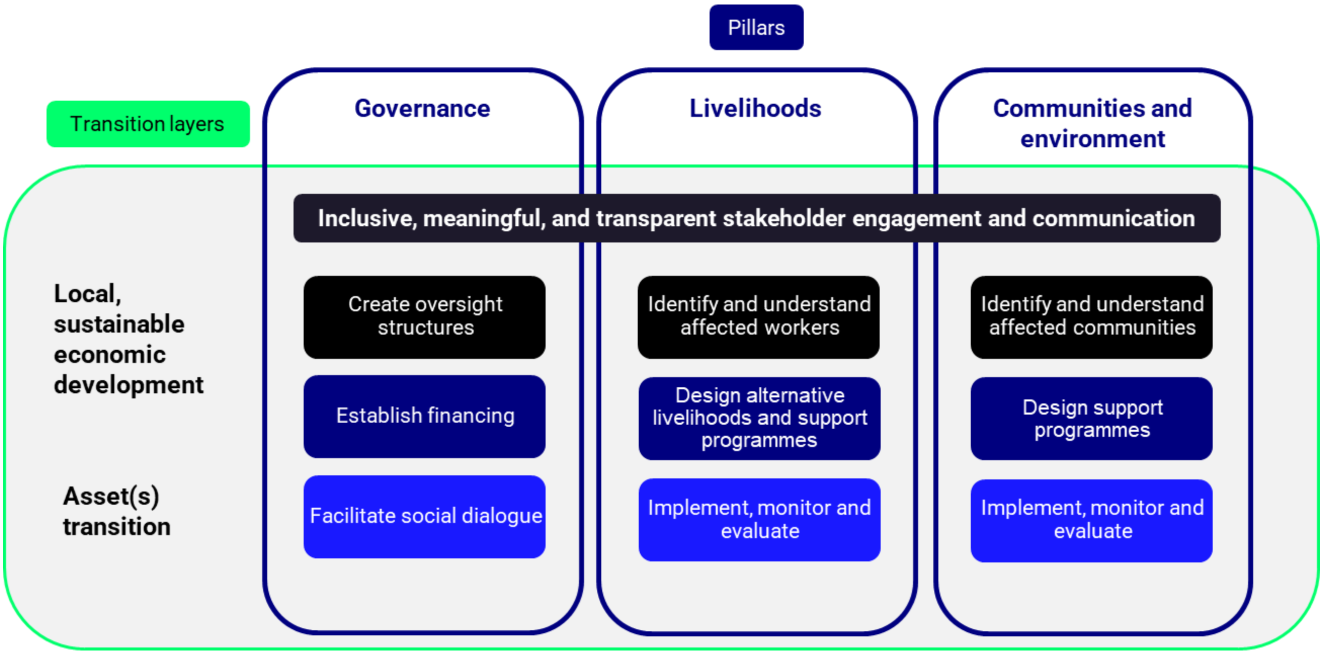


Figure 4. The Just Transition Planning Framework demonstrates the different layers of the just transition from asset to regional level, as well as key pillars and processes.

transitions. Inclusive, meaningful, and transparent stakeholder engagement is central to planning processes throughout and is a key enabler of a fair and just transition. The full JTPF and its guidance under each of these steps, can be found in Technical Appendix 1.

The next section presents a case study of elements of the JTPF applied in the context of Odisha, India to illustrate at a high level how this planning approach could be applied and used to support transition planning in Odisha.

3. Case study: Just transition and alternative livelihoods planning in Odisha, India

3.1. Background and context

Odisha seeks to 'undertake an inclusive journey towards energy transition through higher adoption of renewable energy', emphasising in their recent renewable energy policy that 'any such transition must be just'.[42] While the state government is dedicating significant resources to accelerate the development of renewable energy projects, currently Odisha has a high dependency on old, inefficient, and polluting coal assets, which risk being stranded due to the low cost of alternative technologies and growing environmental regulations. In addition to the direct workers who may face livelihood loss in the transition, there is a significant informal sector that supports Odisha's economy and is likely to be affected by the transition. Prioritising an inclusive, place-based approach to economic diversification and community revitalisation to establish a resilient, low carbon economy can mitigate the risks and take advantage of the multitude of opportunities that the energy transition presents.

The following sections apply elements of the JTPF in the context of Odisha to support the state's just transition objectives. Figure 5 highlights the elements of the JTPF that this case study applies in the Odisha context. Using secondary data, we aimed to understand the high-level implications of a transition for workers and communities dependent on coal and CFPPs through a socioeconomic baseline assessment. We further used the framework to support a gap analysis and develop recommendations for just energy transition planning in Odisha that aligns with emerging best practice.

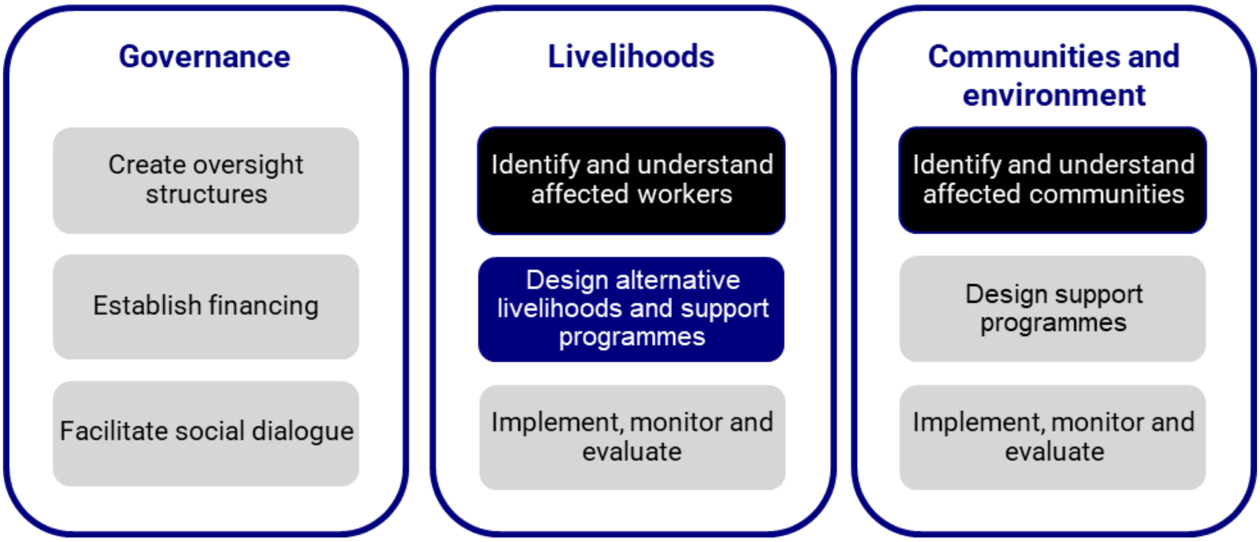


Figure 5. Highlighted elements of the Just Transition Planning Framework are applied here in the Odisha context, using publicly available data.

3.2. Just transition governance

A robust just transition governance structure with clearly defined functions for oversight, coordination and processes for social dialogue, should be established to support Odisha's just transition. The governance structure will need to ensure that roles and responsibilities are allocated for the facilitation of social dialogue, the day-to-day management of planning and implementation. It will also need to explicitly link the just transition planning and implementation to sources of finance.

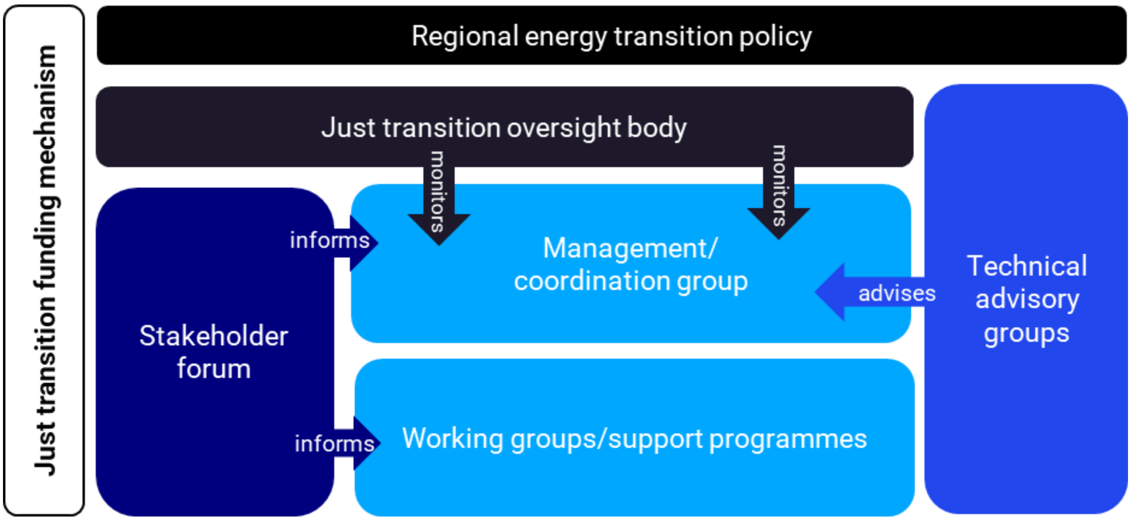


Figure 6. Illustrative governance structure.

While any governance arrangement ought to be appropriate to local contexts, emerging best practices suggest that robust and effective governance involves mechanisms for oversight and accountability, coordination, stakeholder engagement and dialogue, and should be linked to finance. An example of what a governance structure could like, and potential governance bodies, is included in Figure 6.

The governance structure could include the following:

(1) **An oversight function to provide accountability and transparency and oversee governance processes including stakeholder engagement and dialogue.** The oversight body should be appropriately empowered to oversee the planning and implementation process. The body could comprise senior decision-makers within the Department of Energy, for instance.

(2) **Technical advisory group(s) to provide strategic direction and expert guidance.** The just transition is complex, and the governance structure will need to manage power imbalances, conflicts, and trade-offs. An independent commission, sitting outside the government could also be established to enhance accountability, but also provide expert advice and objective guidance to government decision-makers.

(3) **Coordination and management functions to work across scales (local, regional, national), departments (e.g., energy, education, employment) and manage the planning and implementation processes.** Given the complex, crosscutting and multi-scalar nature of the just transition, coordination is essential to ensure that planning is aligned. The coordination body must be sufficiently empowered to convene senior decision-makers from across government. For example, Jharkhand established a Just Transition Task Force, which comprises 17 institutions, including state government departments.

(4) **Stakeholder forum and social dialogue governance processes.** The stakeholder forum should provide social dialogue mechanisms to inform planning and implementation. This can support buy-in and build trust in the transition process, particularly with impacted stakeholders. Engaging with vulnerable and disproportionately impacted communities will be essential to inform a detailed and nuanced understanding of the likely impacts and to work towards a shared vision for managing the transition. This is particularly true of groups where data is limited and transition consequences are not well understood, such as informal workers. An illustrative summary of relevant stakeholders

for comprehensive social dialogue in Odisha is provided in Box 2 below.

(5) **Linkage to a just transition financing mechanism.** Significant resources will be required to provide the necessary just transition support measures. There are several potential funding sources for the just transition in Odisha, including public, private and international financiers, such as multilateral development banks (MDBs), direct foreign investment (DFI) and private sector financing. Any governance structure must be clearly linked with financing channels so that plans and interventions can be implemented.

BOX 2. Examples of key stakeholders for the just transition in Odisha.

This box provides an illustrative summary of key stakeholders who are likely to be impacted by and have interest in the energy transition in Odisha. Dialogue with and between stakeholders can enable collaboration, build support for and trust in the transition, and increase the efficacy of just transition planning.

Workers and trade unions	Centre of Indian Trade Unions, National Workers' Federation, All India Trade Union Congress, All India Coal Workers' Federation, Indian National Electricity Workers' Federation.
Communities and energy consumers	District-level communities in Angul, Cuttack, Sambalpur, Jharsuguda, Sambalpur, Dhenkanal, Jajpur; community representatives, civil society organisations.
Energy sector businesses	Odisha Power Generation Corporation Limited, NTPC Limited, Jindal India Thermal Power, Vedanta Resources Plc, Tata Steel, Hindalco Industries, National Aluminium Co. Ltd, Coal India Limited.
Local government	Department of Energy Odisha, Odisha Renewable Energy Development Agency, Department of Industries, Odisha Livelihood Mission, Mission Shakti, Department of Skill Development & Technical Education.
National government	Ministry of Coal, Ministry of New and Renewable Energy, National Institution for Transforming India, Ministry of Labour, Ministry of Social Justice and Empowerment, Skill Council for Green Jobs.
Education providers	Odisha State Open University, Kalahandi University, Centurion University of Technology and Management, National Institute of Technology Rourkela, Indian Institute of Technology Bhubaneswar.
NGOs	International Forum for Environment, Sustainability and Technology (iForest), Centre for Policy Research India (CPRI), Centre for Social and Economic Progress (CSEP), Shakti Foundation.

CIF, Supporting Just Transitions in India, 2021

3.3. Socioeconomic impacts of the energy transition in Odisha

The impact of the energy transition in Odisha will be significant, with implications for workers, communities, and asset owners. Yet there is an opportunity to invest in a low carbon, resilient, and diverse economy. This section focuses on the risks and opportunities for those impacted by the transition, with a focus on the impacts of CFPP closure and the transition to renewable energy.

3.3.1. Jobs and livelihoods impact assessment

Identify and understand affected workers

Direct CFPP workers are at risk of losing their livelihoods and should receive support to transition to livelihoods of equal or higher quality. Direct workers tend to be relatively well paid and highly unionised. They are less vulnerable than other groups but will still require support in the transition. Alternative employment opportunities must be provided and should be of similar pay and quality. Direct power plant employees in India tend to have strong technical backgrounds, so there is a strong baseline for retraining them for employment in other sectors. This is reflected in the general education levels as over a third of workers hold graduate and postgraduate degrees (see Figure 7). Characteristics including age, wages and worker preferences will also need to inform alternative livelihood support programmes.

Contracted and informal workers are at greater risk in the transition due to reduced labour rights and lower skill levels. Contracted power plant workers, who outnumber direct workers by two to three times, are at greater risk due to limited labour rights, lack of union representation, and lower skill levels and are likely to be the first impacted by closures. CFPP closures can impact livelihoods across the coal value chain, including in coal mining, transportation and iron and steel manufacturing.

Taking into consideration worker ages and retirement plans to inform closure programmes can aim to minimise redundancies. There will be a large proportion of workers retiring in the next three decades. In the district of Angul, about 61% of coal mining employees are aged between 40-60. In the next 30 years, about 88% of the current employees will retire.[43] Planning a phased closure aligned with retirement plans can therefore mitigate negative impacts on workers. However, it leaves limited capacity to take on large numbers of younger workers, who will need to be supported through future closures.

CFPP closures will impact livelihoods across the coal value chain, including in coal mining, transportation and iron and steel manufacturing. In Angul, for example, 29% of the district's labour force are employed in coal mining, coal-based industries, and coal transport sectors, with 69% of these workers categorised as informal. [44] The number of both formal and informal workers in Odisha's coal industry is expected to increase over the next decade with the expansion of existing mines and the opening of new mines, power plants and coal-related industrial units.[45, 46] This will significantly increase the scope and scale of the energy transition impact on workers and communities.

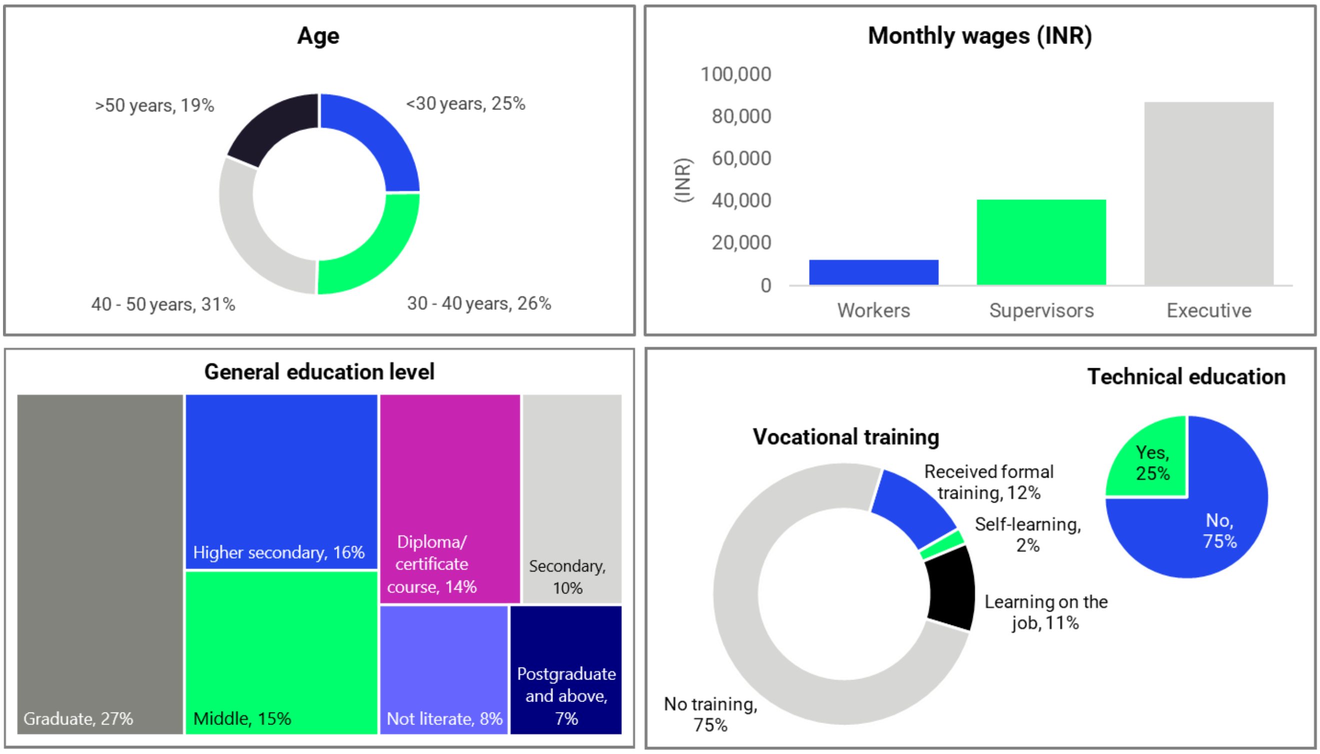


Figure 7. Profile of power plant workers in India. Source: National Foundation for India.

3.3.2. Community impact assessment

Identify and understand affected workers

Regional revenue and basic services

The transition in Odisha will impact the state's public finances and services. Royalties from coal, primarily from the mining industry, account for approximately 6% of Odisha's state income while the contribution of Coal India Limited's (CIL) royalties accounts for 15% of the state's non-tax revenue, so closures represent a significant risk to public finance.[47] CFPP closures may impact the coal mining industry upstream. Coal-dependent industries, such as manufacturing, also contribute to state revenue.[48] As the energy transition progresses, there is a risk that more workers will require support while simultaneously having less state funding to support these workers. A significant loss in state revenue is likely to have wide-ranging implications for public services in the region, including the maintenance of infrastructure, schools, health, and water services.

In Odisha, the coal industry provides spending and public services through corporate social responsibility (CSR) and related social spending. CIL and its subsidiaries spent 19.8 billion rupees (₹) on CSR initiatives between FY 2017 and FY 2020, and currently ranks in the top 20 companies by CSR spend in India.[49] In Angul, the total fund outlay under CSR in 2020-21 was $5.6 million, which was used to support welfare activities including water supply, the construction and repair of schools and the development of a medical college and hospital at Talcher.[50] Additionally, the District Mineral Fund (DMF) is a levy which collects a proportion of the mining industry's revenue and spends it for the direct benefit of local communities.[51] Angul's total DMF collection over 2016-17 and 2017-18 has been over $128 million.[52] There is potential for the DMF to be used in the short-term for skills development and training programmes to support workers impacted by the coal transition.

Pensions for existing and future coal sector retirees will be a major financial consideration. As the coal sector declines and more assets are closed, there will be reduced funding available from the sector for the provision of pension funds.

Community cohesion and identity

The coal industry has a long history in Odisha and has likely played an important role in shaping community identity. The presence of mining and links to coal-dependent industries in Odisha dates back to the early 20th century, and so communities in coal mining and power plant areas are likely to have strong emotional and cultural ties to the sector.[53] In Angul, a survey found that residents had a deep sense of reliance on mining for day-to-day survival.[54]

Potential negative feelings towards the energy transition due to cultural and emotional ties to the coal industry should be acknowledged and understood. Impacts can be mitigated through support, which helps to maintain a sense of community cohesion. The Odisha region has a long history with the coal industry. Consequently, support measures must account for cultural and emotional losses to minimise social disruption and maintain public support.

Community ownership of renewable energy projects in Odisha which provide tangible benefits to the community could help to maintain a sense of cohesion and foster a sense of pride.[55] In India, Swayam Shishan Prayog, a non-governmental organisation (NGO) based in Maharashtra, has empowered women in rural communities by enabling them to become clean energy entrepreneurs through training and capacity building.[56] This has led to women embracing community leadership roles, pushing for improved local environments, expanding access to clean energy and promoting agricultural best practice.[57]

Environment and health

Asset closures could help to address key health and environmental challenges in Odisha. Odisha's coal regions, particularly the Angul-Talcher coal belt, are highly polluted and power plant closures offer an opportunity to address air pollution and water stress. However, closures also risk leaving behind polluting waste, which must be disposed of by specialists to avoid contaminating the surrounding land and water. The environmental and health aspects of the transition must be carefully managed to mitigate any risks.

The energy transition is an opportunity to address major environmental and health challenges in Odisha's coal regions, including air pollution, water stress and land degradation. CFPPs are the largest source of industrial pollution in India, limiting access to clean water and reducing agricultural productivity in the local area.[58, 59] Air pollution has emerged as an urgent challenge in India, causing nearly 1.2 million premature deaths in 2019, with the energy sector being the largest source of three of the major air pollutants.[60]

3.3.3. Summary and next steps

The coal transition in Odisha will have widespread implications across the value chain and for workers and communities. There is a risk of livelihood loss for direct, indirect, and induced workers, and closures can impact regional revenue streams, public spending, and local services. However, the transition presents a significant opportunity to invest in green industries, long-term, resilient jobs, and the provision of clean energy for communities. Closures can also address critical environmental and health challenges caused by CFPPs, including air pollution and associated health issues. Early planning and transition management, including investment in alternative livelihoods, can mitigate the risks and take advantage of the opportunities of the transition.

3.4. Alternative livelihoods assessment in Odisha

Design alternative livelihoods and support programmes

There is an opportunity to leverage the energy transition to diversify Odisha's economy, develop new industries and create new employment opportunities. In Odisha, there are several potential alternative livelihoods for coal workers, including renewable energy, industry, manufacturing and services. A just transition must prioritise investment in and support for sectors that align with just transition objectives and worker and community preferences. Development of new industries should embed a sustainable, low carbon and socially responsible economy that is aligned with Net Zero objectives and supports regional economic and social resilience in the energy transition.

Odisha has significant renewable energy potential, which will be important to harness to meet India's emissions reduction targets and ensure energy security. According to the '2022 Odisha Renewable Energy Policy' (OREP), Odisha is 'endowed with vast and largely untapped renewable energy potential' with an objective to reach 43% share of renewables in the energy mix by 2030.[61, 62] However, Odisha currently uses a large amount of hydropower, which is vulnerable to climate change and conflicts with agricultural and industrial water uses, so it will be important to diversify Odisha's renewable energy capacity.[63] Odisha also imports renewable energy from other states to meet the requirements of the national renewable purchase obligation (RPO) and is therefore not currently seeing the economic and employment benefits of these projects within the state.

The following section outlines examples of industries which could provide alternative livelihoods and economic diversification in Odisha. As this report is focused on the transition to a low carbon energy system, the alternative livelihoods analysis in this section focuses on renewable energy. Given that renewable energy projects often require fewer workers in the long-term, it will be important to consider a range of diverse alternative industries, which can provide long-term livelihood opportunities and support broader economic diversification.

3.4.1. Solar power

Odisha has a significant amount of solar energy potential with around 300 sunny days a year.[64] There is therefore an opportunity to pursue an increase in solar energy generation capacity with associated economic and employment benefits for local communities.

Jobs and livelihoods

In line with the objectives of the 'OREP 2022', which includes setting up 17,000 MW of solar capacity, 478,890 jobs are expected to be created in the solar power sector. [65] However, the majority of employment opportunities are likely to be in design and re-construction (153,850), and construction and pre-commission activities (281,180) and will therefore be largely short-term jobs.[66] Long-term opportunities will be fewer and tend to require a higher level of qualification. There is therefore a need to map out and create diverse alternative livelihood options which are long-term in nature.

Floating solar PV (FPV) can create additional employment opportunities across a range of skillsets and throughout the deployment of the project. Over the course of their deployment, a small-scale FPV plant (capacity < 1 MW) directly employs 58 workers, while a mid-scale (capacity < 10 MW) employs 45.[67] Odisha has vast stretches of water bodies and multiple reservoirs that can be used to set up large-scale floating solar projects.[68] However, new jobs created may not be in the same location as those lost from the transition away from coal.

The sector can also generate indirect employment opportunities through the manufacturing of components for solar energy developments.[69] In line with the 'OREP 2022', an additional 44,200 jobs can be created through solar module manufacturing facilities established in Odisha.[70] This has the potential to provide more long-term job opportunities through the establishment of renewable energy manufacturing hubs for domestic and international markets.

Communities and environment

Solar power supports the transition to the low carbon energy system and reduces air pollution relative to existing coal-fired power generation, with significant health benefits for local communities. Solar projects can also support downstream economic activities and enable the development of local industries.

However, utility-scale solar developments require significant land use, and can give rise to land conflicts, impact traditional livelihoods or cause displacement of communities. Developments should be in collaboration with local communities to ensure that the project is aligned with local interests and needs, and creates tangible benefits for local communities.

Solar power therefore has the potential to bring significant benefits to local communities and support the creation of new industries and revenue sources for local landowners and state governments. Solar development must be done in a way that aligns with local needs, particularly those who are most vulnerable and likely to be adversely impacted.

3.4.2. Wind power

The east coast of India, including off Odisha's coast, looks to provide significant offshore wind power generation opportunities. Odisha's 'State Action Plan on Climate Change 2018-23' includes a priority to promote grid-connected wind power, which has the potential to create a significant number of long-term jobs.[71, 72] However, the potential for both onshore and offshore wind in Odisha has not been comprehensively assessed.

Jobs and livelihoods

Wind power can provide employment opportunities and downstream economic activities, but the opportunity in Odisha is unclear. Setting up 3,500 MW of wind capacity to meet the wind RPO requirements by 2029-30 could create 4,445 jobs. [73] Expanding wind power can also generate revenue for local landowners and support indirect employment in manufacturing industries to provide the required components. Existing jobs in manufacturing may be transferable to the manufacturing of wind turbines, while construction jobs may be relevant for wind turbine installation.

Communities and environment

Wind power generation capacity supports the low carbon energy transition and can contribute to enhanced energy security. However, large-scale wind power can give rise to land conflicts, impact traditional livelihoods or cause displacement of communities if not managed in alignment with community interests. As with large-scale solar projects, wind power developments must be carried out in collaboration with local communities to ensure that their needs and concerns inform planning processes. This can enable tangible benefits for local communities, including employment and wealth generation.

3.4.3. Distributed energy resources

DER can include rooftop solar, distributed energy storage, smart energy management, electric vehicle (EV) charging infrastructure and agricultural energy generation. DER provides an opportunity to address existing socioeconomic challenges and inequalities such as energy access and employment, particularly in rural areas.

Odisha has committed to developing distributed solar generation facilities in additional to utility-scale projects, which will support rural livelihoods. The 'OREP 2022' outlines a commitment to promote deployment of distributed solar generation facilities to meet energy needs in remote and inaccessible areas in a sustainable manner. This will include large-scale deployment of solar applications like solar cookers, solar water heaters, solar desalination, and solar food dryers to generate solar energy locally and in a decentralised manner. Solar-based EV charging stations will also be explored. [74]

Jobs and livelihoods

DER projects can offer a higher concentration of employment opportunities as they are more labour-intensive than utility-scale renewable energy projects. For example, Mlinda, a DER provider in India combines energy services with capacity building initiatives. Its community mini-grid deployment efforts have created an estimated 986 jobs from 2016-2020, with 15 to 28 jobs created per mini-grid. The total jobs include approximately 180 direct, full-time jobs, 131 full-time equivalent (FTE) jobs from contractual work and 675 productive-use jobs (existing and new entrepreneurial jobs that have been enhanced due to the use of DER) through additional entrepreneurial activities.[75]

DER projects offer advantages over utility-scale projects, including scalability, greater employment opportunities, and the ability to offer multiple benefits to rural communities. DER projects avoid the long lead times and development bottlenecks associated with public sector offtake procurement projects and can therefore provide immediate opportunities. DER can enable multiple downstream industries, including energy storage, EV charging, solar pumps, solar cold storage and rural non-farm productive use appliances. It is estimated that DER solutions can create up to five times more indirect jobs in local communities than number of direct jobs, creating added local value and further employment opportunities in the region.[76]

Communities and environment

DER can help to reduce energy poverty and improve the quality of electricity, particularly in rural areas. DER can also help to address gendered health inequalities, for example through the provision of clean cooking facilities. Women are disproportionately exposed to household air pollution from the burning of biomass, leading to a higher prevalence of asthma, pulmonary diseases, and lung cancer.[77] The provision of clean cooking options through DER projects could therefore provide important health improvements for women, in particular for those in low-income households.

3.4.4. Critical mineral mining

Odisha is endowed with vast natural resources, and critical mineral mining is expected to form a significant part of Odisha's economic development strategy. [78] Odisha has reserves of major minerals and produces iron ore, chromite, coal, bauxite, and manganese ore, and rapid deployment of low-emissions technologies is set to boost demand for critical minerals globally. [79]

Jobs and livelihoods

Significant retraining and reskilling interventions would be required to transfer workers from the coal industry into critical mineral mining. Coal and critical minerals require similar skills in the exploration and extraction phases, including heavy machinery operation, operations planning, handling of explosives and safety compliance.[80] However, critical mineral ore processing is much more complex than coal processing and is specific to each mineral. It must be carried out by highly skilled workers and so significant retraining would be required for coal processing workers to transfer to these jobs.[81] Overall, critical mineral mining generally requires fewer workers than coal mining and skills requirements and locational factors will require support and investment to enable workers to transition.[82]

Critical mineral processing facilities and their workers may not be located where coal workers are.[83] Disruption will be much lower where critical minerals are close to coal mines, and the pay and revenues from the mineral mining could be invested in former coal communities. Furthermore, it is essential that industrial growth in this sector is part of a broader programme of economic diversification to mitigate the risk of being reliant on one concentrated industry, and to broaden the economic benefits to non-mineral rich districts.[84]

Communities and environment

Critical minerals can be a source of revenue for the state government, but it is essential that local communities see the benefits of this economic opportunity, as specified in Odisha's economic survey. [85] The total state revenue collection from these minerals was ₹13,918 crore in 2020-21.[86] India plans to increase crude steel capacity by 300 MT by 2030, and Odisha will be expected to play an important role in supplying the key raw material of iron ore. Downstream industries producing auto components, electrical machinery, and engineering machinery would help to generate more value in the state and provide employment to large numbers of people.[87]

Critical mineral mining gives rise to a wide range of environmental and social challenges. Air pollution, water use, water quality, biodiversity and land use, handling of mining waste and greenhouse gas emissions are all associated with the mining of critical minerals. These impacts must be carefully managed to ensure that the direct environmental impacts of mineral mining are minimised and mitigated. There are also social and governance challenges, including poor working conditions and safety hazards, which are associated with the industry worldwide. The impacts on ecosystems and communities are therefore a significant challenge to a just transition in this industry, and companies must ensure high levels of environmental and social performance to enable a just transition and share the benefits equitably across the community.[88]

3.4.5. Key recommendations for alternative livelihoods in Odisha

There are a range of renewable energy, 'green' and other alternative livelihood opportunities identified in Odisha for further assessment. Prioritisation of these for investment and support can be guided by just transition objectives and local priorities.

Key findings from the assessment of alternative livelihood opportunities and application of the JTPF are outlined below:

- There is an opportunity to leverage the energy transition to diversify Odisha's economy, develop new industries, for example in renewable energy project development and manufacturing, and create new employment opportunities.
- Investment in industry, incentives for renewable energy development and training programmes to develop local skills can support Odisha in taking advantage of this opportunity.
- Odisha has significant renewable energy potential that the 'OREP 2022' looks to tap into, opening the door to major economic and employment opportunities.
- Development and operation of utility-scale renewable energy alone may not provide sufficient long-term employment opportunities for impacted workers.
- Small-scale and community-driven clean energy projects can provide more long-term and local employment opportunities and generate increased regional value, particularly by bringing clean, reliable energy to rural areas, enabling development and bringing wider benefits including access to clean cooking.
- Support for workers, including training and upskilling, will be required to enable the transition to employment in new industries.
- There are a number of non-renewable energy alternative livelihood opportunities in Odisha,

including industry, manufacturing and critical mineral mining. However, industries such as critical mineral mining are associated with significant socioeconomic and environmental challenges and are therefore unlikely to be a feasible alternative livelihood in line with just transition principles.

- Odisha is a major industrial hub in eastern India and expansion can take advantage of the region's economic strengths. However, many of Odisha's existing industries currently rely on fossil fuel power generation and so may be vulnerable in the energy transition.
- Regional economic diversification with a range of industries is important to create a breadth of employment opportunities and contribute to social and economic resilience.
- Prioritising alternative livelihoods which align with just transition principles, in line with local social, economic, and environmental objectives, can support development of a sustainable, low carbon and resilient economy.
- Once alternative livelihood opportunities have been prioritised and assessed in collaboration with local stakeholders, workers and communities must be supported through a range of broad and targeted measures (see Box 1) to enable the transition.

3.5. Next steps

The development of the JTPF sought to embed international emerging best practice principles and approaches to just transition planning. In applying elements of this framework to Odisha's context, key opportunities and next steps to support the implementation of Odisha's 'OREP 2022' in an equitable and inclusive way were identified. These include:

- Early, proactive stakeholder dialogue across public, private and community stakeholders to further understand the impacts and opportunities of the energy transition in Odisha.
- Establish just transition governance structures, building on the 'OREP 2022' to facilitate and provide accountability for the just transition.
- Develop a just transition plan or strategy which aligns with regional objectives and enables progress.
- Identify and engage with potential financing channels to provide the necessary resources for support measures and interventions.

Integrating just transition principles into planning from the outset will be essential to ensure effective management. As well as addressing the impacts of coal plant retirement, planning will include identifying opportunities where CFPPs can be repurposed to align with low carbon transition objectives. The required worker and community support will vary depending on whether the plant undergoing transition is being retired or repurposed, and support measures must be adapted accordingly. For example, support can provide upskilling for impacted workers to support the successful repurposing of the plant. As such, the next section presents the steps involved in identifying suitable assets for retirement or repurposing to supplement the JTPF.

4. Prioritisation Framework

4.1. Introduction

Urgent, rapid, and large-scale action is needed to accelerate the transition away from coal. CFPPs produce one fifth of global emissions – more than any other single source.[89] Meeting global emissions reduction targets will require stopping the construction of new plants, and more crucially, rapidly phasing out existing plants.

Despite awareness of the urgency needed for the coal transition and increasing viability of clean energy alternatives, transitioning away from coal has not kept pace with environmental needs. This is due to the presence of several socio-technical complexities that need to be addressed first such as investing in reliable grid infrastructure, providing retraining support for displaced workers, and enabling affected communities to be involved in grid planning decisions affecting their health, livelihoods, and access to energy. Given these complexities and the multidimensional nature of the energy landscape, a wide range of regional and plant-level factors must be understood and considered when selecting CFPPs for transition.

This section sets out a Prioritisation Framework which ranks CFPPs for repurposing or early retirement against a standardised set of criteria and metrics. This enables a high-level screening of a region's coal fleet with the purpose of assessing the suitability of CFPPs for repurposing or retirement, taking into account key considerations within the energy system, policy and social aspects of the coal transition.

The Prioritisation Framework can provide certainty and confidence to governments and stakeholders that a whole systems approach has been taken when considering CFPPs for early retirement or repurposing.

4.1.1. Aims

The Prioritisation Framework aims to:

1. Provide a robust and systematic methodology to rank CFPPs from highest to lowest priority over a given timeframe for repurposing or early retirement.
2. Provide high-level insights on which CFPPs can be considered for repurposing or early retirement to inform transition planning at the systems level.
3. Offer a foundation for engagement with governments and international stakeholders on appropriate financing mechanisms that can support plant retirement or repurposing.

4.1.2. Guidance for use

The Prioritisation Framework can be used as:

1. An entry point for comprehensive discussions with policymakers and key energy sector stakeholders on how they should plan support for energy transition initiatives.
2. A tool to help size the potential scope of a clean energy transition policy.
3. An indicator of the scale of renewable energy deployment that is needed and potential investment opportunities.

It should be noted that the results of the Prioritisation Framework should only be used as a guiding reference point. It should not be viewed as a definitive list of CFPPs which should be repurposed or retired, or a roadmap for coal phase-out. Further engagement with policymakers and key stakeholders is necessary to build a more comprehensive picture of the feasibility of phasing out coal within a region.

As a region's energy transition becomes more advanced, the Prioritisation Framework can evolve over time and incorporate new learnings and developments.

4.2. Summary of learnings from the literature

This section collates best practices from a literature review covering 12 reports on the approaches and criteria used globally to prioritise CFPPs for early retirement and/or repurposing.[90, 91, 92, 93, 94, 95, 96, 97, 98, 99, 100, 101, 102, 103]

4.2.1. Summary of best practice criteria to inform prioritisation of CFPPs

The table below consolidates the list of indicators identified from the literature review that have been used to inform the prioritisation of CFPP early retirement and repurposing decisions. The indicators are categorised as follows: (1) technical indicators relate to the plant-level characteristics affecting CFPP operations; (2) financial indicators relate to the CFPPs exposure to costs and its ability to sustain strong cash flows; (3) environmental indicators account for the damages associated with the plant's continued operations as well as the benefits from repurposing or retiring the plant; (4) social indicators cover the socioeconomic benefits as well as the risks and damages to employees and the local community from the plant's continued operations; and (5) policy indicators include the future plans for the energy transition in the context of its implications on CFPP retirement or repurposing.

Table 1. Summary of prioritisation criteria for the early retirement/repurposing of CFPPs.

Technical	Financial	Environmental	Social	Policy
Age	Gross profit	CO_2 emissions/carbon intensity (based on capacity, efficiency, coal type)	Job losses (compensation and fiscal support)	Power generation mix plan and policy
Size	Breakeven operating hours	Local air pollution (population weighted PM2.5)	Community support in favour of plant retirement	Environment assessment rules and emission policies
Combustion technology	Breakeven coal price	Water impact (water risk level)	Public health benefit	Compliance & penalty mechanisms
Max availability factor	Demolition cost	Non-radioactive emissions (NMVOCs, CO_2, NO_x, SO_2, PM)	Green job growth	Fuel imports required by the plant as a % of the country's total fuel imports
Thermal efficiency	Lost tax revenue	Radioactivity	Accident fatalities	
Air emission control mechanisms	Savings from equipment reutilisation	Cost of adhering to environmental regulations	Land requirements	
Cooling water and wastewater treatment	Investment cost	Benefit of land reutilisation	Social acceptance	
	Variable O&M cost	Carbon benefits	Human displacement and resettlement	
	Net Present Value (NPV) per MW	Water benefits	Loss in agricultural productivity	
	Distance to coal source (proxy of transportation cost)	Water pollution	Occupational and community health hazards	
	Total overnight cost (cost to build the plant without financing costs)	Solid waste disposal management	Safety (rare accident probability and impact)	
	System balancing costs	Loss of biodiversity	Loss of life expectancy	
		Fuel reserve years		

4.2.2. Approaches to retiring or repurposing CFPPs

Based on the literature review conducted as part of this study, several approaches to retiring or repurposing coal plants have been identified.[104] These are summarised in Figure 8 and described in further detail below.

Retiring plant and repurpose the site for RE generation	CFPPs that are reaching the end of their technical lifetimes can be retired and their sites repurposed for alternative renewable energy generation. This would allow new plants to benefit from the existing transmission infrastructure in place.
Modifying plant for flexibility provision	A baseload plant's operations can be reduced to focus exclusively on system balance and/or broad flexibility services.
Retrofitting plant to co-fire with alternative fuels	Retrofitting coal plants to co-fire with alternative fuels such as biomass or ammonia is another option to reduce emissions while preserving existing assets, helping avoid the risk of becoming stranded. It offers valuable system benefits and can help ensure that grid stability is maintained.
Retiring plant without decommissioning	Where the plant remains structurally intact but will no longer generate power and have no announced plans to decommission the site and redevelop it for alternative use.
Retiring plant and convert to synchronous condensers	As older CFPPs are retired, their induction generators can still be used even after their furnace turbines are scrapped. This is due to the need to stabilize grids deprived of big power plants. As such, synchronous condensers are an option to improve stability and maintain voltages.
Retiring plant and repurposing site for other commercial activity	Coal plants are often located in areas that can also benefit other commercial activities. With access to railroad, waterways, ports, highways, utility grids, and an existing industrial workforce, commercial development in replacement of the plant can be an attractive option for developers.
Retrofitting plant with carbon capture	Retrofitting coal plants with carbon capture, utilisation and storage provides a means to preserve existing assets, provide dispatchable electricity, help maintain grid stability and offer energy storage in the form of coal.

Figure 8. Types of repurposing approaches for coal-to-clean energy transition.

1. **Retiring plant and repurposing the site for renewable energy generation.** Coal plants that are reaching the end of their technical lifetimes can be retired and their sites repurposed for renewable energy generation. This would allow new plants to benefit from the existing transmission infrastructure in place, including the substation and evacuation lines. Solar PV, solar thermal, and biogas projects can be built on existing coal plant sites, parts of which may have little alternative usage.

2. **Modifying plant for flexibility provision.** This is when a baseload plant's operations are reduced to focus exclusively on system balance through the provision of flexibility services. This means that an unabated coal plant produces less or null electricity (and therefore less emissions) over a certain period but remains available at times when the system's needs are highest. This contributes to the reliability of power systems and enables them to ramp up and down to meet flexibility needs that is also essential to support additional renewables to come online elsewhere on the grid. Modifying plants for flexibility may require minor equipment upgrades, changes to market design and plant operations, and adjusting control systems. This option is also likely to result in lower revenues due to reduced operations which might have socioeconomic impacts on the number of direct jobs it supports, as well as the plant's contribution to tax, and in turn, economic benefits to the community.

3. **Retrofitting plant to co-fire with alternative fuels.** Retrofitting coal plants to co-fire with alternative fuels such as ammonia or biomass is an option to reduce emissions while preserving existing assets, helping avoid the risk of becoming stranded. It offers valuable system benefits and can help maintain grid stability.

   Co-firing with biomass is a mature technology that is used on a commercial scale. High blending rates can be achieved, with biomass accounting for more than 50% of the mix in some cases. This is mainly dependent on pricing and the availability of sustainable biomass supply.[105]

   In comparison, co-firing with ammonia is at a much earlier stage of development. Recent advancements have made it a potential alternative secondary fuel. Blending rates are currently feasible at 20%, and further testing is being done to increase this to 50%.[106] However, net emissions reductions can only be achieved if the ammonia used comes from low-emissions production methods, such as blue or green ammonia. The current viability of producing blue or green ammonia is low and is expected to face production challenges for the coming years, limiting the possible environmental advantages associated with its use and risking fuel lock in due to insufficient testing.[107] The production process of ammonia can also release harmful and damaging gases such as nitrogen oxide. The impact of ammonia production on the surrounding community is a significant concern. This is because the extraction of required raw materials can disrupt local ecosystems and there are health and safety concerns regarding the storage of ammonia due to the potential of leakages.[108]

   Retrofitting involves the modification and potential replacement of burners and additional infrastructure may also be needed to support the storage of ammonia. It is also important to account for the potential costs of this option, given the capital investment that may be required and the higher fuel cost of ammonia, relative to coal.[109]

4. **Retiring plant without decommissioning.** This is when the plant remains structurally intact but will no longer generate power and there are no announced plans to decommission the site and redevelop it for alternative use. The reason so many coal plants remain structurally intact post-retirement relates to the costs associated with cleaning up accumulated toxic coal ash and waste. Due to the costs of decommissioning and the lack of regulation, remediation and redevelopment are either non-existent or uncertain for many coal plants.[110]

5. **Retiring plant and converting to synchronous condensers.** As older CFPPs are retired, their induction generators can be used even after their furnaces and turbines are scrapped. This is due to the need to stabilise grids deprived of big power plants. As such, synchronous condensers (huge, free-spinning generators synchronised to a grid's AC frequency) are becoming an increasingly popular option to improve stability and maintain voltages within desired limits under changing load conditions and contingency situations.[111]

6. **Retiring plant and repurposing site for other commercial activity.** Aside from the locational benefits associated with fuel switches and remote transmission, coal plants are often located in areas that can also benefit other commercial activities. With access to railroad, waterways, ports, highways, utility grids, and an existing industrial workforce, commercial development in replacement of the plant can be an attractive option for developers. However, coal plant remediation efforts are costly and lengthy and commercial developers are usually cautious about accepting the risk associated with clean-up.[112]

7. **Retrofitting plant with carbon capture:** Retrofitting coal plants with carbon capture,

utilisation and storage (CCUS) provides a means to preserve existing assets, provide dispatchable electricity, help maintain grid stability and offer energy storage in the form of coal.

However, it is important to account for the significant challenges with CCUS when considering the suitability of this retrofit option given the high capital investment requirements and technical uncertainty and complexity that affects its commercial viability and ability to scale.[113] In addition, while CCUS may offer emissions reduction solutions in the short term, it allows for a continued use of coal that diverts the attention away from addressing the necessary shift towards renewable energy in order to meet long-term climate goals.

In some cases, as with other repurposing options, retrofitting newer plants with CCUS may also be a reasonable option to avoid the plant's closure and full write - off, and keep plants close to active coal mines in operation, maintain mining jobs and support mining communities. Supercritical and ultra - supercritical power plants are better candidates for CCUS retrofits because they will have higher efficiencies and therefore lower marginal costs.

4.3. Approach to developing the Prioritisation Framework

The approach to developing the Prioritisation Framework involves consideration of (1) the objectives related to prioritising plants for repurposing or retirement, and (2) the regional and plant-level factors that are most relevant to inform the prioritisation process.

4.3.1. Determining the objectives of the Prioritisation Framework

There are a variety of ways in which the Prioritisation Framework can be conceptualised depending on the energy transition status of a region and what this would mean for the end of life of CFPPs. Two options for the Prioritisation Framework are available for selection depending on the region's energy transition goals:

1. Where the framework is designed to prioritise CFPPs exclusively for retirement and the plants are shortlisted for decommissioning.
2. Where the framework is designed to prioritise CFPPs for both repurposing or retirement, with an indication of what type of repurposing they may be most suitable for, accounting for short-term and long-term timeframes where relevant.

Recent global discourse has focussed on different repurposing and retirement options for CFPPs rather than exclusively on early retirement, driven by the recognition that coal cannot be phased out immediately. Instead, gradual measures need to be taken to support the energy system to transition away from coal and reduce the risk of stranded assets. The choice of the framework used to analyse CFPPs will ultimately depend on the region's priorities and objectives for energy transition and the characteristics of its coal fleet.

4.3.2. Repurposing assumptions under the Prioritisation Framework

As a starting point, the Prioritisation Framework focuses on the following three options for repurposing, covering both plant repurposing and early plant retirement with site repurposing:

1. **Replacing the plant with renewable energy generation through early retirement and site repurposing.**
2. **Modifying the plant for flexibility provision.**
3. **Retrofitting the plant to co-fire with alternative fuels.**

These three options will be referred to throughout the report as 'replace', 'modify' and 'retrofit' respectively. The options have been selected as they are widely recognised in the literature and align with the approaches identified in the International Energy Agency's (IEA) Coal in Net Zero Transitions report. Additional repurposing options can be integrated into the framework based on technologies suited to the local context.

It should be noted that the Prioritisation Framework relies on certain assumptions to indicate appropriate repurposing options for plants. Further plant-level assessments are necessary to validate the economic and technical feasibility of the repurposing option selected by the framework. The suitability of repurposing options depends on several factors including land size or location constraints, transmission constraints, grid stability, access to infrastructure, renewable energy potential of the location, plant age, environmental and social risks including impacts on workers and communities, financial impact and the availability of financing, company priorities and the interests of policymakers.[114] Ultimately, it is important to ensure that the operating life of the coal plant is not extended by the selected repurposing option in order to preserve a climate-aligned emissions pathway. For simplicity, the following assumptions in Table 2 have been made for the repurposing options considered in the Prioritisation Framework, based on a review of international best practices.

Table 2. Repurposing options and corresponding assumptions.

	Replacement with renewable energy	Modifying for flexibility	Retrofitting to co-fire with alternative fuels
[1]Suitable CFPP age range[115]	Over 30 years old	10-30 years old	0-10 years old
Implementation timelines	Long-term for full replacement with renewable energy	Short-term to modify with potential retrofitting	Medium-term to complete retrofitting
Cost of repurposing (excluding generation cost)	High: Demolition, clean up, outstanding working capital debt and workforce pay out	Low: Limited additional costs[2]	Moderate: Retrofitting, additional infrastructure to support alternative fuels, and workforce retraining
Workforce retraining	Significant re-training required; long timeline for replacement means workers may be deployed elsewhere	No change in skillset, limited impact on number of workers	High transferability of skills; limited retraining so some workers can stay on
Purpose	Removing CFPP installed capacity, thereby initiating coal exit	Reducing coal's contribution to electricity generated per MWh; thereby enabling coal exit	Reducing coal's contribution to electricity generated per MWh; thereby enabling coal exit
CO_2 emissions impact	High reduction; removal of induced CO_2 emissions	Moderate to high reduction, subject to reduction of CFPP utilisation	Moderate reduction, subject to share of alternative fuels

[1] The CFPP ages are suggested by the World Economic Forum (WEF) as indicators to guide repurposing options based on case studies of different repurposing strategies that have been pursued. The overarching guidance based on best practices suggests that older, inefficient CFPPs approaching their end of life are considered more suitable for replacement with renewable energy, while newer, more efficient CFPPs with active PPAs are more appropriate for retrofitting to co-fire with alternative fuels. The guidance is informed based on a range of considerations such as cost savings, energy supply and economic disruptions, environmental benefits, grid stability and reliability, social acceptance etc. However, repurposing options should be selected on a case-by-case basis, accounting for the local circumstances, company priorities, renewable resource availability, grid stability requirements and reskilling priorities, among other factors.
[2] Modifying for flexibility can have an impact on loan servicing if there are no payment structures (e.g., market-driven subsidies) in place to make up for reduced plant operations to facilitate flexibility.

4.3.3. Identifying the regional and plant-level components of the Prioritisation Framework

The development of the Prioritisation Framework accounts for: (1) the regional context in terms of its degree of readiness to transition to clean energy and (2) the plant's operating conditions and their impact on the environment and the community.

The key questions framing the development of the framework are shown in Figure 9 below.

A

Regional-level:

- Is the region going to be heavily reliant on coal to meet its future energy demand?
- Will the region be able to ensure a secure supply of clean energy (via regional interconnections, PPAs, state-level power generation etc.) in the future while phasing out coal?
- Is the market regulation and decarbonisation policy conducive to phasing out coal?
- How important is coal and coal-fired generation to the region's economy in terms of national GDP, workforce employed and potential of job creation?

B

Plant-level:

- How could the repurposing of a CFPP affect a grid's security of supply?
- How costly is it to operate CFPPs?
- How damaging is the CFPP in terms of its contribution to emissions, air pollution and water stress?
- How does the CFPP's operations affect workers' quality of life and what impact does it have on the local economy?

Figure 9. Regional and plant-level considerations of the Prioritisation Framework.

4.3.4. Prioritisation Framework scoring approach

To ensure that both regional and plant-level considerations are captured in the Prioritisation Framework, a set of four scores were developed to help frame the interconnections between the energy system, policy, economic and social dimensions of the coal transition:

- **Security Score —** Indicates how important a plant is to maintain the power system security of supply in the future, either in the short or long-term to reflect the different nature of the energy system and its ability to handle disruptions over time. The years 2030 and 2050 have been chosen as reference points for short and long-term timeframes and can be adjusted based on the local context. As such, there are two Security Scores that can be generated by the Prioritisation Framework:

  - **Security Score (2030) —** Renewable energy development and investments in grid integration are expected to be limited in the short-term. Under this scenario, CFPPs that play a significant role in the power generation mix should not be prioritised for retirement or repurposing. The 2030 score should be used to inform candidate plants that a region can reasonably retire or repurpose in the short-term, so that the prioritised plants are those that will have minimal disruptions to the grid.
  - **Security Score (2050) —** The grid is expected to be more robust in the long-term, with increased renewable energy penetration and an enhanced energy system that can integrate renewable generation with minimal disruptions. Under this scenario, CFPPs that play a significant role in the power generation mix can be prioritised for retirement or repurposing. The 2050 score should be used to inform the CFPPs suitable for retirement or repurposing in the long-term once necessary investments to the grid have been made, so that large and highly utilised CFPPs can be removed with limited disruptions to energy supply.

  The Security Score (2030) should be used by regions intending to begin the retirement or repurposing of CFPPs in the short-term. However, if the region has already made sufficient upgrades to the grid to accommodate the reduced role of coal, the Security Score (2050) can be used. This score should also be used if the selected region intends to begin the retirement or repurposing process of CFPPs in the long-term.

- **Cost Score —** Indicates how costly it is to continue operating the CFPP. The more costly it is, the greater the likelihood that the owner might be willing to explore retirement or repurposing options.
- **Environment Score —** Indicates how damaging the plant is in terms of its contribution to emissions, air pollution and water stress. The greater damage it causes to the environment, the higher the priority it should be to retire or repurpose the plant.
- **Socioeconomic Score —** Indicates the quality of life of those directly affected by the CFPP's continued operations in terms of their exposure to safety risks as well as impact on the local economy. Plants with high safety risks and low economic impact should be prioritised for retirement or repurposing.

4.4. Framework overview and scoring methodology

The framework is designed to prioritise CFPPs that:

- will have the least impact on the security of supply;
- are the costliest to operate;
- are most environmentally damaging; and
- present the greatest risk to workers and have least economic impact.

Based on this, and as per the findings from the literature review, the following criteria were chosen for the respective scoring categories.

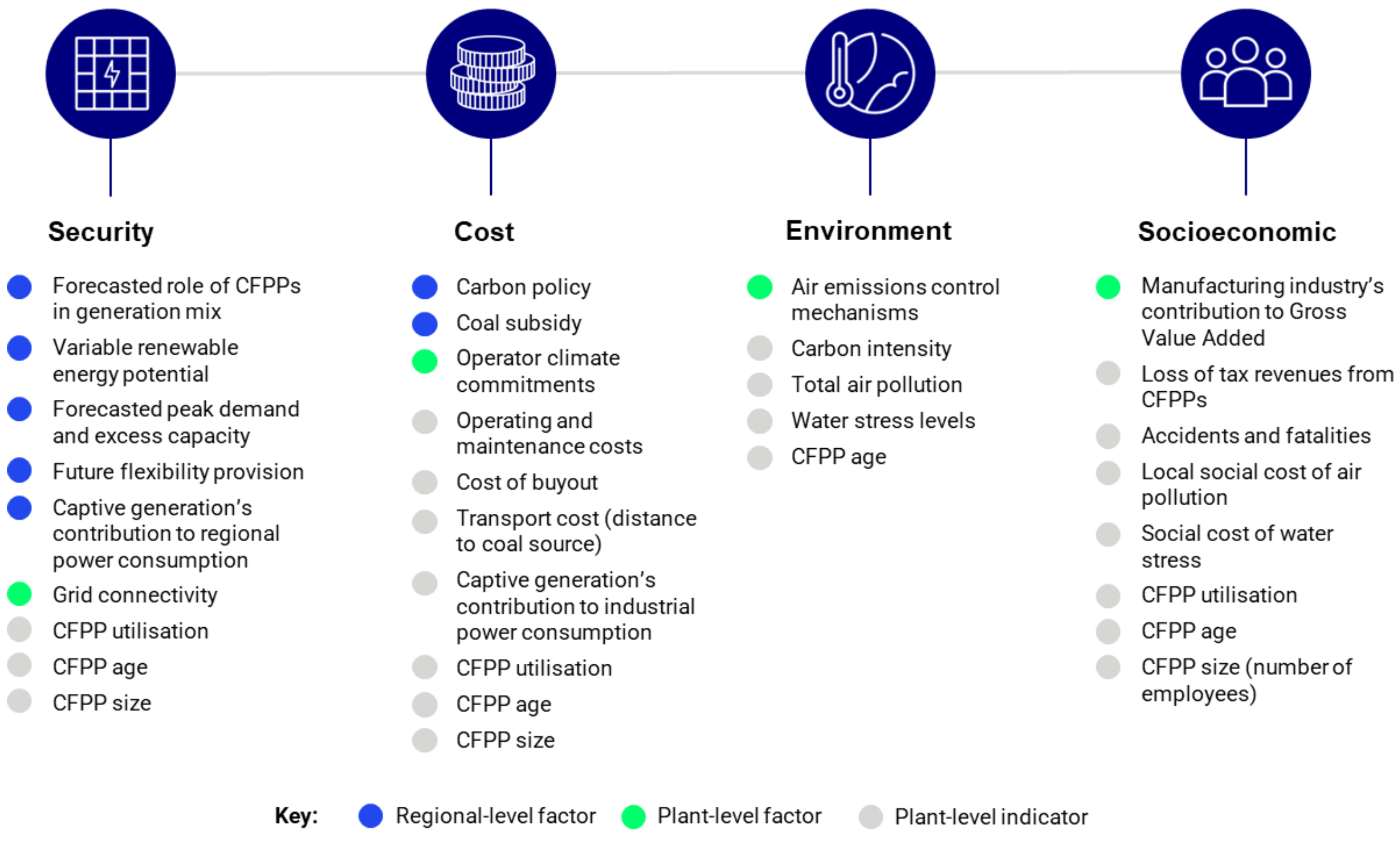


Figure 10. Overview of the Prioritisation Framework criteria.

It should be noted that all four scoring dimensions — security, cost, environment and socioeconomic — each contribute significantly to the process of prioritising coal plants for early retirement or repurposing. However, the dimensions do not necessarily have to be equally weighted and can be adjusted to reflect stakeholder priorities. In addition, it is also possible to apply a stage gate approach whereby one dimension is used to screen plants initially, after which the remaining dimensions play a smaller role in influencing the final prioritisation results. This method can be used where one dimension is deemed more critical to a stakeholder group during the initial screening process. As such, the Prioritisation Framework provides a flexible approach to reflect stakeholder priorities and considerations.

The Prioritisation Framework is composed of regional and plant-level factors, and plant-level indicators. The difference between a factor and an indicator is that the former is not scored directly, and instead provides the policy context or plant-level status against which the indicator is scored. On the other hand, an indicator is assigned a score either independent to the factor, or in the context of the factor. For example, the indicator 'CFPP utilisation' is typically assigned a score based on factors such as 'Forecasted role of CFPPs in generation mix', while the indicator 'Accidents and fatalities' is scored independent to any factor.

Plant-level indicators are scored based on pre-defined rules and thresholds. Selected indicators have scoring rules for different scenarios which are informed by regional and plant-level factors. These plant-level indicators are then scored based on an assessment of the factors.

The **regional-level factors** highlighted in blue in Figure 10 are detailed in the next column. Where energy forecasts are required, 2030 and 2050 data should be used for the respective short-term and long-term scenarios. Where this is unavailable, the closest available year of data should be used.

In addition, depending on the local context, stakeholder preferences, and the objectives of a prioritisation exercise, different power generation forecast scenarios for the factors stated below can be used as inputs to the framework. By building varying degrees of climate ambition into the results, a more robust comparison of suitable CFPPs for retirement or repurposing is possible. This will allow stakeholders to assess key differences in the types of CFPPs prioritised under different energy futures and select options for retirement or repurposing based on scenarios more in line with their expectations.

- **Forecasted role of CFPPs in the generation mix**: The forecasted share of CFPPs within the generation mix.
- **Variable renewable energy potential:** The forecasted share of solar and wind power within the generation mix.
- **Forecasted peak demand and excess capacity:** The forecasted excess of installed capacity compared to peak demand.
- **Future flexibility provision:** The future role of CFPPs in the supply of ancillary services such as frequency regulation, short and long-term operational reserves.
- **Captive generation's contribution to regional power consumption:** The present contribution of power generation from captive plants towards power consumption in the region.
- **Carbon policy:** Whether there is an incoming carbon policy that could impact the cost of operating CFPPs.
- **Coal subsidies:** Whether CFPP operators benefit from any form of subsidisation.
- **Manufacturing industry's contribution to the economy:** The economic importance of the local manufacturing industry, as measured by its contribution to gross value added.

The **plant-level factors** highlighted in green in Figure 10 cover:

- **Grid connectivity:** Whether the plant provides power to the main grid or is off-grid.

- **Operator climate commitments:** Whether the CFPP operator has made a climate commitment of carbon neutrality or Net Zero.
- **Air emissions control mechanisms**: Whether the CFPP has air pollution control devices or post-combustion co-benefit mechanisms to treat contaminants, e.g., SO_2, NOx, PM, and heavy metals emitted from the plants.

Plant unit-level indicators highlighted in grey in Figure 10 cover:

- **Age:** Number of years since the unit was commissioned.
- **Size:** Corresponds to the nameplate installed capacity.
- **Utilisation:** The average energy generated in a year compared to the maximum energy that could be generated in the same period at maximum capacity.
- **Operating and maintenance costs:** Fixed and variable costs associated with the operation and maintenance of the plant.
- **Cost of buyout**: The total cost for a third party to buy out the plant in the case of early retirement.
- **Transportation cost (distance to coal source):** The total distance from the plant unit to the source of coal e.g., port or coal mine; this can be used to proxy the transportation costs borne by the plant.
- **Captive generation's contribution to industrial power consumption:** The percentage of an industrial business's power consumption that is sourced from energy generated by their captive units.
- **Carbon intensity**: This is the volume of carbon emissions measured in tCO_2eq/MWh.
- **Water stress levels**: The ratio of fresh water demanded over its supply in the region where the plant is located; this helps capture the water impact per plant.
- **Total air pollution:** The contribution of the plant to air pollution is estimated by using the metric total social cost of air pollution. This captures the social cost of air pollution without accounting for territorial restrictions (i.e., it is not adjusted for local impact within national borders).
- **Accidents and fatalities:** Refers to the lost lives or injuries faced by workers and the public over a selected period as a result of the plant's operations.
- **Social cost of water stress:** The cost of socioeconomic losses stemming from water stress as a result of the operation of CFPPs.
- **Loss of tax revenues from CFPPs:** The expected loss of tax revenues stemming from the operation of CFPPs if they were to be retired or repurposed.
- **Local social cost of air pollution:** This considers only in-country impacts of air pollution as a result of the plant's operations.
- **Number of workers employed:** The total number of direct workers employed. The plant size could be used to proxy this in case of data unavailability.

It should be noted that the role of the Prioritisation Framework is to identify plants suitable for retirement or repurposing based on their characteristics at a moment in time and therefore relies on the latest data available at the time of analysis. The Prioritisation Framework can therefore be updated to reflect any significant changes in power generation planning or plant-level data availability over time to generate an up-to-date version of the plants prioritised for retirement or repurposing. Further information regarding the assumptions used to determine the scoring of each factor and indicator, as well as their interlinkages, are provided in the Technical Appendix 2.

Box 3 below provides a sample illustration of how regional-level factors influence the scoring of plant-level indicators.

BOX 3. Regional-level factor application example under the Security Score.

Plant-level indicator: Utilisation

Utilisation is selected as a plant-level indicator under the Security Score as it relates to the amount of the plant's current capacity that is being used to contribute to a region's energy security. Under the security dimension, five regional-level factors are applied to the utilisation plant-level indicator, based on if the CFPP is non-captive or captive. If a CFPP is non-captive, the following four regional-level factors are applied: 1) the forecasted role of CFPPs in the region's generation mix, 2) the level of variable renewable energy potential, 3) the expected amount of peak demand and excess capacity in the system, and 4) the type of technologies used as flexibility suppliers in the energy system. If a CFPP is captive, then only one regional-level factor is applied: 5) the contribution of captive power generation to regional power consumption.

1. **Regional-level factor: Forecasted role of CFPPs in generation mix**

Scoring rationale

Forecasted role of CFPPs in the generation mix

CFPP utilisation

The importance of coal as an energy source in the future will inform the plant's score depending on its utilisation. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment shows a low level of coal in the forecasted generation mix.

CFPPs are a small % of the future generation mix — **CFPPs are a large % of the future generation mix**

Non-captive plants with high utilisation are prioritised — *Non-captive plants with low utilisation are prioritised*

2. **Regional-level factor: Variable renewable energy potential**

Scoring rationale

Variable renewable energy potential

CFPP utilisation

The expected contribution of variable renewable energy in the region's future generation mix can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment notes a high development of variable renewable energy. This suggests that there will be sufficient alternative capacity built in time to cope with the forecasted demand.

Variable RE is a small % of the future generation mix — **Variable RE is a large % of the future generation mix**

Non-captive plants with low utilisation are prioritised — *Non-captive plants with high utilisation are prioritised*

3. Regional-level factor: Forecasted peak demand and excess capacity

Scoring rationale

Forecasted peak demand and excess capacity → CFPP utilisation

The expected amount of future excess capacity in the energy system can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised unless the regional-level assessment concludes a high level of future excess capacity compared to the forecasted peak demand. A low level of future excess capacity may suggest that there will not be a sufficient availability of reserves.

Low excess capacity ↔ **High excess capacity**

Non-captive plants with low utilisation are prioritised — *Non-captive plants with high utilisation are prioritised*

4. Regional-level factor: Future flexibility provision

Scoring rationale

Future flexibility provision → CFPP utilisation

The role of different technology types in flexibility provision can be used to determine whether highly utilised CFPPs can be phased down with minimum disruptions to the energy system. Non-captive plants with high utilisation should not be prioritised if the CFPPs are forecasted as the exclusive or main supplier of flexibility to the system.

Coal plays a small role in flexibility provision ↔ **Coal plays a large role in flexibility provision**

Non-captive plants with high utilisation are prioritised — *Non-captive plants with low utilisation are prioritised*

5. Regional-level factor: Captive generation's contribution to regional power consumption

Scoring rationale

Captive generation's contribution to regional power consumption → CFPP utilisation

If captive generation has a low contribution to regional power consumption, then all captive plants should be prioritised as their removal will not have significant impact on the security of supply. If captive generation has a high contribution to regional power consumption, then all captive plants should not be prioritised as they will be critical to security of supply.

Captive generation makes a limited contribution to regional power consumption ↔ **Captive generation makes a significant contribution to regional power consumption**

All captive plants are prioritised — *All captive plants are not prioritised*

4.4.1. Building blocks of the Prioritisation Framework

As described in the previous section, the Prioritisation Framework integrates both regional-level and plant-level factors to inform how CFPPs are ranked for early retirement or repurposing.

Figure 11 on the next page provides an overview of the four steps involved in scoring CFPPs through the Prioritisation Framework.

The Prioritisation Framework is structured as follows:

- **Step 1:** Each plant-level indicator under the security, cost, environment and socioeconomic dimension is assigned a value between 0-1 based on pre-defined rules and thresholds. The scoring thresholds are largely developed based on the fleet characteristics of the region being assessed (in this case, Odisha) and can be adjusted to different geographies to account for their local context. However, certain scoring thresholds, for example CFPP utilisation or carbon intensity indicators, would remain consistent across geographies as these are determined based on non-context-specific circumstances that are applicable regardless of the specific location. Selected indicators are scored based on an assessment of regional-level and plant-level factors, which have different scoring rules across scenarios. A normalised score is then calculated as an average of the indicator scores for each dimension.

  The indicators within this step have been selected to inform how suitable a unit is for early retirement or repurposing.

- **Step 2:** This step adds an assessment of repurposing options to the analysis. If only retirement is considered for CFPPs, then this step can be omitted. Units are screened in terms of the type of repurposing that may be most feasible given unit-level characteristics. The repurposing adjustment considers either plant repurposing or plant retirement with site repurposing. Again, each indicator is assigned a value from 0-1 based on pre-defined thresholds and scored based on the size and/or age of the plant and the dimension being assessed (security, cost, environment or socioeconomic). A repurposing adjustment is calculated as an average of the indicator scores for each dimension.

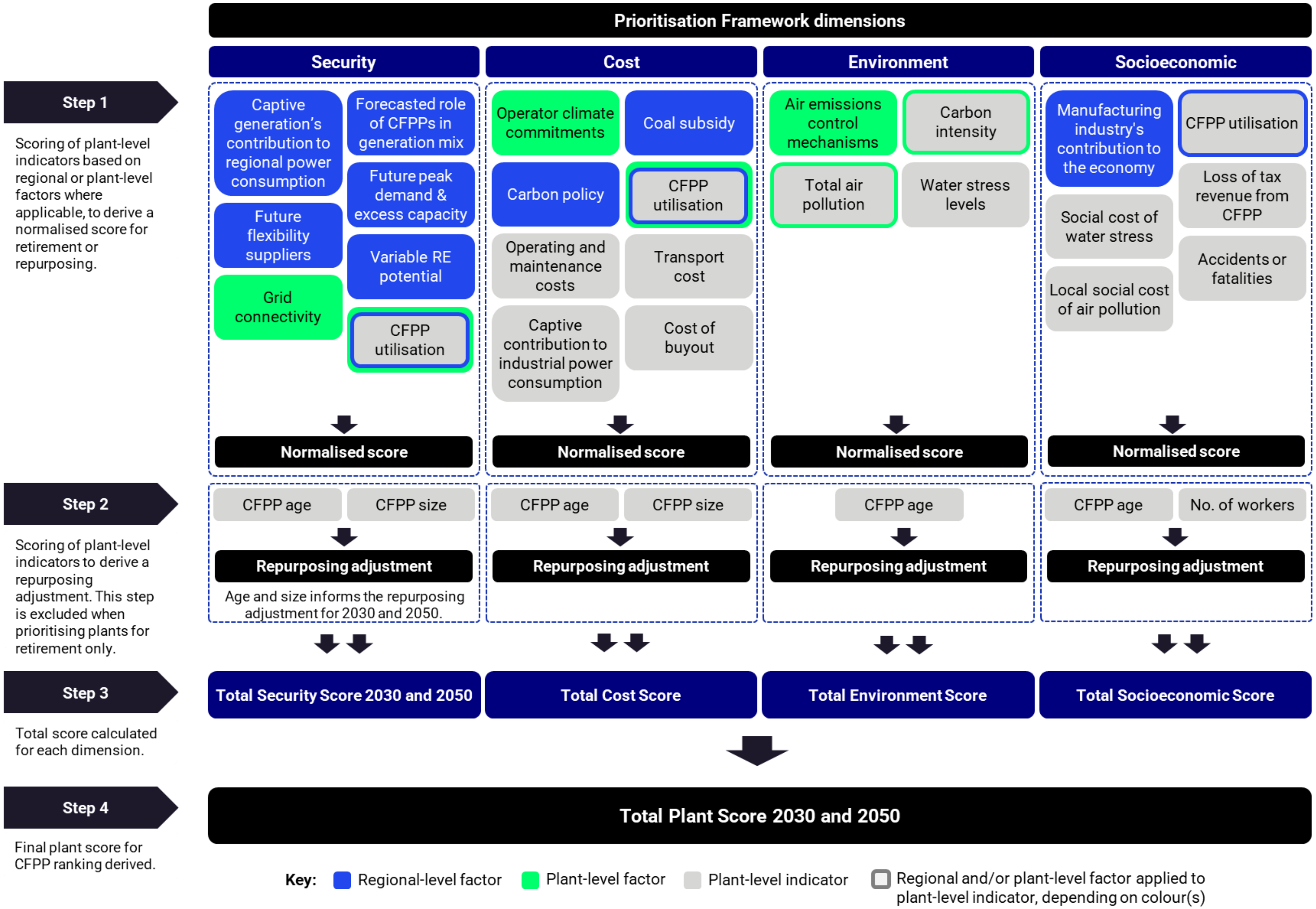
  It is important to note that the scoring of repurposing options requires further study to determine how additional plant-level characteristics can be evaluated in the framework to inform a suitable repurposing approach.

- **Step 3:** A total score is calculated for each dimension, taken as the average of the normalised score and repurposing adjustment. If the framework is used only to assess early retirement, then this step can be skipped, and the normalised score can be taken as the total score for each dimension.

- **Step 4:** The average of the total Security, Cost, Environment and Socioeconomic scores are taken to derive the Total Plant Score which is used to inform the final ranking of the CFPPs. While all four dimensions will be weighted equally in the default scenario, it is possible to adjust the weightings to develop different CFPP ranking lists to reflect the importance attached to each dimension by stakeholders.

In summary, if the Prioritisation Framework is being used to assess the suitability of CFPPs for early retirement, then only steps 1 and 4 should be followed. If the framework is being used to assess CFPPs for early retirement or repurposing, then steps 1 to 4 should be followed.

Each building block under the Prioritisation Framework is described in more detail in Technical Appendix 2 accompanying this report, alongside the scoring rules for each plant-level indicator under the four dimensions.



Note: The years 2030 and 2050 have been selected as reference points to reflect short-term and long-term timeframes and can be adjusted based on the local context.

Figure 11. Detailed building blocks of the Prioritisation Framework.

4.4.2. Limitations of the Prioritisation Framework

While the Prioritisation Framework offers several benefits to policymakers and key energy sector stakeholders in terms of providing a practical and transparent reference point to plan energy transition initiatives and serving as a tool to determine the scale of renewable energy deployment necessary to support coal asset retirement or repurposing, there are key limitations which should be taken note of when being used to inform transition planning. As such, its use should be accompanied by the considerations noted below.

Firstly, the framework does not consider the practical aspects of retiring or repurposing CFPPs, as this is outside its intended scope. For example, the framework does not include any financial assessment of CFPPs or consideration of specific power purchase agreements (PPAs). Therefore, further analysis needs to be undertaken alongside the prioritisation exercise to determine the feasibility of early retirement or repurposing. While the framework includes a policy element, it does not provide a comprehensive assessment of a region's policy and regulatory environment, and a separate analysis is needed to evaluate whether this is conducive to coal phase-out.

Secondly, while the framework indicates potential repurposing options based on the CFPP's age, further consideration of various other factors including land size or location constraints, transmission constraints, grid stability, access to infrastructure, and renewable energy potential of the location is required to identify the most suitable option for each CFPP. While an assessment of these factors is beyond the scope of the framework and requires further analysis, it is important to recognise that this is a key limitation, and the results must be taken as a high-level indication of the types of repurposing options that should be further explored through a detailed assessment.

Thirdly, the accuracy of the Prioritisation Framework's results is dependent on granular, latest available plant-level data and regional-level energy forecasts at the time of analysis, which may not be readily available or easily accessible. Although proxy data and assumptions can be used to fill data gaps, this may limit the accuracy and usefulness of the results.

Finally, it should be noted that the framework's results are not intended to be a definitive list of CFPPs that should be repurposed or retired, nor is it a roadmap for coal phase-out. Instead, it serves as a starting point for further discussions with government and key stakeholders on testing the feasibility of plants as candidates for early retirement or repurposing.

The next section presents a case study of the Prioritisation Framework applied in the context of Odisha, India.

5. Case study — Applying the Prioritisation Framework to Odisha's CFPP fleet

5.1. Context

Odisha has many active captive and non-captive thermal plants with the economy and society at large being heavily dependent on coal. With the vast abundance of cheap coal from local coalfields, the state also houses carbon-intensive industries such as steel, cement, fertiliser, and bauxite. Many captive plants are used to power these industries, and account for around 50% of Odisha's installed capacity of thermal plants. At the same time, Odisha has developed plans, policies and incentives for accelerating renewables and is keen to develop just energy transition policies to create jobs, support livelihoods, and reduce the impact of transition on communities and workforce, thus contributing to the country's national determined contribution (NDC) targets.

For instance, Odisha's Renewable Energy Policy (2022-2030) aims to increase the installed capacity of renewable energy in the overall energy mix to 43% by 2030 compared to approximately 15% in 2023.[116] Plans to accelerate renewables integration are critical given the inefficiencies of coal-based power generation, and the high operating costs borne by plant owners, distribution companies and the government. As such, a Prioritisation Framework for the retirement and/or repurposing of CFPPs in Odisha provides a valuable starting point to accelerate the deployment of clean technologies, improve energy system efficiencies, and reduce costs.

This section demonstrates how the Prioritisation Framework is applied to the CFPP fleet in Odisha, accounting for the state's energy system as well as plant-specific characteristics. The Prioritisation Framework for repurposing or retirement has been selected for Odisha's CFPP fleet rather than solely the framework for retirement, in order to account for the local context. As a coal transition policy has not yet been developed in the state, exploring repurposing and retirement options for CFPPs is more relevant and useful for transition planning and complementary to the state's current progress on renewable energy project development. A full list of data sources and assumptions used for this case study can be found in Appendix 1.

Table 3. Non-captive and captive plant characteristics.

Plant characteristics	Captive	Non-captive
Average plant unit size (MW)	79.9	486.8
Average plant size (MW)	213.3	1,578.6
Average age	15	13
Average utilisation (%)	55%	63%
Average cost of buyout ($ millions)	60.8	142.0
Average carbon intensity (tCO_2/MWh)	0.96	0.95
Average social cost of water stress ($/MWh)	2.76	2.84

Source: Author's calculations based on data from NITI Aayog and modelling by TransitionZero.

5.2. Overview of Odisha's CFPP fleet

Data on Odisha's CFPP fleet has been compiled based on publicly available data and modelling provided by TransitionZero. As a result, the following characterisation of the fleet is likely to have some differences from the actual fleet.

According to NITI Aayog's energy dashboard, the total installed capacity of the CFPP fleet in Odisha as of 2020 is 21,726 MW, of which 49% (10,725 MW) are privately-owned captive plants and 51% (11,000 MW) are non-captive plants operated by state-owned power generation utilities (55%) and independent power producers (IPPs) (45%).[117] Based on publicly available data, 19,954 MW of CFPPs from the total fleet has been identified, which does not exactly account for the state's reported total capacity value. The average plant unit size of the total fleet is 130 MW, while the average plant size is 379 MW; the average age (calculated as of 2022) is 15, and the average utilisation is 57%.

Analysis has been provided for both the captive and non-captive portions of the coal fleet to highlight the differences in characteristics, as outlined in Table 3. This distinction is important as each plant type serves a different purpose – with captive plants principally supplying energy to businesses, and non-captive plants providing energy to the grid. In terms of plant size, the average non-captive unit and plant are significantly larger than captive CFPPs. Non-captive plants also have slightly higher utilisation rates, water usage and significantly greater costs of buyout.

The distribution of captive and non-captive units by age, size and utilisation are illustrated in Figures 12, 13 and 14.

- **Plant age:** The majority of the units across the fleet analysed for this study are captive plants between 6-15 years old. Most non-captive plants are also between 6-15 years old, although it is interesting to note that across the dataset, most of the young plants (< 5 years) and most of the older plants (> 16 years) are also non-captive plants.

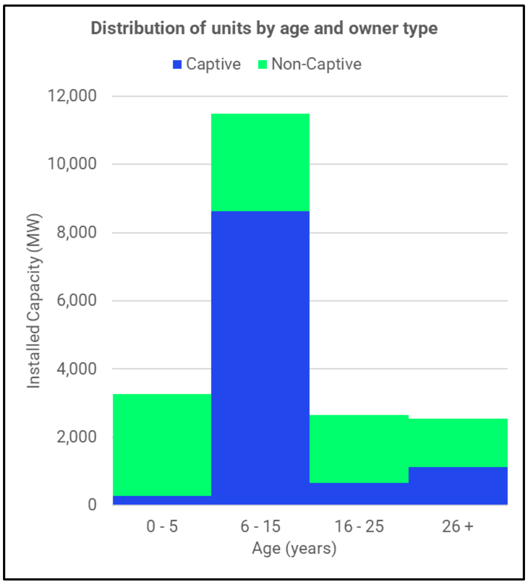


Figure 12. Unit-level characteristics by age.

- **Installed capacity:** It is evident that captive units are smaller compared to non-captive units as they almost entirely make up the units sized less than or equal to 200 MW. The majority of the larger sized units (greater than 200 MW) are comprised of non-captive units.

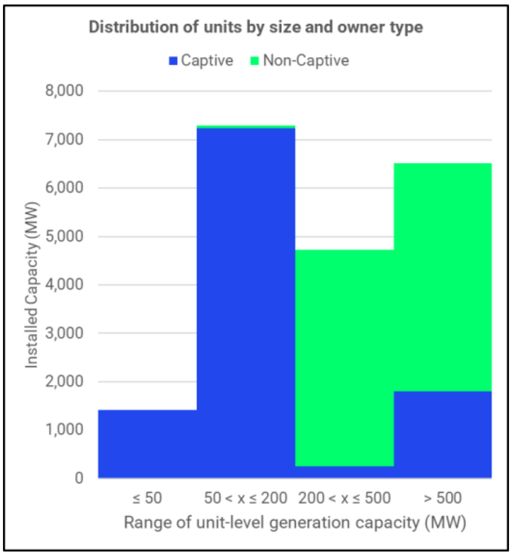


Figure 13. Unit-level characteristics by size.

- **Utilisation rates:** In terms of utilisation rates, most units, both captive and non-captive, are between 21% to 80%. Very few units have a utilisation rate of less than or equal to 20%, and this predominantly comprises of non-captive plants. Approximately 3,200 MW of installed capacity (16%) have utilisation rates exceeding 80%, of which 62% of this installed capacity is comprised of non-captive units, which is clear evidence demonstrating the high reliance of the coal power within Odisha's energy system.

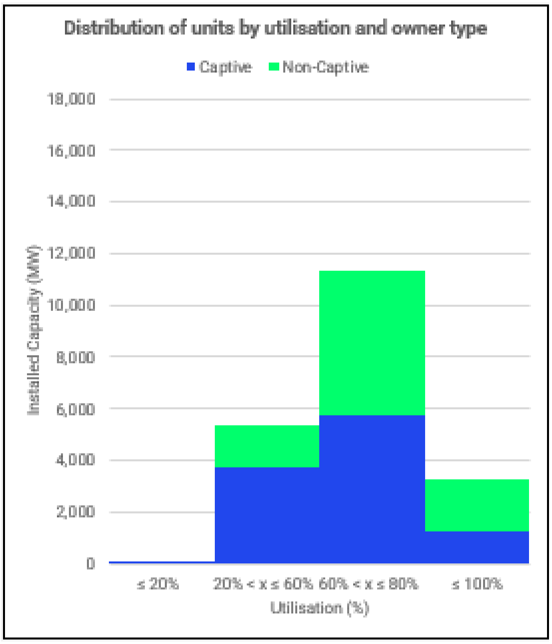


Figure 14. Unit-level characteristics by utilisation.

The regional distribution of CFPP units that are captive and non-captive are illustrated in Figure 15. The districts of Angul, Jharsuguda, Sundargarh, Dhenkanal and Sambalpur have the largest amount of installed capacity, while the lowest amounts of installed capacity are located in Baleswar, Ganjam, Bargarh, Kalahandi and Koraput.

It is also interesting to note that the units are concentrated together, particularly in the eastern part of Odisha rather than evenly dispersed across the state which may reflect the geographic distribution of manufacturing industries in Odisha since most of the units are captive. Non-captive plants are primarily located near the big cities of Odisha as expected given that the demand for power would be the greatest in such areas.

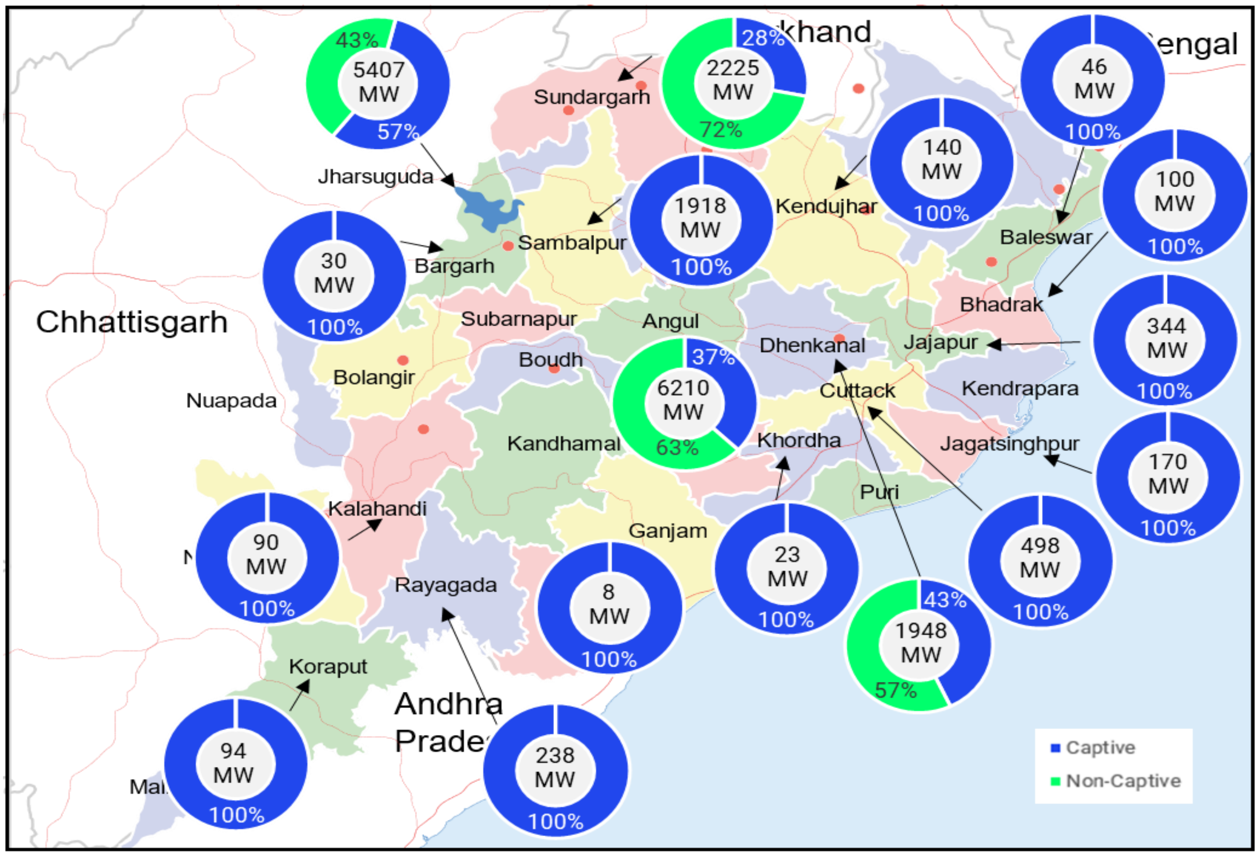


Figure 15. Location of units by owner type.

5.3. Assessment of Odisha's energy system characteristics against the Prioritisation Framework

At the energy system level, the Prioritisation Framework considers the forecasted power generation mix including the role of variable renewable energy, installed capacity and peak demand, and the role of flexibility provision to determine how important coal is to the future energy security of the state, and the extent to which captive power generation contributes to regional power consumption. These factors are used to inform the 'Security Score' of CFPPs based on their utilisation rates. This is illustrated in Box 4 below.

BOX 4. Assessment of regional-level energy system characteristics in Odisha against the Prioritisation Framework.

This box illustrates how regional-level factors are applied to Odisha's local context, and the implications for how non-captive and captive CFPPs are scored in the Prioritisation Framework.

Plant-level Indicator: CFPP utilisation

1. **Regional-level factor: Forecasted role of CFPPs in generation mix**

Scoring application

Forecasted role of CFPPs in the generation mix

CFPP utilisation

Coal is a significant contributor to Odisha's power generation, responsible for 91.6% of the state's energy mix in 2020. 2023 data indicates that coal is expected to decrease to 66% of Odisha's power generation mix, with renewables starting to play a greater role. While national targets see the role of coal decrease from 74% in 2020 to 53.9% by 2030, it is unclear the extent to which the Odisha government is willing and able to reduce its coal dependence. As long-term forecasts for the state are unavailable, the national forecast for 2030 is assumed, and it is expected that CFPPs will continue to play an important role in Odisha's future generation mix.

*As coal is expected to continue to play an important role in the power generation mix, **non-captive plants with low utilisation rates should be prioritised** to minimise disruptions to the grid.*

CFPPs are a small % of the future generation mix

Non-captive plants with high utilisation are prioritised

CFPPs are a large % of the future generation mix

Non-captive plants with low utilisation are prioritised

2. **Regional-level factor: Variable renewable energy potential**

Scoring application

Variable renewable energy potential

CFPP utilisation

The Odisha government published its recent Renewable Energy Policy in November 2022 which aims to increase the penetration of renewable energy to 43% of the energy mix by 2030. This replaces the previous Renewable Energy Policy issued in 2016 which targeted 2750 MW of renewable energy capacity by 2022, of which less than 25% of the goal had been installed as of March 2022.

*As the renewable energy potential is expected to be significant, **non-captive plants with high utilisation rates can be prioritised** for early retirement or repurposing as there is sufficient alternative energy resources available to support the state's energy security.*

Variable RE is a small % of the future generation mix

Non-captive plants with low utilisation are prioritised

Variable RE is a large % of the future generation mix

Non-captive plants with high utilisation are prioritised

Sources: National Institution for Transforming India (NITI) Aayog, Odisha Electricity Regulatory Commission, Odisha Gazette, Central Electricity Authority 1 2 3, Ministry of Power, India, State Load Dispatch Centre Odisha

3. Regional-level factor: Forecasted peak demand and excess capacity

Scoring application

Forecasted peak demand and excess capacity → CFPP utilisation

Peak demand is expected to grow by 67% in India from 203 GW in 2021 to 340 GW in 2030, while installed capacity is expected to see an increase of 112% in the same period from 386 GW in 2021 to 817 GW in 2030. Excess capacity in 2030 is therefore expected to be high, reaching 58%. It is not clear by how much installed capacity is expected to grow in Odisha, although peak demand projections note an expected growth of 52% from 5 GW in 2020 to 7.7 GW in 2030.

If the future excess capacity of Odisha is expected to follow a similar trajectory as India, then ***non-captive plants with high utilisation rates can be prioritised*** *without impacting energy security.*

Low excess capacity ↔ **High excess capacity**

Non-captive plants with low utilisation are prioritised | *Non-captive plants with high utilisation are prioritised*

4. Regional-level factor: Future flexibility provision

Scoring application

Future flexibility provision → CFPP utilisation

There are limits to the ability of coal plants to provide flexible generation as it is not viable for them to operate in very low loads especially due to the high ash content of Indian coal. As such, a two-shift operation of certain CFPPs are envisaged to support flexibility provision in Odisha, alongside other technologies.

As coal is expected to play a role in flexibility provision along with other technologies, ***non-captive plants with medium utilisation rates are prioritised*** *over plants with high utilisation rates to ensure that sufficient flexibility exists in the future energy system.*

Coal plays a small role in flexibility provision ↔ **Coal and other technologies provide flexibility** ↔ **Coal plays a large role in flexibility provision**

Non-captive plants with high utilisation are prioritised | *Non-captive plants with medium utilisation are prioritised* | *Non-captive plants with low utilisation are prioritised*

5. Regional-level factor: Captive generation's contribution to regional power consumption

Scoring rationale

Captive generation's contribution to regional power consumption → CFPP utilisation

According to Odisha's state load dispatch centre, captive power generation contributes 9.7% to state load share, and therefore has a low contribution to the state's power consumption.

As captive generation's contribution to regional power consumption is low, ***all captive plants regardless of utilisation rates can be prioritised*** *without impacting energy security.*

Captive generation makes a limited contribution to regional power consumption ↔ **Captive generation makes a significant contribution to regional power consumption**

All captive plants are prioritised | *All captive plants are not prioritised*

5.4. Prioritisation of Odisha's CFPP fleet for repurposing

The Prioritisation Framework detailed in the previous section has been implemented via an excel tool to Odisha's coal fleet to prioritise CFPPs for repurposing or retirement. This section details the results obtained for Odisha's fleet as a case study for the framework's application and provides discussion on the trends identified.

The results present the top ranked captive and non-captive power plants by Total Plant Score according to the framework and identifies overall trends for the fleet and its possibilities for repurposing or retirement. Given that India's net zero target is set for 2070, it is assumed that Odisha will begin its efforts to retire or repurpose CFPPs in the long-term. As such, only the results for 2050 are presented in this section.

It should be noted that the data used for this prioritisation exercise is solely based on publicly available data and modelling provided by TransitionZero. Therefore, the results should be viewed as illustrative.

5.4.1. Overview of Total Plant Score results for 2050

The Total Plant Score results for 2050 are presented in this section, distinguished by captive and non-captive plants to account for the different power generation objectives of the plants. The Total Plant Score is derived using an equally weighted average of the security, cost, environment and socioeconomic scores.

Figure 16 illustrates the distribution of captive and non-captive plants by Total Plant Score, age and size, with the top ranked plants under the 2050 scenario identified.

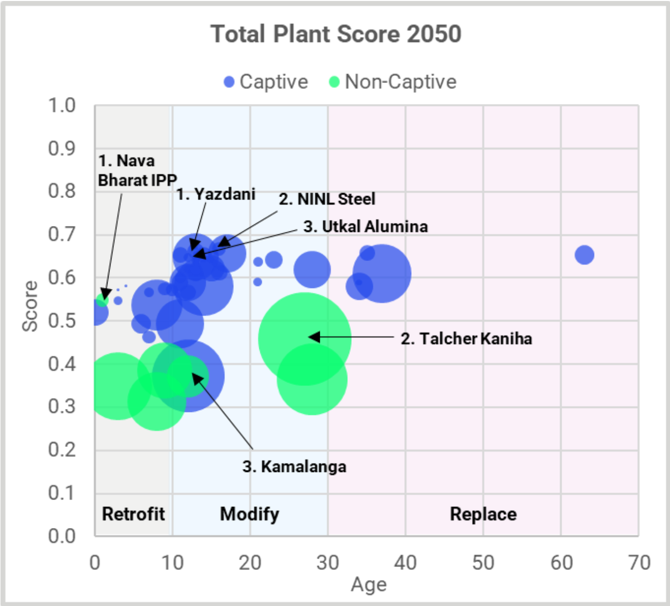


Figure 16. Distribution of plants by Total Plant Score, age and size for 2050.

It can be observed that small, captive plants have the highest scores and are prioritised over larger and non-captive plants. Most CFPPs have modify for flexibility as the proposed repurposing option, reflecting the medium age of Odisha's coal fleet.[3] Older plants can be considered as low-hanging fruits for replacement with renewable energy.

Nava Bharat IPP, Talcher Kaniha and Kamalanga are top ranked across the list of non-captive plants. Given their age, Nava Bharat IPP and Kamalanga are prioritised for retrofitting for co-fire with alternative fuels, while Talcher Kaniha is prioritised for modification for flexibility. Nava Bharat IPP and Talcher Kaniha in particular have the highest scores across the four dimensions: Security, Cost, Environment and Socioeconomic.

With regards to captive plants, Yazdani, NINL Steel and Utkal Alumina are ranked highest, and are all prioritised for modification for flexibility given their age. All three plants score highly across the cost and socioeconomic dimensions,

[33] While the Prioritisation Framework uses the plant's age to inform suitable repurposing options, it is important to note that additional considerations such as land size or location constraints, transmission constraints, grid stability, access to infrastructure, renewable energy potential are also factored in. As such, the results presented are illustrative and require further study.

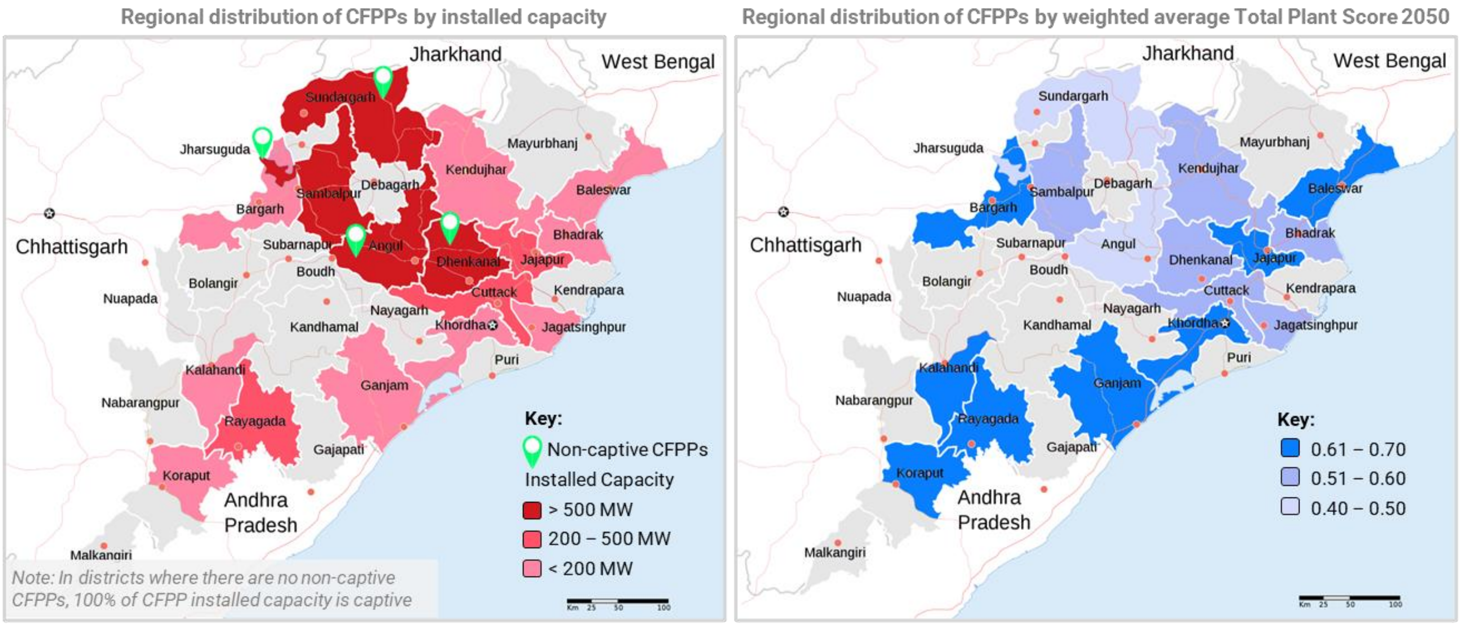


Figure 17. Regional distribution of installed capacity and weighted average Total Plant Score for 2050.

with average environment scores and low scores under security. This is primarily due to the repurposing option associated with the CFPP's medium age not being a priority under the 2050 scenario for security, compared to replacement with renewable energy which is more suited for older plants and would help initiate an exit from coal.

Figure 17 above shows the regional distribution of the coal fleet by installed capacity, compared to the weighted average total scores for 2050.

The districts with the highest range of scores (0.61-0.70) are Kalahandi, Bargarh, Ganjam, Koraput, Baleswar, Khordha, Jajapur and Ragayada. Among these regions, Baleswar, Bargarh, Ganjam, Jajapur, Kalahandi, and Koraput are likely to be impacted the most, as the top scoring plants represent 100% of the total installed capacity in each of these locations. These districts may therefore face the biggest relative socioeconomic impacts related to the disruption to livelihoods if all the high scoring plants were in fact repurposed or retired.

It is interesting to note that the districts of Angul, Sundargarh, Dhenkanal, and Jharsuguda, which have large non-captive plants and a high concentration of total CFPP capacity, have lower weighted average total plant scores, while districts with smaller amounts of 100% captive CFPP capacity have higher average plant scores. Due to the smaller plant sizes, disruption to the workforce in terms of job displacement and re-training requirements will be at a smaller scale. However, repurposing or retiring these plants without adequate measures may also negatively impact the private industries by disrupting their energy supply.

The region which has the largest amount of CFPP installed capacity in the highest score range (0.61-0.70) is Angul, with 1,200 MW of installed capacity prioritised for repurposing or retirement, equivalent to one plant. Notably, the district also has a low weighted average total score.

From a regional perspective, two different approaches can be taken for repurposing or retiring priority CFFPs. Either focussing on CFPPs in regions with high weighted average total scores or focussing on high scoring CFPPs in regions with lower weighted average total scores, as they may have a lower impact on the region overall. The approach taken will depend on stakeholder priorities.

The total amount of CFPP installed capacity within the highest range of scores (0.61-0.70) is 4,360 MW, equating to over 20% of the fleet. It is assumed that larger plants (most of which are non-captive) are prioritised for repurposing or retirement in the 2050 scenario as the energy system is expected to be more capable of handling larger disruptions to the system as a result of more renewable energy integration and excess capacity available.

5.4.2. Insights for Odisha

The results of the prioritisation exercise provide the following insights in terms of the types of plants most suitable for repurposing or retirement in Odisha as well as the impacts of this where relevant on supporting the state's energy transition:

- **The top ranked non-captive plants are diverse in terms of their age, size and utilisation rates,** suggesting that other factors such as their cost of operations, environmental and socioeconomic impacts are playing a more significant role in how they are scored compared to their technical characteristics.
- **The top ranked captive plants are all less than 100 MW in size and between 13-16 years old.** While the age of the top ranked plants reflects the average age of the entire captive fleet, the small plant size is interesting to note and may be due to smaller plants being prioritised under the cost and socioeconomic score. This is because the smaller the plant, the less expensive it might be to repurpose, and its smaller workforce might result in a lower level of community disruption during the repurposing period.
- **As the majority of plants are prioritised for modification to enhance flexibility, there is a strong case to establish a flexibility market in Odisha.** The majority of installed capacity corresponds to relatively small captive plants, whose main purpose is not to provide energy to the grid but to the industries they supply. This suggests that Odisha should really push for the creation of a flexibility market where these plants could participate as a way of supporting renewable deployment. Although this will mean that a full coal phase-down for Odisha might only be feasible over a longer-term horizon as the CFPP fleet matures, this process can be accelerated by the presence of competitive technologies participating within the flexibility market, such as storage, pushing CFPPs to move towards more disruptive repurposing options.
- **The top ranked plants featured within the highest range of total plant scores under 2050 scenario are primarily comprised of captive plants.** In 2050, a significantly large amount of CFPP capacity is prioritised – over 20% of the fleet, reflecting the expectation that the energy system in the long-term is more equipped to handle the repurposing of larger plants.
- **From a regional perspective, two approaches can be taken for repurposing priority CFFPs depending on stakeholder priorities.** Either focussing on CFPPs in regions with high weighted average total plant scores or focussing on high scoring CFPPs in regions with lower weighted average total plant scores, as they may have a lower impact on the region overall.

The Prioritisation Framework developed for this study can be used to screen any coal fleet in the world. The results of the screening can help provide relevant insights related to the impact of the transition from coal to renewables, as well as the identification of plants that could be prioritised for repurposing, including the option of early retirement.

For the case of Odisha, the insights summarised above provide a valuable foundation to inform roadmaps, policies and financial instruments needed to enable a transition from coal to renewables in a secure, socially, economically, and environmentally sound way. Moreover, the tool can be used to test different approaches for selecting the CFPPs to prioritise given the local characteristics of the fleet.

It is important to mention that the use of this framework does not aim to necessarily outline a definitive roadmap for coal phase-out. Further engagement with policymakers and stakeholders is necessary to build a more comprehensive picture of the feasibility of coal retirement within a region. As a region's energy transition becomes more advanced, the Prioritisation Framework can be evolved over time, incorporating new learnings and developments.

As a starting point, the Prioritisation Framework can be used to alleviate some of the common concerns in Odisha and provide insights to support just transition planning across stakeholder groups:

- **Utilities:** The results of the prioritisation exercise can be used by decision-makers to further assess the impact of early retirement or repurposing of the shortlisted plants on grid stability, and accordingly plan investments to increase renewable energy penetration and facilitate greater integration with the grid.

- **Government:** The total capacity of the plants prioritised for early retirement or repurposing provides an important gauge for the government to determine what the capacity replacement requirements will be and their associated timeline. The outcome of the prioritisation exercise also provides the Odisha government with insight on the alignment of their renewable energy targets and emissions reduction goals with the feasibility of gradually reducing coal power generation.

- **Financiers:** The analysis from the Prioritisation Framework provides high-level guidance on the comparative cost implications of acquiring plants for early retirement or repurposing, as well as how willing asset owners would be able to engage in such transactions. This information can guide financial institutions and investors to conduct further plant-level analysis on the financial viability and risks associated with retirement or repurposing.

- **Community and workers:** A key concern for the community is whether environmental and social justice factors are appropriately built into the Prioritisation Framework, and how the results can impact the entire value chain of coal power generation. As their voices are often left out of grid planning decisions, the Prioritisation Framework and its results can be shared with the local community to increase transparency and facilitate their participation in the decision-making process. This will ensure that there is room to further strengthen the criteria of the framework and create community buy-in for plants ultimately selected for retirement or repurposing, contributing towards a just energy transition.

5.4.3. Next steps

When using the JTPF outlined in Section 2, and the Prioritisation Framework detailed in Section 4 alongside each other, the two frameworks can be a powerful toolkit for policymakers and key energy sector stakeholders to begin planning for a just energy transition.

For example, the JTPF can be used to identify communities and workers who are most vulnerable to the impacts of coal asset retirement. This information can then be fed into the Prioritisation Framework to ensure that retirement decisions account for the social impacts of the transition. Similarly, where the Prioritisation Framework identifies a cluster of CFPPs which are prioritised for retirement or repurposing within a particular region, the JTPF provides a framework for developing a comprehensive plan to support workers and communities that may be impacted, including alternative livelihood options.

6. Conclusion

The JTPF and Prioritisation Framework presented in this report provide a structured approach to support planning for a just energy transition in any region. The two frameworks synthesise best practices on supporting a just transition from coal to clean energy and provide a transparent and adaptable approach to support regions to phase down CFPPs. This addresses the current gap between the widely acknowledged case for urgent, rapid, and large-scale action to accelerate the transition away from coal, and a step-by-step approach to achieving a just energy transition.

Together, these frameworks offer policymakers and key energy sector stakeholders, including asset owners, guidance to enable an energy transition which delivers against carbon reduction goals whilst realising the benefits of a just and equitable transition. This approach can mitigate the risk of livelihood loss faced by workers and communities by taking advantage of the multitude of opportunities that the energy transition presents.

Key takeaways

The key elements of the Just Transition Planning Framework covered in the report include:

1. The importance of stakeholder engagement and participatory planning processes to enable social and political buy-in. This can support a proactive, transparent and inclusive transition planning process that accounts for inequalities affecting marginalised communities and ensures that costs and benefits of the energy transition are distributed equitably.
2. The necessity of developing just transition interventions at all levels of impact that include top-down measures involving financing and governance structures; worker-level support that addresses the risk of livelihood losses; and building community-level resilience through green economic development.
3. The responsibility of policymakers to plan for a transition to a low carbon economy from the outset before pursuing asset-level transitions, by investing in community resilience and revitalisation upfront to minimise the socioeconomic risks of an energy transition.

The JTPF is applied in the context of Odisha, India, to provide a case study and develop high-level findings to support planning. The case study looks specifically at the opportunities to expand access to decent livelihoods, embed green, sustainable local economic development and meet the energy needs of communities and businesses. There are a number of green and 'non-green' potential alternative livelihoods for workers in Odisha, providing opportunities to diversify the regional economy, develop low carbon energy systems and create local wealth.

The JTPF can be applied in new contexts, outside of India, to support just energy transition planning. There is scope to undertake further testing of the framework to ensure that it is effective in meeting the needs of communities and is adaptable to local contexts. Policymakers and key energy sector stakeholders can build on the findings outlined in this report and apply the JTPF by working with local partners to gather primary data.

The Prioritisation Framework is designed to account for the regional context in terms of its degree of readiness to transition to clean energy, and the CFPP's operating conditions and their impact on the environment and the community. The Prioritisation Framework is not designed to be a one size fits all approach to ranking CFPPs for repurposing or retirement and offers flexibility to stakeholders in the following ways:

1. While the Prioritisation Framework is developed to rank plants for either replacement with renewable energy generation through early retirement and site repurposing, modification for flexibility

provision, or retrofitting to co-fire with alternative fuels, additional repurposing options can be integrated into the framework by the user based on other technologies suited to the local context.

2. The criteria used to assess and rank plants and the weightings applied to the indicators under each criterion can be adjusted to reflect regional priorities and stakeholder interests. While the Prioritisation Framework in the report is designed to prioritise CFPPs that (1) will have the least impact on the security of energy supply, (2) are the most costly to operate, (3) are most environmentally damaging, and (4) present the greatest risk to workers and have the lowest economic impact, the importance of each of these dimensions can be re-assessed to generate different CFPP ranking lists.

3. The timeframe preferences for repurposing or retirement decisions can also be accounted for by the Prioritisation Framework, whereby different scoring criteria is used for regions willing to begin the process of retiring or repurposing CFPPs in the short-term (2030 is used as a reference point) or over the long-term (2030-2050 or beyond) to reflect the different nature of the energy system and its ability to handle disruptions over time.

Insights from the Prioritisation Framework's application to the CFPP fleet in Odisha suggest that (1) a large amount of CFPP capacity is prioritised for repurposing under the long-term (2050) scenario as the energy system is expected to be more equipped to handle the repurposing of larger plants, and (2) the majority of plants prioritised for repurposing are most suitable for modification for flexibility provision given the characteristics of the CFPP fleet.

This would be appropriate in the context of Odisha, as the majority of installed capacity corresponds to relatively small captive plants, whose main purpose is not to provide energy to the grid but to the industries they supply. This suggests that Odisha should really push for the creation of a flexibility market where these plants could participate as a way of supporting renewable deployment. Although this will mean that a full coal phase-down for Odisha may only be feasible over a longer-term horizon as the CFPP fleet matures, this process can be supported through the state government's existing policies and incentives which are accelerating the presence of competitive technologies participating within the flexibility market, such as storage, pushing CFPPs to move towards more disruptive repurposing options.

When replicated for other regions, the Prioritisation Framework can serve as an entry point for comprehensive discussions with policymakers and key energy sector stakeholders on how they should plan support for energy transition initiatives. The results can provide a reference point on the potential scale of renewable energy deployment needed and corresponding investment requirements based on the size of coal capacity prioritised for repurposing.

Using the frameworks for effective planning

The JTPF and Prioritisation Framework can be used independently to support just transition planning processes and evaluation of asset-level retirement or repurposing. When used alongside each other, the two frameworks can form a powerful approach for policymakers and key energy sector stakeholders to begin planning for a just energy transition, considering key technical, economic, environmental and social factors.

For example, the JTPF can be used to identify communities and workers who are most vulnerable to the impacts of coal asset retirement. This information can then be fed into the Prioritisation Framework to ensure that retirement decisions account for the social impacts of the transition. Similarly, where the Prioritisation Framework identifies a cluster of CFPPs which are prioritised for retirement or repurposing within a particular region, the JTPF provides an approach for developing a comprehensive plan to support workers and communities that may be impacted, including alternative livelihood options.

Planning for a just energy transition requires careful consideration of key contradictions and trade-offs. One such trade-off is the balance between ensuring a rapid transition while achieving 'just' processes and outcomes, which can be resource and time intensive. Balancing environmental, health, and efficiency considerations against the need for job security and workers' rights is complex but essential to build political support and ensure that workers and communities are protected during the transition. Ignoring these considerations may lead to future resistance to climate action. It is therefore critical that a just transition approach is integrated into any decisions that may accelerate the energy transition.

The way forward

The JTPF and Prioritisation Framework provide a valuable foundation to inform roadmaps, policies and financial instruments needed to enable a region's transition from coal to renewables in a secure, socially, economically, and environmentally sound way.

For a just energy transition to be viewed as a credible way forward by key decision-makers, it must be designed with the local context in mind. The two frameworks covered in this report offer a practical and transparent approach to this by building in a level of flexibility that can allow users to manage regional priorities appropriately.

As the report is not intended to provide a definitive roadmap for coal phase-out, further engagement with policymakers and key energy sector stakeholders is necessary to build a more comprehensive picture of the feasibility of coal retirement within a region. As a region's energy transition becomes more advanced, the JTPF and Prioritisation Framework can be evolved over time, incorporating new learnings and developments.

Appendix 1: Data sources and assumptions for the Odisha Prioritisation Framework case study

Metric	Methodology	Source
Power generation mix plan and policy	Desk research	Central Electricity Authority, Niti Aayog, India Ministry of Power
Plant characteristics	Global Energy Monitor (GEM) data supplemented by desk research. Age is calculated as of 2022.	Global Energy Monitor, company reports, government publications, and other sources
Capacity factor (utilisation)	Varies by plant type. For public sector power plants and IPPs, based on government reporting, for captive plants, based on government reporting where available. In circumstances where no data is available, the average capacity factor of the fleet of plants with similar characteristics is used.	Daily Coal Reports, Power Generation reports, CEA reports, PAT reports, company reports, and TransitionZero in-house methodology.
Efficiency	Estimated based on plant age, combustion technology and other technological factors.	TransitionZero's in-house methodology.
PPA price estimates	Varies by plant type. For public sector power plants and IPPs, based on DISCOM reporting. For captive plants, based on cost-plus approach.	DISCOM reports and TransitionZero's in-house methodology.
Grid connectivity	Varies by plant type. For public sector power plants and IPPs, assumed connectivity by default. For captive plants, based on government reporting where available. In circumstances where no data is available, it is assumed that plants are grid connected if they are over 30 MW.	Daily Coal Reports, Power Generation reports, Central Electricity Authority (CEA reports), PAT reports, company reports, and TransitionZero in-house methodology.
Captive generation's contribution to regional power consumption	Desk research	Odisha State Load Dispatch Centre
Manufacturing industry's contribution to the economy	Estimated using the industrial sector's contribution to Odisha's gross value added (GVA) and calculated based on the manufacturing sector's proportion of the industry sector's GVA.	Odisha Economic Survey 2021 – 2022[118]
Operator climate commitments	Desk research.	Company websites
Fixed operating and maintenance costs ($/MWh)	Estimated based on plant age, combustion technology and other technological factors.	TransitionZero's in-house methodology
Variable operating and maintenance costs ($/MWh)	Estimated based on plant age, combustion technology and other technological factors.	TransitionZero's in-house methodology
Cost of buyout — early retirement ($ millions)	Estimated based on PPA price, average plant capacity factor, remaining years of plant life, and a five-year cap for buy-out. The cost of buyout was estimated according to each plant type as follows:	TransitionZero's in-house methodology

	• Public non-captive power plants: PPA price * Average plant load factor (%)* 8760 * Remaining years. • IPPs with multiple PPAs with different tenors: Cost of buyout based on the remaining value of each PPA (no discount factor included). It is assumed that there is no PPA extension once the contract expires. • Public and private captive plants: Cost of buyout based on own consumption only.	
Transport cost (distance to coal source)	Estimated by identifying the coal mine that is responsible for providing the CFPP with coal and using Google Maps to estimate the distance between the CFPP and the mine. Where information is not available on the coal source, the mine typically cited as the source by other plants located close to the CFPP is used as a proxy.	Company reports, Google Maps
Loss of tax revenues	Estimated based on plant size and age.	Global Energy Monitor
Air emissions control mechanisms	Desk research.	Global Energy Monitor
Carbon intensity (tCO_2/MWh)	Estimated based on plant age, combustion technology and other technological factors.	Emissions intensity (tCO_2/MWh)
Annual emissions (tCO_2)	Calculated using baseline emissions factor for coal based on UNFCCC figures, adjusted by plant efficiency.	UNFCCC and TransitionZero's in-house methodology
Social cost of water ($/MWh)	Estimated based on water usage, which is calculated using TransitionZero's in-house methodology.	TransitionZero's in-house methodology
Water stress levels	Estimated using the World Resources Institute's Aqueduct Water Risk Atlas based on each plant's location.	World Resources Institute
Total social cost of air pollution ($/MWh)	TransitionZero's in-house methodology.	TransitionZero's in-house methodology
Local social cost of air pollution ($/MWh)	TransitionZero's in-house methodology.	TransitionZero's in-house methodology
Captive contribution to industrial power consumption	As data for this indicator was not available, a proxy figure of 70% has been used for all captive CFPPs. This figure has been chosen to indicate a high contribution to industrial power consumption, as it is assumed that industrial facilities with captive units will likely consume the majority of its electricity from captive generated power.	N/A

Appendix 2: References

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