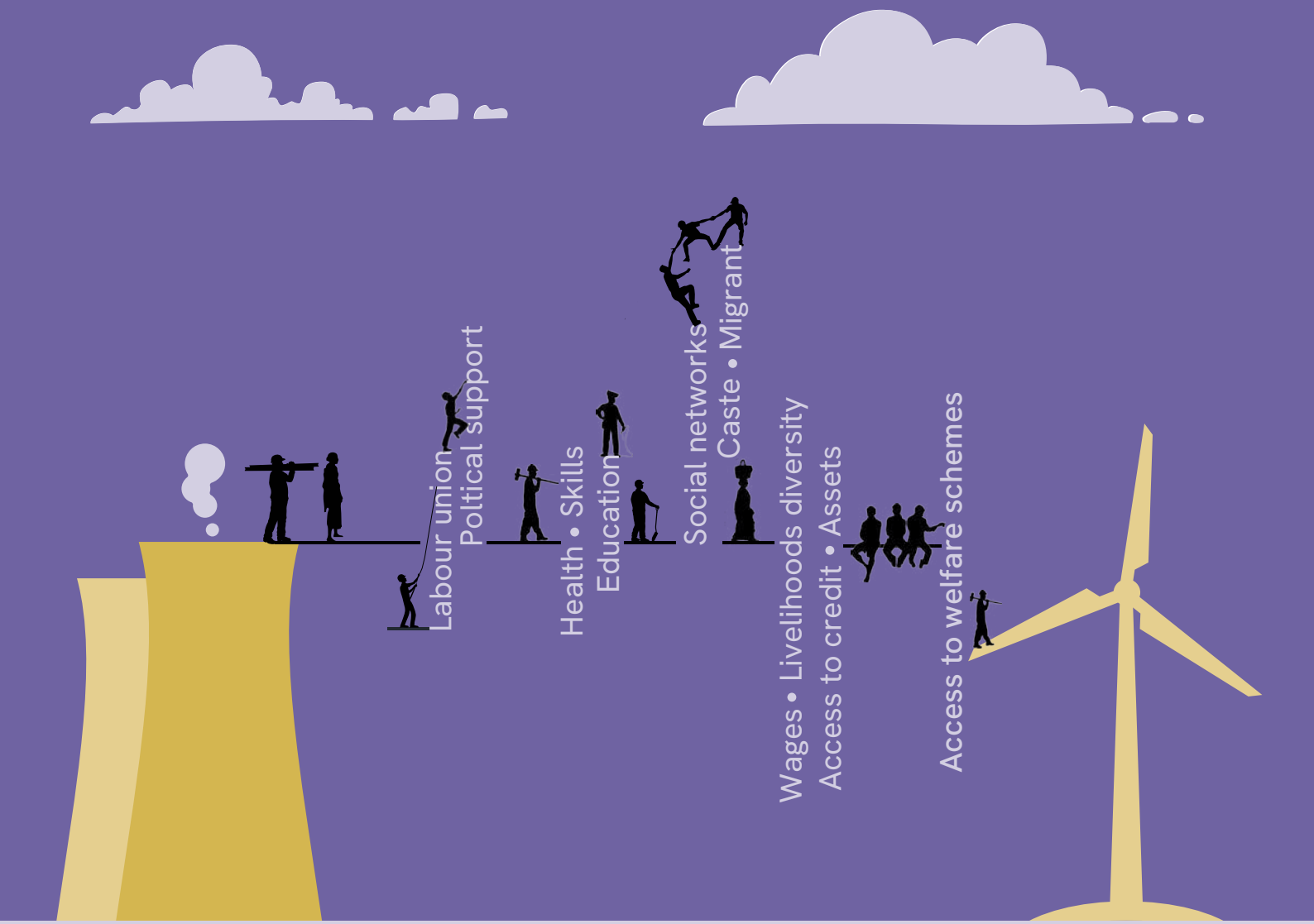

‘Justice’ in Energy Transition

Measuring Resilience of Workers in Thermal Power Plants

November 2025

CENTRE FOR ENERGY, ENVIRONMENT & PEOPLE

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About Centre for Energy, Environment & People (CEEP)

Centre for Energy, Environment and People (CEEP) is a human-centric research and policy advocacy initiative working towards energy justice in Rajasthan. Our work prioritises workers, communities, and environment at the intersection of energy infrastructure and services.

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This report is a publication of the Centre for Energy, Environment and People (CEEP). Every effort has been made to ensure the accuracy and reliability of the information, analysis, and conclusion presented herein. CEEP claims full responsibility for the views and positions expressed in this report.

This work has been undertaken in the public interest and in support of informed dialogue on energy and workforce transition.

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Executive Summary

As the third-largest carbon emitter globally, India's accelerated pace of clean energy transition is critical to mitigate the effects of climate change.

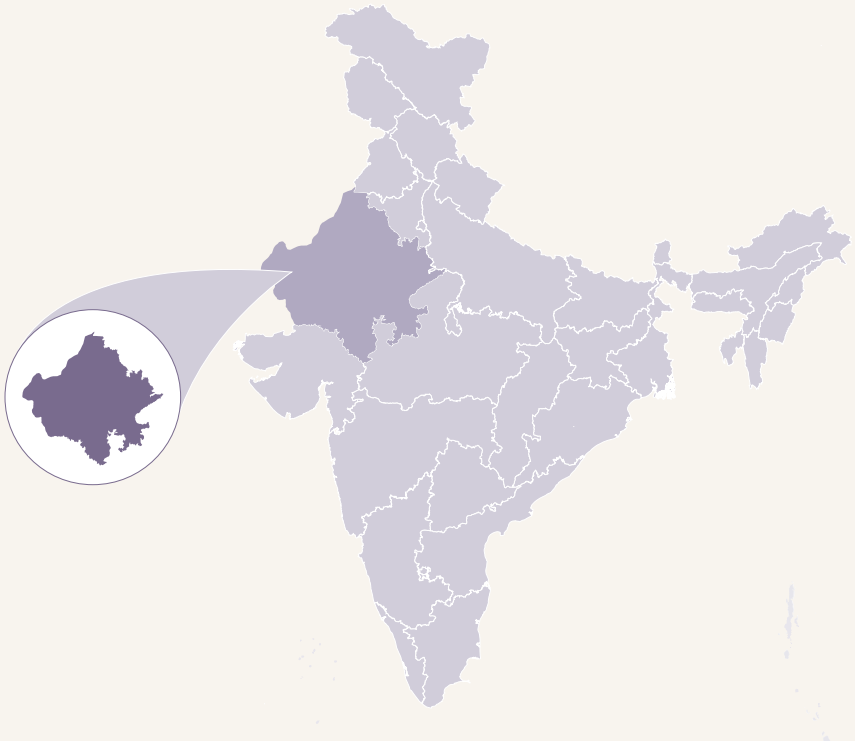
India has committed to achieving net-zero emissions by 2070 and reducing the carbon footprint of its GDP in the short term[1], which has pushed for the massive deployment of large-scale renewable energy projects.

However, irrespective of India's renewable energy commitments and its transition journey, thermal assets are expected to face closure because of technological, economic and legal reasons.

The closure of such assets shall induce risks and increase vulnerability for workers and their families. While renewable energy investments shall create new opportunities, the aforementioned risk may not be addressed because of spatial and temporal differences. Consequently, the loss of livelihood may entail the depletion of economic, social, cultural, and human capital in carbon-intensive ecosystems. Such transitions may induce economic shocks, resulting in long hauls of poverty. Hence, there is a need to improve resilience among these workers to ensure a fair and just transition for all stakeholders.

Resilience is a multidimensional phenomenon that includes the measurement of social, political, human, and economic dimensions and involves tracking multiple and often correlated variables, that produce livelihoods effectively (Al-Maruf, Jenkins, Bernzen, & Braun, 2021; Jones & Tanner, 2015; Quandt, 2018; Walker & Salt, 2012). Hence, there is little agreement on measuring the resilience of workers in coal thermal power plants. This report puts forth a framework to estimate the current level of well-being and assess the resilience of workers by measuring financial capital, social capital, human capital, political capital, and welfare schemes.

We use the Alkire-Foster Methodology (Alkire & Foster, 2011) to produce a multi-dimensional non-resilience index to identify gaps in the transitional resilience of contractual workers[2]. It allows us to measure both the spread of non-resilience and the intensity of non-resilience among contractual thermal power plant workers. This study assesses the resilience of contractual workers across coal-based power plants in Rajasthan, India, by quantifying their ability to sustain their current levels of well-being in the event of a clean energy transition and proposes interventions to build resilience.



1 India's Panchamrit declaration at COP26. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1961797

2 Contractual workers are workers with an annual contract in a power plant, but not directly with the plant owner. These workers receive lower wages, have weak social security, and precarious working conditions in power plant compared to permanent workers, employed directly with the plant owner.

We collected household-level data from 433 contractual workers employed in Chhabra Thermal Power Plant (CTPP), Kota Super Thermal Power Station (KSTPS), and Suratgarh Super Thermal Power Station (STPS) on workers' livelihoods, economic and financial resources, social capital, political capital, human capital, and access to welfare schemes.

Our results indicate that 84% of the contractual workers are non-resilient and at a risk of falling into long-term poverty if they lose their livelihoods. Furthermore, workers from weaker sections of society are more vulnerable than others, leading to the persistence of historical, social and economic inequalities. We also demonstrate that the non-resilience of workers is not solely due to low economic and financial capital but also stems from their limited ability to organise politically, lower human capital, inadequate access to welfare schemes, and restricted social networks. These non-economic and financial factors play an important role in strengthening the resilience of contractual workers. Moreover, the contribution of different capital stocks to workers' resilience varies across the thermal power plants. Hence, a one-size-fits-all solution may not be effective in strengthening the resilience capabilities of contractual workers.

Based on our findings, we recommend a two-level support programme to ensure a just, equitable, and inclusive transition for contractual workers in the case of the closure of thermal power plants. First, we advocate for a universal basic income programme for all contractual workers during the transition period to maintain their living standards and mitigate the risk of falling into poverty. The recommendation is based on the nation's median mean per capita expenditure (MPCE) and family size. This report also estimates the total cost of implementing the universal basic income programme under different scenarios, which should be included as part of the transition costs. Second, we argue that other programmes that improve human capital, enhance social capital, strengthen workers' position in collective negotiations, and provide access to welfare may help make contractual workers resilient in the long term. These programmes are less ubiquitous than universal basic income support and are rooted in current levels of socio-economic and cultural capital stocks. However, we could not estimate the costs of such programmes due to a lack of data and other complexities. This report argues that intervention to ensure a just transition needs to be implemented now rather than during the transition process itself, as translating interventions into improvement of resilience is a complex and time-consuming issue. Hence, governments and generation companies should move early rather than wait for a human crisis.

The proposed framework can also be used to analyse the vulnerability of workers and design support programmes to ensure a 'just' transition. However, our methodology has some limitations, which future scholars can address to customise interventions to enhance contractual workers' resilience. First, we used a subjective weighing scheme to construct capital scores based on our interactions with the local communities, which could be improved by more nuanced and objective weighing schemes. Second, while different capital stocks may not influence non-resilience or resilience equally, we assigned equal weights to all the capital stocks without sufficient theoretical and empirical evidence. Therefore, it is important to estimate the weights of different capital stocks in determining the resilience of households using more sophisticated statistical tools.

01

Introduction

Farmland in the foreground, and behind it a thermal power plant.

As natural and human-induced disasters due to climate change continue to increase, policymakers, development practitioners, academicians, and philanthropists have shifted their focus to building resilience in affected regions. Resilience refers to the ability of a household or community to recover from a shock or disaster and maintain its living standards (Leslie & McCabe, 2013; Walker & Salt, 2012). A growing body of literature has examined various dimensions of resilience, including its conceptualisation, measurement, and the politics surrounding it (Knippenberg, Jensen, & Constas, 2019). Meanwhile, the world is working toward shifting from fossil-fuel-based energy to renewable energy to mitigate the effects of the climate crisis. Governments are pushing industries to transition to low-carbon technologies and reduce their carbon footprints to achieve their net-zero targets,[3] shrinking the role of fossil fuels in the future energy landscape.

Regardless of India's transition journey, it is inevitable that its thermal assets shall face closure or repurposing decisions in the future. Majority transition debates often neglect the concerns of highly vulnerable populations who depend on existing fossil-fuel-based power plants and the associated value chain of fossil fuels for their livelihoods. The energy transition may result in planned disasters and shocks in the lives of these populations, as many of them lack sufficient access to safety nets and are at risk of sliding into poverty. The transition to renewable energy resources may perpetuate historical inequities without addressing the needs of people dependent on a fossil-fuel-based economy. To prevent this, building resilience among these populations is critical to ensure a fair and just transition that does not leave anyone behind.

Energy transition to renewable energy resources may perpetuate historical inequities without addressing the needs of people dependent on a fossil-fuel-based economy.

The transition process may adversely impact the existing workforce, as workers risk losing their livelihoods, economic well-being, and social security, which poses a risk to the transition itself. Thus, addressing issues related to interregional, intergenerational, and inter-country distributive justice during the green transition is necessary (Geels, 2005; Newell & Mulvaney, 2013). Distributive justice is a critical aspect of the transition to low-carbon economies and is rooted in the labour movements of the late 1970s, when labour unions in the United States demanded support for workers engaged in polluting industries who were facing the risk of job loss due to environmental regulations (Gambhir, Green, & Person, 2018). The International Labour Organization has adopted the 'just transition' as an international goal and has proposed guidelines for realising a just transition to environmentally sustainable economies and societies for all, as referenced in the Paris Agreement (ILO, 2015; Trade Union Congress, 2008). It advocates for the equitable and just distribution of the benefits and costs of the transition without impacting the current economic, social, and environmental well-being of workers dependent on the fossil fuel economy.

To build resilience and support communities during the energy transition, their well-being needs to be assessed. Such evaluations will help inform the design and implementation of support programmes that reduce the risk of households falling into the long haul of poverty and enhance their capacity to bounce back (Ramilan et al., 2022). While the transition from a fossil-fuel-based to a renewable-based economy is a progressive and desired movement, it may lead to the further marginalisation of the workforce dependent on the fossil-fuel economies, contrary to the objectives of a 'just transition'. Hence, it is necessary to assess their capability to adapt and identify the gaps that need to be addressed to build what we call 'transitional resilience'. However, resilience is a multidimensional phenomenon that includes their ability to sustain their livelihoods, health, social well-being, social and cultural capital, and access to ecological resources (Al-Maruf, Jenkins, Bernzen, & Braun, 2021; Jones & Tanner, 2015; Quandt, 2018; Walker & Salt, 2012). Measuring social, political,

[3] The net-zero target refers to a state of low carbon emissions in an economy, where generated carbon emissions can be removed from the environment through natural biochemical processes, leaving no additional carbon in the atmosphere.

human, and economic dimensions involves tracking multiple and often correlated variables, increasing the complexity of measuring transitional resilience. We present a framework to measure the resilience of contractual workers in thermal power plants using the Alkire-Foster method.

14 coal-fired thermal power plants

16,000 workers, with over half on contractual terms.

Rajasthan has emerged as a hub for solar energy and the energy transition, as India has committed to achieving net-zero emissions by 2070 and reducing the carbon footprint of its GDP in the short term[4]. Hence, it is natural that existing fossil-fuel- or coal-based power plants will eventually retire or be repurposed[5], although the government has remained non-committal and has yet to announce any timeframe. There are 14 coal-fired thermal power plants in Rajasthan, employing around 16,000 workers. The livelihoods of these workers will be at risk in the event of closure. However, workers in power plants are not a homogeneous group, and more than half of them are contractual workers,[6] who lack a state-sponsored safety net and are at greater risk than permanent workers. These contractual workers are solely dependent on their jobs for their survival, and most likely, they will not be retained or transferred to other jobs, unlike permanent workers. The loss of livelihood for them will entail the depletion of economic, social, cultural, and human capital. Therefore, it is necessary to estimate their current level of well-being and stocks of capital to understand their capability to navigate transition shocks. This assessment will help in designing and implementing programmes to support contractual workers during the transition and ensure a just, equitable, and inclusive transition for all stakeholders.

[4] India is committed to achieving NetZero emissions target by 2070. For more information, see. https://pib.gov.in/PressReleaseIframePage.aspx?PRID=1961797
[5] India has retired 19 coal-based thermal power plants totalling 2.3 GW over the last three years. For more information, see https://pib.gov.in/PressReleaseIframePage.aspx?PRID=2003926.
[6] As per the data obtained through an RTI response filed with RVUNL in 2023.

02

Literature review

A fly ash silo for collecting and storing fly ash generated during plant operations.

A rapid low-carbon energy transition from fossil-fuel-based technologies to low-carbon renewable sources has become a necessity amid increasing global concerns regarding climate change (Gambhir, Green, & Person, 2018). Green energy sources are gaining immense popularity among policymakers, businesses, and civil society across both developed and developing countries due to technological improvements, increased efficiency, and decreasing costs over time. This trend has led to the large-scale deployment of low-carbon/ clean technologies, often termed "the winning of the carbon war" (Legget, 2018). While the transition to low-carbon technologies has generated multiple employment opportunities across the value chain in the manufacturing, installation, operation, and maintenance of these technologies, it also bears the risks of appropriating the livelihoods of those directly or indirectly dependent on the fossil fuel economy. Therefore, the current discourse on decarbonisation focuses not just on realising a technological transition but also on mitigating social and political risks that may arise due to the transition. By doing so, we hope to realise a 'just transition'. The just transition framework aspires to create enabling conditions or support systems for transitioning labour and communities dependent on the traditional fossil-fuel economy to a renewable-based economy. However, this shift would entail certain costs, which should be considered part of green transition costs. To determine the actual transition cost, assessing the nature and extent of support required for transitioning the existing labour force is necessary.

2.1 Livelihood resilience and just transition

Transitioning the workforce from fossil-fuel-based industries represents a critical cost for firms, which needs to be considered during transition planning. This cost will depend on the existing financial, social, human, and political capabilities of workers, which determine their ability to withstand, adapt, and recover from the socioeconomic shocks of the transition without impacting their current well-being, known as resilience (Holling & Chambers, 1973; Quandt 2018). Walker and Salt (2012. p. xiii) define the resilience of ecological systems as the "capacity of a system to absorb disturbance and still retain its basic function and structure". Recently, the notion of resilience has gained prominence in the literature on the just transition to promote sustainable management of ecological resources and human development (Folke, Colding, & Berkes 2003; Jones & Tanner, 2015; Walsh-Dilley, Wolford, & McCarthy, 2016). Now, resilience also encompasses issues related to the distribution of opportunities and externalities arising from the transition, recognising both the socio-political and ecological aspects of resilience (Brown, 2014). This has led to a socially and politically grounded conception of livelihood resilience to analyse the transitional ability of workers dependent on traditional fossil-fuel-based industries.

Tanner et al. (2015, p. 23) define livelihood resilience as "the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social and political disturbances". This perspective shifts the conceptualisation of resilience from a purely technical and naturalistic concept by incorporating people's lives, politics, rights, and power hierarchies (Quandt 2018; Tanner et al. 2015). Humanising resilience allows us to address issues such as unequal access to resources, individual circumstances, and perception of impact, which shape individuals' ability to adapt during environmental, social, and political crises (Quandt, 2018). Accurately assessing livelihood resilience can help households develop better coping strategies, manage adverse impacts, and navigate uncertainties during the transition (Marschke & Berkes, 2006).

While the assessment of household livelihood resilience to risks like natural disasters and climate change has received attention (Al-Maruf et al., 2021; Quandt, 2018; Ramilan et al., 2022), risks related to shifts in environmental policies driven by global commitments have not yet been thoroughly studied. Governments worldwide are committing to decarbonising their economies and are increasingly taking steps to retire fossil-fuel-based power plants. Such policy decisions have increased workers' vulnerability, dependent on traditional fossil-fuel-based power plants. Understanding the relationship between these policy risks and household well-being is essential for designing welfare measures that reduce vulnerability and ensure a just transition (Knippenberg, Jensen, & Constas, 2019), underscoring the need to measure resilience. Moreover, measuring resilience can provide insights into the complex and dynamic interactions of multiple socio-economic factors that influence resilience during and after a shock.

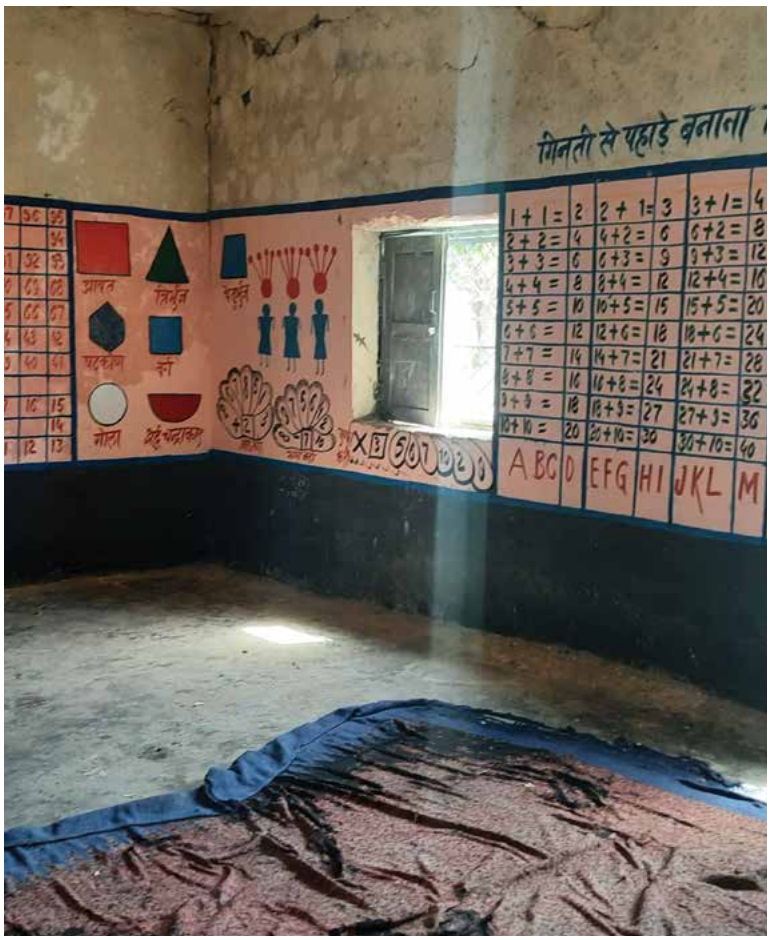
Livelihood resilience is the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social and political disturbances.

Pipelines transporting bottom ash to an ash pond, with visible ash leakage. Alongside, a water pipeline and a tractor carrying a water tanker used for local distribution.

2.2 Measuring livelihood resilience

Measuring resilience is very complex as it is not directly measurable (Berkes, Kislalioglu, Folke, and Gadgil, 1998; Carpenter, Walker, Anderies, & Abel, 2001; Leslie & McCabe, 2013). Measuring the resilience of social systems and households becomes even more complex due to the continuous interaction of multiple factors. For example, investments in education may initially deplete economic capital, but they ultimately increase human capital, which can significantly enhance resilience. This multidimensional nature of resilience makes measuring social resilience one of the most challenging and complex tasks (Awazi & Quandt, 2021; Knippenberg, Jensen, & Constas, 2019; Leslie & McCabe, 2013; Nelson & Stathers, 2009), as it requires the use of quantifiable surrogates for different dimensions (Tanner et al. 2015; Carpenter, Westley, & Turner, 2005). Despite these difficulties, scholars have attempted to measure the resilience of households and social systems globally. The Food and Agriculture Organization (FAO) has conducted some of the most comprehensive and diverse studies on household resilience, beginning with studies on household resilience against food insecurity in Palestine (Alinovi, Mane, & Romano, 2009). Recent studies on resilience measurement have also been conducted in the context of a natural disaster and wars across Africa (d'Errico, Grazioli, & Pietrelli, 2018; d'Errico, Romano, & Pietrelli, 2018) and Asia (Al-Maruf et al. 2021; Brück, d'Errico, & Pietrelli, 2019). These studies attempt to adopt a more coherent method for measuring resilience, though consensus on resilience indicators remains limited.

Quandt (2018) argues that agreement among scholars is unnecessary; however, a coherent strategy that includes major aspects such as social, economic, political, and ecological factors is essential for effective measurement. Hence, he used the capital-asset approach of the sustainable livelihood concept proposed by the Brundtland Commission in their report titled *Our Common Future: Report of the World Commission on Environment and*

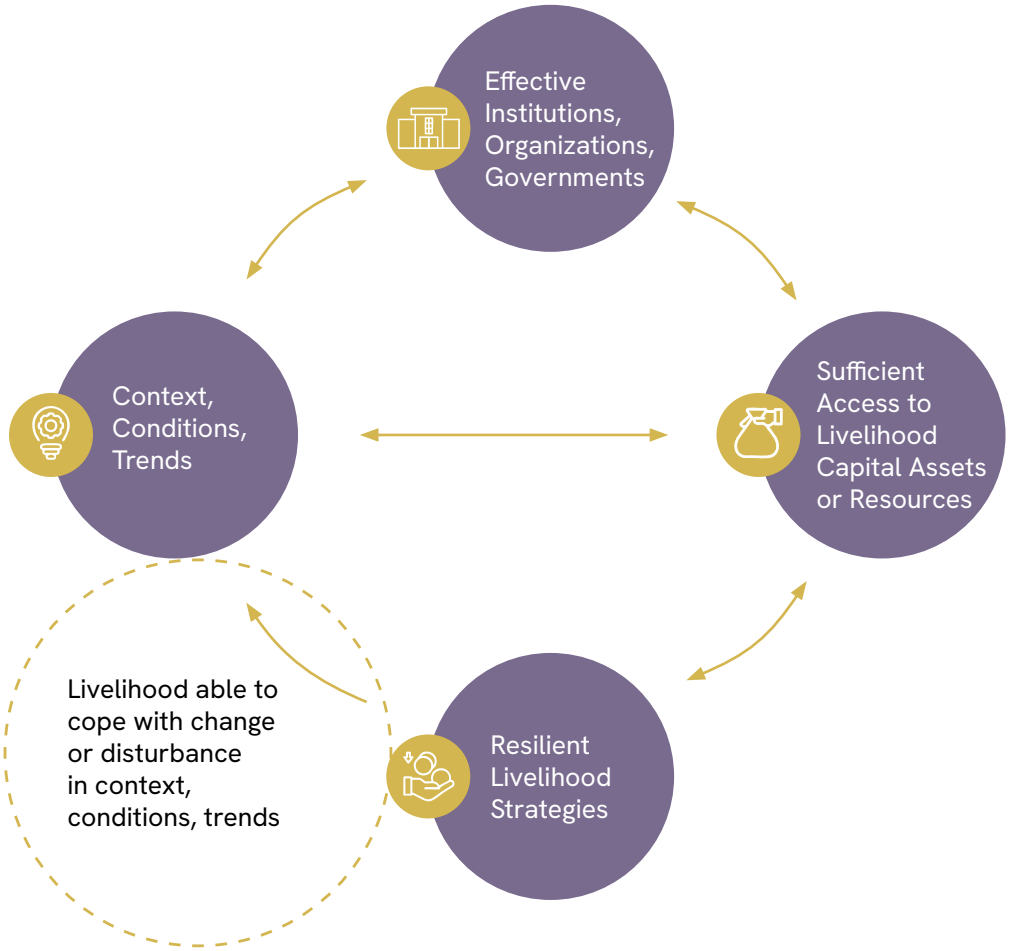


Snippets from inside a school largely attended by children of contractual workers.

Development (The World Commission of Environment and Development, 1987). This approach argues that people's livelihoods are influenced by their access to financial, physical, human, social, and natural capitals, which they combine in various permutations to sustain their livelihoods (Chambers & Conway, 1991; Quandt, 2018). These capital assets are stocks of capital that households use to generate an income; procure means of production; and create buffers against economic, social, political, and ecological uncertainties (Babulo et al., 2008; Scoones, 1998). However, a single asset may not be effective in isolation; a household needs a minimum level of all assets and must combine them effectively to generate a meaningful livelihood. For example, primary access to human capital is essential for converting financial, physical, and natural capital into income, generating livelihoods, and creating buffers for the future.

Even the accumulation of all assets is insufficient to produce meaningful livelihoods without physical security, market access, and other factors. Moreover, households' capacity to organise livelihoods can be impeded by power hierarchies, access to social networks, and information asymmetries. However, the sustainable livelihood approach needs to account for the problem of power hierarchies and access to political capital, which plays a vital role in generating livelihoods (Quandt, 2018; Scoones, 1998). Hence, it is necessary to modify the sustainable livelihood framework to include political capital and power asymmetries.

Figure 1 **Building resilience under the Household Livelihood Resilience Assessment Framework**



Source: (Quandt 2018)

The HLRA framework assesses livelihood resilience based on five capitals of sustainable livelihoods, along with power asymmetries, which are ultimately arranged in different combinations to produce livelihoods.

The Household Livelihood Resilience Assessment (HLRA) Framework (Figure 1) assesses resilience based on the five capitals of sustainable livelihoods, along with power asymmetries, which are ultimately arranged in different combinations to produce livelihoods. These five capitals are essential for identifying material, social, and design strategies to strengthen household resilience (Awazi & Quandt, 2021; Quandt, 2018). The HLRA framework recognises the role of access to social and political capital in organising livelihoods (Quandt, 2018), as uneven access can lead to the asymmetric penetration of welfare schemes in developing countries like India (Das & Maiorano, 2019). Membership in political networks and access to social security benefits often supplement everyday consumption and, at times, become essential inputs in the livelihood strategies of poor households in developing countries (Green-Pedersen & Jensen, 2019; Gupta, Goyal, & Bhattacharya, 2022; Maiorano, 2014). Benefits from welfare schemes can become productive assets that serve as a means of production[7] in times of uncertainty. Therefore, assessing access to welfare schemes in developing countries like India is essential when measuring a household's resilience to disaster-induced shocks, whether from natural events or policy decisions. Quandt (2018) argued that measuring access to various capital stocks helps determine whether a household has sufficient resources to build resilience and identify what is needed to enhance it. He outlines a conceptual framework summarising processes for building strategies and strengthening household livelihood resilience.

Livelihood diversification increases households' ability to cope with disasters (Hodbod & Eakin, 2015). Diversification provides additional income to accumulate resources, spreads risk, and supports income generation during large-scale environmental, political, and social changes (Hussein & Nelson, 1998). The HLRA framework includes indicators directly related to livelihood resilience, such as diversification, risk, non-financial stocks, and capital (Quandt, 2018). The modified HLRA framework also focuses on political and social linkages that facilitate the conversion of financial assets into productive income during crises. Accordingly, this paper incorporates a range of non-financial factors to provide a grounded assessment of households' ability to convert financial assets into meaningful livelihoods during and after a crisis. This can enable policymakers and governments to design programmes that provide financial support and enhance non-financial capabilities. While most studies focus on exogenous events like natural disasters and wars (Alinovi, Mane, & Romano, 2009; Awazi & Quandt, 2021; Babulo et al., 2008; d'Errico, Grazioli, & Pietrelli, 2018; d'Errico, Romano, & Pietrelli, 2018; Nelson & Stathers, 2009), the increasing vulnerability of households due to policy changes and systemic shifts triggered by climate action, particularly energy transition, have remained understudied. Measuring resilience is especially important in cases of planned obsolescence due to climate change policies. This approach will not only aid in designing and implementing programmes that support vulnerable communities but also help estimate more appropriate and realistic transition costs. We summarised various economic and non-economic factors in our analysis in Table 1.

[7] Means of production refers to the physical resources necessary to produce any good or services.

Table 1 **A synopsis of the literature on different capitals**

Economic/ financial capital	Social capital	Human capital	Political capital	Acess to welfare
Income and savings (Jones & Tanner, 2015; Scoones, 1998)	Caste (Sengupta & Sarker, 2011)	Skill level (Scoones, 1998; Tacoli, 1998)	Membership of labour union (Moore, Onaran, Guschanski, Antunes, & Symon, 2019)	Access to welfare schemes (Gupta, Goyal, & Bhattacharya, 2022)
Land ownership (Quandt, 2018)	Migration (Grabowska & Jastrzebowska, 2021)	Education (Sen, 1999)	Participation (Constantino, Cooperman, & Muñoz, 2023)	
House ownership (Al-Maruf et al., 2021)	Membership in social organisation (Scoones, 1998; Tacoli, 1998)	Health (Drèze & Sen, 2013)	Access to local politicians (Satterthwaite, 2013)	
Access to credit (Scoones, 1998)		Job transferability (Hodbod & Eakin, 2015)		
Livelihood diversity (Hodbod & Eakin, 2015)				
Dependency ratio (Below et al., 2012)				

Source: Authors' Analysis

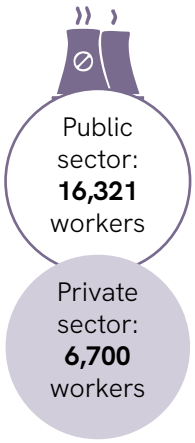
03

Contractual Workers in Coal-Fired Thermal Power Plants in Rajasthan, India

Kota Super Thermal Power Station (KSTPS) in Kota, Rajasthan.

Chhabra Thermal Power Plant (CTPP) in Baran, Rajasthan.

Suratgarh Thermal Power Station (STPS) in Sri Ganganagar, Rajasthan.



Rajasthan has 14 coal- and gas-fired thermal power plants with a combined capacity of 11.63 GW. Of these, 10 thermal plants are owned by public-sector units, employing 16,321 workers, while the private sector owns the rest, employing 6,700 workers. The state-owned plants account for a large share of power generation and employment. However, nearly half of the workforce in state-owned thermal power plants are contractual workers who lack job security, fair wages, and access to social welfare schemes available to permanent government employees.

Contractual workers are more vulnerable and marginalised in comparison to permanent workers due to veracity of reasons, which may become more pronounced in case of shocks like the closure of thermal power plants. Firstly, contractual workers in these plants are at a higher risk of losing their income and livelihoods, as permanent workers are likely to be absorbed into other assets or compensated for job loss. There are no such provisions for contractual workers. Secondly, contractual workers' economic, social, and political conditions are worse than those of permanent workers, particularly in terms of wages and access to social and political networks. The contractual workers get minimum wages decided by the Ministry of Labour based on inflation in the items of a predetermined basket of goods; therefore, the minimum wages are merely enough to survive, leaving the possibility of savings and investments. In contrast, permanent workers are paid as per the government salaries decided by a pay commission periodically, which are substantially higher than the minimum wages. As a result, contractual workers have lower financial and non-financial capital than permanent workers, which can deplete rapidly in the case of job loss. Thirdly, permanent workers are more organised compared to contractual workers; hence, they have more negotiating capacity with the government to address their issues. Fourth, contractual workers do not possess documentary evidence of employment and skills, which increases their difficulties in searching for an alternative job in the job market.

Contractual workers in thermal power plants are at a higher risk of losing their income and livelihoods as compared to permanent workers.

Hence, it is necessary to measure the capacity and gaps in capacity of contractual workers to survive a shock triggered by the closure of a thermal power plant for any reason. This analysis will be immensely helpful in designing policies and plans to ensure a just transition for all stakeholders. We estimate the transitional resilience of contractual workers' households, analyse the factors that contribute to their low resilience in the event of the closure or repurposing of existing coal-fired power plants, and design interventions to improve their resilience.

A turbine-generator unit inside a thermal power plant.

A contractual worker pauses for a water break, with a cooling tower in the background.

A worker collects coal spillage beneath conveyor belts carrying coal at a thermal power plant.

04

Methodology and Data

CEEP team in conversation with workers to understand their lived experiences around a thermal power plant.

This section outlines the detailed methodological approach used to measure the resilience of contractual worker households in the event of livelihood loss due to policy decisions related to the transition from coal to renewable energy. It explains variables associated with different types of capitals, their assigned weights, and the calculations used to construct a composite resilience score for our analysis.

4.1 Methodology

We developed a set of quantifiable indicators to measure different livelihood capital stocks based on the literature (Babulo et al., 2008; Chambers & Conway, 1991; Gupta, Goyal, & Bhattacharya, 2022; Nelson & Stathers, 2009; Quandt, 2018; Sen, 1999). Additionally, we conducted qualitative interviews at the three locations to explore local perspectives on livelihood strategies, power dynamics within and outside the plant between contractual workers, permanent workers, and management, the resources required to transition to alternative livelihoods, and the risks posed by the power plant's closure. These visits have deepened our understanding of the impacts of plants' closure on the livelihoods of contractual workers and highlighted various capacity gaps. Filling these capacity gaps can help contractual workers adapt and recover during the transition. Access to social welfare schemes and the influence of political authorities have emerged as key indicators of resilience in household livelihood strategies. Further, a community is not a homogeneous unit, and there are internal differentiations within it, as noted by others (Agrawal & Gibson, 1999). The effect of contextual indicators can vary significantly within the community due to differing power structures and capabilities. Therefore, our indicators focus not only on the availability of resources but also on the households' access to social and political networks (Quandt, 2018), which may be essential for the rearrangement of resources to generate alternative livelihoods.

> **Multi-dimensional non-Resilience Index is a measure of spread and intensity of household level (non) resilience of contractual workers employed in the coal-fired thermal power plants across economic, social, human, political and state welfare dimensions.**

We used the Alkire-Foster Methodology[8] (Alkire & Foster, 2011) to generate a Multidimensional Non-Resilience Index[9] for contractual workers in thermal power plants. This method has been widely used to measure poverty and its intensity across developing countries and in various poverty indices, such as the global Multidimensional Poverty Index (MPI) by the Oxford Poverty & Human Development Initiative (OHPI), and the United Nations Development Programme (UNDP), national MPI by the National Institute for Transforming India (NITI Aayog), and MPI for Latin America (Pasha, 2017; Santos & Villatoro, 2018). These indices have been central to the design and implementation of poverty eradication policies across the developing world (Alkire & Santos, 2014). The Alkire-Foster method allows for the measurement of both the proportion of the deprived individuals and the average number of dimensions in which they are deprived, aiding in a more accurate estimation of poverty and designing targeted programmes for poverty eradication (ibid.). Oxfam has argued that the Alkire-Foster method is apt for measuring resilience due to its multidimensional nature and the ability to capture complex factors (Oxfam, 2013). In this paper, we primarily followed the Alkire-Foster methodology, with adjustments to suit our specific needs and data requirements.

The Alkire-Foster Methodology specifies binary cut-offs for each indicator to reduce them into binary variables. However, specific indicators, such as caste, skill level, and dignity-related perceptions, are relative and should not be compressed into binary variables at

[8] See Annexure 3 for details.

[9] Multi-dimensional non-resilience index measure ratio of non-resilient workers by considering multiple deprivations simultaneously across wages and economic wellbeing, social and human capital, access to political networks, and welfare schemes.

the indicator level. Therefore, we first constructed capital scores using simple composite indices based on the weighted sum of different indicators. Our methodology preserves these nuances through the relative scoring of all indicators. Survey results for each indicator were then scaled from 0 to 1. Results were assigned such that a value of 1 represented the most desirable response, and a value of 0 represented the least desirable response. For example, households received a score of 1 if their MPCE fell in the fourth quartile, 0.75 if their MPCE was in the third quartile, 0.50 if their MPCE was in the second quartile, and 0.25 if their MPCE was in the first quartile. Questions with binary answers were scored as 1 for yes and 0 for no. This approach assumes that higher scores indicate more excellent livelihood assets and resilience, helping to maintain the reliability of the data.

However, one of the critical weaknesses of earlier studies based on the Alkire-Foster approach is that they assign equal weights when measuring household resilience (Below et al., 2012). The weighing of indicators is essential, as not all indicators affect resilience equally (ibid.). Nonetheless, it is challenging to operationalise an objective scheme to weigh relatively abstract determinants of resilience at the household level (Glwadys, Hassan, & Ringler, 2010b; Glwadys, Ringler, and Hassan, 2010a). Scholars have used principal component analysis to determine the weights objectively, but these weights are determined by the data structure, often resulting in biased weights (Below et al., 2012). Therefore, this paper adopts a unique weighing scheme based on our qualitative interviews and focus group discussions with the community and assigns weights to each indicator. While a community-based weighing scheme can be biased and subjective, it is more grounded and reflects local realities rather than being arbitrarily decided by the researcher. In the future, we would like to base our method on the literature concerning the weighing of indices and develop a more objective weighing scheme for measuring livelihood resilience. The scores for each indicator are multiplied by the weights in Table 2, and composite scores for each capital are computed. However, we still assign equal weights to the capital stocks, as others have done (Alkire & Santos, 2014; NITI Aayog, 2023; Santos & Villatoro, 2018), due to difficulties in operationalisation and the absence of clear understanding from our qualitative engagement with the community.

Table 2 **Resilience indicators associated with different capital stock and their descriptive statistics**

Capital stock	Indicator	Indicator weight	Capital weight	Standard deviation
Economic capital	Monthly per capita income	0.18		2466.24
	Household land possession	0.18		0.4889
	House ownership status	0.18		0.2335
	Household insurance cover	0.09		0.4111
	Employee provident fund cover	0.09		0.4345
	Household dependency ratio	0.09	0.2	0.8417
	Livelihood diversity index	0.09		0.5722
	Institutional access to credit*	0.09		0.4971
Social capital	Household caste category	0.33		0.7675
	Social organisation participation	0.33	0.2	0.3576
	Migration status	0.33		0.8112
Human capital	Education	0.15		1.5271
	Skill category	0.25		0.8678
	Job resilience index[10]	0.20		0.1828
	Physical health	0.20	0.2	0.1377
	Mental health	0.20		0.1680
Political capital	Membership of labour union	0.50		0.3459
	Participation in public meetings	0.25	0.2	0.9615
	Access to local politicians	0.25		0.9617
Access to welfare	ESI	0.33	0.2	0.4793
	Ration card	0.67		0.4174

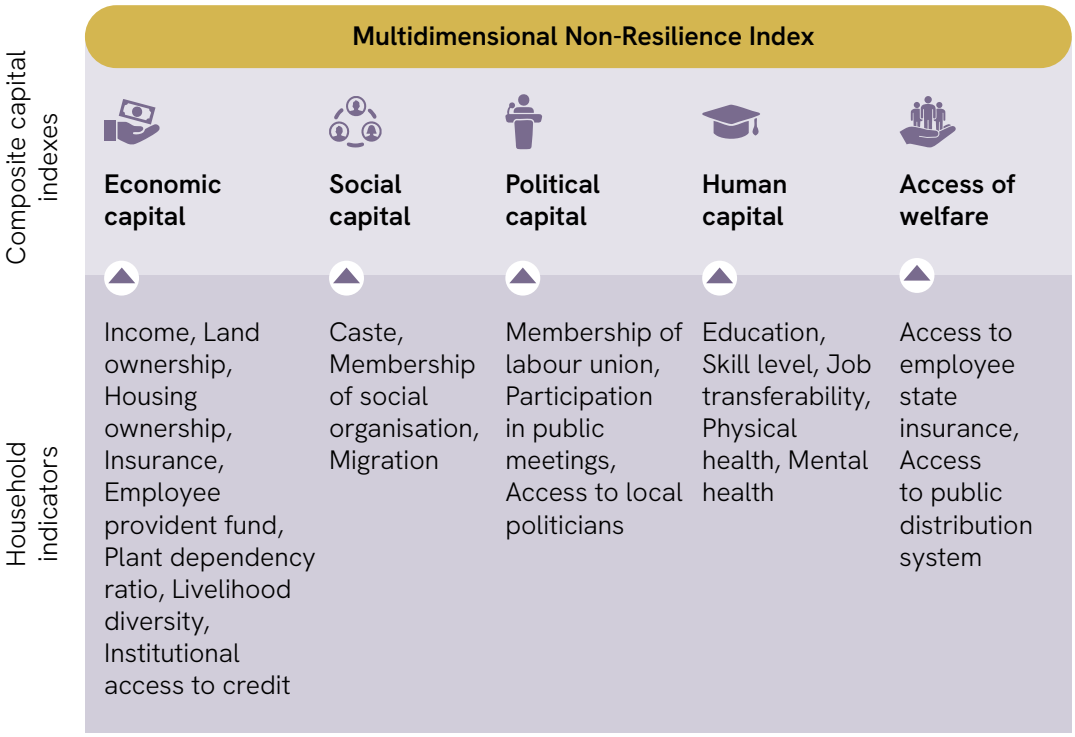
Note 1: All capital stocks have equal weightage in the resilience index, and the indicator weightage in the column corresponds to the particular capital.

Note 2: We do not have data on institutional access to credit for all households. Thus, we have dropped it from our main calculations but calculated a multidimensional resilience index for households with data on access to institutional credit separately, and the results are presented in Annexure 2.

[10] See Annexure 4 for more details.

Mean	Comment
2854.579	A categorical variable based on income bracket
0.6074	Yes = 1, No = 0
0.9423	Yes = 1, No = 0
0.2148	Yes = 1, No = 0
0.7483	Yes = 1, No = 0
2.2448	A categorical variable based on the bracket of dependency ratio
1.4573	A composite index comprising equal weightage to the number of income sources and number of persons employed in the plant
0.4391	Yes = 1, No = 0, data not available for all households
2.7621	General (1), OBC (2), SC (3), ST (4)
0.1501	Yes = 1, No = 0
2.4965	Yes = 1, No = 0
3.1132	A categorical variable based on education
2.0624	Unskilled (1), Semi-skilled (2), Skilled (3)
0.6990	A composite index of equal weightage to the perception of existing competencies and transferability of skills
0.8163	A composite index of equal weightage to existing chronic disease, physical disability, and perception of everyday fatigue
0.6662	A composite index of equal weightage to average sleep hours and perception of dignity at the workplace
0.1386	Yes = 1, No = 0
1.9630	Yes = 1, No = 0
2.2610	Yes = 1, No = 0
0.3557	Yes = 1, No = 0
0.7760	Yes = 1, No = 0

Figure 2 **A pictorial representation of the methodology**



Source: (Quandt 2018)

A household is considered resilient if it surpasses the threshold value in at least three capital stocks.

Using the Alkire-Foster method, we created binary values for each household's capital score using two threshold values: one at the 67th fractile[11] and the other at the median[12]. The 67th fractile value was chosen as the threshold value because the contractual worker population is already a vulnerable group, and very few are generally resilient. Meanwhile, the median is a standard threshold value used to construct relative scores in multidimensional indices (Alkire & Santos, 2014). A household is considered resilient for a particular capital if it exceeds its threshold value; otherwise, it is considered non-resilient. Each household has been assigned a score of 0 for resilient or 1 for non-resilient on each capital using the above method, which produces two non-resilience score matrices for the entire sample: one for the 67th fractile and the other for the median.

Next, we multiplied the non-resilience score matrices by their respective capital weights to generate weighted non-resilience score vector matrices for the entire population. Using standard matrix operations, we summed up the weighted capital scores of each household, which produced two single-column matrices with the final capital score, referred to as the total weighted non-resilience vector. For further calculations according to the Alkire-Foster methodology, we replaced the weighted non-resilient vector score of households with zero if that household has a non-resilience score less than 0.6. In other words, a household is considered resilient if it has a resilience score greater than the threshold for at least three capital stocks. The new matrices, with zero scores for overall resilient households, are known as censored non-resilient vectors, which are used to calculate the headcount ratio, intensity, and indices described by Alkire and Foster (2011). Further, we also calculated the contribution of different capitals in the overall non-resilience of households and divided our sample into various groups based on caste, plant location, and skill level to assess the variability in resilience and the variation in factors influencing the resilience of households among other groups.

[11] 2/3rd of households fall below the 67th fractile value for the sample.
[12] 50% of the households are below the median value for the sample.

4.2 Data and preliminary observations

Residential shacks of contractual workers stand in contrast to a multi-storey residential building designated for plant officials in the background.

This study is based on a primary survey of 433 households of contractual workers employed in three coal-fired thermal power plants.

Chhabra
180 households

Kota
118 households

Suratgarh
135 households

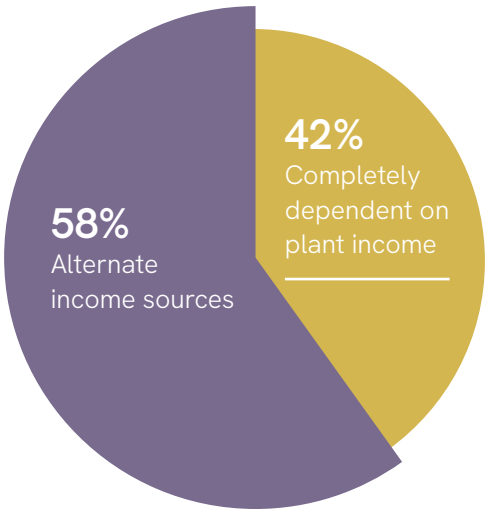
These plants are distinct from each other and represent the diversity within Rajasthan's thermal power stations. Chhabra Thermal Power Plant (CTPP), the newest of the three, is situated in the economically disadvantaged district of Baran. Kota Super Thermal Power Station (KSTPS), the oldest, faces an imminent retirement threat and is located within city boundaries. Suratgarh Super Thermal Power Station (STPS), a supercritical thermal power plant in agriculturally prosperous northern Rajasthan, relies on water from the Indira Gandhi Canal. Hence, we adopted a clustered random sampling method to get statistically representative data at the plant level. Enumerators conducted household surveys by visiting every other household along the transect route for the day and interviewing contractual workers at their residences. The average household size is six, with 1.43 persons per household directly or indirectly employed in the thermal power plant. The average age of respondents was 32 years, and 94% were male. Additionally, 43% of households reported that income from the plant is their primary source of livelihood.

94%
of respondents were male

43%
of households reported that income from the plant is their primary source of livelihood

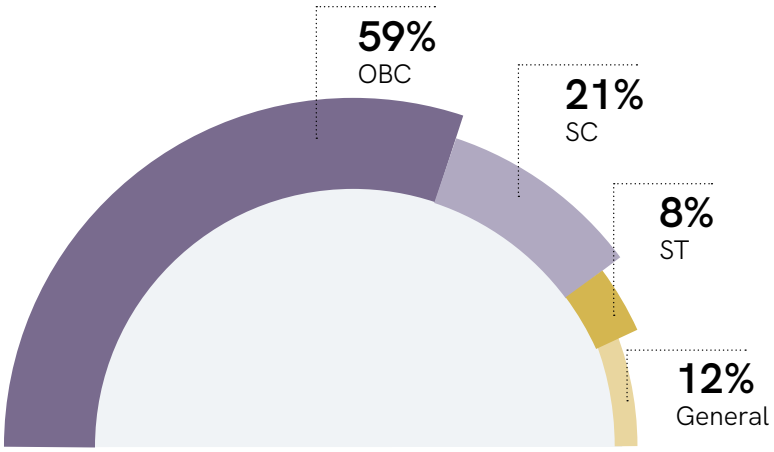
The exploratory analysis of primary data shows that most contractual workers primarily depend on thermal power plants for their livelihood, and only 42% have an alternative income source (Figure 3). In addition, the majority of the workers are from weaker sections of society (Figure 4), lack access to capital or social networks, and often face discrimination. They are politically and socially disempowered, economically weak, and hence, less resilient to the sudden changes in their lives and livelihoods. Most of these workers need to participate in social organisations that can help them network, build collaborations, and act as safety nets in the event of adverse occurrences. The data shows that only 18% of the total workforce participates in the activities of any social organisation (Figure 5), significantly limiting their ability to counter historical and hegemonic inequalities in terms of social capital. In fact, 71% of those who participate are involved in caste and religion-based groups, which indicates the prominence of caste and religion-based boundaries. Participation within caste and religious groups is limited to OBC contractual workers in KSTPS, while participation in social or other organisations is almost non-existent in STPS and CTPP.

Figure 3 **Share of households with an alternate income source**



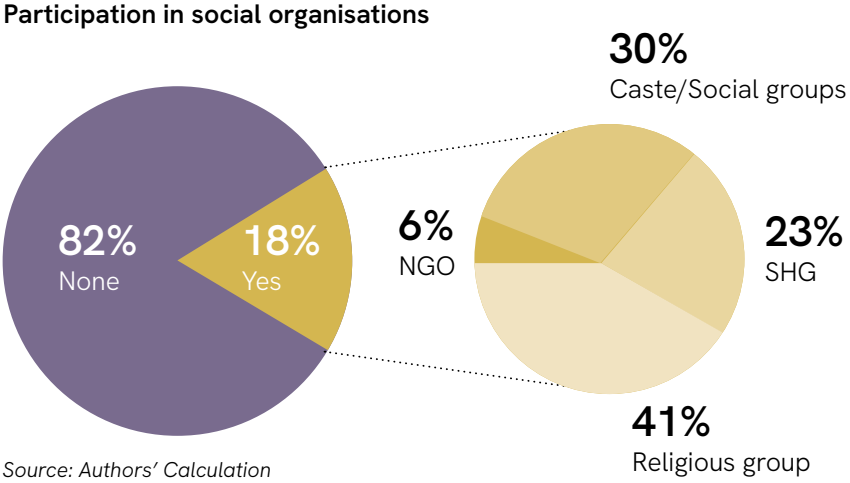
Source: Authors' Calculation

Figure 4 **Caste composition of the sample**



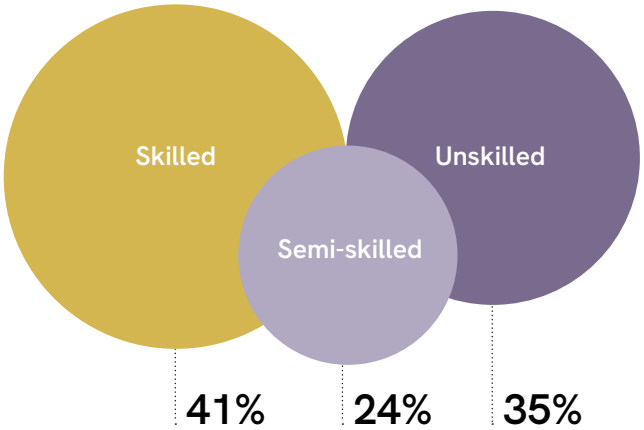
Source: Authors' Calculation

Figure 5 **Participation in social organisations**



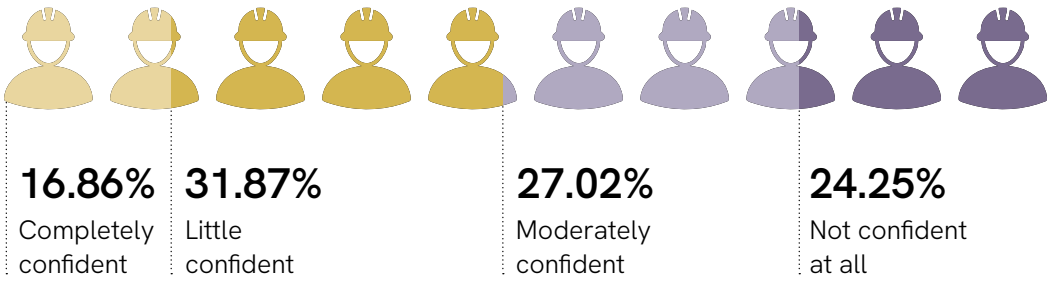
Source: Authors' Calculation

Figure 6 **Skill category of the respodents**



Source: Authors' Calculation

Figure 7 **Workers' confidence in finding another job within a 60 km radius of the current place of residence[13]**



Source: Authors' Calculation

Furthermore, most contractual workers are either semi-skilled or unskilled and lack confidence in finding a job in case of job loss, as shown in Figures 6 and 7. Further, respondents belonging to OBCs, SCs, and STs have a higher proportion of unskilled workers in comparison to general caste respondents (Figure 8). Low human capital significantly reduces their ability to raise concerns during collective actions due to weak communicative and discursive

[13] 60 km is used as a benchmark for acceptable commuting distance to secure and maintain employment in India.

capabilities within the space. The data shows that only 14% of contractual labourers in the total workforce are part of a labour union (Figure 9). However, the labour union for contractual workers exists only in KSTPS, and even then, it has limited membership[14].

Figure 8 **Distribution of skills across caste categories**

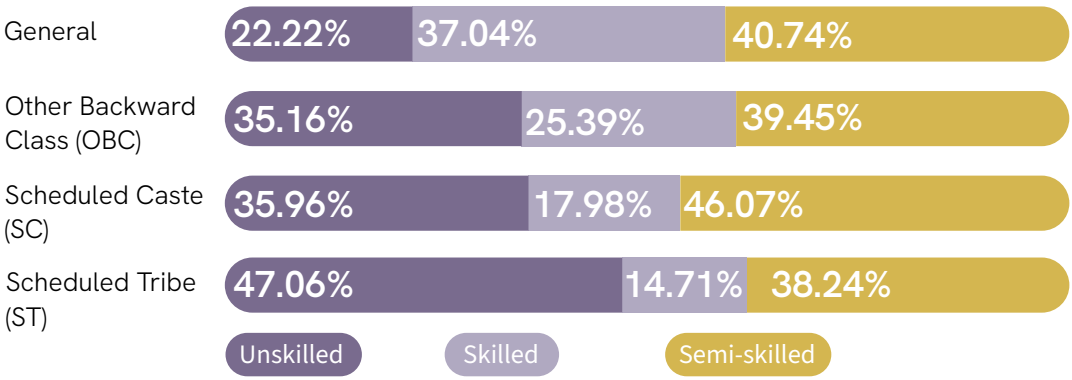
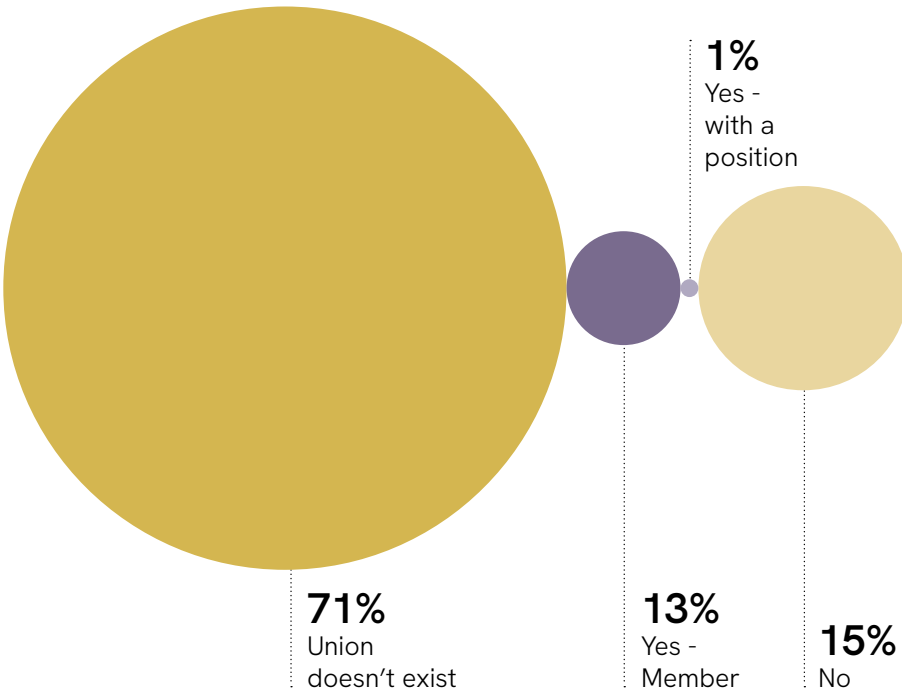


Figure 9 **Membership in labour union**



Source: Authors' Calculation

[14] Labour unions of contractual workers remain unrecognised by the management, and do not get a seat on negotiation table. Hence their concerns remain on the margins.

Preliminary data analysis reveals that most contractual workers are worse off regarding economic, social, political, and human capital. Most of them live in precarious conditions and are unlikely to maintain their current level of well-being in the case of job loss due to an exogenous shock. Therefore, a detailed analysis of their resilience is needed to design interventions to improve their resilience.

A village in the neighbourhood of a thermal power plant with open drains and muddy pathways.

The display board of the Hind Mazdoor Sabha (Contract Workers' Union) placed outside the main gate of a thermal power plant (above); union members in conversation with the CEEP team (below).

Office of one of the permanent workers' unions, operating in decent condition within the plant premises (above); view from inside a union meeting (below).

05

Results

A worker carrying wires and tools inside a power plant as part of his daily routine.

84% of contractual workers are non-resilient, lacking resources to navigate the transition.

The household non-resilience score, or Multidimensional Non-Resilience Index, is presented in Table 3 for the entire population and different subgroups. The results clearly show a very high level of non-resilience among contractual workers' households across the thermal power plants in Rajasthan. Our findings indicate that 84% of households are non-resilient across the plants at the 67th fractile level and lack sufficient resources to maintain their current level of well-being without endogenous support. The Multidimensional Non-Resilience Index at the 67th fractile level is 0.673, indicating a high prevalence of non-resilience among contractual workers. These results show similar values even at the median level (Annexure 1). However, the prevalence of non-resilience among contractual workers is not homogeneous, and certain social groups are more advantaged than others due to social and historical reasons.

Table 3 **Multidimensional Non-Resilience Index for contractual workers in thermal power plants**

Group	H = Headcount ratio (in %)	A = Intensity[15] (in %)	Multidimensional Non-Resilience Index
Overall	84.06	80.00	0.673
Skill level			
Skilled	72.88	74.11	0.540
Semi-skilled	87.73	80.43	0.706
Unskilled	94.66	85.07	0.805
Social groups			
General	70.37	74.74	0.526
OBC	85.15	78.99	0.673
SC	86.51	84.16	0.728
ST	91.17	83.23	0.759

Source: Authors' Calculation

Scheduled Tribe, Scheduled Caste, and OBC workers are worse off than those from the general caste, indicating the perpetuation of historical socio-material inequalities.

Our results show that the social group-based analysis follows the traditional division of caste groups in India, with the prevalence of non-resilience being highest among scheduled tribes, followed by scheduled castes, other backward castes, and least among the general castes. The sample's Multidimensional Non-Resilience Index for ST households is 45% higher than for general caste households at the 67th fractile level. The sample was also subdivided based on skill level: skilled workers demonstrate the highest resilience, followed by semi-skilled and unskilled workers. Similarly, households with access to social security benefits, such as Employee State Insurance (ESI), are significantly more resilient than those without access. The social group-based bifurcation of the sample also shows that both the headcount ratio and intensity of non-resilience are proportional to the socio-economic positions of the respective groups, as shown in Table 4. Thus, the traditionally weaker sections are less resilient than the others, suggesting that historical social and economic inequalities may intensify during the transition without policies supporting the just transition of communities.

[15] Intensity refers to the severity of non-resilience among the non-resilient households.

Table 4 **Multidimensional Non-Resilience Index across different groups**

Social group	Skill Level	H = Headcount ratio (in %)	A = Intensity (in %)	Multidimensional Non-Resilience Index
General	Skilled	50.00	70.90	0.355
	Semi-skilled	85.00	75.29	0.640
	Unskilled	83.33	78.00	0.650
OBC	Skilled	74.26	73.07	0.543
	Semi-skilled	89.23	79.31	0.708
	Unskilled	94.44	84.00	0.793
SC	Skilled	78.05	77.50	0.605
	Semi-skilled	87.50	88.57	0.775
	Unskilled	96.88	89.03	0.863
ST	Skilled	84.62	74.55	0.631
	Semi-skilled	80.00	90.00	0.720
	Unskilled	100.00	87.50	0.875

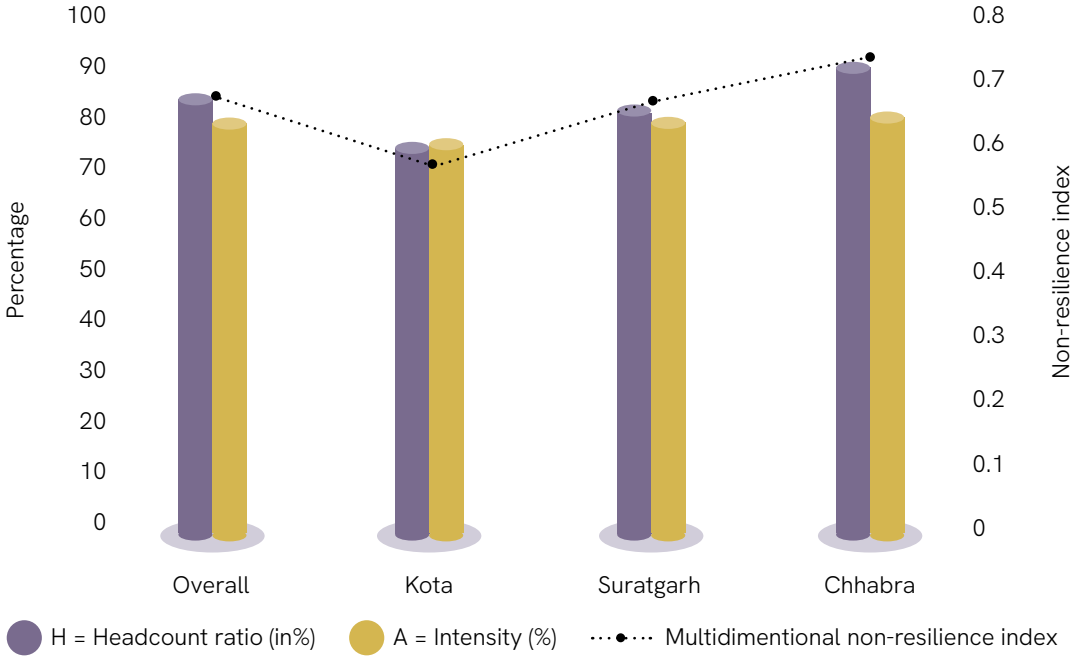
Source: Authors' Calculation

Caste-based inequalities persist, making a skilled worker from a Scheduled Tribe or Scheduled Caste more vulnerable than an unskilled worker from the general caste. However, within any caste category, skilled workers are more resilient than semi-skilled or unskilled ones.

We intersected caste and skill levels to analyse the interaction of two primary categories that drive socio-material and historical inequalities (Table 4). Differentiation in skill level impacts households differently within the same caste groups while enabling a more nuanced comparison of different caste groups according to their skill level. This analysis helps understand resilience patterns among contractual workers by caste and skill level. The results show that skilled workers are more resilient than semi-skilled and unskilled workers within the caste groups. This holds for both the headcount ratio and intensity of non-resilience within a caste group, confirming the results for the overall sample.

Caste-based inequalities also hold across all skill categories, and the results show that a skilled worker from a general caste is 57% more resilient than a skilled scheduled tribal worker. This means that both caste- and skill-based social divisions will impact the resilience of a household during the transition. While caste and skill categories behave as expected, a skilled scheduled tribe worker is much worse off than a general semi-skilled worker and almost equally worse off than a general unskilled worker. The trends remain similar for workers from the other backward and scheduled castes compared to the general caste workers. It indicates that historical socio-material inequalities are potent determinants of resilience among contractual workers, and different social groups may need customised support to successfully navigate through the transition.

Figure 10 **Multidimensional Non-Resilience Index across plants**

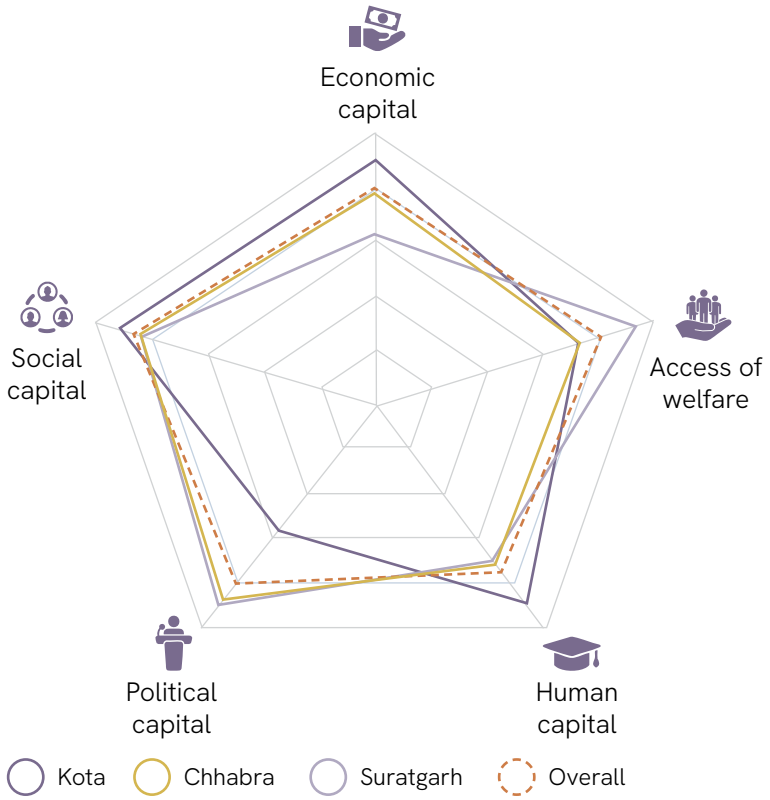


Source: Authors' Calculation

There are significant spatial variations in terms of the resilience of contractual workers. Contractual workers are most resilient in Kota, followed by Suratgarh and Chhabra.

Furthermore, we subdivided the sample based on plant locations and calculated the Multidimensional Non-Resilience Index to analyse the effect of spatial inequality and understand variations in the contribution of different dimensions. Our results show that workers in KSTPS are comparatively the most resilient, followed by STPS and CTPP (Figure 10). These results indicate that the non-resilience index of workers in CTPP is 30%, and in STPS, it is 13% higher than that of KSTPS. While the headcount ratio of KSTPS and STPS is almost equal, there is a significant gap in the intensity of non-resilience. However, workers in CTPP are worse off in both headcount ratio and intensity than those in KSTPS. It is surprising to see such stark differences in the resilience capacity of contractual workers across three locations, as all three power plants are owned and operated by the same public sector company, Rajasthan Vidyut Utpadan Nigam Limited (RVUNL). We assume that RVUNL provides similar compensation, social security policies, safety norms, and welfare support for contractual workers across all three plants. However, other spatial differences may contribute to the variation in the resilience of contractual workers across these locations. Thus, we analysed the contribution of economic, social, human, political, and state capitals or access to social welfare schemes.

Figure 11 **Capital-wise contribution in household non-resilience across locations**

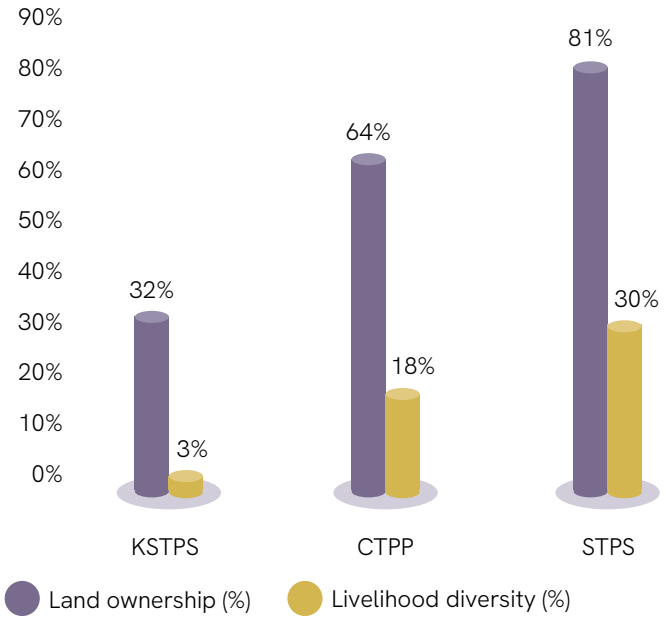


Source: Authors' Calculation

Non-resilience due to economic or financial capital is highest among the contractual workers in KSTPS, followed by CTPP, and least in STPS, primarily due to differences in land ownership and income diversity.

First, non-resilience due to economic or financial capital is highest among the contractual workers in KSTPS, followed by CTPP, and it is least in STPS (Figure 11). The primary reasons for variation in non-resilience in economic capital dimensions are differentiation in land ownership and income diversity. As shown in Figure 12, only 32% of contractual workers in KSTPS possess land, compared to 64% in CTPP and 81% in STPS. The possession of land is an important asset for resilience during livelihood shocks. Similarly, the livelihoods of contractual workers in STPS are more diversified than in CTPP and KSTPS, increasing the resilience of households during transitions, as found by others (Hodbod & Eakin 2015). Thirty per cent of households in STPS have more than one income source, compared to 18% in CTPP and a mere 3% in KSTPS (Figure 12). While the overall non-resilience index is low in KSTPS, its workers are less resilient compared to those in suburban and rural locations regarding the stock of economic resources. Higher real estate prices in urban areas and the implementation of welfare schemes like the Mahatma Gandhi National Rural Employment Guarantee Act, 2005 (MNREGA) in rural areas could be the primary reason behind the disparity between KSTPS, STPS, and CTPP.

Figure 12 **Spatial differences in economic capital across locations**

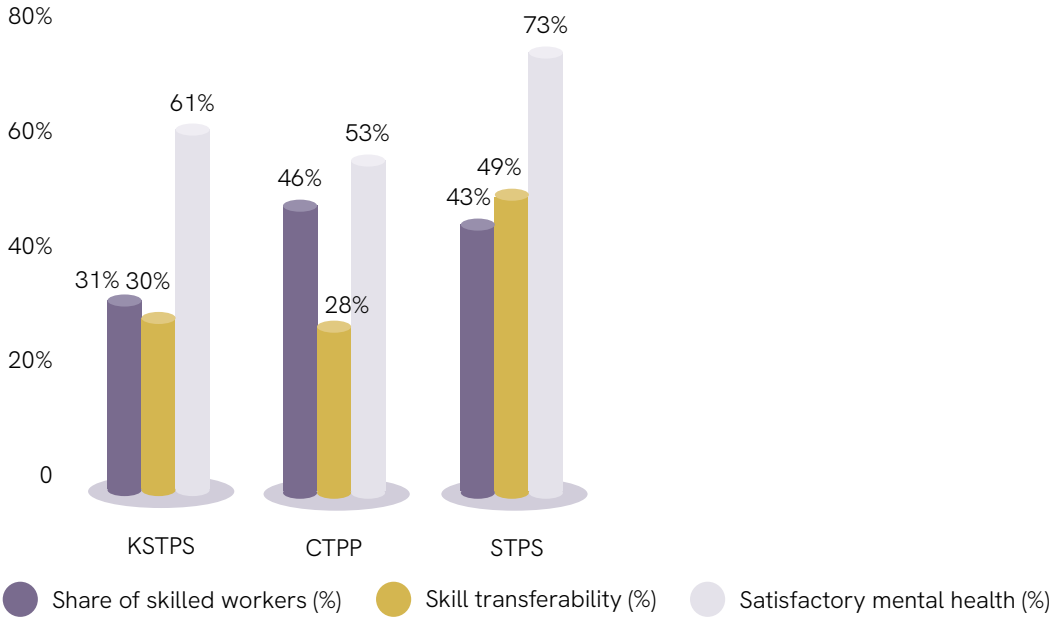


Source: Authors' Calculation

> It is necessary to increase information penetration and link workers from weaker sections to networks that may strengthen their linkages in securing new livelihood opportunities.

Second, the contribution of social capital to overall non-resilience is similar across the plants, as most contractual workers are from weaker sections of society, such as OBC, SC, and ST groups. However, STPS has the lowest contribution of social capital to overall non-resilience (Figure 11) due to a higher proportion (24%) of general caste among contractual workers compared to CTPP (7%) and KSTPS (8%). Caste in India plays an essential role in accessing networks, information, and support systems during crises (Gupta, Veettil, & Speelman, 2020), making it an essential determinant of resilience in India. Furthermore, caste concentration is also significant in searching for jobs, referrals, and apprenticeships (Chari, 2000), positioning upper-caste workers significantly higher regarding social capital. Therefore, it is necessary to increase information penetration and link workers from weaker sections to networks that may strengthen their linkages in securing new livelihood opportunities.

Figure 13 **Spatial differences in human captial across locations**

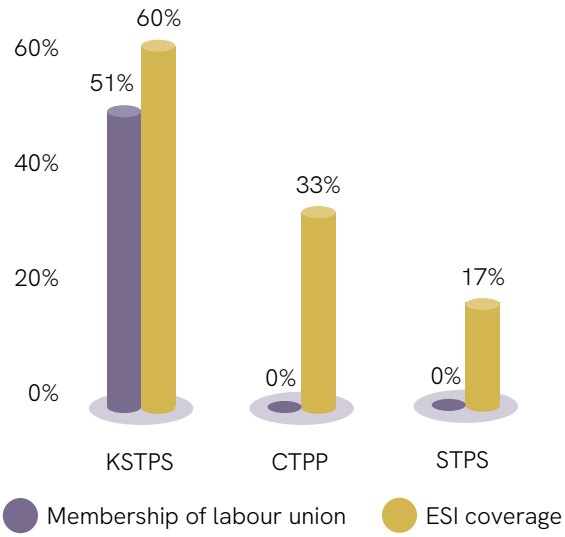


Source: Authors' Calculation

> The higher contribution of human capital to the overall non-resilience of households highlights the need for upskilling, enhancing the transferability of current skills to other industries, and improving working conditions to boost overall resilience.

Third, STPS and CTPP have lower contributions of human capital to overall non-resilience than KSTPS (Figure 11). Figure 13 illustrates that KSTPS has fewer skilled workers than CTPP and STPS. Contractual workers in CTPP and KSTPS also exhibit lower job transferability and weaker mental health compared to those in STPS. The higher contribution of human capital to the overall non-resilience of households highlights the need for upskilling, enhancing the transferability of current skills to other industries, and improving working conditions to boost overall resilience.

Figure 14 **Spatial differences in political capital and access to welfare schemes**



Source: Authors' Calculation

Contractual workers in Kota show greater resilience than those in Suratgarh and Chhabra, despite facing worse conditions in most aspects - except for labour union membership. This highlights that political organisation is the most powerful tool for strengthening worker resilience.

Fourth, KSTPS has the lowest contribution of political capital to non-resilience compared to CTPP and STPS (Figure 11). While nearly 50% of contractual workers in KSTPS are part of a labour union, there is no labour union for contractual workers in CTPP and STPS (Figure 14). A labour union provides a platform through which contract workers can negotiate collectively, circulate information about their rights, organise themselves, and help workers beyond plant boundaries. The absence of labour unions places the relatively better-off workers of CTPP and STPS in other dimensions behind the contractual workers in KSTPS. Labour unions play a crucial role in restructuring institutional spaces and creating a level-playing field for negotiations between labourers, ensuring the protection of labour interests (Moore et al. 2019). In addition, labour unions provide networking opportunities and strengthen social capital for labourers. These networks can play a vital role in overcoming historical social and economic inequalities, thereby affecting the stock of other capitals. For instance, 60% of contractual workers in KSTPS are covered under the ESI scheme, which provides medical facilities for workers and their families (Figure 14).

In contrast, the corresponding figures for STPS and CTPP are just 17% and 33%, respectively (Figure 14). Studies indicate that idiosyncratic shocks, such as illness, are one of the most significant contributors to income and consumption decline, with people experiencing poverty often forced to use their savings to cope with such shocks in the absence of public health and other welfare systems (Jha, Nagarajan, & Pradhan, 2012). Thus, coverage under schemes like ESI serves as a safeguard for contractual workers in thermal power plants facing such idiosyncratic shocks. Labour unions' presence in KSTPS could contribute to better coverage of workers under the state insurance policy, thereby enhancing their resilience. Therefore, despite being worse off in most dimensions, workers in KSTPS may be more resilient than in the other two locations.

The above analysis shows that most contractual workers are non-resilient across all three thermal power plants, with workers from weaker sections of society being more vulnerable than others. Additionally, the contribution of different capital stocks to household resilience varies across locations, and there are endogenous relationships between different capital stocks. For example, higher financial or economic capital can lead to increased human capital, as households with more economic resources can invest in skills and education. Similarly, higher education and skill levels can lead to better economic outcomes, improved network access, and greater access to welfare schemes. Therefore, any intervention aimed at strengthening contractual households' coping and adaptation capabilities should be rooted in spatial dynamics, socio-cultural and political realities, and economic constraints.

06

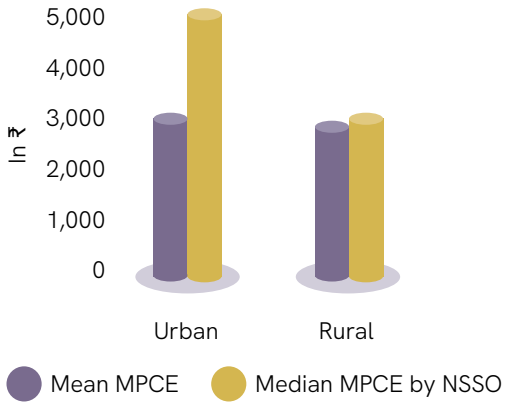
Transitional Readiness: Building Resilience for Contractual Workers in Thermal Power Plants

Increased vehicular movement due to fly ash transportation.

Only 10% of contractual worker households in KSTPS (an urban location) and 20% of those in CTPP and STPS (rural locations) have an MPCE above the median urban and rural MPCE.

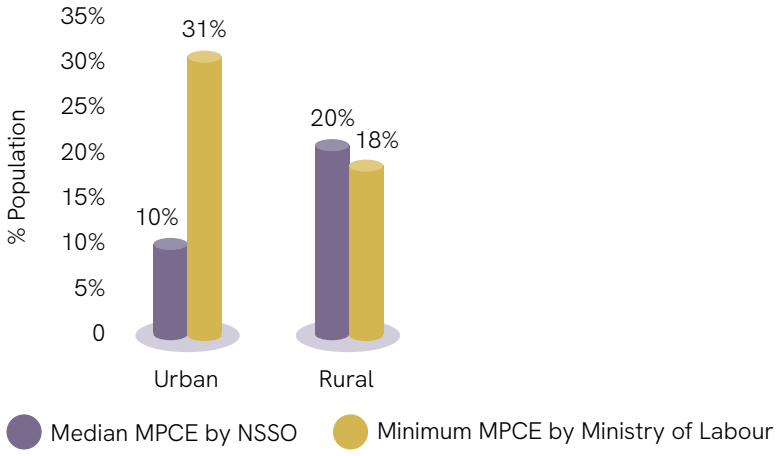
The above results indicate that contractual workers in thermal power plants live in precarious conditions, with most struggling to maintain their current levels of well-being in case of loss of employment. The data shows that their monthly per-capita expenditure (MPCE) is below the median MPCE of rural and urban areas reported in the 79th survey on household consumption and expenditure by the National Sample and Survey Organisation (NSSO) (NSSO, 2024). Only 10% of contractual worker households in KSTPS (an urban location) and 20% of those in CTPP and STPS (rural locations) have an MPCE above the median urban and rural MPCE reported by NSSO (Figure 15). Furthermore, the MPCE reported by contractual worker households falls below the threshold recommended by the expert committee on determining the methodology for fixing the national minimum wages of the Ministry of Labour and Employment, Government of India (Ministry of Labour and Employment, 2019). Moreover, these contractual workers face deprivation on the non-economic front with low social, human, and political capital, making them more vulnerable during idiosyncratic events. Their non-economic and economic deprivation stems from their current precarious working conditions. Therefore, we propose a two-pronged strategy to improve working conditions, reskilling opportunities, and the overall welfare of contractual worker households to promote a just transition from the coal economy to a new one.

Figure 15 **Survey sample's mean MPCE versus median MPCE by NSSO**



Source: Authors' Calculation

Figure 16 **Percentage of population above the median MPCE by NSSO and minimum MPCE by the Ministry of Labour**



Source: Authors' Calculation

6.1 Continual resilience building programme

A temporary shack in a plant used as an office by contractors and as a resting place by contractual workers.

Resilience building in a community is not a scattered or isolated process; rather, it is an outcome of continual and coordinated programmes that strengthen households across multiple dimensions. It involves improving financial and non-financial capabilities such as physical and mental health, social linkages, and political participation. Contractual workers in thermal power plants face challenges beyond low wages, including poor physical and mental health, unsafe working conditions, limited organisational opportunities, job insecurity, and low pay. Hence, their resilience can be improved with a tectonic shift in their current working conditions. There is an acute need to improve wages, ensure safe working conditions, and increase the job security of contractual workers, which will positively impact the political, social, human, and economic capital of contractual workers' families.

However, the socio-economic situation of contractual workers varies across power plants in terms of human, social, and political capital, as well as welfare access, as shown in previous sections. Based on the current capital stock of contractual workers at different locations and their specific needs, we propose customised programmes across different plants to strengthen the capital stock based on its contribution to non-resilience. Programmes to improve the highest contributing capital to non-resilience at each location have been prioritised. However, it should be recognised that enhancing a particular capital stock will generate positive spillover effects on other capitals, improving the overall resilience of contractual workers.

Contractual workers resuming work at a power plant's coal stockyard after lunch break. Their task involves transferring coal from the stockyard to the conveyors, which transport it to the mills for processing.

6.1.1 Continual resilience building programme for Chhabra Thermal Power Plant

The contractual labour in CTPP faces poor working conditions and lacks access to basic facilities like drinking water, clean toilets, and safety equipment. This absence increases the risks to their health and long-term well-being. The health and hazard risks for contractual workers further increase as CTPP often violates environmental and hazardous waste disposal norms, making this the largest contributor to non-resilience in Chhabra. Most of these basic issues still need to be resolved due to low political capital among workers (Figure 5). Addressing these issues requires that labourers represent their interests and advocate for their rights to the management and government authorities. Their lack of representation leads to the exclusion of their interests in decision-making processes, feeble collective action and advocacy, and limited dissemination of information related to workers' benefits and welfare schemes.

Additionally, organising workers can help reduce socio-historical inequalities rooted in caste- and community-based networks, thereby empowering workers from weaker sections of society. We argue that organisations such as labour unions improve working conditions, ensure decent wages, and increase access to different socio-political and cultural networks, thereby enhancing workers' aspirational capacity and collaborative abilities. These improvements can lead to enhanced overall resilience and improved well-being. Therefore, we recommend that the government, political parties, and management work to organise contractual workers and encourage their participation. This would result in the political empowerment of workers and better implementation of welfare schemes such as the Provident Fund and ESI. Consequently, workers' political organisation should be the top priority of CTPP.

After improving the weakest capital of contractual workers at each location, interventions should focus on secondary aspects to further improve the resilience of contractual workers. In the case of CTPP, we recommend an upskilling programme to improve employability and enhance income. CTPP has low livelihood diversity (Figure 12), and skill transferability (Figure 13) is the second-largest contributor to the non-resilience of contractual workers at the plant. Therefore, upskilling programmes and the organisation of workers for collective negotiation should improve their overall resilience.

In certain areas, interventions may not have a direct impact but can indirectly improve workers' resilience. While most contractual workers are literate, literacy alone is not helpful if it cannot be translated into functional competencies in various aspects of life. We recommend explicitly designing programmes focused on financial literacy, workers' rights, remediation, and establishing common facilities such as libraries, youth and sports clubs, environmental clubs, and other associations. These activities will not only disseminate knowledge and raise awareness but also foster collaboration that supports contractual workers, strengthening their ability to organise, negotiate, and counter the effects of socio-historical inequalities. These initiatives must continuously enhance inter- and intra-community dialogue and cooperation. Furthermore, these activities can help raise awareness about social security schemes that could strengthen the resilience of contractual workers.

Coal being unloaded from railway wagons into a coal bunker via a wagon tippler at a thermal power plant. A fog gun is in operation, controlling coal dust during the unloading process.

6.1.2 Continual resilience building programme for Kota Super Thermal Power Station

KSTPS has an active labour union, resulting in better implementation of welfare schemes, stronger networks, and other positive externalities. As a result, workers in Kota enjoy relatively better working conditions, such as access to drinking water, clean toilets, safety equipment, and medical facilities. However, workers in KSTPS are entirely dependent on the plant for their livelihood and have the least livelihood diversity (Figure 12), leaving them worse off than workers at other plants. One potential reason could be the low share of skilled workers and limited skill transferability (Figure 13). Additionally, since Kota is an urban location, workers neither engage in supplementary activities such as agriculture nor do they have access to rural welfare schemes such as the MNREGA. High dependency on the plant is a key factor in the non-resilience of contractual workers in Kota, which could be addressed through an upskilling programme. This programme would improve their income and livelihood diversity, reducing their reliance on KSTPS for employment. These skills would also help workers search for new jobs in case of retirement from KSTPS. Therefore, the upskilling programme should be the top priority at KSTPS as it will enhance workers' coping and adaptation capabilities during the transition from fossil to non-fossil fuel energy sources.

The second priority should be strengthening the current labour union and providing more avenues for social and cultural interactions. Most contractual labourers come from historically weaker sections of society with low social capital, which limits their ability to organise livelihoods, access safety nets, and enhance their capacity to aspire. The organisation of labour in KSTPS will help workers overcome such historical socio-material disadvantages. These organisations can also promote economic activities by helping workers form self-help groups and cooperative societies, thereby assisting workers in diversifying their livelihoods and accessing networks to secure alternative jobs in other industries in Kota, a large city. Additionally, most workers in Kota live in rented housing, which significantly increases their cost of living and vulnerability. Therefore, KSTPS should allocate some unused land to contractual workers to improve their well-being. In addition to this, there should be ongoing efforts to raise awareness about workers' rights, occupational safety, and livelihood diversification in the long term.

6.1.3 Continual resilience building programme for Suratgarh Thermal Power Station

Similar to CTPP, contractual labour at STPS suffers from poor working conditions, long working hours, lack of access to drinking water and clean toilets, and limited access to welfare schemes. These poor working conditions contribute to poor mental health and low social and human capital, which need to be improved. Therefore, focused efforts should be made to organise labour as in CTPP to enhance working conditions. Most of these basic issues are rooted in the low political capital of labour (Figure 5). Hence, the political organisation of labour should be the top priority of STPS, which should have similar positive effects as seen in CTPP.

After addressing the weakest capital of contractual workers at each location, interventions should focus on secondary aspects to further improve their resilience (Table 5). In the case of STPS, we recommend an upskilling programme to improve employability and enhance income. STPS, like KSTPS, has low livelihood diversity (Figure 12) and limited skill transferability (Figure 13), with human capital being the second-largest contributor to non-resilience among contractual workers. Therefore, upskilling programmes and the organisation of workers to enable collective negotiation should enhance overall resilience. However, in STPS, workers also suffer from poor mental health due to insufficient sleeping hours, poor working conditions, and a lack of access to welfare schemes. While the political

organisation of workers should address these issues to some extent, active interventions to improve working conditions and increase access to welfare schemes will further strengthen their resilience. An upskilling programme similar to those proposed for CTPP and KSTPS should be implemented after improving working conditions.

In certain areas, interventions may not directly impact resilience but can improve workers' resilience indirectly. Most contractual workers are literate, but literacy alone is not helpful if it cannot be converted into functional competencies in various aspects of life. We recommend explicitly designing programmes on financial literacy, workers' rights, and remediation, as well as establishing common facilities such as libraries, youth and sports clubs, environmental clubs, and other associations. These activities will not only disseminate knowledge and raise awareness but also foster collaboration, providing various kinds of support to contractual workers and strengthening their ability to organise, negotiate, and counter the effects of socio-historical inequalities. These initiatives must continuously enhance inter- and intra-community dialogue and cooperation.

Table 5 **A snapshot of location-wise non-financial interventions**

Priority	Plant	Intervention
High	CTPP	Political organisation of labour
	KSTPS	Upgrading skills and livelihood diversity
	STPS	Political organisation of labour
Medium	CTPP	Upgrading skills, livelihood diversity, and welfare access
	KSTPS	Empowering existing labour unions and strengthening social organisations
	STPS	Upgrading skills and livelihood diversity, welfare access, and improving working conditions
Low	CTPP	Conducting literacy programmes related to finance, workers' rights, and remediation mechanisms and establishing social and cultural organisations
	KSTPS	
	STPS	

Source: Authors' Analysis

The development of non-financial capabilities is a time-consuming and complex process that will not only help improve resilience during the transition but also enhance workers' current situation and their capacity to aspire (Appadurai, 2004). The capacity to aspire plays an essential role in creating pathways to avoid long-term poverty and increase resilience. For example, building human capital can help workers strengthen their networks, improve their physical and mental health, and increase information penetration, which will not only help enhance current livelihoods but may also open new opportunities. However, we cannot assess the cost or efficacy of these interventions due to the unavailability of data, dependence on local factors, and the interconnectedness of interventions. Therefore, it is advisable to develop a coherent programme implementation and monitoring strategy when designing these programmes, which can be used to refine and customise them according to local needs.

6.2 Universal basic income during the transition

The closure of thermal power plants will pose an immediate threat to the livelihoods of contractual workers since they do not have access to secure employment terms and retirement benefits like permanent employees. The cessation of wages from plants will jeopardise their economic and social stability, putting most workers at high risk of falling into long-term poverty. It is assumed that all contractual workers will lose their jobs due to the transition from a coal-based economy, making it essential to provide them with income support to help them maintain their standard of living. Hence, we propose a universal basic income support for all contractual workers for a duration of 6–18 months, depending on their skill level. This section outlines the financial cost of such an intervention under different scenarios based on the number of workers and the duration of support across all thermal power plants in Rajasthan.

The recent NSSO survey on household consumption and expenditure reported that the MPCE for 50% of households is below ₹3,183 in rural areas and ₹5,032 in urban areas, which is less than the global poverty line of $2 (₹170) per day. In the first scenario, we propose monthly support equivalent to the mean MPCE as per the 79th round of the NSSO survey, multiplied by the number of family members for each contractual worker, based on whether the plant is located in a rural or urban location. Furthermore, income support should be extended for at least six months for skilled workers, 12 months for semi-skilled workers, and 18 months for unskilled workers. We assume that skilled workers will be able to find alternative employment directly, while semi-skilled and unskilled workers will need upskilling to become job-ready. Based on our discussions with experts, a skilled worker generally requires 5–6 months to find a new job. In the second scenario, we propose uniform 12-month support for all workers irrespective of their skill level or socio-economic conditions. In the third scenario, we repeat the first scenario but base the MPCE on the recommendations of the expert committee on determining the methodology for setting national minimum wages (Ministry of Labour and Employment, 2019). This estimate, however, should be revised in the future to reflect changes in consumption patterns and inflation rates. The estimates of the total cost under these three scenarios are presented in Table 6. The financial planning for the transition away from thermal power plants should incorporate the cost of this universal basic income support. Due to complex socio-material and historical relationships, we recognise that the income support programme may not fully address equality and distributional justice issues. Therefore, further engagement is essential to capture these nuances and design a more equitable and just support system for contractual workers.

Table 6 **Cost of financial support for contractual workers during transition under different scenarios**

Scenario	Location	Skill level	Number of workers	Average family size (sample)
I	Rural	Skilled	3,464	5.78
		Semi-skilled	1,058	5.81
		Unskilled	2,444	5.78
	Urban	Skilled	896	5.67
		Semi-skilled	441	5.7
		Unskilled	675	5.42
II	Rural	Skilled	3,464	5.78
		Semi-skilled	1,058	5.81
		Unskilled	2,444	5.78
	Urban	Skilled	896	5.67
		Semi-skilled	441	5.7
		Unskilled	675	5.42
III	Rural	Skilled	3,464	5.78
		Semi-skilled	1,058	5.81
		Unskilled	2,444	5.78
	Urban	Skilled	896	5.67
		Semi-skilled	441	5.7
		Unskilled	675	5.42

Source: Authors' Calculation

Note: The cost and MPCE are calculated based on current prices, which need to be adjusted for inflation at the time of designing interventions.

MPCE	Source	Duration (in months)	Cost (in crore)	Total cost (in crore)
		6	₹38.24	
₹3,183	NSSO	12	₹23.48	₹142.65
		18	₹80.94	
		6	₹15.34	
₹5,032	NSSO	12	₹15.18	₹63.65
		18	₹33.14	
		12	₹76.48	
₹3,183	NSSO	12	₹23.48	₹153.92
		12	₹53.96	
		12	₹30.68	
₹5,032	NSSO	12	₹15.18	₹67.94
		12	₹22.10	
		6	₹41.41	
₹3,447	Ministry of Labour	12	₹25.43	₹154.48
		18	₹87.65	
		6	₹10.51	
₹3,447	Ministry of Labour	12	₹10.40	₹43.61
		18	₹22.70	

07

Conclusion

A truck transporting fly ash from a thermal power plant to nearby cement industries.

The disproportionate burden of the energy transition on weaker sections dependent on the existing fossil-fuel-based economy may result in social and political upheavals and can derail energy transition and climate action.

It is important to ensure that the interests of all stakeholders are considered when planning the transition away from fossil-fuel-based plants, ensuring the equitable distribution of the costs and benefits of energy transitions. The disproportionate burden of the energy transition on weaker sections dependent on the existing fossil-fuel-based economy may result in social and political upheavals, creating hindrances to the energy transition and climate action. Thus, it is essential to support all direct, indirect, and allied workers and their families during these transitions and include this cost in transition planning.

The framework above provides a tool to measure the intensity and prevalence of non-resilience among contractual workers and can help policymakers and corporate managers estimate the real cost of the transition by including the cost of resilience enhancement in the retirement plans of thermal power plants. It considers both financial and non-financial aspects and highlights the multidimensional nature of worker resilience. Our framework shows that worker resilience is rooted in their current socio-economic and political vulnerabilities and capabilities. The well-being of most contractual workers in thermal power plants is compromised by inhuman working conditions, low wages, limited access to social security schemes, and insufficient institutional support to address historic socio-material inequalities. To improve the resilience of contractual workers, sustained efforts are required to improve their current conditions. Therefore, this framework recommends early engagement with workers to improve their current working conditions by raising wages, expanding social security schemes, and building networks to support their resilience in the future. Although we calculated the cost of interventions during the transition phase, we were unable to do so for long-term resilience-building programmes due to a lack of data and the complexity of these programmes. We argue that including such costs in transition plans will ensure a just and equitable transition from a fossil-fuel-based economy to a renewable-based economy, ultimately resulting in reduced political and social resistance.

However, we also highlighted that the nature of vulnerabilities and non-resilience varies across locations, social groups, and levels of human capital. Therefore, a just transition should not focus on financial compensation alone; it must invest in the capabilities of vulnerable populations, such as contractual workers. Moreover, this framework helps analyse the root causes of non-resilience among different groups, enabling the design of tailored interventions to improve the resilience of workers dependent on the traditional fossil-fuel-based economy. Although the framework is empirically based on contractual workers employed in coal-fired thermal power plants in Rajasthan, it can also apply to workers in other industries facing risks from climate change, technological innovations, and policy changes. We argue that workers will face similar types of risk due to any form of transition, although the impact of these transitions can vary depending on their nature and may differ across worker classes. Thus, adjustments can be made to adapt the framework accordingly.

While the above-mentioned method for measuring non-resilience, its intensity, and its varied nature marks a step forward, it has some limitations. First, the relative weights of the indicators used to assess capital stocks are based on qualitative interviews with the community; therefore, these weights are not statistically objective. However, developing a relative weightage scheme for the different indicators is outside the scope of this project. Second, the list of indicators associated with each type of capital is not exhaustive; it is based on the literature survey and internal discussions. Consequently, there is a chance that we may have inadvertently omitted some relevant indicators. Third, these indicators are not mutually exclusive; a change in one indicator may influence multiple capital stocks. For example, access to better education improves not only a worker's human capital but also their social capital, access to political networks, and access to welfare schemes. However,

our study did not account for these cross-impacts when calculating capital scores. Fourth, we assigned equal weight to each capital stock that contributes to resilience. However, not all capital stocks affect household resilience equally. To design more nuanced interventions, it is essential to understand inter-relationships between different capital stocks to improve the resilience of households during the transition. Though computing the inter-relativity of different capital stocks was not part of this project, future research could refine interventions, improve efficiency, and reduce costs to enhance the resilience of workers. These limitations can be overcome in future studies without compromising the theoretical foundations of our framework. Despite its limitations, this framework can serve as a policy tool across industries to strengthen the resilience of workers. It can also help corporations, and the state understand the actual costs of transitions and plan accordingly. However, the cost estimates must be updated to account for inflation, consumption levels, and other relevant factors.

08

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Annexure 1

Table A 1.1 **Multidimensional Non-Resilience Index at the median boundary**

Group	H = Headcount ratio (in %)	A = Intensity (in %)	Multidimensional Non-Resilience Index
Overall	77.13626	77.24551	0.595843
Skill level			
Skilled	63.842	70.442	0.450
Semi-skilled	75.472	77.000	0.581
Unskilled	94.000	82.837	0.779
Social groups			
General	57.407	73.548	0.422
OBC	78.906	75.743	0.598
SC	80.899	82.222	0.665
ST	85.294	79.310	0.676

Source: Authors' Calculation

Table A 1.2 **Multidimensional Non-Resilience Index across different groups at the median boundary**

Group	Skill level	H = Headcount ratio (in %)	A = Intensity (in %)	Multidimensional Non-Resilience Index
General	Skilled	31.82	68.57	0.218
	Semi-skilled	70.00	74.29	0.520
	Unskilled	83.33	76.00	0.633
OBC	Skilled	67.33	68.82	0.463
	Semi-skilled	76.92	75.20	0.578
	Unskilled	93.33	81.67	0.762
SC	Skilled	70.73	74.48	0.527
	Semi-skilled	75.00	86.67	0.650
	Unskilled	96.88	87.74	0.850
ST	Skilled	69.23	71.11	0.492
	Semi-skilled	80.00	80.00	0.640
	Unskilled	100.00	83.75	0.838

Source: Authors' Calculation

Annexure 2

Table 2.1 **Multidimensional Non-Resilience Index with access to institutional credit at 67th fractile**

Group	H = Headcount ratio (in %)	A = Intensity (in %)	Multidimensional Non-Resilience Index
Overall	81.410	79.843	0.650

Source: Authors' Calculation

Annexure 3

This section outlines the methodology used for calculating the multidimensional resilience index, the share of the non-resilient population, and the intensity of non-resilience based on the Alkire-Foster Method (Alkire et al., 2015) for this paper.

1. Identification of indicators associated with different capital stocks

We identified quantifiable variables associated with each type of capital stock through a literature survey and qualitative interviews, assigning each quantifiable indicator a relative weight as shown in Table 2. Our quantitative survey collected data on these indicators with each indicator converted to a scale of 0 to 1, where 1 indicates the most desirable response and 0 is the least desirable response. The composite index for each capital stock is calculated as a weighted sum of the indicators grouped for that capital. Each capital index indicates a household's well-being for that specific capital stock. The following example illustrates a matrix displaying composite capital scores for each household (h_n). Each row corresponds to a household, with each of the five capital stocks represented in the columns.

Example

Matrix of the composite capital index for 'h_n' households across the identified capitals, that is, EC (economic capital), SC (social capital), PC (political capital), HC (human capital), and WA (welfare access).

Capitals

$$x = \begin{bmatrix} & \text{EC} & \text{SC} & \text{PC} & \text{HC} & \text{WA} \\ h_1 & 0.67 & 0.81 & 0 & 0.58 & 0.78 \\ h_2 & 0.39 & 0.67 & 0 & 0.61 & 0.23 \\ h_3 & 0.41 & 0.52 & 0.25 & 0.78 & 0.41 \\ h_4 & 0.36 & 0.42 & 0 & 0.51 & 0.53 \\ h_5 & 0.28 & 0.61 & 0.25 & 0.82 & 0.61 \\ h_6 & 0.74 & 0.72 & 0 & 0.84 & 0.53 \end{bmatrix}$$

Households

2. Computation of non-resilience score matrix

To assess the resilience of household h_n in capital C, we established two threshold values for each capital stock. These thresholds, set at the 67th percentile and the median value, serve as cut-offs for categorising households as resilient or non-resilient in each capital. A household is considered resilient in a specific capital if it exceeds the threshold value; otherwise, it is classified as non-resilient. Using this method, each household is assigned a binary score of 0 for resilient or 1 for non-resilient for each capital. This step generates two matrices of non-resilience scores for the entire sample: one based on the 67th percentile and the other on the median. By summing these scores, we derive a total count of capitals in which each respondent is non-resilient, referred to as the capital sum matrix.

For the example above, the identified cut-off (z) at the 67th fractile is used to determine the resilience of households for each capital stock. The values in red in [x] are below the cut-off

z, indicating households that are non-resilient in those capitals. For each capital where a household falls below the identified threshold, a score of 1 is assigned in the non-resilience score matrix. Conversely, resilient households are indicated by a score of 0.

z (*cut-offs*) = (*EC* = 0.55, *SC* = 0.57, *PC* = 0.25, *HC* = 0.75, *WA* = 0.67)

$$x = \begin{array}{c} \\ h_1 \\ h_2 \\ h_3 \\ h_4 \\ h_5 \\ h_6 \end{array} \begin{bmatrix} EC & SC & PC & HC & WA \\ 0.67 & 0.81 & 0 & 0.58 & 0.78 \\ 0.39 & 0.67 & 0 & 0.61 & 0.23 \\ 0.41 & 0.52 & 0.25 & 0.78 & 0.41 \\ 0.36 & 0.42 & 0 & 0.51 & 0.53 \\ 0.28 & 0.61 & 0.25 & 0.82 & 0.61 \\ 0.74 & 0.72 & 0 & 0.84 & 0.52 \end{bmatrix} \textit{Households}$$

$$\textit{Non-resilience score} = \begin{bmatrix} 0 & 0 & 1 & 1 & 0 \\ 1 & 0 & 1 & 1 & 1 \\ 1 & 1 & 0 & 0 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 0 & 0 & 0 & 1 \\ 0 & 0 & 1 & 0 & 1 \end{bmatrix} \begin{matrix} \textit{[Capitals]} \\ \\ \\ \\ \\ \\ \end{matrix} \quad \begin{bmatrix} 2 \\ 4 \\ 3 \\ 5 \\ 2 \\ 2 \end{bmatrix} \textit{[Capital_Sum]}$$

3. Computation of weighted non-resilience score matrix

In our study, we assigned an equal weight of 20% to each capital. Multiplying the non-resilience score matrix by the capital weight will produce a weighted non-resilience score matrix for all households. To determine whether a household is multidimensionally non-resilient, we established a composite capital cut-off. A household is classified as multidimensionally non-resilient if it is non-resilient in at least three capital stocks. Summing these weighted scores will produce a weighted capital sum matrix, with a household considered non-resilient if its weighted capital sum is ≥ 0.6.

$$\textit{Weighted non-resilience score} = \begin{bmatrix} 0 & 0 & 0.2 & 0.2 & 0 \\ 0.2 & 0 & 0.2 & 0.2 & 0.2 \\ 0.2 & 0.2 & 0 & 0 & 0.2 \\ 0.2 & 0.2 & 0.2 & 0.2 & 0.2 \\ 0.2 & 0 & 0 & 0 & 0.2 \\ 0 & 0 & 0.2 & 0 & 0.2 \end{bmatrix} \begin{matrix} \textit{[Weighted_Capital_Sum]} \\ \\ \\ \\ \\ \\ \end{matrix} \quad \begin{bmatrix} 0.4 \\ 0.8 \\ 0.6 \\ 1 \\ 0.4 \\ 0.4 \end{bmatrix} \textit{[Capital_Sum]}$$

Replacing values less than 0.6 with 0 in the weighted capital sum will yield a censored non-resilience score matrix. This censored non-resilience score matrix and the weighted capital sum matrix are then used to calculate the headcount ratio of multidimensionally non-resilient households, their intensity of non-resilience, and their index.

$$\textit{Censored non-resilient score} = \begin{bmatrix} 0 \\ 0.8 \\ 0.6 \\ 1 \\ 0 \\ 0 \end{bmatrix}$$

4. Computation of headcount ratio, average intensity, and Multidimensional Non-Resilience Index

In the Alkire-Foster Methodology, the headcount ratio (H) represents the proportion of non-resilient households and is computed as shown in equation (1). Similarly, the intensity of multidimensional non-resilience (A) is calculated by averaging the share of weighted indicators that classify households as non-resilient, as shown in equation (2). The Multidimensional Non-Resilience Index (MnRI) is the product of the headcount ratio and intensity and can be mathematically expressed as equation (3).

$$\textit{Headcount ratio (H)} = \frac{\textit{Count of nonresilient households}}{\textit{Total sample count}}$$

.....*equation (1)*

H *= 3/6 = 0.5 =* ***50%***

$$\textit{Intensity of multidimensional non-resilience (A)} = \left(\frac{\textit{Sum of censored\_non\_resilient\_score\_vector}}{\textit{Count of non-resilient persons}} \right)$$

.....*equation (2)*

A *= 2.4/3 = 0.8 =* ***80%***

$$MNRI = H \times A$$

.....*equation (3)*

*MNRI = H*A = 0.5 * 0.8 =* ***0.4***

5. Contribution of capitals to non-resilience

After identifying non-resilient households and calculating the overall headcount ratio (H), intensity (A), and MnRI, we aimed to analyse the contribution of each capital stock in making a household non-resilient. Calculating the contribution of each capital required computing the censored headcount ratio for each capital. The censored headcount ratio of capital indicates the proportion of households that are multidimensionally non-resilient and non-resilient in that capital simultaneously. Mathematically, the censored headcount ratio (H_C) for a particular capital stock can be expressed as shown in equation (4). Multiplying this censored headcount ratio by the respective capital weight and then dividing by the overall MnRI gives the percentage contribution of that capital to household non-resilience, as expressed in equation (5).

(H_C)

=

$$\frac{\text{Count of multidimensionally non-resilient persons who are non-resilient in capital C}}{\text{(Total sample count)}}$$

.....equation (4)

$$\%\ \text{contribution of C} = \frac{\text{Weightage of capital C} * H_C}{MnRI}$$

.....equation (5)

Sample computation of the contribution of social capital in making a household non-resilient is as follows:

$$\%\ \text{contribution of SC} = \frac{0.2 * 0.33}{0.4} = 16.5\%$$

Annexure 4

1. Methodology for computing the job resilience index

The job resilience index is a composite index with equal weight assigned to perceived competencies and the transferability of the existing skills of a household member employed as a contractual worker in a thermal power plant. It indicates a worker's ability to secure another job in case of job loss due to the closure of a thermal power plant. Below is the methodology and approach employed for the computation of this composite index.

2. Components of the job resilience index

The survey instrument used in this study captures the current job details of each respondent such as their skill category, department of work, designation, and their perceived competency. An exhaustive consultation with industry stakeholders was conducted to categorise these jobs into 33 distinct categories. A comprehensive rating exercise was then carried out to assess the transferability and skill competency of each job type.

Skill transferability refers to the extent to which skills acquired in the current job can be effectively applied in different industries. It is evaluated using a rating scale of high, medium, and low. A high rating indicates that the skills are highly adaptable and useful across various industries, while a low rating suggests minimal applicability beyond thermal power plants. This rating provides valuable insights into the adaptability of these roles outside of thermal power plants.

Similarly, skill competency refers to the level of proficiency and expertise required to effectively perform the tasks and responsibilities associated with a particular job category. It is also evaluated using a rating scale with three levels – high, medium, and low – to indicate the extent to which a job demands specific skills. A high rating signifies that a job requires advanced skills and a high degree of competency, while medium and low ratings reflect moderate and basic skill requirements respectively. This assessment provides a detailed understanding of the skill levels necessary for each job type, aiding in the evaluation of respondents' capabilities.

These ratings of skill transferability and competency are then validated through consultations with stakeholders.

3. Computation of the job resilience index

Both the skill transferability rating and skill competency rating are weighted equally at 50% each in computing the job resilience index. We have assigned a score of 3 for high, 2 for medium, and 1 for low. The formula for calculating this composite index is as follows:

Job resilience index

= (0.5*skill transferability rating/3) + (0.5*skill competency rating/3)

.....equation (6)

Table 4.1 **Details of skills and competency scoring**

Job category	Job transferability rating	Skill competency rating
Boiler work	High	High
Crane operator	High	High
Computer operator	Low	Medium
Masonry work	Medium	Medium
Security and surveillance	Medium	Low
Carpentry work	Medium	High
Coal-related work – helper	Low	Low
Housekeeping work	Low	Low
Office work	Low	Medium
Fitter	High	High
Welding	High	High
Driving	Medium	High
Machine operator	Medium	High
Gardening	Low	Medium
Electrician	High	Low
Turbine work – helper	Medium	High
Rail-line work	Medium	High
Motor work	Medium	High
CHP operator	Low	Medium
Turbine operator	High	High
Field operator	High	Low
Helper	low	Low
Machine – operator	Medium	High
Machine – helper	Low	Low
Rigor work	Low	Low
Belt maintenance	low	High
Electrician – helper	Medium	Low
Firefighting – helper	Low	Low
Electrician – operator	Medium	High
Maintenance work	Low	Medium
Technician	Medium	High
Supervision	Low	Low
Other	Low	Low

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