北京大学能源研究院
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CLIMATE CHANGE AND ENERGY TRANSITION PROGRAM

NAVIGATING THE PATH TO A JUST TRANSITION: EMPLOYMENT IMPLICATIONS OF CHINA'S GREEN TRANSITION

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北京大学能源研究院
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NAVIGATING THE PATH TO A JUST TRANSITION: EMPLOYMENT IMPLICATIONS OF CHINA'S GREEN TRANSITION

June 2023

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LIST OF ACRONYMS

DPES	Department of Population and Employment Statistics
EGD	European Green Deal
EIC	Employment Impact Coefficients
ESGW	Electricity, Steam, Gas and Water Production and Supply
ETS	Emission Trading System
FTE	Full-time-equivalent
FYP	Five Year Plan
GHG	Greenhouse Gas
IC	Installed Power Capacity
I-O model	Input-output Model
JTF	Just Transition Fund
JTM	Just Transition Mechanism
JTP	Just Transition Platform
KWSB	Commission on Growth, Structural Change and Employment
NGOs	Non-governmental Organizations
OM	Operational and Maintenance
PGC	Power Generation Capacity
POWER	Partnerships for Opportunity and Workforce and Economic Revitalization
PSLF	Public Sector Loan Facility
SCF	Social Climate Fund
SDGs	Sustainable Development Goals
SMEs	Small and Medium-sized Enterprises
TCE	Tons of Coal Equivalent
UNFCCC	United Nations Framework Convention on Climate Change
YOY	Year-over-year

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EXECUTIVE SUMMARY

For the world to meet the Paris Agreement, and for China to ensure its own dual climate goals of carbon peaking by 2030 and carbon neutrality by 2060, the transformation of China's economic structure, energy mix, production methods and lifestyles towards low carbon pathways is essential. This 'green transition' will not only be vital in safeguarding the environment on which we all depend. It could also create more than 3.6 million jobs in China's clean energy sector alone y.[1]

However, the industrial overhaul it requires may also disproportionately affect certain sectors, regions and groups, as not all will have equal access to new green job opportunities. Therefore, it is critical to **mitigate potential negative socio-economic impacts and risks, to ensure a just transition that includes everyone**.

While China has yet to establish a clear institutional framework for a just transition, some **key elements of this are reflected in China's policy documents and development vision.** At the Leaders' Summit on Climate in 2021, Chinese President Xi Jinping also highlighted the importance of putting people first and coordinating efforts in environmental protection, economic growth, job creation and poverty eradication.

This raises the need for evidence-based research to better inform policy-makers on how best to balance the energy transition with social and economic considerations. To this effect, this report examines the employment impacts of China's energy transition on two key industries – the coal mining and preparation industry, as well as the electricity industry. It also proposes policy tools to minimize labour shocks and maximize opportunities.

Key findings include the following:

- Based on China's current policy trajectory, 52 percent of jobs in the coal sector are projected to disappear by 2030, with this number increasing to 90-94 percent by 2050. This translates to an expected direct loss of 1.3 million jobs within the next decade and 2.35 million jobs within the next 30 years. **While significant, the scale of employment change is smaller than that experienced during China's supply-side structural reform**, which resulted in a loss of 1.4 million jobs in the coal sector between 2016 and 2021.
- The study forecasts employment under a variety of technology and policy scenarios and found that the difference in employment change between different technical scenarios is smaller than that between different policy scenarios. **This suggests that energy transition actions resulting from policy changes will play a more important role in downsizing coal jobs than technological innovations in improving labor productivity**.
- Our analysis shows that for every job lost in coal, there will be a corresponding 1.08 jobs lost in related industries. Additionally, this ratio has been decreasing since 2010, suggesting that **the negative employment effects of the coal industry's transition are expected to be mostly limited to the coal industry itself, and its significance for related jobs will continue to wane**.
- Over the next 10 and 50 years, coal power employment is projected to decrease by 30 percent and 95 percent, respectively. **However, overall the electricity industry is expected to see an increase in employment, due to new jobs created in renewable energy.** Employment in wind and solar power generation are expected to double and quadruple respectively, within 50 years.

The study also examines the current composition of the coal industry workforce, to identify the groups of people most affected by the coal phase-down:

1 International Energy Agency. (2021). An energy sector roadmap to carbon neutrality in China. https://www.iea.org/reports/an-energy-sector-roadmap-to-carbon-neutrality-in-china

Education: coal industry employees are generally less educated and lower-skilled than workers in other sectors. Moreover, the few well-educated professionals in the industry are mostly concentrated in large coal companies, resulting in a growing disparity in the human resource assets between large and small coal companies.

Gender: About 80 percent of coal industry employees are male. Therefore, it is commonly assumed that any labor shock within the industry would disproportionately affect men. However, the share of female employees in the sector has declined from 21.9 percent in 2003 to 13.3 percent in 2020, while men's share has climbed from 78.1 percent to 86.7 percent, suggesting **women are more vulnerable and at higher risk of unemployment when the sector shrinks**.

To provide concrete recommendations for protecting and including these groups in China's green transition, this study summarizes experiences from representative countries and provides case studies of best practices from Germany and the EU. The review of international best practices has identified five priority areas that are crucial to ensuring a just transition. Under each area, suggestions are proposed as follows:

- **Establish a task force to enhance inter-agency coordination and stakeholder engagement.** China could consider either establishing a new taskforce for its just transition, or expanding the scope of an existing coordination mechanism, such as the State Council's leading group on employment.
- **Support workers in need by strengthening China's existing employment policy,** including by continuously evaluating and adapting policies to ensure their effectiveness in a fast-changing context. Revising the eligibility criteria for employment stabilization subsidies and specifying the proportion of financial assistance that needs to be set aside for supporting affected workers (versus repaying company debts or other obligations) are two ways to ensure that such support reaches the companies and workers that need it the most. Additionally, China should formulate medium- and long-term national plans for green employment, setting clear targets and establishing key priorities, to guide efforts in this area. In the meantime, it is crucial to actively provide affected workers with suitable green skills training, enabling them to benefit from the opportunities presented by the growth of green jobs.
- **Coordinate social protection and employment policies for mutual reinforcement.** To effectively assist laid-off workers, targeted measures should also be designed based on their willingness to work, age, gender and skill level. A different combination of social protection and employment policy tools could be used for different groups.
- **Diversify the economy through industrial restructuring and enhance coordination between economic transitions and job creation.** To achieve balanced progress in environmental protection, economic development and employment generation, policies must be implemented in a more synchronized manner. This proposes that any new industrial policy should be accompanied by complementary environmental and employment policies, to mitigate potential environmental or social impacts that it might cause.
- **Pool funds from diverse sources and guard against financial risks.** It is vital to leverage private along with public finance to support the energy transition. This involves promoting transition finance and incorporating social considerations in lending decisions. For example, for SDG-linked bonds, to set the number of workers retained as a key performance indicator (KPIs), with a view to incentivizing enterprises in transition to retain workers. China could draw on the experience of the EU and create transition funds that direct resources

towards vulnerable and negatively affected areas and companies.

Overall, if **groups most at risk are placed at the heart of decisions** regarding the major industrial changes needed in going green, it is possible for China and all countries to build a new green economy through a just transition, leaving no one behind.

1

OVERVIEW AND BACKGROUND

1.1 BACKGROUND

The 2015 Paris Agreement sets clear goals: To limit the global average temperature increase to well below 2°C, compared to pre-industrial levels of this century, while also pursuing efforts to limit it to 1.5°C above pre-industrial levels.[2] This goal would be consistent with a reduction in global emissions by around 45% by 2030 and achieving net-zero by around 2050,[3] through a green and sustainable transition. As part of that process, in September 2020 China made the pledge to peak carbon emissions before 2030 and become carbon neutral before 2060 (two goals referred to jointly as the "3060" goal).

To achieve the "3060" goal, China must transform its economic and social development paradigms. This shift will require a whole-of-economy transformation, the optimizing of China's energy structure and improving of energy efficiency levels, the controlling of greenhouse gas (GHG) emissions from non-energy activities, and an acceleration in the use of tools such as carbon sinks. To this end, the Central Committee of the Chinese Communist Party and the State Council released the *Working Guidance for Carbon Dioxide Peaking and Carbon Neutrality in Full and Faithful Implementation of the New Development Philosophy* ("Working Guidance") in 2021, presenting an overarching high-level policy framework. The document specifies key timelines and priorities for action during the 14th Five Year Plan (FYP) period and also leading up to 2030 and 2060. For example, by 2025, non-fossil energy should account for about 20% of total energy consumption, with these levels increasing to 25% by 2030 and then 80% by 2060, implying a progressive phase-out of coal. This transition will inevitably affect the job market in China, with the impact of different policies and implementation pathways on employment being varied across sectors and regions, while also generating demands for new skills.

In the long term, new jobs created during the low carbon transitional period will offset job losses caused by it.[4] In the short term however, achieving the "3060" goal will have a significantly negative effect on employment in traditional industrial sectors, including coal mining, steel, cement production, and power generation and supply. The phase-out of high-emission manufacturing capacities will result in the loss of many jobs and subsequently may threaten social stability. Jobs created by climate action are not expected to be available where and when this unemployment arises, therefore evidence-based, in-depth studies are needed to provide accurate impact assessments and targeted policy recommendations, aiming to promote the rapid development of green sectors while buffering the negative impacts that the "3060" goal will have on traditional sectors and related regions.

1.2 THE EVOLUTION OF "JUST TRANSITION"

The concept of just transition was first proposed to promote equity for workers in the 1970s, when labor unions in the United States called upon policy makers to factor in social justice and thus protect, support, and compensate workers who were losing their jobs due to environmental protection policies.[5]

2 UNFCCC. (2015). Paris Agreement, Decision 11/CP.21 [Z/OL]. Retrieved from https://unfccc.int/process-and-meetings/conferences/past-conferences/paris-climate-change-conference-november-2015/cop-21/cop-21-decision

3 United Nations. (n.d.). Net-Zero Coalition. Retrieved from https://www.un.org/en/climatechange/net-zero-coalition

4 Stanef-Puică, M. R., Badea, L., Şerban-Oprescu, G. L., Şerban-Oprescu, A. T., Frâncu, L. G., & Creţu, A. (2022). Green Jobs—A Literature Review. International Journal of Environmental Research and Public Health, 19(13), 7998.

5 Markey, R. (2021). Edouard Morena, Dunja Krause and Dimitris Stevis (eds), Just Transitions: Social Justice in the Shift Towards a Low-Carbon World. Journal of Industrial Relations, 63(1), 104–106. https://doi.org/10.1177/0022185620957459

Today, discussions of just transitions remain focused on the workforce, but the term now has an increasing importance in the field of global environmental and social governance, and its meaning continues to expand as a growing number of countries are committing to net-zero emissions targets and embarking on low carbon pathways. The social elements of such transitions are attracting more attention globally, including from development agencies, governments, and non-governmental organizations (NGOs). Groups serving to benefit from just transitions have broadened from directly affected workers, to other people or entire regions vulnerable to the more immediate adverse social and economic effects of transition, and now even include those who cannot equally share the benefits that low carbon transitions might produce in the long run. These groups and regions are incapable of managing large-scale employment and social transitions on their own, and need policy support and external assistance to help them identify new opportunities for development and find a sustainable way forward. History shows similar transitions of scale affected certain groups of workers by making them jobless, plunging them into poverty, and therefore excluding them from mainstream prosperous society. Such negative shocks not only affected individual workers, but also their families and the regions where they were located. A failure to ensure a just low carbon transition may therefore compromise the "leave no one behind" principle underpinning the 2030 Agenda for Sustainable Development and thus jeopardize the pursuit of the Sustainable Development Goals (SDGs).

Despite worldwide consensus on the importance of just transition, the term lacks an agreed-upon definition. Institutions and experts define just transition based on their own understandings and priorities, expanding the meaning of the term exponentially, in a variety of ways. Dozens of international institutions have now released reports on just transition, each with its own definition. Table 1-1 provides a list of examples of currently used definitions for just transition, and their associated goals. One notable document is the *Guidelines for a Just Transition Towards Environmentally Sustainable Economies and Societies for All* published in 2015 by the International Labour Organization (ILO). ILO's Guidelines set forth the vision, opportunities, and challenges, as well as the guiding principles for just transition, including key policy areas and institutional arrangements. The document points out that a just transition towards an environmentally sustainable economy must proceed in an equitable and inclusive manner, with opportunities for decent work provided for all and steps taken to ensure that during the transition, no one is left behind.

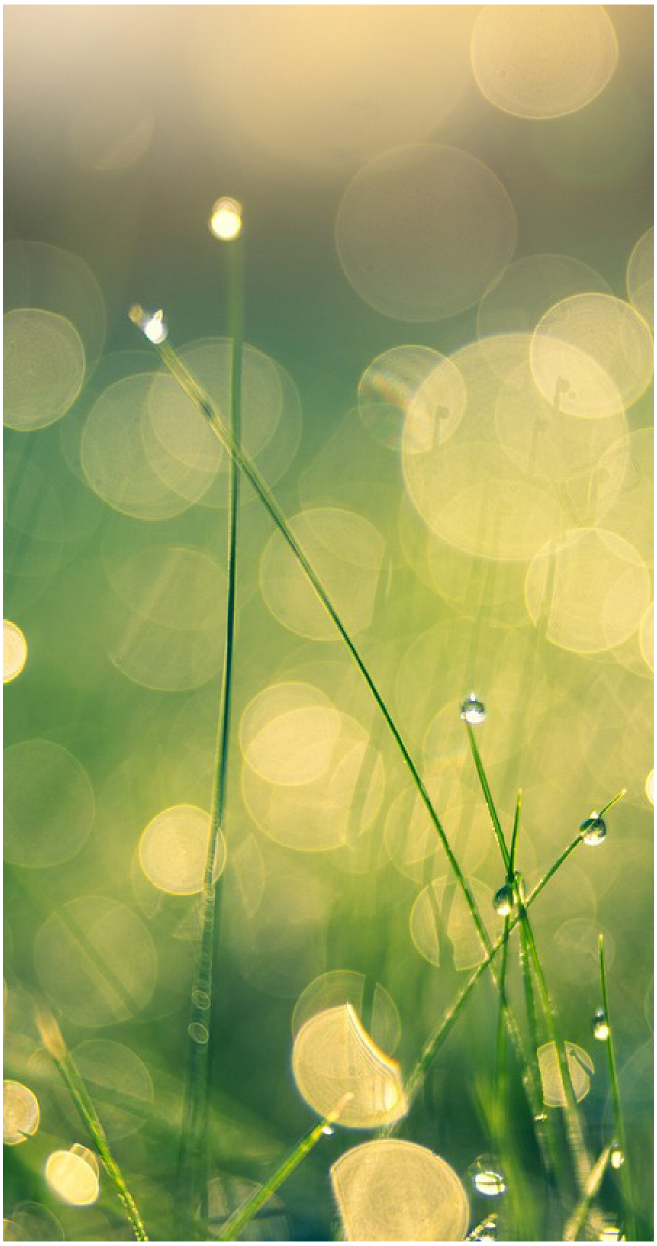

Table I-I: Definitions of just transition provided by international organizations

Organization	Definition
International Labor Organization (ILO)	A just transition means greening the economy in a way that is as fair and inclusive as possible to everyone concerned, creating decent work opportunities and leaving no one behind.
International Trade Union Confederation (ITUC)	On a national or regional scale, a just transition is an economy-wide process that produces the plans, policies and investments that lead to a future where all jobs are green and decent, emissions are at net zero, poverty is eradicated, and communities are thriving and resilient.
Climate Strategies	Just transition also relates to the process of planning for change. It demands an inclusive process where many stakeholders have a say in the vision and strategy for renewing affected regions. In addition to managing the negative impacts of transition, it is also important to consider how the positive benefits of transition are distributed while aiming at a wide benefit sharing within communities.
World Benchmarking Alliance (WBA)	A "just transition" is an economy-wide process that aims to deliver the transition of economies and companies to low carbon, "socially just" and "environmentally sustainable" activities, by promoting social dialogue between employers, unions, governments and communities.
Climate Justice Alliance	Just transition is a vision-led, unifying and location-based set of principles, processes, and practices that leverage economic and political resources to transition from an extractive economy to a renewable economy.

Source: Author based on relevant report and websites[6]

In 2015, the concept was written into the Paris Agreement at the 21st Conference (COP21) of the Parties to the United Nations Framework Convention on Climate Change (UNFCCC), highlighting the need to prioritize employment issues during the response to climate change. In 2016, the UNFCCC Secretariat released a report, *Just Transition of*

6 International Labour Organization. (n.d.). Green jobs. Retrieved from https://www.ilo.org/global/topics/green-jobs/WCMS_824102/lang--en/index.htm
International Trade Union Confederation. (2017). Climate justice on the frontline: Trade union briefing. Retrieved from https://www.ituc-csi.org/IMG/pdf/ituc_climate_justice_frontline_briefing_2017.pdf
Climate Strategies. (2022). Exploring just transition in the Global South [PDF]. Retrieved from https://climatestrategies.org/wp-content/uploads/2022/05/Exploring-Just-Transition-in-the-Global-South_FINAL.pdf
Eye on ESG. (2021, December). Just transition: The World Benchmarking Alliance publishes its just transition assessment. Retrieved from https://www.eyeonesg.com/2021/12/just-transition-the-world-benchmarking-alliance-publishes-its-just-transition-assessment/
Climate Justice Alliance. (n.d.). Just transition. Retrieved from https://climatejusticealliance.org/just-transition/

the Workforce and the Creation of Decent and Quality Jobs, providing a synthesis of job-related issues in the work of the Convention and a step-by-step guide to help developing country Parties mitigate the negative impacts of energy transition on local job markets. The report was the UNFCCC Secretariat's first technical paper on jobs.

1.3 THE SIGNIFICANCE OF RESEARCH ON JUST TRANSITION FOR CHINA

To achieve its "3060" goal, China will have to transform its entire energy sector, particularly in regard to the production and use of coal, considering its significant contribution to emissions. To align with the Paris Agreement's target of limiting global warming to 1.5°C, the share of coal usage in primary energy consumption needs to decrease to approximately five percent by 2050, compared to the 2022 level of 56.2 percent.[7]

Such a substantial reduction in coal consumption will have a profound impact on all coal dependent sectors. Some researchers warn that China becoming carbon neutral by 2060 will directly result in the loss of 20.5 million to 28 million jobs[8]. With employment being at the top of key lists of China's economic goals, ensuring a just transition is of great importance to China's own development agenda.[9]

The key elements of just transition are well reflected in initiatives relating to China's development vision. While China has not yet established a clear institutional framework for just transition, some inclusive job relocation and reemployment measures that the country adopted during the supply side reform launched in 2016 are similar to practices taken by other countries to ensure just transitions.[10] Objectives pursued by just transitions, including environmental protection, job market stability, social inclusion, and the eradication of poverty, all align with the requirements of "ecological civilization".[11] At the Leaders' Summit on Climate in 2021, Chinese President Xi Jinping highlighted the need to put people first and coordinate efforts in environmental protection, economic growth, job creation, and poverty eradication. A white paper released the same year, *Responding to Climate Change: China's Policies and Actions,* identified "a people-centered approach" as one of the five principles of China's climate change response. In July 2022, outcomes of the 8th BRICS Labor and Employment Ministers' Meeting included the declaration: "We will act to acquire a deeper understanding of green jobs, adopt policy measures for employment and human resources development that meet the needs of green growth, low-carbon and sustainable development together with other government agencies and social partners. This would help take advantage of the triple benefits of mitigating and adapting to climate change with a just transition for all, developing the economy and boosting employment."[12] This was the first time that just transition featured in an official document issued by the Ministry of Human Resources and Social Security, and therefore represented China's acknowledgement of the significance of just transitions on an international stage.

7 Tsinghua University (2020). China's Long-Term Low-Carbon Development Strategy and Pathway. Slide presentation by Prof. He Jiankun. https://mp.weixin.qq.com/s/S_8ajdq963YL7X3sRJSWGg;

8 Jia, Y., Bo, C., Ying, W., & Nuo, L. (2022). Just Transition in China under the "3060" Goal: Challenges and Solutions. Financial Development Review, Issue 1.

9 Guaranteeing and stabilizing employment is the top priority of China's 'six guarantees' and 'six stabilizations' which are key economic policy initiatives announced after COVID-19 aimed at ensuring stability and promoting growth.

10 The supply side reform refers to China's economic policy that focuses on improving the supply side of the economy to drive sustainable growth and enhance overall economic efficiency. A series of policy measures and initiatives are implemented with an aim to tackle the issue of overcapacity in several industries, including steel, coal, and cement, by phasing out inefficient and surplus production capacity.

11 The concept of ecological civilization was first proposed in at the 18th National Congress of the Communist Party of China in 2012. It has been written into China's constitution and serves as a guiding goal for the country's environmental policies.

12 The BRICS refers to five major emerging economies: Brazil, Russia, India, China, and South Africa. The declaration can be found at https://www.brics23.com/wp-content/uploads/2023/02/BRCIS-CHINA-2022-Ministers-Declaration-final.pdf

China's "3060" goal is intended to provide people with growth that is of quality, efficient, equitable and sustainable. It is therefore important to adopt a people-centric and interdisciplinary approach in designing a road map for China's transition, which takes into account the employability, livelihoods, rights, and interests of people adversely affected by this process. The diverse conditions between China and the nation's western counterparts means that to be effective, policy frameworks need to be adapted to address China's actual circumstances and needs with targeted arrangements. The ultimate goals of such efforts are to prevent transition costs being passed on to vulnerable groups, and to shield people and groups against any major adverse impacts. Furthermore, planning needs to consider how to avoid an increase in poverty levels and a loss of livelihoods that an economic recession in coal-mining regions might cause, and public and private sectors need to be encouraged to help fund the just transition of affected regions, sectors and groups.

With this context in mind, this report examines the employment impacts of China's energy transition, to provide Chinese policymakers with empirical research to inform decisions that will allow for the achievement of an inclusive and just green transition towards its "3060" goal. **Chapter 2** presents a theoretical analysis of the possible economic and employment impacts of an energy transition in China. **Chapter 3** forecasts the employment changes in the two sectors most impacted by the energy transition, namely the coal and power sectors, both in the short and long term under different policy scenarios. The chapter's analysis also identifies the populations potentially most affected by the phasing-down of coal based on the current employment profiles of the two sectors. **Chapter 4** provides a discussion of international best practices in just transitions, with a focus on the examples of Germany and the EU. Finally, **Chapter 5** offers policy recommendations on how to develop an actionable and sustainable just transition roadmap for China.

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2

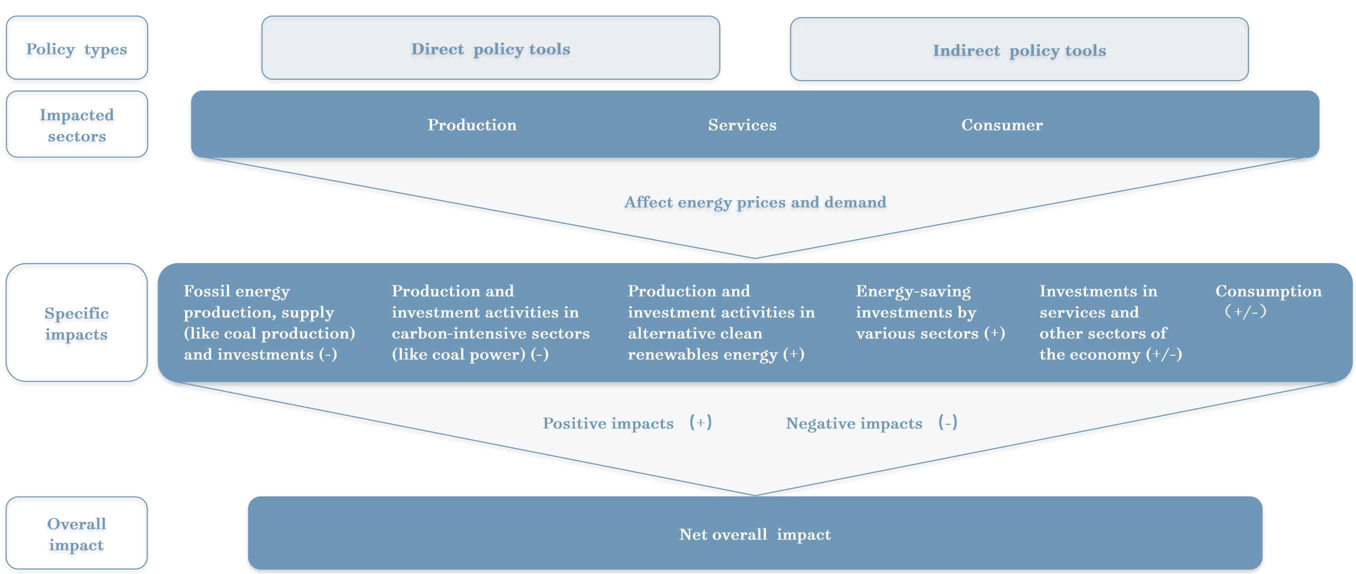
ECONOMIC AND EMPLOYMENT IMPACTS OF A TRANSITION TO CLEAN ENERGY

Given the complexity of the energy transition, an understanding of how economy and employment are affected by energy decarbonization is essential, in order to plan throughout the transitory process to minimize negative impacts. Energy transitions affect economies in various ways, including initiating changes in consumption patterns, energy production and utilization methods, as well as having an impact on the broader fields of energy technology development and industrial planning. These shifts lead to simultaneous adjustments in economic and industrial structures, presenting both new challenges and new opportunities. To provide a theoretical basis for assessing the social and economic impacts of an energy transition, this chapter reviews relevant literature and summarizes the effects that may be expected from this shift.

2.1 ECONOMIC IMPACTS OF AN ENERGY TRANSITION

Achieving China's "3060" goals require shifting away from a fossil fuel-dominated energy structure by increasing the use of clean energy and improving energy efficiency. Policy measures required to drive this energy transition involve different fields, including macroeconomic development, energy and environmental management, as well as advocacy for awareness raising on green lifestyles. These measures include both direct policy tools that impact the supply and demand of fossil fuels and renewable energy sources, such as controlling total coal consumption and enforcing strict industry access standards for fossil energy production sectors, as well as indirect policy tools such as preferential financial or fiscal policies that provide economic incentives for energy conservation and emissions reduction. The outcomes of these policies and related measures, directly or indirectly, will have market impacts that will be felt by producers, service providers, and consumers. One major mechanism is energy pricing, which when changed, impacts market demand and furthermore, has ripple effects on fossil energy development, utilization levels and overall supply chains, as well as on the behavior of renewable energy investors and producers (see Figure 2-1).

Figure 2-1: Economic impacts of an energy transition



Source: Authors

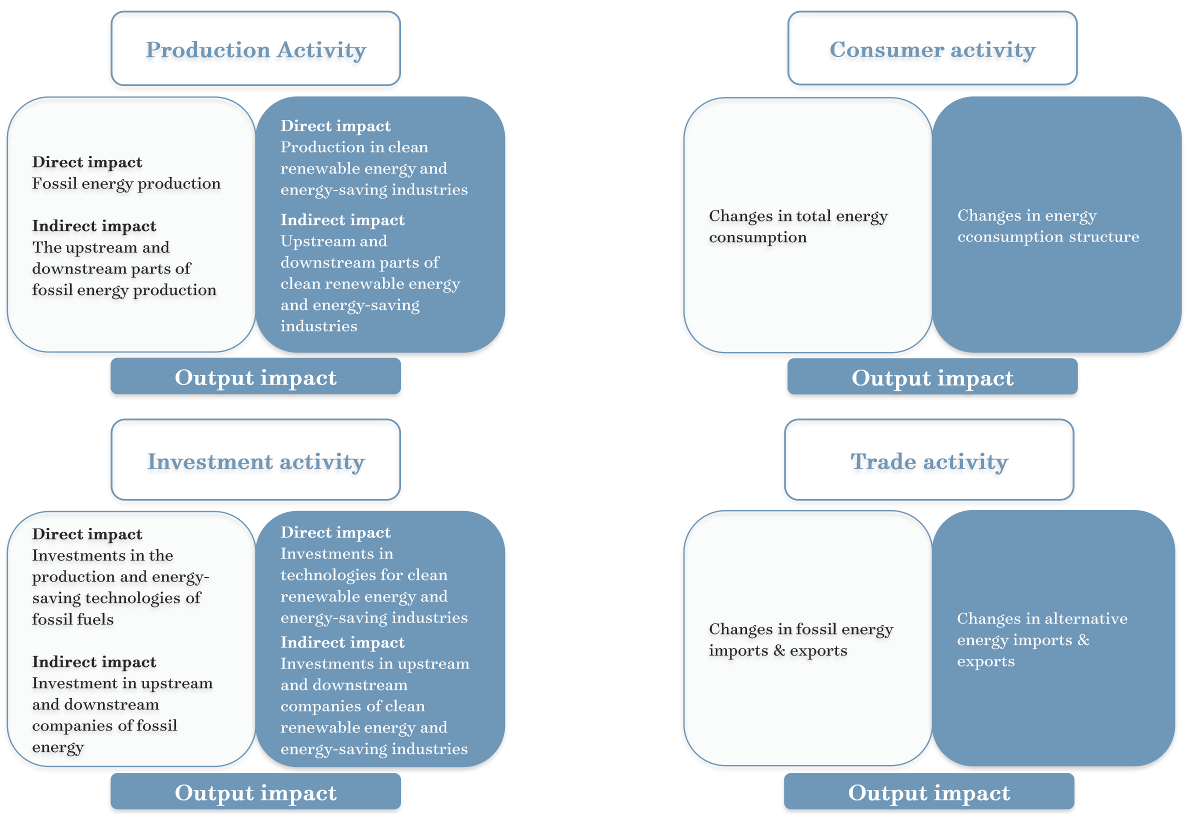
Energy transition measures and policies will reshape the behaviors of economic actors, such as producers, consumers, investors, and traders (see Figure 2-2), which will produce the following three effects:

Productivity/innovation changes will occur across related sectors. An energy transition will drive productivity and innovation changes in associated sectors. For example, an energy transition will stem the flow of investments into the fossil fuel industry, as well as reduce direct investments going into related equipment manufacturing and technical services. Capital will be diverted towards clean energy, led by the wind and solar sectors, thus boosting innovation and productivity in the renewable energy industry. This will help speed up processes relating to the research and development (R&D) of energy-saving and new energy technologies, accelerate the development of climate-friendly products and services, and ultimately, boost the overall productivity of the economy.

Shifting prices and costs will cause structural changes in energy demands. Policy measures and tools intended to promote an energy transition will push up the relative prices of fossil fuels, therefore increasing their cost while simultaneously reducing the cost of cleaner alternatives. This movement will reshape the energy consumption patterns of producers and households, directly affecting the profitability of energy-related sectors.

Multiplier effects will be felt across other economic sectors. Changing the energy consumption patterns of producers and households will, through a multiplier effect, also have an impact on other sectors of the economy, to varying degrees.

FIGURE 2-2: Impacts of an energy transition on production, consumer, investment and trade activities



Source: Authors

2.2 EMPLOYMENT IMPACTS OF AN ENERGY TRANSITION

An energy transition affects multiple industrial sectors, and subsequent employment impacts will vary both by sectors and by regions. For instance, a study found that US$1 million in spending on fossil fuels creates 2.65 full-time-equivalent (FTE) jobs, while the same amount invested in renewables or energy efficiency creates 7.49 FTE jobs [13].

The total number of jobs provided by an industry is determined by two factors, namely the industry's total output, and productivity, or more specifically:

1) Output changes. An energy transition and its associated policy shifts will affect the output level of different sectors in diverse ways, to varying extents. For example, the implementation of policy that limits coal consumption indicates that China's coal production is likely to experience slower growth in the coming years and may even decline in the long run.

2) Technological progress. International experience shows there has been steady technological progress in both the fossil energy industry and the fast-growing renewable energy sector, leading to a continuing decline in the number of jobs created per unit of output. By redirecting the flow of investments, an energy transition has the potential to accelerate, or conversely, decelerate technological progress and productivity gains in different sectors, leaving long-term impacts on these sectors' total employment numbers, structures, and skill requirements for current and new positions.

In general, these two progressions of change will bring about three noticeable trend shifts relating to employment:

(i) Relocation of jobs across sectors.

Negative impacts: Existing sectors such as fossil energy production, transportation, and associated equipment manufacturing services will be negatively impacted by a direct loss of jobs driven by a transition to cleaner energy sources. During this process, highly polluting, resource-intensive and energy-intensive companies as well as small and medium-sized companies that have less capacity to respond to more stringent climate-related regulatory requirements will be the first groups to lose employment numbers.

Positive impacts: As demand for energy is inelastic, limits placed on fossil fuels need to be met in parallel with the speeding up of the production and supply of clean energy. The development of renewable energy sources such as hydropower, wind, solar, and biomass energy will create jobs along the whole supply chain, including in the fields of technology development, equipment manufacturing, installation, and repairs and maintenance.

Higher energy efficiency standards will entail old technologies and equipment to be replaced with more efficient and environmentally-friendly alternatives. The development of energy-saving technologies in different sectors, such as the fields of power, transportation, construction, metallurgy, chemicals, petrochemicals, and automobiles, will drive the creation of new jobs in related technical fields, including specialist roles for energy advisory consultants and management services.

The transition to a low carbon economy also requires significant investments in renewable energy and energy efficiency projects which will boost job creation in the financial sector, particularly in areas of clean energy investment, green finance, and insurance, as well as in carbon emissions

13 Garrett-Peltier, H. (2017). Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model. Economic Modelling, 61, 439-447.

trading. At the same time, the massive investments triggered by low-carbon development will create new demands in the services sector, including on carbon verification and carbon consultancy, as well as in capacity building and training on energy conservation and emissions reduction, therefore creating space for the development of a considerable number of new jobs.

(ii) Changes in employment structures within sectors.

A transition in the field of energy will force shifts in employment not only between, but also within, certain sectors. For instance, as China places a greater emphasis on the clean utilization of coal, there will be more jobs in coal preparation, increasing its share relative to the number of jobs required for coal mining. Employment structures will also change within the coal transportation sector (including a mixture of roles relating to railway, water and road transportation and slurry pipelines). Due to its higher cost, road transportation will gradually be replaced by railway and water transportation, leading to a decrease in the proportion of employment necessary in one area, but increasing it in others. Such structural changes also will drive shifts in the numbers of high skill and low skill jobs.

(iii) Changes in required skillsets.

New technologies and related industries require a different skill set. An energy transition will also result in new and increased responsibilities for workers, calling not only for specialized training initiatives on new and improved skills, but also for changes in working practices, to sustainably and safely make way for jobs in new energy-saving technologies.

Changes in the type of skillset required for workers are likely to result in a rise of unemployment in some fields, as workers in traditional energy sectors are often low-skilled or unskilled, and may face difficulties transitioning to more technical roles in renewable energy sectors. Low-skilled technicians working in heavy industry, the chemical sector, machinery manufacturing and steel are at high risk of losing their jobs due to technological advancements. To increase employment opportunities for these workers, education and training programs should be provided to help them acquire the necessary skills they require to shift into new roles.

3

EMPLOYMENT IMPACTS OF AN ENERGY TRANSITION ON THE COAL AND ELECTRICITY GENERATION INDUSTRIES

This chapter analyzes two industries most directly affected by the energy transition embedded in the carbon neutrality goal and the phase-out of fossil fuels, namely coal mining and preparation (hereafter also referred to as the coal industry), and electricity generation, within the broader power industry.[14] The primary objectives of this report are to assist policy makers to comprehend the extent of job losses that can be expected due to an energy transition and propose policy tools to mitigate adverse effects wherever possible. Given this focus, the report will not provide a detailed perspective into the possibly positive effects which the transition might have in relation to job creation.

As China's main energy source and an important resource, coal is significant both for the economy and energy security. The "3060" goal, however, requires a phase-out of coal and other fossil energy sources as part of the plan's energy transition strategy, meaning that the output of the coal industry will inevitably shrink.

The power sector, meanwhile, is a major part of the energy industry and consumes huge quantities of coal in order to power social and economic progress. To achieve its climate targets, China will need to accelerate its shift towards a renewable-based energy system and dramatically expand electrification while also enabling a green, low carbon, and efficient development of the electricity system. In this broader context, a low carbon transition and possibly accelerated phase-out of coal power will become an unstoppable trend. The energy- and labor-intensive coal power industry will then face employment pressures.

3.1 EMPLOYMENT IMPACTS OF AN ENERGY TRANSITION ON THE COAL INDUSTRY

3.1.1 China's coal industry

(1) Sector outlook

Coal is China's major energy source, therefore a sustainable and just transition of the coal industry towards greener fuels will be critical for the "3060" goal. To fast-track the industry's transition, central government agencies have introduced a flurry of coal-related policies, guiding the industry to ensure coal supplies are secured, promoting the clean utilization of the resources, speeding up the use of smart technologies, improving safety, and supporting the economic transition of coal-dependent locations.

According to China's 14th Five-Year Plan (FYP), the country aims to control the pace of coal development and encourage the clean and efficient use of coal and other fossil fuels. China's 14th Five-Year Plan for the energy sector stressed coal's importance in safeguarding energy security and emphasized and proposed the streamlining of the allocation of coal production capacity and the establishment of prominent coal supply hubs in Shanxi, Inner Mongolia, Northern Shaanxi, and Xinjiang, thus changing the geographical distribution of coal-related jobs.[15]

More specifically, the China National Coal Association (CNCA) has released Guidelines on the High-Quality Development of the Coal Industry in the 14th Five Year Period. The Guideline provides guidance for the transition of the coal industry from the perspectives of coal development, the transition of coal-mining regions, and the greening of the coal industry. In terms of total production, **China set a goal to cap domestic annual coal production at 4.1 billion**

14 The electric power industry refers to the sector responsible for the generation, transmission, and distribution of electricity, Due to data availability issues, our analysis only focuses on the generation part of the industry, which will be discussed in detail in section 3.2.

15 Government of China. (2022). 14th Five Year Plan for a Modern Energy System. Retrieved from http://www.gov.cn/zhengce/zhengce-ku/2022-03/23/5680759/files/ccc7dffca8f24880a80af12755558f4a.pdf

tons by the end of the 14th FYP period (2021-2025), a slight increase from 3.9 billion tons in 2020. This amount of growth within the industry is much smaller than the growth experienced during the 13th FYP period (2016-2020), which was 0.5 billion ton.[16] Mergers, acquisitions, and restructuring efforts are being encouraged to speed the removal of inefficient and costly coal production activities. The number of coal mines is expected to shrink from 4,700 in 2020 to approximately 4,000 at the end of the 14th FYP period. The coal industry has also been instructed to form a highly professional, well-structured workforce to further boost labor productivity across the industry.[17]

(2) Employment trends

Due to limited data availability, this report presents two sets of data from different sources in order to provide a more comprehensive overview of China's coal employment trends over the past three decades. China's official data source, the Labor Statistics Yearbook, only provides information on employment in urban, non-private coal mining and preparation units. Since the majority of the coal industry is comprised of non-private enterprises, the Yearbook is considered to be the first official source of primary data. As a cross-reference to the Yearbook, this report uses CEIC data, which provides estimates of employment in the coal sector as a whole.

Figure 3-1 shows the changing trends in the coal industry's employment numbers, since recorded from 1988. Two time periods recorded marked increases in the number of people involved in the coal industry. First, between 1988 and 1994, employment numbers in the coal industry rose, peaking at 5.3 million before then falling to 3.3 million in 2002.[18] An increase in raw coal production then pushed up demand for labor, leading to a second boom in hiring between 2003 to 2013, which was referred as coal's 'golden decade'. By 2013, the employment numbers in the coal industry reached 4.5 million, the highest since 2000, according to the Yearbook. In comparison however, CEIC data shows an estimated 5.297 million people worked in the industry as a whole in 2013.

The industry's 'golden decade' came to an end as China's economic growth slowed, leading to a weakened demand for coal. This shift, coupled with a renewed focus on tackling air pollution, provoked a rethinking of the coal-dominated energy structure. At the same time, China also started to strengthen its environmental policies and controls on the industry, resulting in dwindling coal production numbers and workforces.

The year 2016 provided another key turning point for the coal industry when China initiated supply-side structural reforms, which helped phase out surplus capacity and enhanced overall productivity levels by removing inefficient operations. This move resulted in a steady increase in raw coal production against a continuous shrinking of the workforce, on the back of productivity gains.

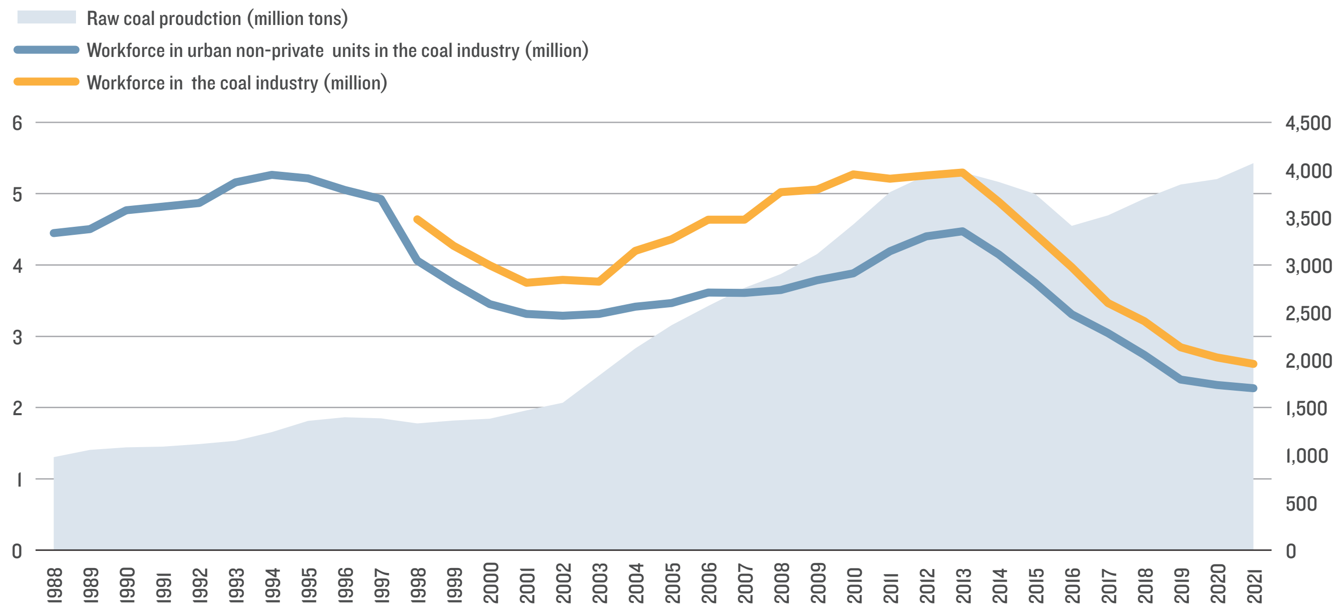
By 2021, the number of people working in the industry dropped from a peak of over 5 million to approximately 2.612 million, as suggested by CEIC data.

16 National Bureau of Statistics of China. China Statistical Database. Retrieved from https://data.stats.gov.cn/easyquery.htm?cn=C01&zb=A070R&sj=2022

17 China National Coal Association. (2021). Guidelines on the High-Quality Development of the Coal Industry in the 14th Five Year Plan Period. Retrieved from http://www.coalchina.org.cn/uploadfile/2021/0603/20210603114439221.pdf

18 For the purpose of this report, employment is defined as worker's work at urban non-private coal mining & preparation units. An urban non-private unit is a statistical category used in China's labor survey which includes legal entities in urban areas, including state-owned enterprises, collective-owned enterprises, limited liability companies, share-holding corporations, and only excludes those self-employed and small business that do not count as legal entities.

Figure 3-1: Changing trends in raw coal production and the workforce of the coal industry



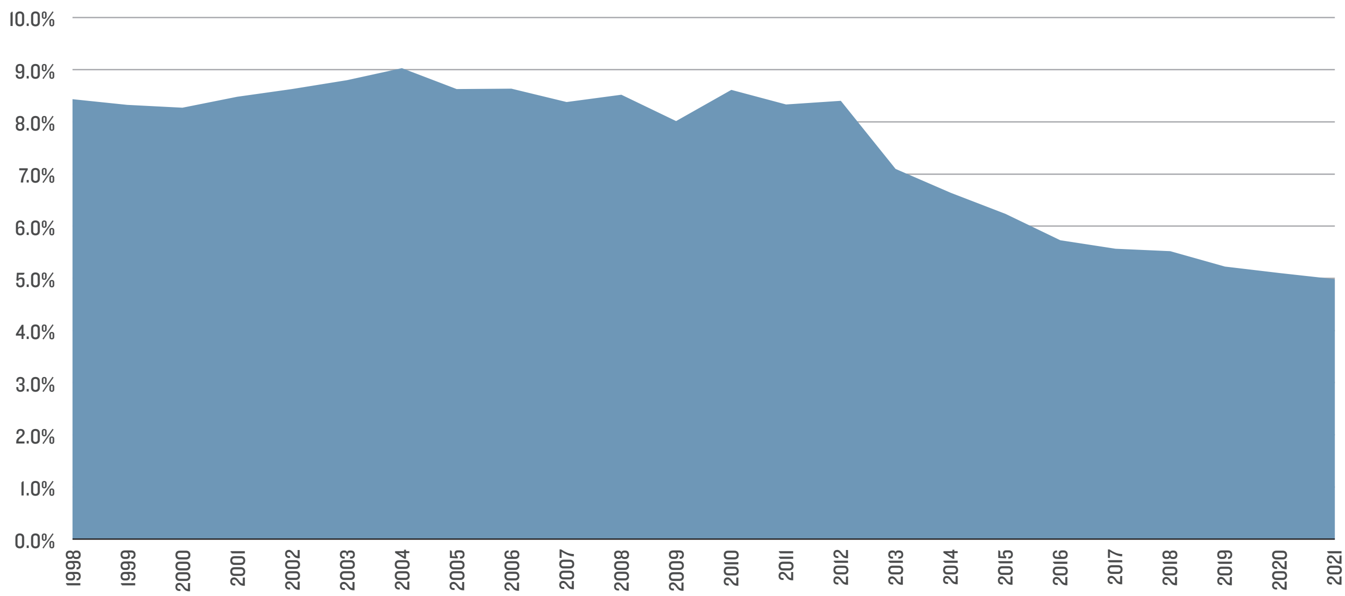
Source: China Labor Statistical Yearbooks, CEIC database[19].

The coal industry has not only experienced a decline in the total number of jobs, but its relative share of the total labor force has also been decreasing. China's first economic census carried out in 2004 found that the coal industry was the third largest employer in the industrial sector, after nonmetal mineral products and textile industries.[20] However, by 2020 the coal industry workforce, as a percentage of industrial sector employment, dropped to 5.0% in 2021 from 8.4% in 1998 (see Figure 3-2).

19 The China Labor Statistical Yearbooks provide annual data on employment in urban non-private organizations. The CEIC's data is based on data published by the Department of Population and Employment Statistics of the National Bureau of Statistics according to the Statistical Reporting System on Labor, the Labor Survey System, and the Rural Socio-Economic Survey Program. To provide a more comprehensive view on China's employment in the coal industry, this report presents both data series to complement each other.

20 Government of China. (2006). First National Economic Census. Retrieved from http://www.gov.cn/gongbao/content/2006/content_180438.htm

Figure 3-2: The coal industry as a percentage of the overall number of employees in the industrial sector



Source: China Labor Statistical Yearbooks

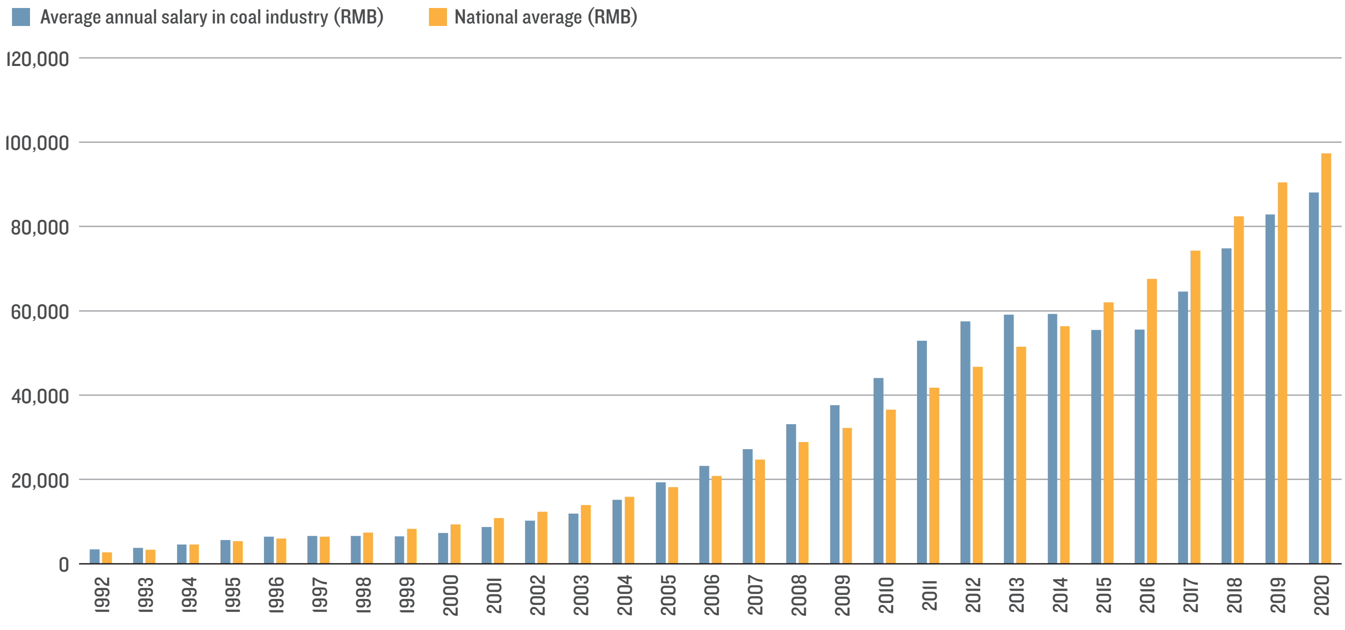
(3) Salary levels

Salary levels in the industry are closely related to its economic competitiveness. The 'golden decade' of growth saw a rapid increase in average salaries in the industry, which eventually overtook the national salary average. In 2011, the average annual salary in the industry was RMB 53,000, which was 26.7% higher than the national average (see Figure 3-3). However, as the industry declined, by 2015 the average salary dropped for the first time and was quickly overtaken by the national average. Even though supply-side structural reform turned the industry around and its average salary has since risen year on year, it still remains lower than the national average. In 2020, the average annual salary in the industry was RMB 88,000, 9.6% lower than the national average of RMB 97,000. That gap narrowed in 2021, thanks to continuous increases in coal and other resource prices, and its annual growth rate rose to 14.5% year-over-year (YOY) compared to the national average at 12.2% YOY[21].

The economic slowdown in the coal industry, compounded by reduced revenues for companies, has increased uncertainty for employers and employees alike. In some cases, companies have failed to make social security payments for their employees, making it increasingly difficult for the industry to attract and retain talents, resulting in a decline in the quality of its workforce over time.

21 National Bureau of Statistics of China. (2022). China's national average salary in urban area in 2021. Retrieved from http://www.stats.gov.cn/sj/sjjd/202302/t20230202_1896630.html

Figure 3-3: Average annual salary in the coal industry vs. the national average salary[22]



Source: China Labor Statistical Yearbooks

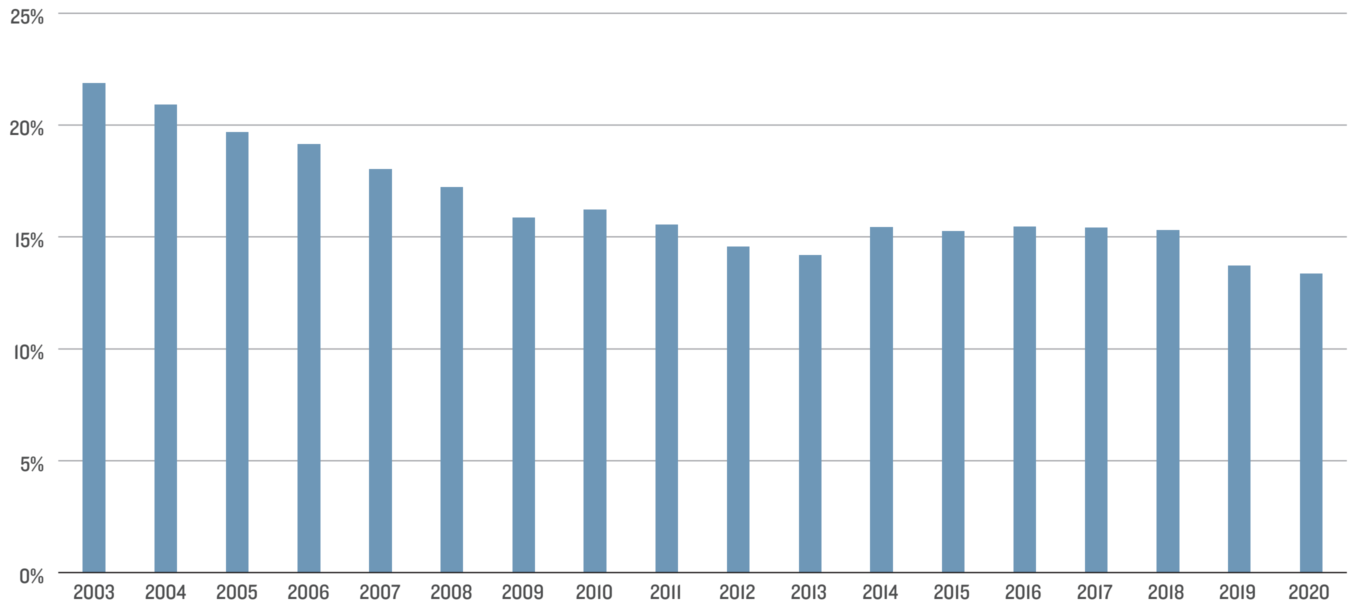
(4) The social and economic profile of coal workers in China

To better identify the groups most vulnerable to the contraction of the coal industry, research for this report examined the current composition of the coal industry workforce by gender, age, education and across the formal and informal sectors.

Gender: Overall, the coal industry is male-dominated, with about 80% of employees being male. It is therefore commonly assumed that any labor shock within the industry would disproportionately affect men. However, a further analysis of changes in the share of female employees over the past two decades shows women are more vulnerable and at higher risk of unemployment when employment shrinks. Over the years, the percentage of women in the coal workforce has fallen, from 21.9% in 2003 to 13.3% in 2020 (see Figure 3-4). Moreover, the decreasing percentage of female employees during the 'golden decade' suggests that not only are women fired more quickly during times of crisis, but they are also less likely to be hired during periods of growth.

22 The income level of the coal mining industry and the national average level are calculated based on the salary level of urban non-private units.

Figure 3-4: Women as a percentage of the coal workforce



Source: China Labor Statistical Yearbooks

Education: Coal industry employees are generally less educated and lower-skilled than workers in other sectors. Statistics show that as of 2019, nearly half of all coal workers only had a junior high school diploma or lesser qualification, only about 10% of the workforce held a bachelor or higher degree and most of those employees were managers, and among front-line operatives, especially those working in the mines, more than 80% had only received a junior high school or a vocational school education[23]. Well-educated professionals in mining, ventilation, geology, measurement, operations, law, and government were few in number.

The industry has historically struggled to find highly qualified professionals. In particular, the coal industry faces a serious shortage of well qualified professionals in deep coal mining, disaster management, coal chemicals, clean coal utilization, and international operations. Difficult working conditions, tiring, risky jobs in remote locations, and associated social stereotypes make such jobs unattractive to educated professionals.

A breakdown of coal mining and preparation experts by employer shows most work at colleges, universities, and research institutions. Only a very small number of these individuals are found at coal companies. Moreover, those experts which are present are concentrated within a very few coal conglomerates, such as the Shenhua Group, China Coal, and the China Coal Technology & Engineering Group. The availability of experts to small coal companies and mining areas is very limited, resulting in a widening gap between human resource assets in large and small coal companies.

Age: In terms of age, most front-line workers are 45 or above and workers aged between 40 to 50 account for around 40% of this total[24], therefore the coal industry's workforce is generally older than those in other sectors. Only a small percentage of workers are in their 20s and 30s, resulting in generational skill gaps and an inadequate talent pool.

Informal workers: The issue of informal employment in the coal industry also merits attention. It is a challenge to

23 Shi, L. (2022). A Study of High-caliber Talent Development among State-owned Coal Companies. China Coal Industry, 2022(07), 76-77.

24 Song, S., Wang, A., Yu, K., Chen, G., & Feng, M. (2021). The Status of Talent Availability in Heilongjiang's Coal Industry and Solutions. Coal Technology, 40(08), 222-224.

estimate the number of those working in the industry in this manner, and while there are attempts to do so, most literature only provides estimated numbers at provincial or city levels. For instance, a study in Tangshan (Hebei province) suggested that informal workers, mostly migrants from rural areas, have gradually come to dominate the front line of coal mining, accounting for 40% to 90% of coal miners working underground[25].

At the national level, there are discrepancies between different sources on the number of coal sector workers, which could shed light on the size of the informal workforce. For example, urban non-private coal mining and preparation companies had a combined workforce of 2.74 million in 2018 according to China Labor Statistical Yearbooks, but this number was listed as 2.85 million by the Department of Population and Employment Statistics (DPES) at the National Bureau of Statistics, and again in contrast, at 3.47 million according to the 4th economic census. It can be inferred that about 20% of the industry's workforce at the time were informal employees and so not included in the figures from DPES. Informal workers usually engage in coalface mining, but without the labor protection rights offered to formal employees.

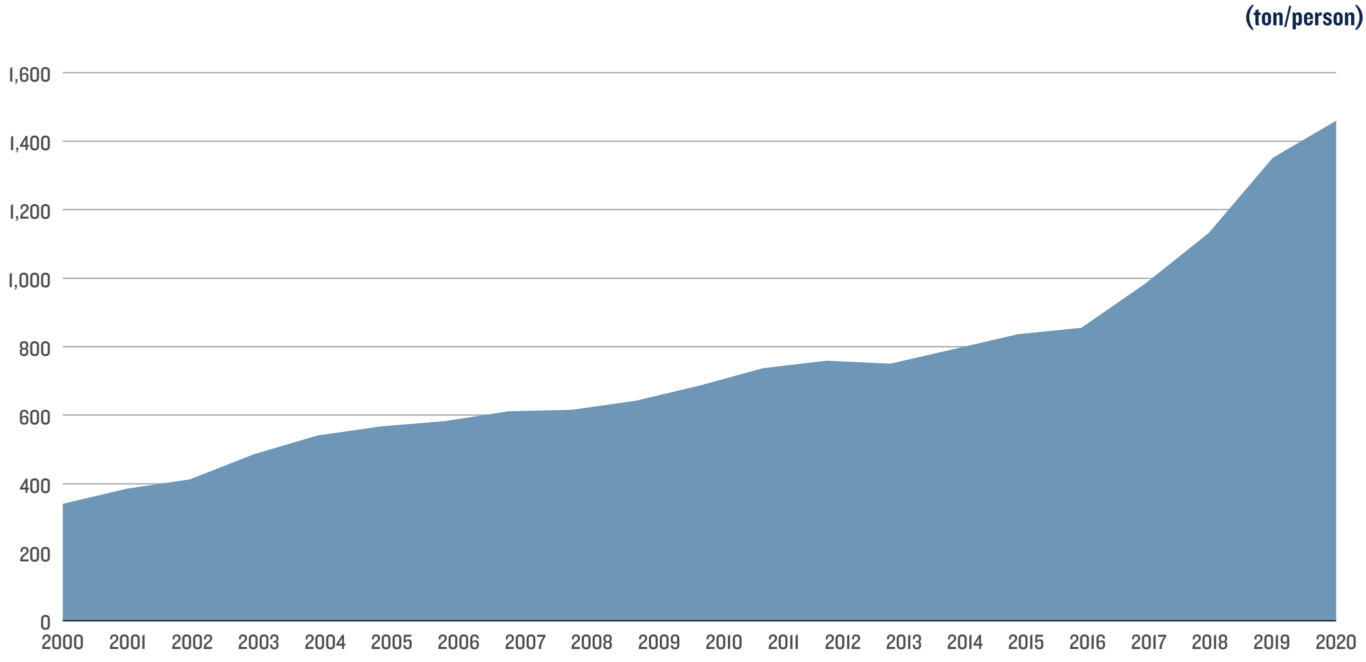
(5) Labor productivity changes

Today's coal industry faces a myriad of pressures and challenges, including from enhanced labor productivity and further mechanizations that will inevitably reduce job opportunities in this traditionally labor-intensive industry. Productivity in the industry has already been increasing. Employment and output data for the industry since 1990 point to constant improvement, and output levels per employee rose from 340.8 tons in 2000 to 686.4 tons in 2010. Ten years later, in 2020, that figure had risen further, to 1,459.7 tons (see Figure 3-5), which results in an average annual growth rate of 7.5%.

© Photo by Jaeyoon Jeong on Unsplash

25 Qiu, K. (2010). An Overall Analysis of Migrant Mining Workers in China. Journal of Tangshan Teachers College, 32(06), 106-108.

Figure 3-5: Labor productivity in China's coal industry from 2000 to 2020



Source: Calculated from statistical data collected by the project team.

Worker productivity in China's coal industry remains lower than in other major coal-producing countries. Labor productivity in the US coal industry increased from less than 2000 tons/person in 1949 to over 10,000 tons/person in 2020, thanks to increased mechanization.[26] Australia and Germany also report high level of coal productivity, driven by 100% mechanization rates. The average annual coal production per person has reached around 10,000 tons in Australia and more than 13,000 tons in Germany. Even lower-middle income countries such as India and Indonesia have outperformed China in this regard, with each worker producing 2,256 to 2,790 tons annually.

26 U.S. Energy Information Administration. (n.d.). Coal data. Retrieved from https://www.eia.gov/coal/annual/

Table 3-1: Coal production and productivity in major coal-producing countries in 2020 [27]

Country	Production (billion tons)	Productivity (ton/person-year) $^{-1}$	Level of mechanization of coal mining (%)
China	3.75	1,423	76
US	0.49	11,511	100
India	0.76	2,790	100
Australia	0.49	9,705	100
Indonesia	0.56	2,256	100
Russia	0.40	28,43	97
South Africa	0.25	2,731	100
Germany	0.17	13,181	100

Note: Author's calculation based on data compiled from the International Energy Agency (IEA), CEIC, Statista and relevant official government sites.

There are underlying factors which limit productivity improvement in China's coal industry. Firstly, China's coal production is dominated by underground mining, where labor productivity is generally lower, with surface mining accounting for only a small share of the industry's methods. In 2015, open-pit mines accounted for 14% of China's total coal production, compared to 65% in the US and 81% in Australia.[28] Secondly, China lags behind in coal mine management and mechanization methods. In 2015, the level of mechanization in China's coal mining industry was only 76%, compared to 100% or close to 100% in other major coal-producing countries. Thirdly, the coal industry in China is not concentrated, with coal reserves widely dispersed and large numbers of small mines being unsuitable for mechanization.[29] Greater levels of concentration and the presence of larger companies are expected to lead to gradual productivity gains. Some large coal companies such as the Shenhua Group have shown notable improvements in productivity, including one mine which produces 20 million tons a year with approximately 500 employees, resulting in productivity

27 All data is from 2020, with the exception of Germany's labor productivity in coal sector which is from 2017 due to data availability

28 Li, R. F., Ren, Y. F., Nie, L. G., Teng, X. Y., & Xing, Xiang. (2017), "A Perspective on Improving Coal Productivity and Reducing Production Capacity", Coal Engineering, 49(3), 1-3.

29 Zhao, K., & Li, Y. (2018). Analysis of current situation of coal resource security in China and its development. Coal Engineering, 10, 185-189.

levels of nearly 40,000 tons per worker. However, much room for improvement in labor productivity remains in China and this, combined with the phase-out of coal, can be expected to lead to continued job losses in the long term.

3.1.2 Forecasting impacts on employment in the coal industry

This section presents a forecast of the impact of China's energy transition on employment in the coal industry in the short and long term. The effective employment impact depends on both changes in the industry's output and changes in the industry's labor productivity, according to the following formula:

*Employment impact = change in industry's output * change in labor productivity (per unit of production)*

To generate findings relating to forecasts, this formula is applied in six different scenarios, based on three different policy scenarios for coal industry production and two technology scenarios for labor productivity growth estimations to 2050.

(1) Scenarios for production changes in the coal industry

Before the announcement of China's "3060" Goal, six internationally renowned energy research organizations—the International Energy Agency (IEA), British Petroleum (BP), the Organization of the Petroleum Exporting Countries (OPEC), the US Energy Information Administration (EIA), the State Grid Energy Research Institute, and the China National Petroleum Corporation (CNPC) Economics & Technology Research Institute—forecasted China's total coal demand. At the lower end of the spectrum, the share of coal in China's energy mix was estimated at over 30% in 2050, which is inconsistent with the achievement of China's carbon neutrality goal for 2060, meaning that coal must be phased out faster than anticipated.

Based on research that outlines pathways for China's "3060" goals attainment using backcasting methods, China should peak its coal consumption around 2025 and gradually reduce the share of coal in the primary energy mix from 2022's 56.2% to 41%-47.2% by 2030 and to 7%-10.25% by 2060.[30]

To assess the impact of an energy transition on employment, this research develops three scenarios related to a decrease in coal consumption: a baseline scenario, a phase-out scenario, and an accelerated phase-out scenario. Table 3-2 provides a brief description of each scenario.

30 Zhang, Y. (2023, May). China's low carbon pathway in the energy sector [Manuscript in preparation]

Table 3-2: Three scenarios for the impact of China's energy transition

	Baseline scenario	Phase-out scenario	Accelerated phase-out scenario
Description	The scenario envisions a continuation of current energy policies and low-carbon transition trends, including: • implementation of the Nationally Determined Contributions established under the Paris Agreement; and • the achievement of energy and carbon intensity targets as well as non-fossil energy share targets as per the Action Plan of the State Council for Peaking Carbon Emissions before 2030.	The baseline scenario plus: • stronger implementation of energy-saving policies; • major energy-intensive sectors, such as steel, cement, plate glass, and papermaking, reach peak production before 2025; and • carbon emissions from industrial and power sectors peak around 2025.	The phase-out scenario plus: • speeding up of the phase-out of fossil fuel to ensure a pathway consistent with a 2°C or even 1.5°C temperature rise; and • carbon emissions from nationwide energy consumption peak in 2025.
Peak year and emission level	Carbon emissions peak at 11.89 billion tons before 2030, with a growth rate of 2.8% between 2020 and 2025 and then reach a plateau from 2025 to 2030.	Carbon emissions will peak at 11.52 billion tons by 2025, with an average growth rate of 2.2% per year in the five years before the peak.	Carbon emissions will peak at 11.26 billion tons by 2025, with an average annual growth rate of 1.7% in the five years before the peak.
Carbon emissions by 2050/2060	Carbon emissions will reach 6.97 billion tons by 2050.	Carbon emissions will drop to 4.87 billion tons by 2050.	Carbon emissions will be reduced to 3.5 billion tons by 2050 and further to 1.5 billion tons by 2060.

Table 3-3 shows research findings on the forecasted energy demands and share of coal under the three scenarios. These figures allow for rough estimates of coal consumption under each scenario.

Table 3-3: Coal consumption forecasts under different policy scenarios

(billion tons of coal equivalent (TCE))

		2020	2025	2030	2035	2050
Baseline scenario	Energy consumption (bn TCE)	4.98	5.76	6.20	6.32	6.00
	Share of coal consumption (%)	56.8	50.0	45.0	39.1	25.4
	Coal consumption (bn TCE)	2.83	2.88	2.79	2.47	1.52
Phase-out scenario	Energy consumption (bn TCE)	4.98	5.61	6.02	6.50	5.89
	Share of coal consumption (%)	56.8	49.0	43.7	36.2	16.7
	Coal consumption (bn TCE)	2.83	2.75	2.63	2.35	0.98
Accelerated phase-out scenario	Energy consumption (bn TCE)	4.98	5.50	5.90	6.10	5.80
	Share of coal consumption (%)	56.8	48.3	41.8	34.1	9.9
	Coal consumption (bn TCE)	2.83	2.66	2.47	2.08	0.57

Apart from coal consumption, coal imports will also affect future levels of coal production. In 2008, rapidly growing amounts of coal imports meant that China switched from being a net exporter to a net importer of the fuel. Since 2012, weakening domestic demand has reduced those imports, but over 200 million tons of coal are still imported annually.[31] Three factors explain the need for imports of coal to China. Firstly, China's coal industry has low levels of productivity, which makes the cost of production much higher than elsewhere. Secondly, a lack of advanced railway transportation of coal makes seaborne coal much cheaper than 'inland' coal, especially as coal consumption is concentrated on the coast. Thirdly, domestically produced coal has a lower quality than that of imported products, and domestic coal has a lower heating value, while tighter environmental requirements have made imports more attractive compared to Chinese coal, which has higher phosphorous and sulfur content. However, import amounts are expected to decline, driven by accelerating transitional processes and domestic productivity gains, as well as rail transport improvements and the constraints of the "3060" goal.

Given overall circumstances at home and abroad, China's coal production is expected to decline in the future. This report provides predictions of how those changes will differ under different scenarios, based on the correlation between coal production and consumption over time (see Table 3-4).

31 National Bureau of Statistics of China. China Statistical Database. Retrieved from https://data.stats.gov.cn/

Table 3-4: Coal production forecasts for China under different scenarios

(bn tons)[32]

	2020	2025	2030	2035	2050
Baseline scenario	3.80	3.87	3.74	3.30	1.98
Phase-out scenario	3.80	3.68	3.52	3.13	1.23
Accelerated phase-out scenario	3.80	3.56	3.29	2.75	0.66

Source: Calculated based on the scenarios constructed by the research team.

(2) Labor productivity scenarios for China's coal industry

Historical labor productivity figures and trends in China's coal industry were used in this research to construct two scenarios for future labor productivity changes. Figures for each scenario are outlined in Table 3-5.

In the **base technology scenario**, research assumed the industry's average annual growth rate in labor productivity between 2020 and 2030 will be approximately 7.5%, in line with the previous 20 years' average. Labor productivity is then expected to decline to 5% YOY between 2030 and 2050. Under this scenario, China's labor productivity in the coal industry will shift to the level recorded in countries like Indonesia and South Africa by 2050.

Alternatively, the **improved technology scenario** hypothesizes growth in labor productivity to maintain the historical annual average rate of 7.5% YOY, to 2050. Under this scenario, China's labor productivity in the coal industry will be close to that of the US and Australia by around 2050.

Table 3-5: Labor productivity in the coal industry under different technology scenarios

(ton/person-year^{-1})

Scenario	Description	2020	2030	2040	2050
Base technology scenario	Productivity will grow at an average yearly rate of 7.5% between 2020 and 2030, and 5% between 2030 and 2050.	1,459.7	3,008.5	4,900.5	7,982.4
Improved technology scenario	Productivity will grow at a yearly rate of 7.5% to 2050.	1,459.7	3,008.5	6,200.6	12,779.5

Source: Based on calculations and discussions of the research team.

32 Please note here the unit for coal production is billion ton while the unit reported in coal consumption is billion TCE

(3) Forecast of employment impacts on the coal industry

This section provides projections of impacts of a transition in the coal industry on the sector's total workforce, under different technology and policy scenarios.

Over 52% of jobs in the coal sector will be lost within a 10-year time frame based on the current policy trajectory (under the baseline scenario).[33] This percentage could increase to 55% or even up to 58% if stronger policies to accelerate the phase-out of coal are adopted (this would occur under the phase-out scenario and accelerated phase-out scenarios respectively). In terms of total numbers, China will see a direct loss of 1.3-1.5 million jobs in the coal sector by 2030. While significant, the scale of employment change is smaller than that experienced during China's supply-side structural reform, which resulted in a loss of 1.4 million jobs in the coal sector between 2016 and 2021.

Looking further ahead, the percentage of job loss in the coal sector by 2050 is projected to range from 90% to 98% of job numbers in 2020, depending on the combination of policy and technology scenarios. Even with the most conservative projections (combining the base case technology scenario and baseline policy scenario), the industry's workforce will plummet from 2.6 million in 2020 to 248,000 in 2050, resulting a decrease of 2.35 million jobs.

Furthermore, current projections indicate that the difference in workforce change between different technical scenarios is smaller than that between different policy scenarios. This suggests that policy changes resulting from energy transition actions will play a more important role in downsizing the coal sector labor force than labor productivity improvement. For instance, under the same baseline policy scenario, the workforce decrease between 2020 and 2050 is projected to be 90.4% for the base technology scenario and 94% for the improved technology scenario, resulting in an overall difference of 3.6%. Meanwhile, under the same base technology scenario, but with different policy scenarios, the difference in workforce change between 2020 and 2050 would be 3.7% (see Table 3-6).

Table 3-6: Size of the coal industry's workforce under different scenarios between 2020 and 2050

(thousands)

Policy scenarios	Technology scenarios	Year					Workforce changes between 2020 and 2050
		2020	2025	2030	2035	2050	
Baseline scenario	Base technology scenario	2,600	1,845	1,244	859	248	-2,352 (90.4%)
	Improved technology scenario	2,600	1,845	1,244	764	155	-2,445 (94.0%)

33 In a 10-year frame, the loss is the same across different productivity scenarios.

Policy scenarios	Technology scenarios	Year					Workforce changes between 2020 and 2050
		2020	2025	2030	2035	2050	
Phase-out scenario	Base technology scenario	2,600	1,758	1,170	816	154	-2,446 (94.1%)
	Improved technology scenario	2,600	1,758	1,170	725	96	-2,504 (96.3%)
Accelerated phase-out scenario	Base technology scenario	2,600	1,697	1,094	717	82	-2,518 (96.8%)
	Improved technology scenario	2,600	1,697	1,094	637	51	-2,548 (98.0%)

Reduced coal output will not only reduce job opportunities within the industry itself, as this shift will cause employment changes across the entire industrial chain. By using an input-output (I-O) model, indirect employment effects can be further estimated.[34]

Using the 2020 I-O table and data from the 2018 national economic census, the employment impact coefficients (EIC) have been calculated to measure the elasticity of employment with respect to output, for various industries.[35] A total EIC reflects the total workforce required to produce RMB 10,000 of output, including labor input from both the industry in question and other industries. The total EIC in the coal industry is low, at 0.0658 per RMB 10,000 in 2020. In other words, RMB 10,000 of coal industry output will result in the employment of 0.0658 people across the economy. The total EIC can also be disaggregated into a direct coefficient that reflects labor needed from its own industry and an indirect EIC, which measures labor needed from other industries. The direct and indirect EICs of China's coal industry are 0.0317 and 0.0341 respectively, which gives an indirect/direct EIC ratio of 1.08, thus one unit of job loss or creation in the coal industry will lead to 1.08 units of job loss or creation in other related industries.

Table 3-7 presents a time series of data relating to EICs over the past two decades. The declining trend of direct, indirect and total EICs of the coal industry suggests that the total number of jobs created, directly and indirectly, by coal industry output has been decreasing, mostly due to productivity improvement. At the same time, the indirect/direct EIC ratio first rises during coal's 'golden decade' and

34 An I-O table shows the links between the inputs and outputs of a country, or of different regions and sectors, as well as interdependence between different economic sectors, for a particular year.

35 Department of National Account, National Bureau of Statistics of China. (2022). Input-Output Table of China 2020. China Statistics Press.

then goes down to 1.08, suggesting that the employment impacts of the coal industry's transition are expected to be mostly limited to the industry itself, and its significance for employment in related industries will continue to wane.

Table 3-7: The indirect/direct EIC ratios of the coal industry

Year	Direct EIC (Person/RMB 10,000)	Indirect EIC (Person/RMB 10,000)	Total EIC (Person/RMB 10,000)	Ratio of indirect/direct EIC
2002	0.2871	0.2754	0.5625	0.96
2005	0.1618	0.2631	0.4249	1.63
2007	0.1525	0.1594	0.3120	1.05
2010	0.0950	0.1729	0.2679	1.82
2012	0.0626	0.0974	0.1601	1.56
2015	0.0424	0.0546	0.0970	1.29
2017	0.0372	0.0433	0.0805	1.16
2018	0.0323	0.0374	0.0696	1.16
2020	0.0317	0.0341	0.0658	1.08

Source: Based on annual I-O tables and sectoral employment data.

The overall employment impact of the phase-out of coal on the economy under different scenarios can be estimated using the indirect/direct EIC ratio in 2020 (see Table 3-8). Under the most conservative scenario (using a baseline policy scenario with a base technology scenario), there will be a reduction of 0.76 million in **direct** employment numbers, and a reduction of 0.82 million in **indirect** employment numbers, by 2025, with a total loss of 1.6 million jobs compared to 2020. By 2050, 4.9 million jobs will have been lost, with 2.4 million of these being direct and 2.5 million being indirect.

A combination of the improved technology scenario and accelerated phase-out scenario will have a more pronounced impact, as under this perspective, by 2025, there will be a total loss of 1.9 million jobs. Between 2020 and 2050, 5.3 million jobs will be lost, with 2.548 million being direct and 2.752 million being indirect.

Table 3-8: The direct and indirect employment impacts of the coal industry

(in thousands)

Period	Base technology +baseline scenario			Improved technology +accelerated phase-out		
	Direct employment impact	Indirect employment impact	Overall employment impact	Direct employment impact	Indirect employment impact	Overall employment impact
2020-2025	-755	-815	-1,570	-903	-975	-1,878
2020-2035	-1,741	-1880	-3,621	-1,962	-2,119	-4,082
2020-2050	-2,352	-2,540	-4,892	-2,548	-2,752	-5,300

3.2 EMPLOYMENT IMPACTS ON THE ELECTRICITY GENERATION INDUSTRY

3.2.1 The prospects of China's power sector

The electricity sector in China is responsible for 36% of the nation's greenhouse gas (GHG) emissions.[36] The high carbon intensity character of China's electricity generation sector is due to the dominance of installed thermal power generation capacity (PGC), accounting for the majority of China's total generation capacity. Despite a clear declining trend, thermal power installed capacity still accounted for 56.6 % of the total power generated at the end of 2020 (see Table 3-9). In light of expectations of relatively benign economic performance in the short and medium term, positively correlated with growth in power demand and trends in the electrification of end-use sectors, the decarbonization of power generation is critical for the achievement of the "3060" goal.

Between 2001 and 2021, China posted an average annual growth rate of 8.9% in total electricity consumption. Growth started to slow from 2010, averaging approximately 5.9% from 2012 to 2021, also stemming from gains in efficiency (Figure 3-6).

36 Climate Trace (2023). China greenhouse gases' generation. Retrieved from https://climatetrace.org/inventory?sector=all&time=2021&country=CHN&gas=co2e100

Figure 3-6: National total electricity consumption from 2012 to 2021

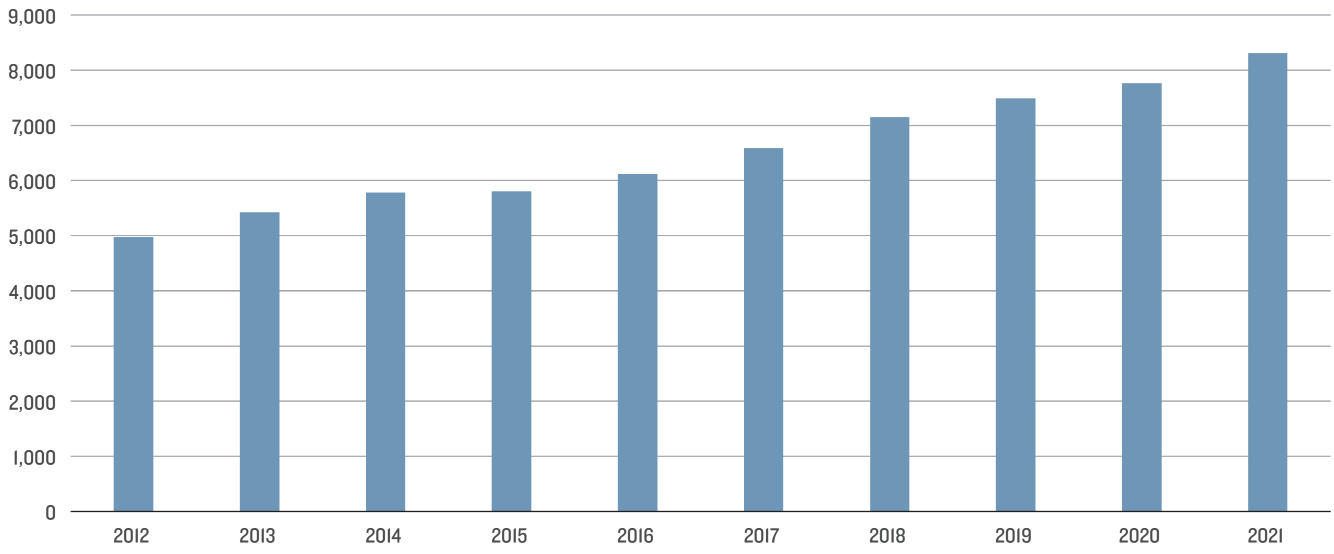
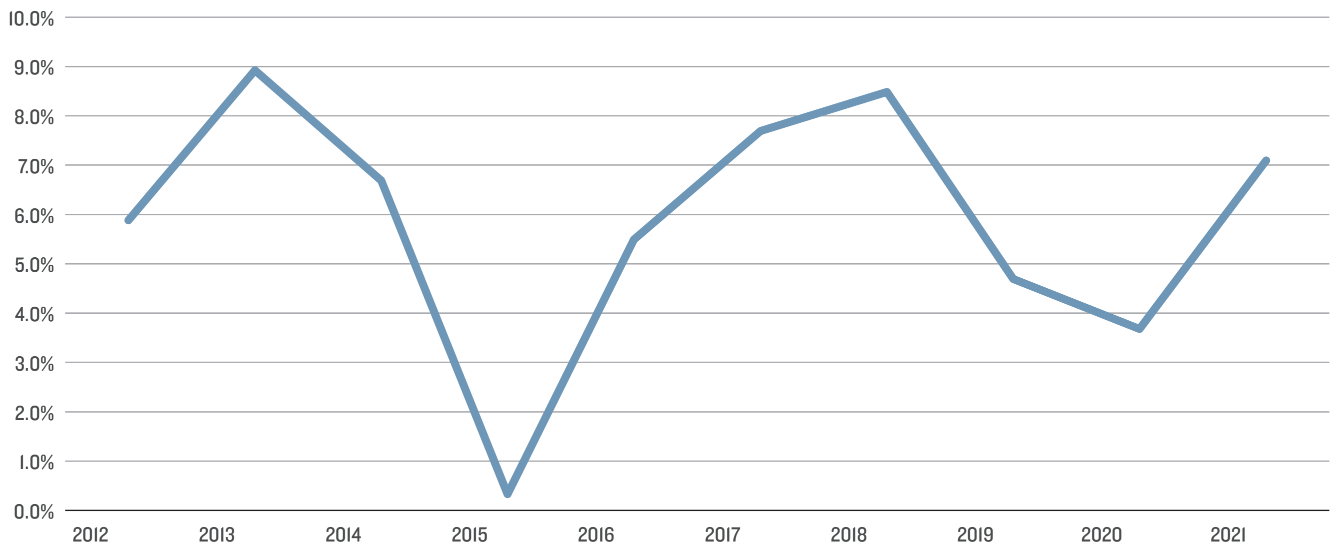


Figure 3-7: National electricity consumption growth rates from 2012 to 2021



Based on current electricity demand forecasts, China must speed up the replacement of coal with non-fossil sources of electricity and construct a new electricity system primarily composed of new energy in order to peak carbon emissions and become carbon neutral. Progress on this task will depend on different technology development and application scenarios as well as on adopted policies.

In recent years, several central government agencies, such as the National Development and Reform Commission (NDRC) and National Energy Administration (NEA), have released a series of policy documents to guide the electricity industry's low-carbon transition. These strategies include the 14th Five-Year Plan (FYP) for a Modern Energy System, the 14th Five-Year Implementation Plan for New Energy Storage Development, and the Implementation Plan for Promoting the High-Quality Development of New Energy in the New Era. These policy documents outline several key priorities, such as the expediting of the transformation of southwest China into a national hydropower hub, fostering safe nuclear power development in coastal areas, and establishing a number of clean energy bases with complementarity amongst multiple energy sources. According to research conducted by the China Electricity Council on the 14th FYP for the electric power industry, carbon emissions from the industry are projected to reach a plateau before 2025. Additionally, out of the total installed capacity of 1245 gigawatts, 20 gigawatts of inefficient thermal PGC will be phased out.[37]

In 2022, China released its 14th Five-Year Plan (FYP) on Renewable Energy Development (2021-2025), which sets targets for a 50% increase in renewable energy generation, from 2.2 trillion kWh in 2020 to 3.3 trillion kWh in 2025. Additionally, the plan stipulates that renewables must account for 50% of China's increase in electricity and energy consumption between 2021 and 2025. This means that emerging industries such as wind, solar and biomass energy will bring significant changes in the employment structure of the electricity supply sector.

Table 3-9: Statistical breakdown of installed power capacity (IC) by source

Year	Thermal power (excluding coal)		Coal Power		Hydropower		Wind power		Solar power		Nuclear power		Other	
	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%
2012	64798	5.7%	754882	65.8%	249470	21.8%	61420	5.4%	3410	0.3%	12570	1.1%	200	0.02%
2013	74306	5.9%	795784	63.3%	280440	22.3%	76520	6.1%	15890	1.3%	14660	1.2%	80	0.01%
2014	99994	7.3%	832326	60.4%	304860	22.1%	96570	7.0%	24860	1.8%	20080	1.5%	190	0.01%
2015	105447	6.9%	900093	59.0%	319540	20.9%	130750	8.6%	42180	2.8%	27170	1.8%	90	0.01%
2016	114696	6.9%	946244	57.3%	332070	20.1%	147470	8.9%	76310	4.6%	33640	2.0%	70	0.00%

37 China Electricity Council. (2021). Research on the 14th Five-Year Plan of the Power Industry. Retrieved from: https://www.cec.org.cn/upload/1/pdf/1609833054935.pdf

Year	Thermal power (excluding coal)		Coal Power		Hydropower		Wind power		Solar power		Nuclear power		Other	
	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%	IC (MW)	%
2017	123650	7.0%	981300	55.2%	343590	19.3%	163250	9.2%	129420	7.3%	35820	2.0%	70	0.00%
2018	135730	7.1%	1008350	53.1%	352590	18.6%	184270	9.7%	174330	9.2%	44660	2.4%	200	0.01%
2019	148940	7.4%	1040630	51.8%	358040	17.8%	209150	10.4%	204180	10.2%	48740	2.4%	370	0.02%
2020	167120	7.6%	1079120	49.0%	370280	16.8%	281650	12.8%	253560	11.5%	49890	2.3%	410	0.02%
2021	187770	7.9%	1109620	46.7%	390940	16.4%	328710	13.8%	306540	12.9%	53260	2.2%	940	0.04%

Source: China Electricity Council

To forecast such change, the first step taken needs to be to understand how China's electricity system will transform to align with related targets set out in China's energy and climate policy documents. This research uses a model developed by the Energy Institute of Peking University which predicts China's total electricity consumption and maximum load based on other developed countries' experiences, including their timetables in reaching peak electricity consumption, and per-capita electricity consumption figures at those peaks. The model also outlines pathways for China's new electricity system projection, taking into account diverse factors such as the potential of various sources of power, technological advancements, carbon market constraints, and evolving business models (see Table 3-10).

Table 3-10: Forecasted pathways for a new electricity system

Year	2020	2025	2030	2035	2050	2060
Total electricity consumption (GWh)	750	950	1090	1240	1560	1520
Installed coal power (TW)	1.08	1.17	1.13	1.06	0.64	0.2
Installed solar power (TW)	0.25	0.555	0.97	1.43	2.81	3.35
Installed wind power (TW)	0.279	0.56	0.87	1.25	2.09	2.28
Installed hydropower (TW)	0.37	0.46	0.55	0.6	0.7	0.73
Installed nuclear power	0.05	0.07	0.1	0.13	0.2	0.22
Installed biomass power (TW)	0.03	0.07	0.1	0.12	0.15	0.16

Source: Institute of Energy of Peking University, The Connotation of and Outlook for the New Electric Power System Dominated by New Energy

3.2.2 Forecasted impacts on employment in the electricity generation industry

Electricity generation and supply falls under the electricity, steam, gas and water production and supply (ESGW) of China's industrial classification of economic activities. In 2020, ESGW employed 3.8 million people, with the majority (about 2.8 million) working in electricity and steam production and supply.

The electricity industry is a technology- and knowledge-intensive sector that requires highly qualified employees with hands-on skills. Earnings for employees in electricity generation and supply therefore fall in the mid-to-upper range compared to other sectors. For example, in 2020 urban employees in the ESGW sector earned an average annual income of RMB 116,728, which was 20% higher than the national average of RMB 97,379.

According to Annual Reports on China's Electricity Industry released by the China Electricity Council, there are three types of jobs in the electricity industry: electricity generation, electricity supply, and electricity construction. Due to the limited availability of employment data for the electricity industry, this analysis focuses only on predicting job changes in the production side, or operational and maintenance (OM) jobs in electricity generation. Jobs created elsewhere in the supply chain, such as in equipment manufacturing, project construction, and power supply, are not included. The model uses the best available data from official sources and fields to calculate the employment intensity or the employment factor[38], in order to estimate the labor absorption capacity of different types of power generation, following Jay Rutovitz's methodology.[39] The number of jobs created by different types of electricity generation can be worked out using this formula:

*Electricity sector jobs in j= cumulative installed capacity of j * OM employment factor for j*

Where *j* is the type of electricity generation.

The OM employment factor for any type of power generation, as determined by the project team's field research, can be multiplied by the cumulative installed capacity of that type of electricity generation to give a rough figure for the number of production-side jobs created. When the results are combined with the forecasts for electricity development, changes in employment and employment structures can be predicted.

(1) Employment factors in the electricity industry

Coal power has the largest workforce in the generation sector, but its figures have been declining both in terms of absolute number and share. Furthermore, workforce composition varies significantly from company to company. According to data from the China Electricity Council, the 16 largest power companies in China have more qualified workforces and more skilled employees compared to their smaller industrial counterparts.[40]

By analyzing research data and comparing Chinese power companies with their international peers, OM employment factors for various types of electricity generation can be roughly determined and future trends are identified, as shown in Table 3-11.

Table 3-11: Forecasts of per-unit electricity generation employment factors by type of power

(person/MW)

Type	2020	2025	2030	2035	2050	2060
Coal	0.5	0.41	0.33	0.27	0.19	0.14
Hydro	0.07	0.06	0.05	0.04	0.03	0.02

38 The employment intensity or the employment factor refers to the number of jobs generated per unit of investment/production that is calculated based on research or statistical calculations.

39 Rutovitz, J., Dominish, E., & Downes, J. (2015). Calculating Global Energy Sector Jobs—2015 Methodology Update. Institute for Sustainable Futures, University of Technology, Sydney. Retrieved from https://opus.lib.uts.edu.au/bitstream/10453/43718/1/Rutovitzetal2015Calculatingglobalenergysectorjobsmethodology.pdf

40 China Electricity Council. (2022). Annual Report on China's Electricity Industry 2022. China Building Materials Press.

Type	2020	2025	2030	2035	2050	2060
Wind	0.5	0.44	0.39	0.34	0.25	0.21
Solar	0.7	0.62	0.54	0.48	0.35	0.29
Nuclear	0.35	0.32	0.29	0.26	0.22	0.20
Biomass	4	3.26	2.66	2.17	1.48	1.15

Source: 2020 levels are determined by the project team based on field research and telephone surveys. Forecasts are based on relevant literature and analysis.

(2) Forecasted impacts on employment in the electricity industry

Based on future scenarios relating to the electricity industry and forecasted changes in employment factors, rough estimates of employment figures by type of electricity generation can be created, as shown in Table 3-12.

The employment size of the **coal power** is expected to decrease significantly in the coming years, due to increasingly tighter controls on coal. By 2030, the employment size for coal power generation is predicted to decrease by 30%, and by 2060 the workforce will be reduced to 28.8 thousand, a 95% decrease compared to 2020 levels. This drop can be explained by two factors. Firstly, the capacity growth in coal power generation will slow down and existing jobs will be lost as energy-saving and emissions policies force old and inefficient smaller generators to shut down. Secondly, jobs created per unit of new capacity will diminish due to the use of more advanced generators. This will both affect employment in the coal power sector and also have indirect impacts on upstream equipment manufacturers and technical service providers.

In the meantime, **wind and solar power generation** are expected to experience significant increases in employment size of 331.1 thousand workers (237%) and 793 thousand workers (453%), respectively. With the growth of wind, solar, and nuclear power generation, job losses in coal power generation will be compensated by opportunities in these other sectors. Overall, employment numbers in the electricity industry are forecasted to increase, up for 68% by 2060 comparing to 2020 level.

With the exception of nuclear power, other types of electricity generation produce more OM jobs per unit of installed capacity than coal generation, which means more jobs will be created for the generation of the same amount of power. Wind, solar, and biomass power in particular have bright prospects and enormous job-creation potential. The development of hydropower generation, especially of pumped hydroelectric energy storage (PHES), will drive growth in associated sectors, such as in the manufacturing of hydroelectric generators and equipment, creating a sizeable number of new jobs. As for nuclear power, its employment growth potential is relatively limited in comparison to solar and wind energy, with a projected increase of almost 27,000 jobs between 2020 and 2060. Compared to other types of power generation, nuclear power generation also requires more technical expertise and higher skills from its employees, making jobs in this sector more demanding but also more stable.

In conclusion, to alleviate the impact of job losses in the coal-related industries caused by the energy transition, promoting mobility of workers from the traditional sector to the renewable energy sector is crucial. Skill training programs are necessary to equip affected workers with the relevant skills to participate in other energy industries that offer great potential for employment.

Table 3-12: Forecasted employment in the electricity sector

(in thousands of people)

Type	2020	2025	2030	2035	2050	2060	Changes between 2020 and 2060
Coal	540.0	477.0	375.6	287.3	118.7	28.8	-511.2 (95%)
Hydro	25.9	26.3	25.6	22.8	18.2	14.7	-11.2 (43%)
Wind	139.5	246.7	337.7	427.5	527.9	470.6	+331.1(237%)
Solar	175.0	342.3	527.1	684.7	993.7	968.0	+793(453%)
Nuclear	17.5	22.1	28.6	33.6	44.5	44.2	+26.7(152%)
Biomass	120.0	228.3	265.9	260.2	222.5	184.2	+64.2 (54%)
Total	1,017.9	1,342.7	1,560.6	1,716.1	1,925.4	1,710.5	+692.6 (68%)

4

INTERNATIONAL BEST PRACTICES IN JUST TRANSITIONS

As emphasis on transitioning towards sustainable and low-carbon pathways increases, so does the amount of focus on the social element of such transitions, with many countries starting to take concrete actions to effectively manage these impacts. As of March 2022, more than one-third (62) of the 166 updated Nationally Determined Contributions (NDC) submitted mentioned the concept of just transitions.[41] According to the Intergovernmental Panel on Climate Change (IPCC), 19 countries have established dedicated commissions, task forces, and dialogues to ensure that the transition is carried out in a fair and inclusive manner.[42] Countries pursuing this approach include both developed nations such as EU members, the US, Canada, and New Zealand, and emerging economies like South Africa. Table 4.1 lists some of the leading countries with examples of their notable just transition practices, highlighting the global, innovative approaches being taken to create a sustainable and equitable future for all.

Table 4-1: Table 4.1 Selection of international examples of just transition practices

Country	Just transition practices
Canada	In 2018, the Government of Canada launched the Task Force on Just Transition for Canadian Coal Power Workers and Communities, which works together with labor unions, coal workers, private sector, NGOs, academics, and local government representatives to provide recommendations on developing a just transition plan for workers and communities affected by the phase-out of coal[43].
Colombia	In 2019, the Government of Colombia and the International Labor Organization signed a Pledge for Green Jobs and Just Transition. Colombia's Ministry of Labor aims to develop a national just transition strategy by 2023[44].
EU	In January 2020, the European Commission published its proposal for a Just Transition Mechanism, intended to provide financial and technical support to territories most seriously affected by the green transition.
Germany	In 2018, the German government set up the Commission on Growth, Structural Change, and Employment (KWSB), also known as the Coal Commission.

41 United Nations Development Programme. (2022). Issue Brief: Just Transition. Retrieved from https://www.undp.org/publications/issue-brief-just-transition

42 IPCC. (2021). Climate Change 2021: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change. Retrieved from https://www.ipcc.ch/report/ar6/wg3/downloads/report/IPCC_AR6_WGIII_FullReport.pdf

43 Government of Canada. (2021). What We Heard: Task Force on Just Transition for Canadian Coal Power Workers and Communities. Retrieved from https://www.canada.ca/en/environment-climate-change/services/climate-change/task-force-just-transition/what-we-heard-report.html

44 World Resources Institute. (2022). Colombia's Early Plans for Green Jobs and Just Transition. Retrieved from https://www.wri.org/update/colombias-early-plans-green-jobs-and-just-transition

Country	Just transition practices
Greece	After setting the goal of withdrawing all lignite power plants by 2028, in 2019 the Government of Greece established a commission of six ministries to ensure a just transition in key areas and in 2020 released a Just Transition Development Plan[45].
India	The Jharkhand state government in India created a Task Force for Just Transition in 2022 to evaluate coal dependency in the state and plan a shift to cleaner energy sources. The task force is made up of 17 institutions and is focusing on seven thematic areas.[46]
Italy	After announcing its commitment to net-zero emissions, Italy's Enel (one of Europe's largest energy companies) launched the "Futur-e" project, dedicated to the redevelopment of 23 thermoelectric power plants and settlements of affected workers during the transition. Enel sets a leading example of just transition promotion at the corporate level[47].
New Zealand	In May 2018, the Government of New Zealand established a Just Transition Unit housed in the Ministry of Business, Innovation and Employment, which helps share and coordinate the work of transitioning New Zealand to a low emissions economy[48].
Poland	In 1998, Poland introduced the Mining Social Package aimed at all underground mineworkers who had worked in the coal sector for at least five years and decided to leave the job voluntarily, and provided special entitlements and privileges to support eligible mining communities, including additional tax revenue and preferential loans[49].
Slovakia	In 2019, To support transition in the Upper Nitra region, Slovakia launched an action plan, which encompasses four pillars: infrastructure, economy, energy sector, as well as quality of life and social aspects.[50]
South Africa	South Africa was one of the first countries to establish a national dialogue on developing just transition plans. The country has also assessed the vulnerability of different sectors to transition[51].

45 Sustainable Development Agenda of the Municipality of Athens. Master Plan for Public Consultation. Retrieved from https://www.sdam.gr/sites/default/files/consultation/Master_Plan_Public_Consultation_ENG.pdf

46 MongaBay India. (2023, February 9). Interview: Ajay Kumar Rastogi on leading India's first Just Transition Task Force. MongaBay India. https://india.mongabay.com/2023/02/interview-ajay-kumar-rastogi-on-leading-indias-first-just-transition-task-force/

47 European Trade Union Institute. (2017). Just Transition - A Round-up [PDF]. Retrieved from https://www.etui.org/sites/default/files/Just%20transition%2004.pdf

48 New Zealand Ministry of Business, Innovation, and Employment. (n.d.). Just Transition. Retrieved from https://www.mbie.govt.nz/business-and-employment/economic-development/just-transition/

49 Cretney, R., & Johnson, D. (2021). Post-Coal Transition in Central and Eastern Europe: Lessons from Wales, Germany, Czech Republic, Ukraine, and Poland [PDF]. Retrieved from https://www.jstor.org/stable/pdf/resrep14806.6.pdf

50 Innovation Origins. (2020). Participation and Ideas Made Slovak Upper Nitra Start Its Post-Coal Era. Retrieved from https://innovationorigins.com/en/participation-and-ideas-made-slovak-upper-nitra-start-its-post-coal-era/

51 World Resources Institute. (2022). South Africa: Strong Foundations for a Just Transition. Retrieved from https://www.wri.org/update/south-africa-strong-foundations-just-transition

Country	Just transition practices
Spain	In 2019, the Government of Spain approved the Strategic Framework for Energy and Climate, including a just transition strategy designed to ensure that all territories and groups can make the most of transition opportunities. Spain's main implementation mechanisms are Just Transition Agreements signed with affected territories, bringing together different stakeholders to develop comprehensive regional action plans[52].
UK	In 2018, the Scottish Government established the Just Transition Commission to help the government develop and monitor key just transition plans, in a way that is co-designed and co-delivered by communities, businesses, unions and workers, and all society. Scotland has also created the Scottish Oil and Gas Transition Training Fund to provide grants to oil and gas workers for training and reskilling for green jobs[53].
US	In 2015, the Obama administration launched the Partnerships for Opportunity and Workforce and Economic Revitalization (POWER) + Plan to address the negative impacts of coal's decline through investments in coal communities[54].

Source: based on the Working Group III Contribution to the Sixth Assessment Report of the IPCC and official information released by the governments.

As table 4.1 demonstrates, with the exception of some early-starters like Poland, most countries started emphasizing a just low carbon transition around 2015-2018, often prompted by the updating of national, regional and corporate climate goals. While the focus of their actions differs among countries, they all demonstrate a clear understanding of the complexity of the just transition issue. As a result, measures taken are often comprehensive and multi-pronged, rather than simple, one-dimensional interventions. The actions of these nations can be broadly categorized into five types of initiatives:

1. Establishing a task force or dedicated departments to oversee a just transition. As the transition will affect different groups, the common practice globally is to adopt a participatory approach, encouraging the setting up of inclusive dialogue or consultation mechanisms. This allows all stakeholders to participate in policymaking and planning processes from an early stage, ensuring the needs of various groups are considered. Examples of these diverse groups include Germany's Coal Commission, New Zealand's Just Transition Unit under the Ministry of Business, Innovation and Employment, and Canada's Task Force on Just Transition for Canadian Coal Power Workers and Communities.

2. Relocating and supporting affected groups. Support can be offered through a variety of means, including providing allowances to jobless workers and offering training and reskilling opportunities to those in need. Italy's national energy company, Enel, provides an excellent example of effectively supporting affected individuals with its Futur-e project, launched in 2015. Under this initiative, by 2019 all

52 Ministry for the Ecological Transition and the Demographic Challenge (Spain). La Transición Justa [The Just Transition]. Retrieved from https://www.transicionjusta.gob.es/La_Transicion_Justa/

53 Scottish Government. Just Transition Commission. Retrieved from https://www.gov.scot/groups/just-transition-commission/

54 U.S. Economic Development Administration. (2016). Powering the New Economy: A Blueprint for the Clean Energy Revolution [Archived Report]. Retrieved from https://www.eda.gov/archives/2016/power/

directly affected employees covered by the project had been resettled. Measures adopted by Enel included: 1) implementing apprenticeship-based recruitment to ensure the transfer of knowledge from older to younger workers; 2) relocating workers through negotiations between the company, workers, and their representatives; and 3) providing training and reskilling to ensure workers' employability during the recruitment stage and throughout their careers.

3. Strengthening social protection. A robust unemployment and pension system can help safeguard the livelihoods of those who are unemployed, especially older job-seekers, and address potential social problems that may arise from a transition. In this regard, Germany's transition process is noteworthy, where its effective unemployment and pension system has played a crucial role in supporting affected groups. To support older people who had lost their jobs during the transition and were struggling to re-enter the labor market, Germany's 2007 plan for coal phase-out allowed underground and surface miners to retire early, at 50 and 57 respectively, with the additional financial burden of this move borne by the government.

4. Promoting economic diversification. Targeted investment, regional development and industrial policies can reduce overreliance on the coal industry. The POWER Initiative in the United States is a notable example of this type of initiative. Led by the Economic Development Administration, the multi-agency POWER effort is intended to invest federal economic and workforce development resources within communities and regions negatively impacted by changes in the coal economy.

5. Ensuring adequate funding support. To ensure the sustainability of efforts and help the most seriously affected groups and regions, it is crucial to diversify sources of funding for the four interventions mentioned above. A prime example of this is the EUR 17.5 billion (USD 17.8 billion) Just Transition Fund established by the European Union, which will be further discussed below.

As most developed countries have initiated their energy transition earlier than developing economies, analyzing challenges they have faced and the measures that they took can provide valuable insights and references for the developing world, including China. To help draw on international experience and enhance the inclusiveness of China's green transition, in addition to summarizing policies and practices from representative countries above, this report will further provide in-depth case studies of best practices stemming from Germany and the EU.

4.1 GERMANY'S COAL TRANSITION

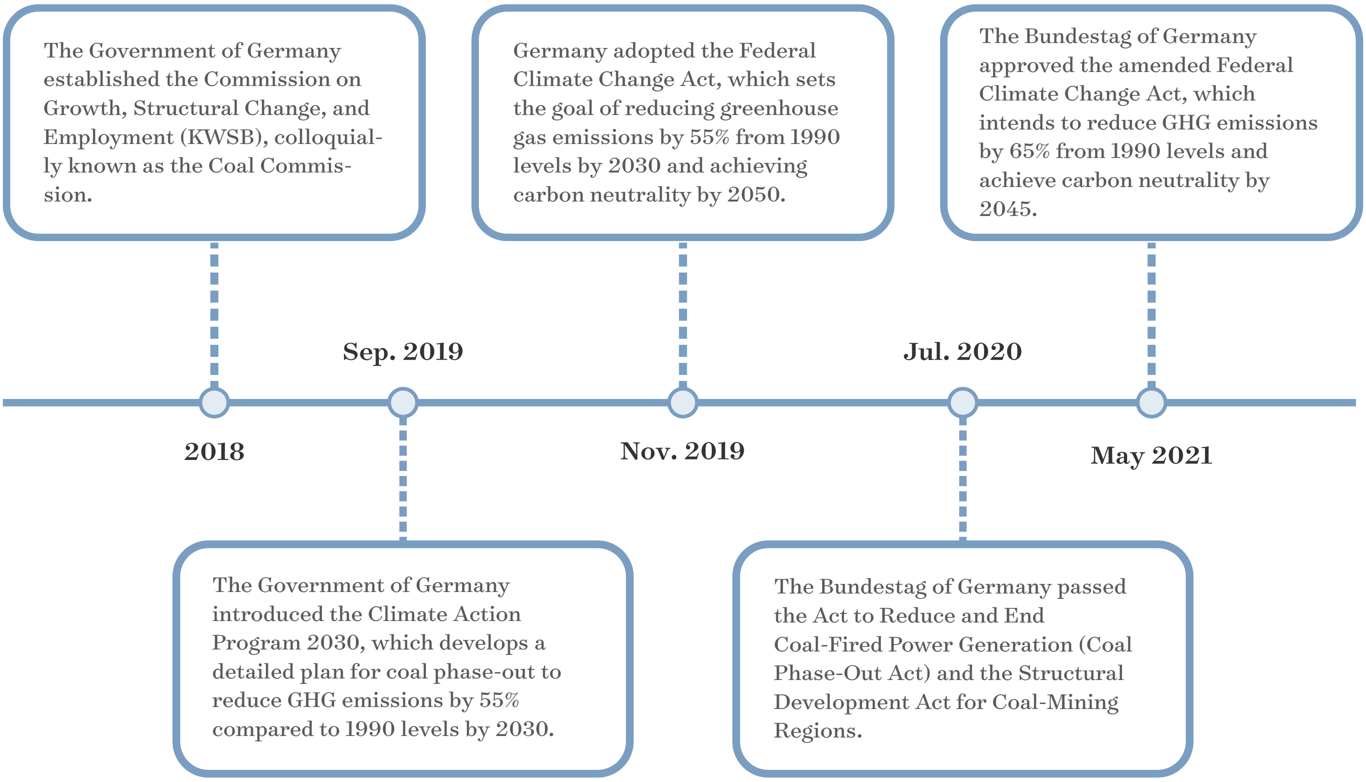
4.1.1 National experience: the role of top-level policy design in ensuring a smooth coal transition

Germany, the world's fourth largest economy and a long-standing industrial power, generates about 30% of its electricity from coal-fired power plants, which in turn account for 80% of the nation's power sector carbon emissions.[55] To achieve its goals set in the 2016 Climate Action Plan, which aim to reduce greenhouse gas emissions by 55% compared to 1990 levels by 2030, Germany will have to gradually phase out coal-fired power.[56] To facilitate such a transition, Germany has taken a series of actions at the top level, which are chronologically summarized in Figure 4.1.

55 Statista. Energy mix in Germany [Data]. Retrieved from https://www.statista.com/statistics/736640/energy-mix-germany/

56 German Federal Ministry for the Environment, Nature Conservation, Building and Nuclear Safety (2016). Climate Action Plan 2050: Principles and goals of the German government's climate policy. Retrieved from https://ec.europa.eu/clima/sites/lts/lts_de_en.pdf

Figure 4-1: Timeline of actions adopted by Germany to achieve its climate targets



Source: Authors' compilation from relevant websites[57]

A key highlight of Germany's approach to coal phase-out is its comprehensive and coordinated nature. Its process involves a top-down design with clear goals, tasks, and responsibilities assigned to different departments, with targets of accountability at all levels. It also facilitates the formation of a consensus amongst various stakeholders through a series of consultations organized by the Coal Commission. Some of the main experiences from this process are outlined below.

4.1.1.1 Establishing a dedicated commission to manage the coal phase-out

Germany's transition away from coal-fired power generation is a complex task that presents significant challenges to the country's lignite mining areas. The government recognized that a socially balanced and equitable transition to a new energy system would require a broad-based consensus. To forge such a consensus, the Federal Government of Germany established the Commission on Growth, Structural Change and Employment (KWSB), also known as the "Coal Commission" in 2018. Its mandate is to deliver recommendations to ensure that "Germany closes the undershoot on its 40% climate target as far as possible while meeting its stated objectives of supply security, affordability and the safeguarding of jobs and value-added, and that the energy industry reliably meets its sector goal for 2030."[58]

57 Federal Ministry of Finance. Climate action programme 2030 frequently asked questions. Retrieved from https://www.bundesfinanzministerium.de/Content/EN/FAQ/climate-protection-faq.html

58 German Federal Ministry for Economic Affairs and Energy. (2019). Commission on Growth, Structural Change and Employment. Retrieved from

The Commission's 31 members represent a wide range of stakeholders, including members of the Parliament, local government representatives, enterprises, and researchers, as well as representatives from the energy industry, environmental organizations, and trade associations. Through extensive discussions and consultations, the Commission provides recommendations to the federal government to guide its transition process. Its final report also formed the basis of the Act on the Phase-out of Coal-fired Power Plants and the Structural Reinforcement Act for Mining Regions, adopted in July 2020[59].

4.1.1.2 Legislating for a smooth phase-out

Germany is indeed one of the few countries in the world that has passed legislation requiring a coal phase-out. The Coal Phase-Out Act specifies a roadmap and deadline for Germany to gradually eliminate coal. The law mandates a phase-out of all coal-fired power plants by 2038 at the latest, with regular reviews required to assess the feasibility of an earlier phase-out by 2035. The Act also prohibits the construction of new coal-fired power plants after August 14, 2020, except where operating licenses have been obtained before January 29, 2020. In addition to setting out the timetable for the coal phase-out, the act also provides detailed plans to address issues such as electricity security, employment and resettlement, the transition of related sectors, and social security.

Germany also introduced a Structural Reinforcement Act, which provides a legal basis for structural-policy support to the affected regions. The Act ensures the provision of financial assistance and other measures until 2038, by which time the use of coal should be phased out entirely.[60] Furthermore, the Act provides funding for research and development, innovation, infrastructure, and training programs to support the development of new industries and job opportunities in the affected regions. The overall aim of the Act is to facilitate the creation of new jobs opportunities and industries in affected regions, to reduce their reliance on coal mining and to facilitate their transition to a sustainable and diversified economy.

4.1.1.3 Compensating for coal power decommissioning through a competitive tender mechanism

To incentivize the early closure of coal-fired power plants, Germany adopted a competitive tender mechanism to award plants that retire early with financial compensation for this achievement. The German Federal Network Agency (FNA) is tasked with organizing seven coal phase-out auctions between 2020 to 2027, and the maximum bid for compensation allowed will decrease over this period, from EUR 165,000 per MW to EUR 89,000 per MW, incentivizing power plants to participate in the tender at an earlier stage. Bids are evaluated based on EUR per tCO2, which is jointly determined by compensation levels (EUR per MW) and emissions intensity (measured by average annual CO2 emissions per MW). The bids that offer the lowest CO2 abatement cost will win the auction, meaning that power plants which seek less compensation and with higher CO2 emission per unit of installed capacity have a greater chance of winning.[61]

As of May 2023, Germany has completed six rounds of tender, with the last round of bidding expected to take place in June 2023. In late 2020, the FNA conducted the first tender. A total of 11 hard coal-fired power plants with a total capacity of 4,800 MW, or 20% of Germany's total hard coal-fired power generation capacity were awarded, with a highest bid of EUR 165,000 per MW. While auction rounds number 1, 2 and 4 were oversubscribed, auction rounds number 3, 5

https://www.bmwk.de/Redaktion/EN/Publikationen/commission-on-growth-structural-change-and-employment.pdf?__blob=publicationFile&v=1

59 German Federal Ministry for Economic Affairs and Energy. (2020, July 3). Final Decision to Launch the Coal Phase-out [Press release]. Retrieved from https://www.bmwk.de/Redaktion/EN/Pressemitteilungen/2020/20200703-final-decision-to-launch-the-coal-phase-out.html

60 German Federal Government. Promoting Coal Regions [Webpage]. Retrieved from https://www.bundesregierung.de/breg-en/service/archive/kohleregionen-foerderung-1665150

61 Agora Energiewende. (2021). Hard Coal Auction 2021: Background and Results [Report]. Retrieved from https://static.agora-energiewende.de/fileadmin/Projekte/2021/2021_12_INT_Hard_Coal_Auction/A-EW_261_Hard-Coal-Auction_WEB.pdf

and 6 remain undersubscribed. In the sixth round of tender, only one power plant with a capacity of 472 MW will receive the compensation.[62]

This compensation mechanism is helping accelerate Germany's coal phase-out, but has also created challenges: the auction mechanism is linked to CO2 emissions, which means that newer power plants that operate for more hours than older ones due to power market merit order are more likely to be awarded a tender for retiring earlier than older ones.[63] After 2027, no compensation will be available and remaining power plants will be forced to shut down.

4.1.1.4 Providing funding for the transition in mining regions

Under the Structural Reinforcement Act, Germany is providing up to EUR 40 billion to regions affected by the coal phase-out, including EUR 26 billion for infrastructure and new research facilities. The remaining EUR 14 billion will be used for transition and development in lignite mining areas or affected federal states, for local public transport, broadband and mobile infrastructure, environmental protection, and landscape conservation. Additionally, the German government has established a EUR 5 billion special fund to enable older coal workers to retire early, with those over 58 years old eligible for up to 5 years of compensation to bridge the gap to their pension eligibility.[64] These measures are designed to alleviate adverse economic impacts of the transition while creating more job opportunities, aiming for a better economic and employment environment than that which existed prior to the coal phase-out.

4.1.2 Regional experience: structural policy in driving the Ruhr area's transformation

The Ruhr area in Germany was once a national hub for energy, steel, and heavy machinery manufacturing, and one of the world's largest heavy industrial areas. In the 1950s however, stronger international competition in the energy market and the gradual depletion of local coal resources started to drive up the cost of hard coal production, leading to a decline in the local mining industry. This shift slowed socio-economic development and increased unemployment numbers. Concurrently, the environmental damage caused by the coal, energy, steel, and chemical industries, and the impact of that damage on the living conditions of millions of residents became increasingly pronounced. The area suffered a range of environmental issues including land subsidence, groundwater depletion, soil and air pollution, and land degradation.

To reverse the processes of social, economic, and environmental decline, strengthen sustainable development, and improve the local quality of life, a series of structural policies were adopted. These efforts were a mixture of industrial policies and regional development policies to promote systematic transformations, heralding a green transition towards sustainable development.[65]

Based on the structural policy adopted, the Ruhr transition can be broadly divided into four stages outlined in Table 4.2.

62 Renewables Now. (2022). Germany's 6th Coal Phase-Out Tender Allocates Only 472 MW [News article]. Retrieved from https://renewablesnow.com/news/germanys-6th-coal-phase-out-tender-allocates-only-472-mw-801342/

63 The term "merit order" refers to the sequence in which power plants are selected to generate electricity. The order is determined by the lowest marginal costs, with an aim to economically optimizing the electricity supply.

64 Library of Congress. (2020, August 31). Germany: Law on Phasing out Coal-Powered Energy by 2038 Enters into Force [Global Legal Monitor]. Retrieved from https://www.loc.gov/item/global-legal-monitor/2020-08-31/germany-law-on-phasing-out-coal-powered-energy-by-2038-enters-into-force/

65 European Environmental Bureau. (2019). Just Transition for Regions and Generations: 10 Principles for How to Ensure a Just Transition to a Zero-Carbon Economy [Report]. Retrieved from https://regionsbeyondcoal.eu/wp-content/uploads/2019/02/2019_01_15_Just-Transition-for-regions-and-generations.pdf

Table 4-2: Policy stages of Ruhr transition

Stage	Feature
Integrated structural policies (1966–1974)	Promoting the development of the region with a focus on expanding infrastructure, including transportation and education infrastructure.
Centralised structural policies (1975–1986)	Shift away from demand-side measures and focus on productivity enhancement and technology promotion in existing industries, plus urban renewal, training and education.
Regional structural policies (1987–1999)	Emphasis on the role of local actors in initiating programs with more participation from regional stakeholders and less control from the central government.
Cluster oriented structural policies (since 2000)	Enhancing the competitiveness of the region through promoting the formation of industrial clusters.

Source: Dahlbeck, E., & Gärtner, S. (2019). Just transition for regions and generations: experiences from structural change in the Ruhr area. Berlin: WWF Germany.

The Ruhr region has undergone successful transitions under such structural policies, moving from economic homogeneity to diversification, from traditional resource-based industries to services, and from low-value to high-tech industries. Its context is widely recognized as a successful case of achieving structural change. The following report section outlines the key steps and highlights of this transformation.

4.1.2.1 Industrial policy and funding support to ensure a smooth industrial transition

Germany's transition away from coal did not result in the abandonment of traditional industries. Rather, the country focused on strengthening or upgrading these industries to make them more sustainable. This process involved upgrading equipment and technology, reducing production, and adjusting product portfolios to enhance competitiveness. For instance, the Ruhr's traditional shipbuilding industry has been transformed to build high-quality and high-value naval and research vessels.

To facilitate this transition, Germany has implemented a targeted industrial policy that created a favorable institutional framework and market environment for industrial development. This included providing financial subsidies and reducing land costs where necessary. During the Ruhr's transition, subsidies were targeted at small and medium-sized enterprises (SMEs), especially those with less than 100 employees, in industries such as rubber processing, handicraft production, chemicals, microelectronics, and biopharmaceuticals. Their aim was to incentivize SME development, thus promoting vitality through the redevelopment of the Ruhr. Additionally, policies aimed at improving the local investment environment attracted a significant number of emerging companies. Statistics show that during the transition period, the fast-growing services sector absorbed 40% of the workers leaving traditional industries.[66]

66 Chen T. (2009). A study of the transformation of the Ruhr industrial area in Germany. Changchun: Jilin University.

4.1.2.2 Utilizing local circumstances to guide development and facilitate economic restructuring

The upgrading and adjustment of the local economic structure was crucial in improving regional productivity and achieving a successful transition in the Ruhr area. Taking into consideration existing resources, including physical infrastructure, available human resources, as well as geographical features, was a critical need while designing structural transformations effective in the local context.

An illustrative example of these efforts is the International Building Exhibition (IBA) Emscher Park initiative, which was implemented in the Ruhr area over a decade, from 1989 to 1999. This initiative focused on preserving and repurposing numerous abandoned industrial sites for other uses, such as creating museums of industrial history, public recreation areas, and comprehensive service facilities. The construction of auxiliary leisure facilities, including food streets, cafes, bars, amusement parks, and sports centers, also accompanied these efforts. These repurposed old facilities have attracted tourists and boosted the development of industrial heritage tourism in the region. This also led to the creation of new jobs, providing opportunities for people who had previously lost their positions during the transition.[67] To finance the initiative, state, federal and EU funds were pooled together, and more than 40 existing subsidy programs were intentionally consolidated to support the projects of the IBA Emscher Park.[68]

In addition, the remaining mining infrastructure offered possibilities for the development and use of renewable energy facilities. New initiatives included using abandoned mine tailings sites for wind and solar power generation, using abandoned mines for pumped hydroelectric storage, and using geothermally heated water from abandoned mines to generate power. For example, contaminated soil at one former mining site in Ruhr area was excavated, with the remaining pits converted into an artificial lake. The excavated soil was piled up nearby to form small hills, sealed, and then covered in clean soil. There are plans to install 120 kW of photovoltaic panels on the surface of the newly created lakes.

4.1.2.3 Regional specialization strategy to promote innovation and economic diversification

Germany has implemented cluster policies since the early 1990s to promote innovation and the expansion of industries. The process involved identifying promising sectors for each region based on their respective strengths across the fields of technology, business or innovation, as well as their unique features. An integrated package, including financial support, was then provided to facilitate cluster policy implementation.

Clusters are comprised of different stakeholders, including companies, research facilities, and non-profit institutions along the value chain, and aim to promote innovation through the strengthening of local networks and cooperation initiatives. The implementation of these policies also resulted in significant improvements in logistics connections for local industries, playing a vital role in driving the economic transition of the Ruhr area.

Some of the clusters include energy, the chemical industry, automobile manufacturing, logistics, advanced materials, and microsystem and optical technologies, artificial materials, biotechnology, green technology, nutrition, health, pharmaceuticals, creative businesses, information and communication technology, and digital media.[69]

A key success factor for cluster policies was the presence of universities and research institutions in the region. The

67 International Labour Organization. (2015). Trade unions and the sustainable development goals: A guide for action. Retrieved from https://www.ilo.org/wcmsp5/groups/public/---ed_dialogue/---actrav/documents/publication/wcms_375223.pdf

68 International Building Exhibitions. IBA Emscher Park - A Future for an Industrial Region. Retrieved from https://www.internationale-bauausstellungen.de/en/history/1989-1999-iba-emscher-park-a-future-for-an-industrial-region/

69 Kabisch, S., & Rink, D. (2013). Industrial Restructuring in the Ruhr Valley: Challenges and Opportunities for Urban Greening. Retrieved from https://c2e2.unepccc.org/wp-content/uploads/sites/3/2016/04/industrial-restructuring-in-the-ruhr-valley.pdf

Ruhr region has 22 universities with over 250,000 students, increasing the attractiveness of the region for companies and citizens, while contributing to the growth of high value-added sectors and the supply of highly skilled workers and research-based innovation hubs.[70]

4.2 THE EU JUST TRANSITION FRAMEWORK

4.2.1 The policy framework

On December 11, 2019, the European Commission unveiled its new development strategy, the European Green Deal (EGD), targeting net-zero GHG emissions and a decoupling of economic growth from resource use by 2050. The aim of this strategy was to conserve and enhance the EU's natural capital while protecting the health and well-being of its citizens from environment-related risks and impacts. The EGD also stressed the need for a just and inclusive transition and presented a set of policy measures in key areas such as energy, industry, construction, transportation, agriculture, ecosystems, and pollution control. Moreover, it highlighted the need to strengthen cooperation between national, regional, city, civil society, and industry stakeholders, as well as with EU institutions and advisory bodies, in order to jointly promote just transition policies that "leave no one behind".

The European Green Deal Investment Plan, which functions as the investment arm of the EGD, seeks to mobilize a minimum of EUR 1 trillion in sustainable investments over the next decade. As part of the Plan, the European Commission has proposed the **Just Transition Mechanism** (JTM) to ensure funding support for a fair and just green transition. The JTM will focus on the regions and sectors that are disproportionately affected by the transition. For this plan, the EU will use its budget and public and private sector resources, including from the European Investment Bank. Funds will also be used to protect the residents and workers who are the most vulnerable to the impacts of the transition, providing them with reskilling programs and job opportunities in new economic sectors. The European Commission will also cooperate with member states and territories to help them develop and implement their own just transition plans.

The JTM provides targeted support to help mobilize around EUR 55 billion over the period 2021-2027, to alleviate the socio-economic impact of the transition in the most affected regions. The mechanism consists of three major funding pillars: the Just Transition Fund, the Public Sector Loan Facility, and a dedicated just transition scheme under InvestEU.

70 Haase, D., & Kabisch, S. (2019). Green infrastructure planning in shrinking cities: The case of the shrinking city of Halle, Germany. International Planning Studies, 24(4), 404-421. doi: 10.1080/14693062.2019.1688636

BOX 1. The Just Transition Fund and the Public Sector Loan Facility[71]

The Just Transition Fund will be equipped with EUR 17.5 billion, financed by the EU budget and the European Recovery Instrument (out of which EUR 7.5 billion will be provided under the EU's 2021-2027 budget and the remaining EUR 10 billion will constitute external assigned revenue stemming from the European Recovery Instrument for 2021-2023). The fund will provide grants to support the most vulnerable carbon-intensive regions, ensuring that all EU members will transition to a climate-neutral economy at the same pace. The specific activities supported by the JTF include investments in research and innovation for SME, renewable energy, clean energy technology, the circular economy, and worker reskilling and re-education. Applicant members are required to provide a national just transition plan, specifying national climate goals, the need for funding, and how the funds will be used to advance the transition. After the funds are provided, project evaluation indicators will be established to assess the outcomes of the transition.

The Public Sector Loan Facility (PSLF) is a blended instrument combining grants of up to EUR 1.5 billion from the EU budget with loans up to EUR 11.5 billion from the European Investment Bank. It provides public sector entities with preferential loans to invest in clean energy, transportation infrastructure, regional heating networks, and building renovations. It also aims to mobilize between EUR 20 and 30 billion in public investment in transition areas.

Under the JTM, a **Just Transition Platform** (JTP) was established on June 29, 2020, to provide technical advice to public and private sectors and individuals in fossil fuel-reliant regions. One of the main tasks of the JTP is to assist EU countries develop their own just transition plans by 2030. These plans will: address the social and economic impacts of the phasing out of fossil fuels and associated high-carbon products and technologies; analyze the policy and funding requirements for the transition, skills training, and environmental restoration, and; establish clear schedules for all just transition agendas and activities.

The required legislation for the JTM and its related pillars has been completed and the initiative is now in operation.[72]

As a new mechanism, the JTM also faces **challenges**, such as ensuring its invested funds achieve the mechanism's desired results. Specifically, at the level of mechanism design, the ultimate goal of the JTM is creating new employment opportunities and providing employability training for target groups. Some studies also point out that with its limited size, the just transition fund may face practical constraints in addressing all of its targets, thus suggesting to narrow down the range of eligible activities to prioritize social support and retraining initiatives.[73].

Quite a few stakeholders have voiced their dissatisfaction over the fund's lack of coordinated participation of the whole of society, and more diverse departments and sectors. At the

71 European Commission. Just Transition Mechanism. European Commission. Retrieved from https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/finance-and-green-deal/just-transition-mechanism_en

72 Official Journal of the European Union. (2021). REGULATION (EU) 2021/1229 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 7 July 2021 establishing a Programme for the Environment and Climate Action (LIFE) and repealing Regulation (EU) No 1293/2013. EUR-Lex. Retrieved from https://eur-lex.europa.eu/eli/reg/2021/1229/oj

73 Darvas, Z. (2020). The Just Transition Fund: How the EU budget can help with the transition. Bruegel. Retrieved from https://www.bruegel.org/report/just-transition-fund-how-eu-budget-can-help-transition

implementation level, the JTM's failure to involve businesses, trade unions, and affected worker groups has been widely criticized. At present, the EU has not clearly mandated the participation of civil society organizations in its JTM-related proposals, nor does its template for Territorial Just Transition Plans (TJTPs) require the applicant territory or country to establish dialogues with businesses, trade unions and affected workers. The redistribution of funds under the just transitions mechanism among member states of the European Union has emerged as a pivotal issue, triggering internal disputes during the phase of proposal deliberations.

Aside from the JTM, the **Social Climate Fund** (SCF) was created under the "Fit for 55" package in 2021.[74] The SCF's scope is to alleviate the potential social impacts that may arise from the inclusion of the buildings and road transport sectors in the EU Emission Trading System (ETS). Its objective is twofold: to provide temporary financial support to vulnerable households and small businesses and to support the implementation of emission reduction plans in the buildings and transportation sectors.

The SCF will be used to provide direct income support to vulnerable households. It will also provide funding for member state investments in energy efficiency, heating and cooling systems, and other related areas. A key highlight of the SCF is its sources of financing, as it is financed by 25% of the revenues from the auctioning of emission allowances for buildings and road transportation under the EU ETS and is expected to receive over EUR 72 billion between 2025 and 2032.

4.2.2 Highlights of EU's experience

The EU's JTM has the potential to address social and economic challenges associated with the regional's transition, securing more support for the EGD and the European Climate Law. The progress and implementation of the JTM provides an inspiring model, which merits China's in-depth analysis in order to help use lessons learned to solve similar issues which might be faced locally in the future.

4.2.2.1 A holistic view and the coordination of sustainable development across industries and populations

The EU's just transition policy framework focuses on the sustainable development of the industries, regions, and workers most affected by just transition measures. Through the Just Transition Platform, the EU provides policy, funding, technical and other various forms of support to member states, including helping them develop just transition plans, build just transition mechanisms, and set up just transition funds, create PSLFs, and establish investment funds. At the macro level, the EU provides top-down designs, while at the micro level, it takes workers into account and is firmly committed to the principle of "leaving no one behind". The EU's JTM requires applicant countries to develop employment assistance and training programs to protect the basic rights of affected groups.

4.2.2.2 Avoid crisis with a preventive and precautionary approach

The JTM was proposed to be used in conjunction with other response mechanisms, rather than after the implementation of climate and environmental measures. This fact demonstrates the EU's holistic and systematic approach to just transition. Right from the outset of their top-down policy design, the EU factored in impacts on key regions and groups and designed measures to mitigate the potential negative effects that a transition might have on employment and livelihoods. This forward-looking approach aimed to prevent issues arising, rather than reacting when they did, which as a result had the potential to reduce the cost of policy implementation and lower overall risk levels, while also cutting the overall social cost of adaptation to environmental governance policies. This holistic and preventative approach also aids the implementation of climate and environmental

74 Fit for 55 is a comprehensive package of legislative proposals by the European Union aimed at reducing greenhouse gas emissions by 55% by 2030 compared to 1990 levels.

policies and the coordination of environmental governance and economic development strategies.

4.2.2.3 Fiscal policy and financial instruments play a crucial role in limiting the spread of risk and promoting just transition

The EU has used fiscal policies—such as subsidizing the use of low-carbon new energy and new technologies and increasing taxes and fees for the use of fossil fuel—to push firms to start their transition efforts as early as possible. All of these policy measures are intended to reduce the risk of business performance suffering, prevent assets from becoming stranded, and minimizing unemployment caused by business closures. Moreover, fiscal policies can provide direct and/or indirect preferential support to the groups and regions at risk, thereby preventing the widening of social inequality. For instance, EU subsidy programs favor supporting transitions in vulnerable regions and population groups.

In terms of financial tools, the finance ministries of developed economies often establish long-term cooperation agreements with commercial banks, insurance and reinsurance companies, investment banks, and other institutions to promote the coordination of fiscal tools with financial instruments, such as insurance, loans, guarantees, and futures (options). They have also identified diverse integration models to facilitate climate disaster prevention and economic transition efforts which can maximize policy effectiveness.

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5

CONCLUSION AND POLICY RECOMMENDATIONS

In light of the complexity of the steps required to guide an effective, inclusive, and accountable transition and the significant social impact that this process brings, China needs to adopt a people-centered systematic approach which balances low-carbon development, economic transition and employment creation, supported by high-level policy designs. To operationalize its "3060" goals, China has released a series of policy documents at both central and local levels, covering various aspects such as energy, resource utilization, technology and financing, which gradually forms its 1+N policy framework.[75] However, the 1+N framework still lacks clear considerations of social dimensions, such as guidance and institutional arrangements on just transition, therefore the guiding principles of safeguarding livelihoods and achieving social equity need to be further embedded into China's climate-related policy strategies.

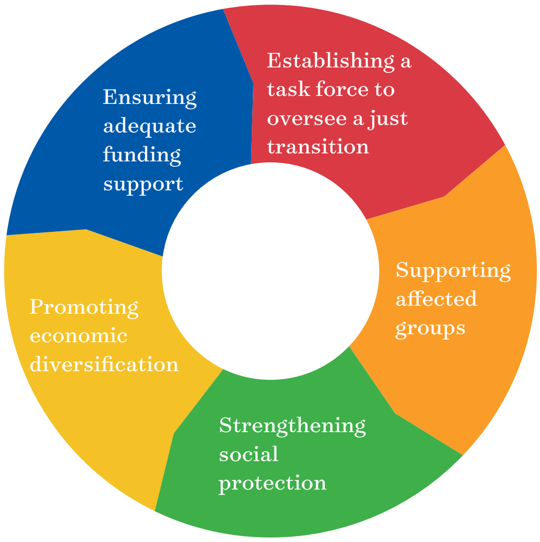
To ensure effective implementation, a strong legal and regulatory framework with clear responsibility and accountability arrangements is crucial, and relevant laws and regulations should be updated to mitigate adverse impacts and promote green employment. The ongoing revision of China's Coal Law presents an opportunity to address the social impacts of coal phase-out in legislation. Enacted in 1996, the Coal Law's primary objectives are to regulate coal mining, promote the efficient use of coal resources, and protect the environment. The latest revision of the law in 2016 includes stricter requirements for mining safety and environmental protection, and also encourages the development of clean and efficient coal utilization technologies. However, it does not reflect the need to support workers and regions affected by an energy transition, with the only article relevant to this goal stating that "the country should establish a system to accumulate funds for the transformation of old coal mines".[76] Similarly, the Employment Promotion Law, enacted in 2007, need to be updated to include provisions that promote and create green jobs, aligning with China's transition to a clean energy economy.

In addition to integrating the need for a just transition into China's overall low-carbon transition policy and legal framework, **the review of international best practices conducted for this research has identified five priority areas** that are crucial to ensuring a just transition (as shown in Figure 5.1). Under each area are proposed relevant recommendations for consideration, drawing on experiences at home and abroad.

75 China's 1+N policy framework refers to a series of policy documents to support China's "3060"goal. "1" refers to the Working Guidance which presents the overarching framework and principles of all forthcoming policies while "N" stands for a combination of action plans in key areas such as energy and circular economy.

76 National energy administration. (2017). Coal Law of the People's Republic of China. Retrieved from http://www.nea.gov.cn/2017-11/02/c_136723041.htm

Figure 5-1: Five key policy areas identified based on international best practices



5.1 ESTABLISH A TASK FORCE TO ENHANCE INTER-AGENCY COORDINATION AND STAKEHOLDER ENGAGEMENT

Given the multi-sectoral nature of the issue, a 'whole of government approach' is required for effective coordination of the just transition. This will require efforts across different ministries, such as the National Development and Reform Commission, the Ministry of Industry and Information Technology, the Ministry of Ecology and Environment, the Ministry of Human Resources and Social Security, the Ministry of Civil Affairs and the Ministry of Finance. A clearer division of labor and roles among these actors, as well as strengthened inter-agency coordination across departments, will be key.

At the national level, China could consider either establishing a new taskforce for just transition or expanding the work scope of an existing relevant coordination mechanism, such as the leading group on employment of the State Council. The main responsibility of the taskforce will be to propose a pathway for a just transition and create synergy between various agencies to balance low-carbon development, economic transition and employment creation. At provincial level, China's supply-side reform experiences suggest that establishing organizational and leadership structures on employment, headed by county-level or higher leaders and involving all relevant departments is instrumental in enhancing accountability at all levels, which would also ensure the effective implementation of policies.

As illustrated by several international case studies discussed in Section 4, another key function of an effective taskforce is to facilitate stakeholder engagement in order to consider needs from different groups affected by the transition when designing the roadmap for a just transition. The importance of organizing social dialogue is also stressed in ILO's *Guidelines for a Just Transition.* In China's context, the government could rely on think tanks affiliated to relevant ministries with support of international organizations in convening relevant stakeholders to ensure voices from different parties are heard and considered.

5.2 SUPPORT WORKERS IN NEED BY STRENGTHENING CHINA'S EXISTING POLICY ARRANGEMENT ON EMPLOYMENT

Since the 1980s, China has been exploring policies to address the issue of unemployment brought about by large scale economic transformation.[77] Building on this foundation, China has developed a proactive employment policy system that prioritizes expanding and creating employment opportunities. To minimize the negative impact of the energy transition on workers, China needs to draw lessons from its past experiences. It should continue to use tools that have proven to be effective, while also seeking to improve those that have yielded less-than desirable results. Efforts are needed in two directions:

Encourage companies to retain workers and provide compensation for laid-off workers

During China's supply-side reform, a key measure has been the provision of stabilization subsidies to eligible companies, aiming at incentivizing them to retain employees. However, the subsidy fails to reach companies that need it the most, due to high policy thresholds. For instance, the majority of heavily affected companies are SMEs with incomplete management systems and low social insurance participation rates. Many of these companies do not meet the set criteria for support, thus they are excluded from receiving such benefits. Additionally, the policy of deferring social insurance payments for one year is only effective for enterprises facing temporary difficulties, but coal enterprises face long-term transition pressure, resulting in them receiving minimal supportive effects.

Furthermore, the financial resources allocated for the compensation of laid-off workers' is limited. From 60-70% of the local governments' special funds for employment are used for creating public welfare positions and providing subsidies for social insurance, leaving less room for supporting individuals who have lost their employment. In addition, financial assistance provided from the central government to enterprises does not specify a clear proportion to be used for worker support. Thus, in practice, enterprises may use a significant proportion of funds to repay debts, with only a relatively small share used for employee compensation.

To better stabilize employment numbers and protect livelihoods, the lessons learned outlined here need to be fully considered when designing new policies to support workers affected during the transition process.

Promote green jobs

At the macro level, China needs to formulate medium- and long-term national plans for green employment, setting clear targets and establishing key priorities, which would help guide China's efforts in this area. At the micro level, suitable areas should start pilot initiatives and explore innovative ways in improving green employment management and services systems.

To create an enabling environment for the development of green jobs, standards and certification systems for new jobs in the green sector also need to be strengthened. For example, currently there is no national qualification certification for positions related to carbon accounting, as relevant certificates are usually issued by individual industry associations or training institutions. However, in 2022, China updated its occupational classification system with 18 new professions, including four directly related to the low carbon transition, such as positions in carbon credit assessment, energy efficiency consulting, integrated energy services, and coal quality improvement.[78] Looking ahead, it is important for China to keep up with the rapidly evolving job market against the backdrop of energy transition, and offer direction

77 An example of this is the large-scale restructuring of state-owned enterprises in China during the 1990s, which resulted in tens of millions of workers being laid-off.

78 Xinhua News Agency. (2022, June 15). The Ministry of Human Resources and Social Security announced 18 new occupations. Retrieved from http://www.gov.cn/xinwen/2022-06/15/content_5695714.htm

for vocational education as well as job standards in emerging industries to ensure that new and existing positions are appropriately staffed.

In addition to green job creation, training programs should also be provided to prepare workforces with the relevant skills required for the new industries. However, based on previous experience, there has been a low willingness to participate in job training. Thus, to encourage more participation, it is suggested to bundle training program with subsidies as a "package" to encourage employers or job seekers to proactively provide or participate in skills trainings. In designing these packages, it may be necessary to adopt a gender-equality and intersectional approach to ensure that women, who are at a higher risk of unemployment, and vulnerable groups such as migrant workers, have equal access to training opportunities. This will help to ensure that all individuals can benefit equally from these programs.

5.3 COORDINATE SOCIAL PROTECTION AND EMPLOYMENT POLICIES FOR MUTUAL REINFORCEMENT

Unemployment insurance should be strengthened to play a greater role in safeguarding livelihoods, preventing unemployment, and promoting reemployment. The use of unemployment insurance fund should be expanded to serve more purposes, such as supporting companies and stabilizing employment schemes.

To effectively assist laid-off workers, targeted measures should be designed based on their willingness to work, age, gender, and skill level. A different combination of social protection and employment policy tools could be used for different groups such as migrant workers, college graduates and those struggling to re-enter the job market. Good examples of local governments' practices adopted during supply side reform could be considered. For instance, concessional loans can be provided to older, low-skilled people to make social security contributions. After they become entitled to pensions, these secure funds can be used to make repayments of loans.

Section 3 highlighted the risk faced by women in the coal sector, as they are highly represented in early stages of contract termination in the coal sector. Further research are needed to understand and address any other barriers women may face when seeking to rejoin the energy sector. To effectively support their reintegration, it is important to understand their specific skill development needs and tailor initiatives accordingly.

As discussed in Section 3, informal workers make up at least 20% of coal sector employees, with this number, in the case of informal workers rising up to proportions of 70-90% of employees working in underground coal mining. Many of these workers remain uncovered by current social protection systems, making them more vulnerable during market transitions. In light of this, innovative approaches should be developed to register uncovered and vulnerable groups . Some temporary measures adopted during the COVID-19 response could be extended and integrated into the official social protection system.

5.4 DIVERSIFY THE ECONOMY THROUGH INDUSTRIAL RESTRUCTURING AND ENHANCE COORDINATION BETWEEN ECONOMIC TRANSITIONS AND EMPLOYMENT CREATION

The successful experience of Germany highlights the role that structural policy effectively played in transforming a coal reliant region and sustainably diversifying the economy. In China's context, taking a similar approach would mean better coordination between existing regional and industrial policies. China's current regional development strategy serves to facilitate a step-by-step shift of industries from coastal areas and promote the rise of central and western China. The promotion of green industries needs to take into consideration the context of regional differences as well as each regions' future development paths and priorities.

Historical evidence suggests that China's industrial policy is usually dominated by economic growth considerations and has a relatively weak synergy with employment policies. To achieve balanced progress in the areas of environmental protection, economic development and employment generation, policies need to be implemented in a more synchronized manner. This suggestion implies that a new industrial policy should be accompanied by complementary environmental and employment policies to mitigate any potential environmental or social impact that a shift in focus or priorities might demand. Likewise, when developing an environmental policy, its potential impact on both economic growth and employment should be thoroughly evaluated.

At the micro level, industrial restructuring inevitably requires the transition of enterprises. Governments are advised to incentivize enterprises to take early action in transforming their businesses to align with China's climate goals, which includes them needing to take efforts in upgrading technology and pursuing diversified business lines. Central government agencies may provide fiscal support, tax benefits and financial services, while local governments could set up special transition funds and provide preferential policies in project approval, land use and access to loans. As demonstrated by the experiences of the Ruhr region in Germany, facilities and infrastructure left idle during transitions have the potential to be repurposed to develop modern services and foster alternative businesses.

5.5 POOL FUNDS FROM DIVERSE SOURCES AND GUARD AGAINST FINANCIAL RISKS

Given the large amounts of capital that this transition will require, it is imperative to leverage private finance to support changes in the field of energy, and ensure that the carbon intensive sector goes through a smooth shift to minimize negative social and economic risks. This requires promoting the development of transition finance and its application in China's context. In 2022, the G20 Sustainable Finance Working Group (SFWG) launched a Transition Finance Framework which specifies 22 principles around five pillars of work, setting the basis for its development worldwide.[79] In China, pioneering cities such as Huzhou in Zhejing province have already introduced Transition Finance Taxonomy at the local level, covering nine carbon-intensive industries.

To better support a credible and inclusive transition in China, experts in the finance field have proposed context-specific recommendations, including: 1) formulate standards to clearly define transition activities and information disclosure requirements such as transition plans and social impact assessments; 2) use social related indicators, such as the number of workers retained, as key performance indicators (KPIs) when designing innovative financial tools such as sustainability-linked bonds to support low carbon transition, creating incentives for enterprises in the transition process to retain workers.[80] To prevent systemic risks, potential financial risks during the transition should be closely monitored.

Fiscal policies have advantages in resilience-building, disaster prevention and relief, as well as in reducing transition risks for climate-vulnerable groups[81]. As fiscal revenues and expenditures are directly related to the distribution of welfare in society, they can play a crucial role in managing the risks of a just transition in a coordinated manner. Fiscal policy can guide changes in the behavior of individuals or enterprises by providing incentive mechanisms. For example, tax breaks and subsidies could be granted to companies who hired laid-off workers from the traditional energy sector. More importantly, fiscal transfers from the central to the local government should consider regional differences and possible disproportional impacts of low carbon transition on

79 G20 Sustainable Finance Report. (2022). Retrieved from https://g20sfwg.org/wp-content/uploads/2022/10/2022-G20-Sustainable-Finance-Report-2.pdf

80 Ma, J., & Zheng, Y. (2023). How finance supports a just transition. Modern Bankers. Retrieved from https://www.sohu.com/a/644401496_121123919

81 Xu, W., & Zhang, L. (2022). Lessons Learned from the International Use of Fiscal Policy to Support Climate Risk Mitigation. Financial Perspectives Journal, 2022(2), 59-65.

regions. National fiscal policies should favor the provinces that face greater challenges in phasing out coal, such as Shanxi and Inner Mongolia.

Additionally, different source of funding should be pooled together to boost government budgets for employment promotion and social security during just transitions. China could draw on the experience of the EU and create transition funds to direct loans from financial institutions and private-sector investments to vulnerable and negatively affected areas and companies, thereby helping to prevent a sharp decline in tax revenue and further job losses. As demonstrated by the case of the EU's Social Climate Funds, fiscal space gained from carbon pricing mechanisms, such as the ETS, can further help fund protective mechanisms for vulnerable groups.

This report used environmental friendly paper.

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