NET ZERO+
Building Climate
and Economic Resilience

Ensuring a just transition to net-zero emissions

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Abstract

The world is at a crucial juncture where decisive action is urgently needed to tackle climate change. However, without consideration for distributional concerns, the costs associated with climate mitigation policies risk falling disproportionately on certain workers, sectors, and socioeconomic groups, exacerbating existing inequalities and undermining popular support for climate action. Embedding the principle of a just transition into climate strategies is crucial to address these issues and accelerate climate action. Drawing on recent OECD work, this paper examines the development of, and different approaches to, the concept of just transition, including how it is put into practice by public and private actors. It addresses the impacts of the net-zero transition on labour markets and households, as well as specific issues faced by developing countries, and outlines key policy tools and approaches available to governments.

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The paper builds on the work of several OECD committees and associated bodies, including (in alphabetical order): the Committee on SMEs and Entrepreneurship, Development Assistance Committee, Development Centre, Economic Policy Committee, Education Policy Committee, Employment, Labour and Social Affairs Committee, Environment Policy Committee, International Energy Agency, and Regional Development Policy Committee.

The Net Zero+ project

The OECD's Horizontal Project "Net Zero+: Building Climate and Economic Resilience" harnesses the multidisciplinary reach of the OECD to support governments in driving the swift transformational change needed to tackle climate change. The project provides analysis and insights for governments to accelerate and scale up climate action: driving a rapid and resilient transition to net zero while building economic and societal resilience to the impacts of climate change.

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Executive Summary

As the need for climate action grows ever more urgent, the pursuit of a just transition has become an important element of climate policy discussions. A just transition to net zero will be one that drives transformative and systemic change and in which the distributional impacts of policy action are well managed, with costs and benefits shared fairly.

This paper builds on work on the pursuit of a just transition carried out by the OECD and IEA over the 2023-2024 biennium. It provides an overview of approaches, examines the differentiated impacts of climate action at the international, national, regional and household levels, and assesses policy options to support just transition efforts.

Key messages

- Embedding a just transition as a core pillar of climate strategies can allow governments to manage distributional impacts (e.g. on certain jobs and households) and improve socio-economic outcomes. This is key to ensuring public support, which is essential to accelerating climate action. Importantly, while climate action entails costs, the cost of inaction is huge and likely to weigh most on disadvantaged groups.
- The net effect of the net-zero transition on aggregate employment is projected to be modest, but significant shifts are expected within and across industries and occupations. Some jobs will disappear, others will be created, there will be changes to skills demand, and many existing jobs will be transformed.
- The energy sector is already seeing significant global employment growth due to the net-zero transition. While fossil-fuel related jobs fell 1% between 2019 and 2023, clean energy employment rose by 15%. The IEA projects that energy employment in 2030 will be substantially higher under a net-zero scenario (83 million) than current policies (74 million). However, skilled labour shortages are emerging as a bottleneck to energy transitions, particularly in vocational roles.
- Job displacement risks are highly concentrated in certain industries and regions. Workers in some of the most affected industries tend to be older, more likely to live in rural areas, and employed in relatively high-paying jobs compared to their educational attainment. Job loss in high-emission industries appears to be 24% more costly than in low-emission industries. In addition, the job quality advantage of green-driven occupations tends to be concentrated in high-skilled jobs.
- Regions with large transformation challenges due to high levels of employment in hard-to-decarbonise activities often perform relatively poorly on several socio-economic indicators, with GDP and wages below the national average, and relatively low levels of educational attainment. These characteristics compound the transition challenge and risk leading to further negative socio-economic outcomes.
- Supporting workers in declining sectors requires overcoming barriers to participation in upskilling and reskilling, active labour market policies (e.g. job search assistance), and income support,

potentially including targeted wage insurance schemes. Skills assessment and anticipation (SAA) can help to identify the most affected sectors and regions and design policies accordingly.

- Increasing women's participation in training and education programmes relevant for the transition (e.g. education in science, technology, engineering and mathematics (STEM)) is a key priority for ensuring equity. Increasing women's enrolment in vocational programmes, such as those for energy sector employment, is equally important.
- Consultations with key stakeholders, starting with social partners, can provide essential input for designing effective measures to support workers, households and regions. In some countries, social partners have extensive experience in managing labour market transitions.
- Policies need to ensure that small and medium-sized enterprises (SMEs), which account for 69% of employment in OECD countries, are not left behind. SMEs face particular transition barriers, including lack of awareness of the costs, benefits and options for green investments; lack of managerial and technical skills to implement new solutions; and more limited access to green finance. Targeted actions may be needed to support regional economies affected by the downsizing of GHG-intensive industries, including investment to diversify their economies and financial support for vulnerable populations. Complementary policies may be needed to overcome barriers to geographical mobility, such as job-search and housing assistance.
- Managing impacts of the net-zero transition on households depends critically on context and policy design. Targeted redistribution of revenues from carbon pricing back to households can allow governments to shape distributional outcomes while ensuring cost-effectiveness. Other climate policy instruments, such as standards, bans and subsidies, garner more public support than carbon pricing, but may tend to be regressive, with larger burdens or smaller benefits for low-income groups. In addition, such instruments do not generate revenue that can be "recycled", for example to offset household impacts. Effective targeting is needed to ensure that vulnerable populations can benefit from these measures.
- Developing countries have the least responsibility for cumulative GHG emissions but are highly exposed to both physical climate and transition risks, which can exacerbate existing socio-economic challenges. Fossil fuel-producer developing countries may be particularly vulnerable to the impacts of global efforts to decarbonise. There is a need in developing countries to achieve universal social protection and leverage growing numbers of green-driven jobs to formalise the workforce. Supporting labour representation and collective bargaining agreements can contribute to better conditions and protection for workers.
- Development co-operation efforts need to better align with the goals of the Paris Agreement and support developing countries' transitions to net-zero emissions. Development co-operation providers need to promote both energy access and energy transitions in order to deliver on their development mandates.

1 Introduction

The world is at a crucia juncture where decisive action is urgently needed to tackle climate change. Global greenhouse gas (GHG) emissions continue to rise, and the average surface temperature in 2024 was approximately 1.55°C above pre-industrial levels (World Meteorological Organization, 2025[1]). Accelerated action is imperative in the critical period to 2030 in order to reach net-zero emissions by mid-century and limit the catastrophic impacts of climate change.

However, the socio-economic transformation implied in the transition to net zero have triggered concerns about the social and economic implications of climate policies. The transition will affect labour markets, households' cost of living, and energy access, among other issues. Without consideration for distributional concerns, the costs associated with climate mitigation policies risk falling disproportionately on certain workers, sectors, and socio-economic groups, exacerbating existing inequalities and undermining public support for climate action.

At the same time, the cost of inaction is enormous,[1] with the consequences weighing more heavily on disadvantaged segments of populations. For example, climate change will lead to increased incidence of heat stress among workers, with those most affected being more likely to be low- or middle-skilled. In European OECD countries and the United States, 13% of workers already report experiencing significant heat-related discomfort at least half of their working time. Low-income households have the least capacity to invest in adaptation actions, such as installing air-conditioning or flood-resistant home improvements (OECD, 2024[2]; OECD, 2024[3]).

Governments are increasingly embedding just transition principles into their climate strategies to ensure that policies are effective, efficient and fair. Rather than an afterthought, the socio-economic dimensions of climate policies must be considered a core element of net-zero strategies to avoid inequitable outcomes and enhance the political viability of the transition. Unlike past transitions driven by technological innovation, the policy-driven nature of the net-zero transition means that governments will be held accountable for its effects. The success and resilience of climate policies relies on these effects being managed equitably and perceived as such by the public.

A just transition is one in which the distributional impacts of climate policies are well managed, costs and benefits are shared fairly, and equitable outcomes are achieved within and between countries. It should offer a transformational opportunity across sectors, communities, socio-economic groups and countries to achieve more equitable benefit-sharing, encompassing a wide range of socio-economic dimensions linked to climate mitigation action. Calls for a just transition stress the need to consider the opportunities created by this global transformation, as well as its impacts within and between countries.

Approaches to a just transition

Although the term is widely used, there is no precise and universally agreed definition of a just transition. Originating from trade union activism in the United States during the 1980s to protect workers in industries facing more stringent environmental standards, the concept has since evolved to encompass a wide range of socio-economic dimensions linked to the transition to low-carbon, resource-efficient

economies (OECD, 2024[4]). The pursuit of a just transition can also be conceived as a transformative process aiming to tackle interconnected challenges related to climate change, development, and poverty eradication (IPCC, 2022[5]; OECD, 2022[6]). In addition to being used by the labour movement, today the concept of a just transition is regularly used by governments and the private sector to consider the interlinked, structural and transboundary impacts of climate policies and actions on the environment and society (OECD, 2023[7]). At the international level, a Just Transition Work Programme was established under the United Nations Framework Convention on Climate Change (UNFCCC) at COP27 in 2022. Just transition can also be seen to support the UN's 2030 Agenda for Sustainable Development, insofar as it is relevant to several of the Sustainable Development Goals (SDGs).

Progress has been made internationally towards building a common understanding of the concept of just transition. For example, the Just Transition Declaration, agreed by a group of developed country governments and the European Union at UNFCCC COP26 in 2021, reflects the International Labour Organization (ILO)'s Guidelines and notes recommendations from the International Energy Agency (IEA) and International Renewable Energy Agency (IRENA) on a just transition in the energy sector (The National Archives, 2021[8]).

Nonetheless, different definitions and focal points persist across various contexts and stakeholders. In particular, approaches differ as to whether to focus on entire economies or specific sectors (e.g. energy, as the largest source of global emissions), and whether a just transition relates primarily to affected workers, or everyone impacted by climate policies. The lack of common metrics for assessing impacts by both public and private actors across production, well-being and sustainability further complicates matters and leads to inconsistency in conceptualisations of, and approaches to, a just transition. Some efforts have been made in this regard. For instance, in 2023, the Business for Inclusive Growth coalition developed a set of indicators to help businesses analyse and measure their actions to support a just transition across four categories: transparent planning processes, employment, upskilling and reskilling, and access to goods and services (OECD, 2023[7]; OECD, 2021[9]).

The concept of a just transition is related to, but distinct from, those of environmental and climate justice. All three emphasise equity and fairness, recognising that some communities are more vulnerable and face greater burdens, whether from climate action or the consequences of inaction. These concepts overlap, but also have key differences: just transition originated to address the employment impacts of environmental and climate policies; climate justice addresses, for instance, loss and damage from physical climate impacts; and environmental justice often aims to redress unequitable shares of environmental costs borne by vulnerable (Box 1) (OECD, 2024[4]; OECD, 2024[10]).

A just transition is increasingly understood not only as ensuring justice for workers within countries, but also as addressing broader climate-related socio-economic inequity between countries. Climate change mitigation policies in one country can have positive and/or negative spillover effects beyond its borders, for example impacts of developed countries' climate or environmental policies on developing countries.

The global transition to net-zero emissions presents profound challenges for developing countries. Developing countries have contributed least to historical global cumulative GHG emissions (Kotz, Levermann and Wenz, 2024[11]), but face greater constraints than developed countries, for instance weaker institutional capacity, restricted access to finance and technology, and limited fiscal space to support economic transformation. At the same time, ensuring a just transition requires that developing countries equally benefit from the opportunities it offers. Appetite is growing among both developed and developing countries for a holistic approach to the pursuit of a just transition that considers justice at the global level (OECD, 2024[10]; OECD, 2022[6]).

In sum, a just transition is conceptually broad and context-dependent. The nature of the net-zero transition, including the challenges and opportunities it presents, varies widely by population group, sector, region, and country. In practice, it encompasses the need to pursue systemic change towards net zero,

manage associated distributional impacts, ensure that benefits are shared fairly, mitigate disproportionate costs, and support those negatively affected within and between countries.

Box 1. Environmental justice and just transition

Environmental justice concerns span multiple domains, particularly: 1) inequitable exposure to environmental hazards and access to environmental amenities; 2) inequitable distribution of the costs and benefits of environmental policy; and 3) barriers to access to environmental information, participation in decision-making, and legal recourse. While domains 1) and 3) raise questions around equity and overlap with the pursuit of a just transition, domain 2) relates most directly to a just transition as addressed in this paper. This is because the pursuit of a just transition involves managing the potential negative impacts or costs of climate policies on certain workers, households and regions while also ensuring equitable benefit-sharing. It also recognises broader interlinkages between this transformative process and others, such as development and poverty eradication. As such, a just transition is an important component of countries' wider efforts to pursue environmental justice. Still, it is worth noting that the scope of just transition extends beyond the boundaries of traditional environmental policy.

Recent stocktaking of national approaches to environmental justice has found that the inequitable distribution of environmental policy costs and benefits deserves greater attention. While countries do take distributional implications of such policies into account, the analysis tends to be at relatively aggregated levels, such as sectoral impacts. More granular analysis, such as on gains and losses by income group or region, is needed to anticipate voter support for or resistance to climate policies and inform the design of effective support strategies.

Source: (OECD, 2024[12]).

Public and private approaches to a just transition

A growing number of countries are incorporating just transition principles into their policies and national initiatives. However, not all countries have adopted whole-of-economy just transition plans, and some have no plan at all (OECD, 2023[7]). Examples of different national and international approaches are provided in (Box 2).

Box 2. Selected national and international approaches to just transition planning

Costa Rica has translated the principles of just transition contained in the Paris Agreement into its Nationally Determined Contributions (NDCs). These principles have also been incorporated into the country's development plan, led primarily by the Ministry of Environment and Energy, that targets the creation of new economic centres and green jobs. This development plan entailed a broad participatory process with stakeholders and potentially vulnerable groups in order to ensure that their interests are represented (OECD, 2023[7]).

As **Canada** looks to stop generating traditional coal power by 2030, the sector-based Task Force on Just Transition for Canadian Coal Power Workers and Communities advises the government on actions to support a just transition for workers and communities reliant on the coal industry. This approach has

involved dialogue with stakeholders, including coal workers, their families, communities, and labour representatives in affected provinces (OECD, 2023[7]).

As part of the European Green Deal, whose aims include ensuring that the transition will "leave no one or no region behind", the **European Commission** has established the Just Transition Mechanism, which mobilises EUR 55 billion over 2021-2027 to support European regions affected by the net-zero transition. Its largest component is the Just Transition Fund, expected to mobilise approximately EUR 25.4 billion to support economic diversification and reconversion of the most adversely affected regions. The Fund can be used for various aims, including skills programmes, transforming existing carbon-intensive industries, and social infrastructure (OECD, 2024[12]).

Spain has incorporated just transition principles in its actions to address the socioeconomic impacts of coal mine and coal-fired power plant closures. The Just Transition Strategy (launched in 2019) and the Just Transition Institute (founded in 2020) provide a framework for targeted Just Transition Agreements, which identify affected regions, assess employment impacts, and engage local stakeholders to design tailored support measures. Public participation processes ensure that communities, workers, and businesses can contribute to shaping solutions, while a key role is also provided for labour unions (Instituto para la Transición Justa, 2022[13])

Growing consumer concern has led private-sector actors to become more vocal and proactive in aligning their business models with the goals of a just transition. There is increasing recognition that climate and social risk translates into investment risk, and businesses that are seen as unsustainable are becoming less attractive for investors. Business coalitions such as the Council for Inclusive Capitalism (CIC) and the World Business Council for Sustainable Development (WBCSD) are working to scale up just transition initiatives. Many examples of just transition strategies and activities exist, particularly in the energy sector. For example, a working group of seven energy companies established by CIC has developed a just transition framework structured around four pillars: universal net-zero energy, workforce evolution, community resilience, and collaboration and transparency (OECD, 2023[7]). At the same time, consumers increasingly face informational challenges related to false or misleading green claims and "greenwashing"[2]

Investors can drive progress towards a just transition through their roles as stewards of assets, allocators of capital and influencers of public policy, by employing strategies such as divestment, investment screening, social impact bonds and impact investing. Investors are increasingly leveraging engagement tools to incentivise companies to take the social dimensions of the net-zero transition into account. For instance, the investor-led initiative Climate Action 100+ has developed the Net Zero Company Benchmark, a disclosure tool to help investors evaluate companies' efforts to tackle climate change (OECD, 2023[7]).

2 Differentiated impacts of climate policies

Labour market implications of the net-zero transition

The net effect of climate mitigation policies on aggregate employment will be modest, but significant shifts are expected within and across certain industries, occupations, and regions.[3] Some jobs will disappear, new opportunities will be created, and many existing professions will be transformed or redefined (OECD, 2024[14]). The net-zero transition is happening alongside other socio-economic transformations or mega-trends such as demographic shifts, digitalisation, and automation (OECD, 2024[15]). These include the lingering impacts of the cost-of-living crisis, the scarring effects of the COVID-19 pandemic, the accelerating digital transition (including advances in generative artificial intelligence), and demographic change, all of which affect the size and composition of the workforce and have implications for equity. Pursuing a just transition will require accounting for how these trends interact with climate action and its associated transformations (OECD, 2024[14]).

Across the OECD, around 20% of workers are employed in green-driven occupations, compared to 6% in GHG-intensive occupations (Figure 1) (Box 3). Green-driven occupations include new jobs emerging due to the net-zero transition, jobs whose skills and tasks will change, and jobs that produce goods and services that support lower-emission activities, even if they are not necessarily "green". As a result, green-driven occupations are heterogeneous. New and emerging green occupations are typically high-skilled (i.e. managers, professionals and technicians) filled by highly educated workers in urban areas. Other green-driven occupations tend to be medium- and low-skilled and employ many more low-educated workers in rural areas. Although significantly fewer people work in GHG-intensive occupations than green-driven ones, their share is higher than workers employed in new and emerging occupations (2.9%); the fastest growing group of green-driven occupations. Relative to the distribution of employment across sectors, green-driven occupations are more likely to be found in manufacturing, utilities and mining, construction and transport. This overlaps with the distribution of GHG-intensive occupations, which are more likely to be found in agriculture, transport, and manufacturing, utilities and mining (OECD, 2024[14]).

Figure 1. Shares of total employment in OECD countries by occupation

Percentages, average 2015-19

Note: Data refer to the average for 2015-19, except for Canada (2017-19) and New Zealand (2018).
Source: Estimates in (OECD, 2024[14]) based on version 24.1 of the O*NET database and the following country-specific sources: Australian Labour Force Survey; Canadian Labour Force Survey; Japanese Labour Force Survey; New Zealand: Household Labour Force Survey; United States: Current Population Survey; All other countries: EU Labour Force Survey.

The net-zero transition will bring significant changes in skills demand. OECD projections using the EU's Fit-for-55 policy package – which aims to cut net GHG emissions by at least 55% by 2030 compared to 1990 levels – as a case study, indicate declining labour market opportunities for blue-collar workers at economy-wide level, along with declining demand for skills involving traditional manufacturing tools and technologies, though sectoral differences exist. In contrast, demand for skills related to interpersonal communication and the use of digital technologies is projected to increase significantly by 2030 (OECD, 2023[16]). Although skills levels of green-driven and GHG-intensive jobs requiring high education and experience are very similar, green-driven occupations with low education and experience profiles generally demand higher skills proficiency than GHG-intensive and neutral jobs with similar education and experience profiles (OECD, 2024[14]).

Box 3. Defining green and GHG-intensive jobs

Defining what constitutes a "green" job is challenging, and no universally accepted definition exists. Definitions may take top-down or bottom-up approaches, or a mixture of both. Top-down approaches define green jobs broadly within sectors or activities that contribute to environmental goals, using process- or output-based criteria. Bottom-up approaches identify green jobs based on specific tasks or keywords in job descriptions, taking a more detailed, occupation-specific perspective. Other specifications may be added: for example, the International Labour Organization requires green jobs to also be "decent", referring to working conditions, fundamental rights at work, and social protection

The absence of a universally agreed definition also poses challenges for policymakers in understanding the magnitude of the labour market impacts of the net-zero transition and designing effective policies in response. It also complicates efforts to accurately assess and anticipate skills needs for the transition For the purposes of this paper, two main approaches are used, both of which build on the taxonomy developed by the US Department of Labor's O*NET database.[4]

- **Green-driven jobs** are defined by (OECD, 2024[14]) as "all jobs that are likely to be affected by the net-zero transition and not just those that may be considered green as such". Green-driven occupations comprise "green new and emerging occupations", i.e. new occupations with distinct tasks and skills requirements (e.g. solar photovoltaic installers, carbon trading analysts, biomass plant engineers); "green-enhanced skills occupations", i.e. existing occupations undergoing changes in their skill sets because of the green transition (e.g. architects, farmers, automotive specialty technicians); and "green increased demand occupations", i.e. existing jobs that will be in demand as they provide goods and services required by green activities (e.g. environmental scientists, construction workers, drivers).
- **Green-task jobs** are defined by (OECD, 2023[17]) as jobs in which a considerable share of tasks (at least 10%) directly contribute to improving environmental sustainability or reducing GHG emissions. Green tasks include assembly of solar PV modules, conducting environmental impact assessments on construction sites, or monitoring companies' compliance with environmental regulations.

"Green" jobs are usually contrasted with "GHG-intensive jobs", defined as follows:

- GHG-intensive jobs are defined by (OECD, 2024[14]) as those particularly concentrated in high-emission industries. In turn, high-emission industries are defined as those with the highest GHG emissions based on data from several European countries between 2009 and 2020. These industries are ranked according to their emissions, with the top 20% being labelled as "high-emission". Together, these industries account for at least 70% of GHG emissions in each OECD country for which data are available. It is worth noting that green-driven and GHG-intensive occupations are not mutually exclusive. About 10% of green-driven occupations – mostly in the "green-enhanced skills occupations" category – are concentrated in high-emission industries.

Note: Other approaches can be taken to tackle the challenge of identifying green and high-emitting jobs. For a more in-depth methodological discussion, refer to (Causa, Nyugen and Solgani, 2024[18]) and (Causa, Nyugen and Soldani, 2024[19]).
Source: (ILO, 2016[20]) (OECD, 2024[14]). (OECD, 2023[17]) (OECD, 2023[21]).

The job quality advantages of green-driven occupations tend to be concentrated in high-skilled occupations. While green-driven jobs tend to pay higher wages on average, low-skilled, green-driven occupations tend to offer significantly lower wages and labour market security than other low-skilled jobs.

This suggests that, without policy action, low-skilled, green-driven occupations may be relatively unattractive for low-skilled workers (OECD, 2024[14]). This is problematic, as attracting workers to these occupations is essential to avoid skills becoming a more severe bottleneck to delivering the net-zero transition.

High-emission industries account for a small share of employment. High-emission industries account for about 80% of GHG emissions across the OECD, and at least 70% in all but two OECD countries for which data is available, yet they represent only about 7% of total employment on average. Under the EU's Fit-for-55 policy package, employment in high-emission industries is projected to decline by 2.3% per year on average – more than twice the average rate of decline between 2000 and 2019, leading to a marked increase in the risk of job displacement for workers in these industries (OECD, 2024[14]; Borgonovi et al., 2023[22]).

Although aggregate economy-wide job loss is projected to be relatively modest, the estimated impacts are concentrated in certain regions and significant for the workers affected. Workers in high-emission sectors often face higher displacement costs due to their specific characteristics: they are predominantly male, older, and more likely to live in rural areas, with relatively low educational attainment compared to workers in low-emission industries. While they tend to be employed in relatively high-paying firms (partly due to higher coverage by collective agreements in GHG-intensive occupations), once displaced, their lower qualifications can make it harder to find jobs with similar levels of remuneration. On average, displaced workers in high-emission industries face a decline in annual earnings of 36% over the six years following displacement, compared to 29% for workers in low-emission industries, indicating that job displacement in the most affected industries appears to be 24% more costly. Analysis has also shown that workers displaced from GHG-intensive jobs tend to move to other GHG-intensive jobs, suggesting mobility barriers to transitioning into lower-emitting occupations (OECD, 2024[14]; Barreto et al., 2024[23]).

A just transition must also consider the particular challenges facing small and medium-sized enterprises (SMEs) and entrepreneurs in navigating the decarbonisation of their activities. SMEs represent an average of 69% of employment in OECD countries (OECD, 2023[24]), yet policy frameworks are often designed with large firms in mind, neglecting the complications this may create for small firms (Box 4). Furthermore, while some sectors key for the green transition are mostly driven by large companies (e.g. steelmaking and cement), SMEs have a much stronger presence in others, such as the labour-intensive textiles and ceramics sectors (OECD, 2025, forthcoming[25]).

Box 4. Small and medium-sized enterprises as part of a just transition to net-zero emissions

Small and medium-sized enterprises (SMEs) account for around 40% of business-sector GHG emissions in the EU (OECD, 2023[26]), and about 50% globally (International Trade Centre, 2021[27]), yet are less likely to take environmental action than large firms (OECD, 2021[28]). SMEs face particular barriers to greening including lack of awareness of the costs and benefits of, and options for, making green investments; lack of managerial and technical skills to implement new solutions: and more limited access to green finance. They also face relatively higher regulatory compliance and reporting burdens compared to larger firms.

Nonetheless, the needs of SMEs do not always feature prominently in climate policy discussions. Climate policies are often designed with larger firms in mind, with the result that regulations and reporting requirements are either disproportionately burdensome for SMEs or exempt them entirely. Policymakers should make space to engage SMEs in the development of climate policies and ensure that they are supported to make green investments and comply with new requirements.

Some countries have implemented measures to support SMEs through the net-zero transition. For example, in Mexico, the Business Eco-Credit programme, co-financed by the Energy Transition and Sustainable Energy Utilisation Fund, within the framework of the country's Energy Transition Law, supports SMEs in making energy-efficient equipment purchases or upgrades (Eco-Crédito Empresarial, n.d.[29]).

Source: (OECD, 2021[28]).

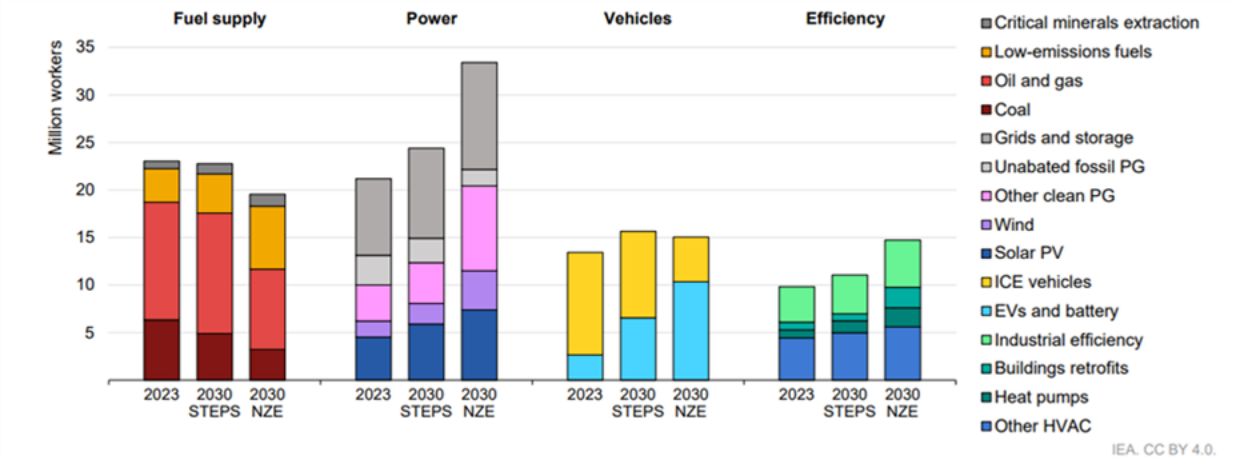
In focus: Implications of the net-zero transition for energy sector employment

Climate policies are having a profound impact on the energy sector. Countries collectively responsible for 70% of global GHG emissions today have pledged to decarbonise their energy sectors. While demand for oil, gas and coal continues to grow, the IEA's Stated Policies Scenario (STEPS)[5] foresees a peak in demand for fossil fuels by 2030, due to a declining rate of overall energy demand growth and accelerating clean energy deployment.[6] Clean energy investment grew by more than 50% from 2020-2024, stimulating major employment growth (IEA, 2024[30]; IEA, 2024[31]).

A major shift in energy employment worldwide has been underway since the COVID-19 pandemic and clean energy now employs more workers than fossil fuels. While global economy-wide employment rose by less than 5% between 2019 and 2023 (World Bank, 2024[32]), energy sector employment grew by 7%, driven largely by a 15% increase in clean energy jobs. Fossil fuel-related jobs fell 1% over the same period (IEA, 2024[33]). Clean energy currently employs a disproportionate share of the global energy workforce relative to its contribution to the energy sector, reflecting the higher labour intensity of building new energy infrastructure rather than operating existing assets. Many new jobs are in construction and manufacturing, with construction alone representing nearly 35% of clean energy employment compared to less than 10% in fossil fuels.

Projected investment growth under current policies is expected to further increase energy sector employment. Employment growth will be even greater on a net-zero pathway, although impacts vary by energy technology (Figure 2). Significant job losses are expected in coal, especially in coal supply, where nearly 1.5 million jobs will be made redundant by 2030 under current policy settings. The picture for oil and gas is more mixed: under current policies, the oil and gas workforce grows by nearly 300,000 workers by 2030 — however, in the IEA's Net Zero Emissions by 2050 Scenario (NZE Scenario),[7] employment falls by nearly 4 million (IEA, 2024[33]). In both the IEA STEPS and NZE scenarios, job creation associated with clean energy technologies comfortably outweighs job losses in fossil fuel and related industries through to 2030. Energy employment in 2030 is substantially higher under the NZE Scenario (83 million) than under STEPS (74 million), largely due to major growth in clean energy jobs under the former scenario (IEA, 2024[33]).

Figure 2. Energy sector employment by technology and scenario, 2023 and 2030



Note: PG = power generation; ICE vehicles = internal combustion engine vehicles; EVs = electric vehicles; HVAC = heating, ventilation and air conditioning. STEPS = Stated Policies Scenario; NZE = Net Zero Emissions by 2050 Scenario. Power grids include transmission, distribution and storage. Low-emission fuels include the supply of bioenergy, nuclear fuels, hydrogen and critical minerals. Other efficiency includes building retrofits, heat pumps and other equipment, and appliances.
Source: (IEA, 2024[33]).

Clean energy job growth presents one of the greatest opportunities for policymakers to rally public support for the energy transition. Policies can, and should, be designed in a way that raises working standards and draws new and diverse people into the energy sector. They must also account for the fact that labour needs will vary widely depending on the pace of the transition, and that workers displaced from energy supply on average experience larger earnings losses than those displaced from jobs in the broader economy (Barreto et al., 2024[23]).

Labour and skills shortages as a barrier to a just and effective transition

Skilled labour shortages are emerging as one of the primary bottlenecks to energy transitions. High vacancy rates across energy sectors indicate that employers are struggling to fill positions. A lack of workers with energy specialisations is a significant barrier for many companies. Labour and skills shortages are already translating into clean energy project delays (IEA, 2023[34]).

Many of the most acute skilled labour shortages in the clean energy industry are in roles associated with vocational education. Most of the jobs in clean energy sectors are in construction and manufacturing, both of which are already facing worker shortages across the broader economy in most parts of the world. Construction and manufacturing are expected to grow significantly through 2030 in all IEA scenarios. Established clean energy sectors such as solar PV and wind mostly need installers and technicians, whereas newer technologies need more highly-skilled workers (IEA, 2023[34]).

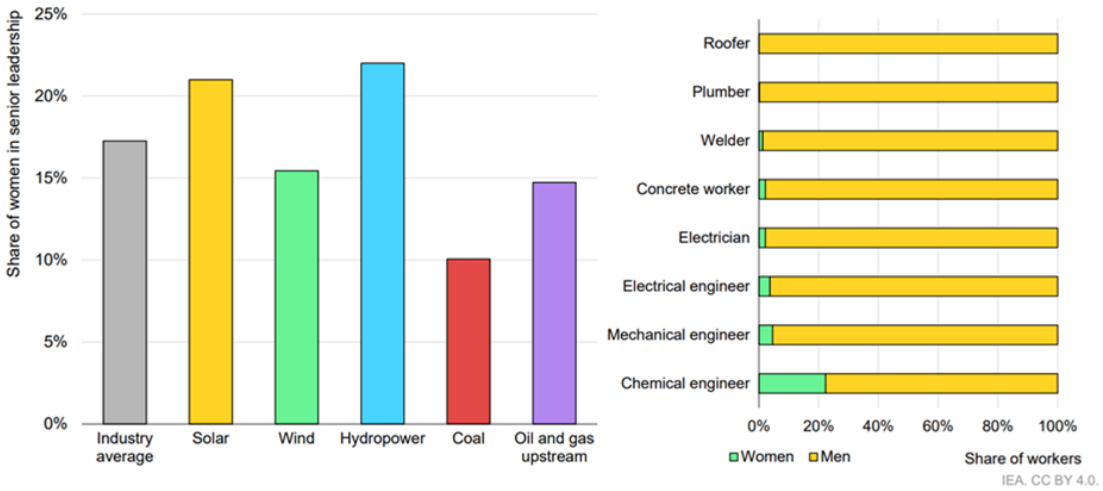
Addressing these labour shortages while supporting workers in declining fossil fuel sectors has implications for training needs. Effective training can help to ensure that workers benefit from growing job opportunities and prevent labour shortages from becoming a bottleneck to the transition. Ensuring widespread and high-quality training is also important for occupational safety, as an inadequately skilled or short-staffed workforce may result in more errors or accidents (IEA, 2024[33]). Developing a sufficiently large and skilled local workforce in every region is essential, as most energy jobs are tied to where installations are developed and cannot be offshored (IEA, 2023[34]).

The number of workers pursuing degrees or certifications relevant to energy sector jobs is not keeping pace with growing demand. STEM degrees relevant to the energy sector are not rising fast enough to supply the required workforce. Vocational education and training (VET) programmes often do not expand or adapt to labour market needs fast enough to meet growing energy industry demand. Insufficient enrolment in VET in many regions can be attributed to factors such as negative perceptions among students, concerns about career options and earnings potential, cultural and gender bias, and programme management problems or lack of investment. In addition, training courses tailored to energy technologies, particularly newer technologies, are not always available (IEA, 2023[34]; IEA, 2024[33]).

The under-representation of women in the energy sector risks their missing out on the benefits of clean energy job growth. Women make up around 20% of the energy workforce, significantly lower than their representation in the broader economy (39%), and the share of women among senior leadership remains low (Figure 3). This reflects women's under-representation in vocational or other educational programmes relevant to energy. For example, women attained only 29% of STEM bachelor degrees in the United States, 34% in the European Union, and 44% in India as of 2022, excluding degrees in biological and medical sciences, where graduates are less likely to work in the energy sector (IEA, 2024[33]). Construction and manufacturing, both key areas of future energy job growth due to the transition, are also male-dominated (OECD et al., 2024[35]).

With clean energy employment projected to grow significantly by 2030, the transition offers an opportunity to address this gender imbalance through more inclusive policy approaches. Beyond equity considerations, there is a strong economic case for doing so. Increasing women's participation in the energy workforce should be a key strategic goal for regions and countries looking to be competitive in growing clean energy industries (IEA, 2023[34]). At the same time, as noted above, workers in high-emitting occupations facing displacement are more likely to be male, underlining the need for gender-responsive policy interventions (OECD, 2024[14]).

Figure 3. Share of women in senior leadership by sector and in selected energy-related occupations, 2023



Source: (IEA, 2024[33]).

Regional perspective

The net-zero transition is a global challenge with local implications. The level and sectoral composition of GHG emissions varies more across subnational regions than countries due to regional

economic specialisation and land-use differences (OECD, 2021[36]). Socio-economic vulnerabilities to the impacts of the transition also differ widely from one region to another. Marked variations in risks and opportunities highlight the importance of a regional perspective.

Green-task jobs tend to be concentrated in cities, especially capital regions. Around 18% of workers in the OECD hold green-task jobs, with regional shares ranging from 7% to more than 35%. Capital regions and those with higher shares of tertiary education are at the forefront of the green transition, with a high and increasing share of green-task jobs and low share of high-emitting jobs at risk of disappearing. Capital regions have the highest share of green-task jobs in 19 out of 25 OECD countries (OECD, 2023[17]).

Local labour market greenness is influenced by factors such as innovation, industrial composition, and workforce education levels. Regions with industries based on professional, technical and scientific activities tend to have above-average shares of green-task jobs. Regions with low employment in sectors such as agriculture or manufacturing have higher green-task job shares than the national average. Regions leading in green-task jobs also typically have a higher share of population with tertiary education (OECD, 2023[17]).

Regions with greater transformation challenges are often socio-economically weaker, requiring more targeted support to prevent the transition from exacerbating existing disparities. Some of the most difficult-to-decarbonise manufacturing activities (e.g. basic metals, including steel and aluminium, and non-metallic minerals including cement) are concentrated in regions that already perform poorly on several socio-economic indicators (Box 5). In regions most exposed to the net-zero transition, where employment shares and emissions per capita are high in key manufacturing sectors, GDP per capita and wages are up to 38% lower than the national average (OECD, 2023[37]). High-emitting manufacturing activities provide relatively well-paid jobs and are central to regional economies. Some regions may have more difficulty developing the infrastructure needed to adapt to cleaner technologies, such as green hydrogen, carbon capture, utilisation and storage (CCUS) and low-carbon freight.

These labour market shifts also have a notable gender dimension. Women are under-represented in green-task jobs (28% across the OECD; less than half across all OECD regions), which is significant as green jobs tend to offer higher pay. At the same time, men (occupying 83% of polluting jobs) are more affected by the disappearance of jobs in high-emitting sectors (OECD, 2023[17]).

Box 5. Focus on manufacturing in Europe

Recent OECD work has examined several key high-emitting manufacturing sectors.[8] Jobs in these sectors tend to be regionally concentrated, with up to 11% of workers in some European regions. Average wages in key manufacturing sectors affected by the net-zero transition are higher than in the overall economy. As such, job loss or transformations in these sectors pose risks to regional wealth. Recent work studying a range of OECD countries has suggested that earnings losses for workers displaced from heavy manufacturing may be particularly severe (Barreto et al., 2024[23]).

Moreover, skills profiles of workers and jobs in some regions highly exposed to the transition to net zero (i.e. regions with high employment shares and emissions per capita in key manufacturing sectors) imply significant transition risks. For example, in regions with high levels of employment in basic metals and vehicle manufacturing, up to three out of four workers are in low-skilled jobs. Workers with lower educational attainment may struggle to access training opportunities and to find new employment.

Of the European regions most exposed to adverse impacts of the transition (based on high emissions per capita and substantial employment in key manufacturing sectors), many are in Central Europe, while others are distributed in other parts of Europe. These vulnerable regions share several

characteristics:

- Most have GDP per capita below the national average and some below the EU average.
- Over two-thirds of most vulnerable regions exhibit wages below the national average.
- Most exhibit a higher poverty risk than the national average.
- Many have unemployment rates below national averages.
- Educational attainment levels vary, but many regions with high wages in key sector jobs tend to have relatively low levels of educational attainment.

The fact that most vulnerable regions tend to underperform on important socio-economic indicators has significant implications for regional development. Regions with below-average GDP per capita and above-average wages may face stark regional development implications if jobs are lost. Loss of well-paid jobs in key sectors could further dampen regional GDP. Without retraining, workers may struggle to find alternative equally well-paid jobs.

Source: (OECD, 2023[37]).

Assessing and addressing distributional impacts of climate policies on households

Beyond employment effects, climate policies affect households in numerous other ways. Policy levers available to governments include carbon pricing to incentivise emissions reductions, subsidies and other incentives to support the uptake of low-carbon and energy-efficient technologies, and regulatory measures including bans (e.g. on certain types of vehicles or residential heating) and standards (e.g. building energy codes or fuel economy standards). The distributional impacts of these policies differ and depend on specific design choices (OECD, 2024[38]).

Carbon pricing (e.g. carbon and energy taxes on fuels) can be regressive in some country contexts but progressive in others. In high-income countries, studies of carbon pricing have documented regressive impacts, i.e. disproportionality affecting lower-income households (Bettarelli et al., 2024[39]). In developing countries, there is evidence that carbon pricing may be progressive, with higher-income households bearing more of the costs (Budolfson et al., 2021[40]). Studies have also found progressive impacts from carbon pricing in developed countries (Cronin, Fullerton and Sexton, 2019[41])). Across countries, low-income households are more likely to occupy energy-inefficient dwellings and own inefficient appliances (OECD, 2024[4]). Low-income households in developed countries tend to experience greater relative burdens from carbon pricing, as they spend a higher share of their income on energy bills and have a lower savings rate.[9] This pattern may not hold in low- and middle-income countries, however, where energy (e.g. transport fuel) can be a “luxury” item (OECD, 2024[38]; OECD, 2021[9]).

Even in cases where carbon pricing effects are neutral or progressive, their impacts can be significant. Even small increases in energy costs can be a concern for households facing financial or other constraints that may already be consuming below their needs (OECD, 2024[38]). In cases where higher energy prices lead to segments of the population needing to reduce heating and cooling, health and well-being may be put at risk, particularly that of vulnerable groups such as children and the elderly (OECD, 2021[9]). In developing countries, the use of fuel sources such as firewood can be widespread and outside the scope of carbon pricing instruments. This may undermine the effectiveness of potential carbon pricing measures and could risk negative consequences if untaxed fuel sources are substituted for carbon-taxed sources (Advani et al., 2021[42]).

When assessing the distributional impacts of carbon pricing, policymakers should consider both direct and indirect effects. Direct effects involve higher prices for fuels used in heating and transport, while indirect effects stem from higher prices for other goods (e.g. food), based on their embodied GHG emissions. Non-fuel consumption contributes a significant share of household emissions but is sometimes overlooked in policy discussions (OECD, 2024[38]).

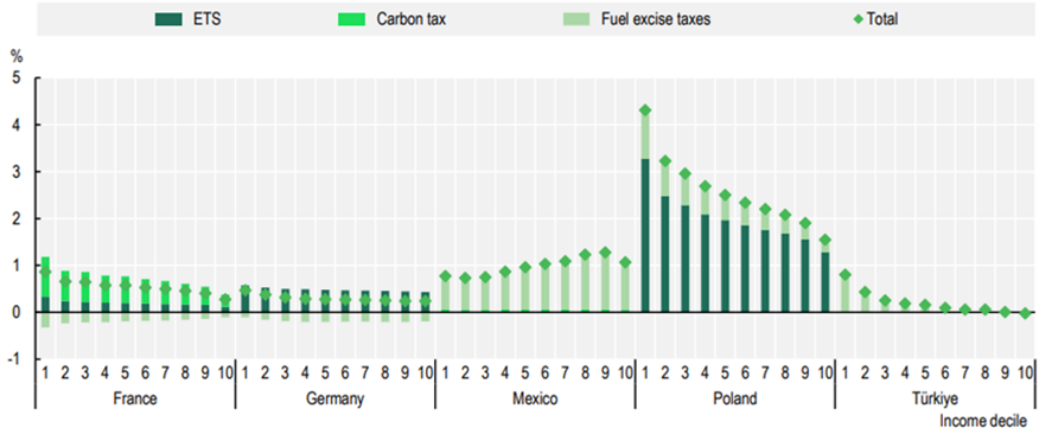
The burden of carbon pricing on households depends not only on their carbon footprint but also the specific carbon pricing mechanism in place. In practice, carbon pricing measures are not applied uniformly across sectors and fuel types, therefore not all emissions are priced equally. For instance, excise taxes, carbon taxes and emissions trading systems often vary substantially between industries and fuel types, with some sectors entirely exempt. As a result, different carbon charges can and do affect households differently (OECD, 2024[38]).

A recent analysis of broad-ranging carbon-pricing reforms[10] in five OECD countries[11] over the 2012-2021 period (OECD, 2024[38]) revealed the following findings:

- Energy spending patterns are mostly regressive. Lower-income households tend to spend a larger share of their income on energy, raising affordability concerns when prices for fuel or electricity go up. In the years before the COVID-19 pandemic, low-income households (bottom 10%) in Poland and Türkiye spent more than one-fifth of their income on energy – three to ten times the shares spent by the highest-income households (top 10%). However, there are variations across countries and types of fuel. For instance, spending shares for motor fuel increase with income in Mexico and Poland, and in Germany vary little between income groups.
- Carbon prices and resulting burdens on households increased only marginally over the 2012-2021 period. In four of the five countries studied, the cost of an average household's consumption basket grew by 1% of income or less – a small increase relative to both recent annual inflation rates and cumulative inflation over the decade prior to the cost-of-living crisis. Average additional burdens were largest in Poland (2.3% of household income), but were negligible in Türkiye.
- Household carbon pricing burdens were significant for some income groups, with mostly regressive effects (Figure 4). This reflects the reliance of low-income households on consumption items embodying high emissions. For instance, in France, the estimated additional burden as a share of income for the lowest-income households (bottom 10%) were three times those for the top 10%. In contrast, in Mexico, relative additional burdens were greater for high-income households, reflecting the top-heavy pattern of energy expenditure.

Figure 4. Burdens of carbon pricing measures on households, selected countries

Percentage of disposable income, 2012-2021



Note: Change in the cost of household-specific consumption baskets, as a share of disposable household incomes, taking consumption baskets (2015 in EU countries, 2016 in Mexico and 2019 in Türkiye) and the fuel mix and carbon intensity of consumption (using the 2016 vintage of the environmentally extended World Input-Output Database – WIOD) as fixed. The changes in carbon pricing burdens are thus only driven by changes in carbon pricing and not by changes in consumption behaviour nor by changes in the fuel mix and carbon intensity of consumption. Effective carbon rates for 2012 and 2021 are converted to real terms to match the corresponding household budget survey vintage. Averages by income decile (equivalised disposable household income). For the average household, burdens from carbon pricing reforms were as follows. France: +0.53% of total household income, Germany: +0.50%, Mexico: +1.03%, Poland: +2.34%, Türkiye: +0.09%. ETS: Emission Trading Systems. Changes are computed against the status quo, and do not account for the distributional impacts of inaction.
Source: (OECD, 2024[14]).

As the urgency of climate change mitigation grows, carbon price increases may be much larger and more rapid in some countries than over the past decade. Estimates suggest that, depending on temperature scenarios and policy design, a global average effective carbon price of USD 50-150 per tonne will be needed by 2050 (Budolfson et al., 2021[40]), an enormous increase from current global effective carbon rates, estimated at around EUR 14 per tonne in 2023 (OECD, 2024[43]). This emphasises the need to carefully consider the distributional impacts of carbon pricing, not only for equity purposes but to secure the social support needed for effective climate action (OECD, 2024[15]).

While carbon pricing may entail a more visible burden for households, it is not necessarily more regressive than other mitigation instruments. Despite negative public perception, particularly in developed countries (Dechezleprêtre et al., 2022[44]), evidence on the regressivity of carbon pricing is mixed. A key advantage of carbon pricing is that its generated revenues can be "recycled" to offset household impacts, which is generally not the case for standards and bans. Given the significant past and expected revenues from carbon pricing, governments have considerable scope for shaping distributional outcomes of mitigation policy packages. Indeed, studies indicate that the way revenues are recycled can have a greater overall distributional impact than a carbon pricing measure itself (OECD, 2024[38]; Immervoll et al., 2023[45]).

Evidence suggests that policy tools such as regulatory standards and bans, which often garner more public support than carbon pricing, can also be regressive, but in a less transparent manner. Higher-income households tend to consume more energy in absolute terms, so generally benefit more from efficiency savings than lower-income households. At the same time, energy efficiency standards tend to disproportionately affect lower-income households, as shifting to low-carbon options is relatively less affordable (Hodok and Kozluk, 2024[46]). Research on Corporate Average Fuel Economy (CAFE) standards implemented for passenger cars and light trucks in the United States has found some evidence of

regressive impacts (Davis and Knittel, 2019[47]; Levinson, 2019[48]). Similarly, regressive effects have been found for building codes that set minimum energy efficiency requirements (Bruegge, Deryugina and Myers, 2019[49]). Research on Switzerland has shown that a ban on fossil fuel cars and fossil fuel boilers could result in disproportionate burdens for low-income households due to the high cost of replacements, but that a compromise between mitigation potential and equitable outcomes could be found by providing exemptions for the lowest-income households (Torné and Trutnevyte, 2024[50]).

As for subsidies, the limited evidence available suggests they may be generally regressive (OECD, 2021[9]; Hodok and Kozluk, 2024[46]). For instance, subsidies that uniformly lower the cost of electric vehicles are more likely to benefit higher-income households who can afford more expensive cars, and urban households with better access to charging infrastructure (OECD, 2024[15]; OECD, 2024[4]). Subsidies promoting the installation of rooftop solar panels tend to target homeowners, potentially excluding low-income households and renters (OECD, 2021[9]). A 2022 OECD survey found that renters were consistently more likely than homeowners to report that installing various energy-efficient and low-carbon technologies was not feasible in their homes (Hassett et al., 2024[51]). Without well-targeted policy design, lower-income and rural households may be generally less likely to benefit from subsidies for energy-efficient and low-carbon technologies. The impacts and benefits of subsidies also depend on the technology in question. Regressive effects have been shown to be larger for subsidies for electric vehicles than for home insulation and solar panels (Borenstein and Davis, 2016[52]). Research on adoption of heat pumps in the United States has found little correlation with household income, suggesting that the distributional impacts of subsidies for heat pumps differ from those for other low-carbon technologies (Davis, 2024[53]).

Accounting for the impacts of the net-zero transition on developing countries

Developing countries risk being left behind in the global transition to net zero. In 2023, high-income countries' per capita emissions were about 70% higher than the global average (IEA, 2024[54]). While developing countries bear the least responsibility for cumulative GHG emissions, they are particularly vulnerable to potentially severe physical impacts from climate change (see (OECD, 2024[55])) and socio-economic impacts of the transition, which could exacerbate existing development challenges. Developing countries face persistent challenges related to high levels of indebtedness and limited fiscal space; high cost of capita,[12] informality in labour markets; underfunded welfare; lower institutional capacity; and technology gaps. Barriers to mobilising climate finance and attracting private investment continue to hinder low-carbon projects in developing countries. Moreover, climate policies implemented in developed countries may have spillover effects in developing countries. Loss of competitiveness is a concern if developing countries cannot adapt to more stringent emissions reduction requirements sometimes set in developed countries (OECD, 2022[6]).

Developing countries have diverse starting points for the transition to net zero. Factors such as the size of countries' industrial sectors and whether they are energy importers or exporters are important considerations. Emissions levels also vary widely across countries. Trends such as rapid demographic growth, urbanisation, and rising energy demand have an impact on transition pathways and also differ across countries (OECD, 2022[6]).

Fossil fuel-producer developing countries may be particularly vulnerable to the impacts of global decarbonisation efforts. The COVID-19 pandemic and Russia's war of aggression against Ukraine have contributed to economic downturns and instability and are reshaping global energy trade, with a focus on energy security and diversification of supply. While this creates opportunities for some developing countries – such as the potential to monetise gas reserves – it also poses risks. These include macroeconomic risks for developing countries dependent on fossil fuels, fiscal risks associated with

potential revenue shortfall due to projected declining fossil fuel demand, and transition risks such as high-carbon infrastructure lock-in and stranded assets (OECD, 2022[6]).

At the same time, the global shift toward net zero presents significant opportunities, if well managed. Structural changes in economies and societies offer the potential to foster more sustainable growth, as well as increased and more formal employment. If well managed and supported by robust legal frameworks and governance, increasing global demand for critical minerals and renewable energy could create transformative opportunities for developing countries to meet their citizens' basic needs. A just transition implies enabling developing countries to capitalise on such opportunities.

However, there are risks associated with countries shifting towards a model reliant on the extraction of critical minerals. In many developing countries, the sector is characterised by low-skilled, informal labour, poor working conditions, and low pay (IEA, 2024[33]). For instance, in Indonesia, working conditions are worse and informality significantly higher in metals mining compared to fossil fuel extraction (OECD, 2024[56]). Additionally, the environmental degradation caused by critical mineral extraction can itself affect working and living conditions for local populations. While extractive industries can be a valuable source of jobs, downstream portions of the energy supply chain involving the development and operation of local clean energy systems and infrastructure account for over two-thirds of clean energy jobs today and provide the greatest future employment potential (IEA, 2024[33]). Some of these opportunities and challenges are illustrated in case studies in Box 6 below.

Synergies and trade-offs between development processes and the net-zero transition

Efforts to reduce emissions should be an essential part of development strategies. Developing countries contribute a growing share of global GHG emissions, driven by demographic pressure, growing energy needs, and industrialisation. Middle-income countries, in particular, account for approximately 68% of global emissions today (World Data Lab, 2024[57]) and therefore need to juggle development priorities alongside calls for rapid decarbonisation. For low-income countries, responsible for only a small share of present-day emissions, development trajectories are constrained by the need to avoid carbon-intensive growth and high-emission lock-ins.

Recent OECD work has outlined a conceptual framework to analyse points of convergence and divergence between the net-zero transition and economic development (Koirala, 2025, forthcoming[58]). The framework breaks both processes down into three components: aims, transformations and underlying drivers.

- *Aims* are the outcomes that each process, climate action or development, strives to promote.
- *Transformations* are the shifts characteristic of each process. They typically reflect the proximate causes of the processes.
- *Drivers* are the conditions that make the transformations possible and feasible, whether directly or indirectly.

Aims of economic development and the net-zero transition

At a broad level and over the long term, the aims of economic development and climate action are aligned. Economic development is fundamentally about improving living standards, which are themselves underpinned by the physical climate. Climate change can have adverse consequences for socio-economic systems such as agriculture; energy; health; labour; and transport and infrastructure. The aim of climate action is to minimise the adverse effects of climate change on economic activities and human well-being. Given their vulnerability to climate change-related risks, developing countries' long-term welfare is predicated on climate action.

However, tensions exist at a more granular level between the global public good nature of climate action and the more localised nature of development. This mismatch can create incentives to pursue

development at the expense of climate mitigation. For example, while expanding road infrastructure can improve connectivity, labour mobility, and market access in developing countries (Straub, 2008[59]), improving socio-economic outcomes locally, it can also lead to increased emissions (Creutzig, 2023[60]). Issues around the historical responsibility for climate change complicate the need for collective action at a global level (Koirala, 2025, forthcoming[58]).

In addition, short-term development needs may tend towards outcomes incompatible with the net-zero transition. The lower willingness to pay for environmental quality over consumption in developing countries has been documented in Greenstone and Kelsey Jack (2015[61]). For example, resource-rich countries have incentives to capitalise on their natural resource endowments for economic development despite potentially increasing emissions. An empirical analysis of 82 countries shows that oil-abundant and oil-dependent countries, on average, have less stringent climate policies (Tadadjeu, Njangang and Woldemichael, 2023[62]).

Transformations for economic development and the net-zero transition

Economic development and the net-zero transition both involve structural transformation. In the former, this involves reallocating economic activity from low-productivity sectors to higher-productivity sectors. Historically, this has often resulted in a shift from agriculture towards manufacturing and services. This change in sectoral composition also tends to lead to urbanisation, as manufacturing or services tend to be concentrated in urban areas (Michaels, Rauch and Redding, 2012[63]). Structural transformation as part of the net-zero transition is exemplified by employment shifts from GHG-intensive to low-carbon industries, and the greening of other job profiles. In both development and the net-zero transition, these structural transformations can have uneven impacts on populations, requiring careful management.

A key point of tension between climate action and development is the increased pressure put on resources as economic activity grows in scale. There is typically a positive relationship between GDP per capita and energy use per capita (Our World in Data, 2022[64]). A study of 34 European countries estimates that an increase in GDP per capita of 1% corresponds to, on average, an increase in energy consumption of 0.46% (Topolewski, 2021[65]). This tension can be addressed, to some degree, by changes to the composition of economic output and production techniques. For example, efficiency gains and a shift to low-carbon energy sources can contribute to decoupling emissions and economic growth. There is some evidence to suggest that development facilitates these climate-positive shifts, for instance by reducing the economic importance of emissions-intensive sectors, and by encouraging uptake of more efficient technology, but this is not automatic (Koirala, 2025, forthcoming[58]).

Aligning the transformations implied by economic development and climate mitigation depends on country context, demanding careful policy planning. The scale and pace of the necessary structural transformations are not uniform. The sectors most affected by structural transformations will also vary by country, depending on countries' individual economic structures and emissions profiles. Differences in countries' energy sectors matter greatly. Some countries with nascent energy systems (e.g. least-developed countries) have an opportunity to incorporate mitigation priorities early in their development processes. However, for resource-rich developing countries, whose national wealth relies on fossil fuels, economy-wide decarbonisation in a just manner represents a more significant challenge (OECD, 2022[6]; Koirala, 2025, forthcoming[58]).

Drivers of economic development and the net-zero transition

There are significant overlaps between the drivers of development and the net-zero transition. Drivers of development include human capital, finance, institutions (e.g. those that protect property rights and incentivise innovation), and market access and integration, among others (Koirala, 2025, forthcoming[58]). Several of these elements also influence the feasibility and speed of the net-zero transition. For instance, a clear overlap relates to finance, which is falling short for both processes.

Estimates suggest that while developing countries will need USD 4 trillion annually to embark on low-carbon, carbon-resilient pathways consistent with warming below 2°C, current annual climate-related development finance only totals USD 44 billion (World Bank, 2020[66]). This mirrors gaps in financing for development more broadly, suggesting that barriers to scaling up finance may be similar across the two processes.

Carefully leveraging these shared drivers and minimising trade-offs can help to ensure that the net-zero transition and the development process improve socio-economic outcomes. For example, financial sector development can facilitate growth in the scale of production, which could have a net effect of increasing emissions (Jayachandran, 2021[67]), especially in the short run (Mesagan and Olunkwa, 2022[68]). To minimise this risk, climate considerations can be better integrated in the design of financial markets and institutions from the outset. Similarly, decarbonising transport is essential to reducing emissions associated with increasing market access and trade. Sound public institutions (without corruption, with sufficient capacity) are essential to effective climate policymaking and for ensuring that economic development translates to tangible socio-economic gains. In the labour market, well-designed social protection mechanisms and active labour market policies (e.g. unemployment insurance, re-skilling) can reduce the costs of disruptions associated with both development and climate action. The formalisation of labour can not only reduce labour market frictions that inhibit development, but also improve social protection coverage among workers, raising resilience to transition risks (Koirala, 2025, forthcoming[58]). Improving educational attainment among populations can enable the labour market changes entailed by the transition to net zero, increase environmental awareness (Koirala, 2025, forthcoming[58]), and facilitate low-carbon technological advancement and innovation (Wang et al., 2022[69]).

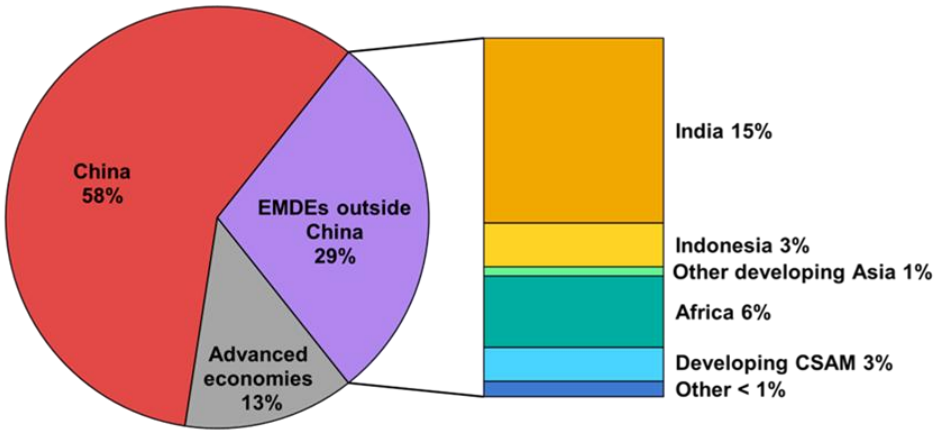
Aligning the drivers of climate action and development, and achieving a just transition within and between countries, requires an integrated approach to climate and development policy. Taking advantage of these links, as well as those between the aims and transformations of both processes, requires close consultation and co-operation across policy communities. Only through co-ordinated efforts can economic growth be reconciled with climate and environmental goals by breaking the vicious cycle of high-carbon emissions, inefficiency, resource depletion, waste generation, pollution, and biodiversity loss.

Energy sector employment in developing countries

Developing countries will play a key role in the global net-zero transition of the energy sector. They account for two-thirds of global energy jobs, with Asia hosting the world's largest energy workforce. China has the largest national energy labour force, of which clean energy accounts for over 60% (IEA, 2023[34]).

While the growth of clean energy employment offers significant potential benefits, so far these have largely been concentrated in developed countries and China. Of the approximately USD 700 billion increase in global annual clean energy investment since 2015, 97% has been in developed economies and China. Clean energy investment in developing countries outside of China is far below what is needed to achieve universal access to modern energy and meet rising energy demand without relying on fossil fuels. Clean energy investment is particularly falling short in Africa, with the entire continent accounting for less than 2% of the global total in 2023. Consequently, two-thirds of all clean energy job additions since 2019 have been in developed economies and China (Figure 5). Most developing countries are also not seeing the strong boost to economic growth that clean energy is providing to other economies (IEA, 2024[33]).

Figure 5. Share of clean energy employment growth by region, 2019-2023



Source: (IEA, 2024[33]).

In developing countries (excluding China), a higher share of new energy jobs are related to fossil fuels than in the rest of the world, representing a significant transition risk. Clean energy jobs in these countries grew by 10% between 2019 and 2023, outpacing fossil fuel employment growth (2.8%) but still far slower than China (30%). While this 10% growth rate is higher than in developed economies (7%), developing countries are starting from a far smaller base and thus have much ground to make up. In developing economies (excluding China), nearly half of all energy sector jobs are in fuel supply (14.3 million), with 11.1 million in fossil fuel supply. Fossil fuels still account for more jobs than clean energy in developing economies (excluding China), whereas in developed economies and China, clean energy jobs already outweigh those related to fossil fuels (IEA, 2024[33]).

The transition risk is particularly acute for coal miners in developing countries. Coal mines in developing countries are less mechanised than in developed countries and China, relying heavily on a large number of unskilled workers. 90% of coal supply jobs lost in the NZE Scenario through 2030 are located in developing countries (including China) (IEA, 2023[34]). Moreover, coal mining is among the energy sectors in developing countries where informal employment is most common, heightening the vulnerability of these workers (IEA, 2024[33]).

Some, but not all, job losses may be transferable to growing clean energy occupations, underlining the need for careful labour market planning and education and training policies (OECD, 2022[6]). Such efforts are well-aligned with broader goals in many developing countries of increasing educational attainment and workforce skill levels and formalising employment (IEA, 2023[34]).

Clean energy manufacturing can benefit developing countries by offering high-quality jobs, greater value-added than extractive industries, and access to a growing export market. However, with the exception of China, these countries have not managed to attract significant levels of clean energy manufacturing. Outside of China, developing countries in total account for only 200,000 manufacturing jobs across five key clean energy technologies – solar PV, wind turbines, electric vehicles, batteries, and heat pumps – representing approximately 7% of the global total. In Africa, clean energy manufacturing jobs are virtually non-existent, and they are minimal in Central and South America. This situation has arisen despite lower labour costs in developing countries, which are offset, to some extent, by higher labour productivity in developed economies and China (IEA, 2024[33]).

The limited skills level of the workforce likely prevents developing countries from attracting more clean energy jobs. Developing countries tend to have lower education levels across the broader

population than developed countries. This creates a barrier to the development of clean energy industries in these countries, especially when considering that the energy sector generally requires more highly-skilled workers than the broader economy. Only 13% of global energy jobs are low-skilled, and most are highly concentrated in developing countries (IEA, 2024[33]).

Other challenges that must be addressed to minimise inequitable energy employment outcomes in developing countries include informality, lack of collective bargaining and inadequate social protection. These issues lead to high vulnerability for many workers in fossil-fuel related occupations, who are at risk of job displacement (IEA, 2024[33]).

Box 6. Case studies from developing countries

Labour market impacts of the energy transition in Indonesia

As the world's largest exporter of coal, challenges could be expected for Indonesia's transition towards low-carbon energy sources, but in fact, this transition promises jobs. Analysis comparing a scenario consistent with a 2°C global temperature rise (the upper limit of the Paris Agreement target) with a business-as-usual scenario showed that the transition in Indonesia's energy sector would result in a total net employment gain of 1,089,000 in Indonesia, or 0.86% more than the business-as-usual scenario. Employment gains are expected to benefit a wide range of sectors, including power, gas, construction, and mining (other than fossil fuels). Fossil fuel mining and manufacturing are the only sectors expected to lose jobs (approximately 31,000) under the 2°C scenario. Moreover, it is estimated that new employment opportunities could benefit workers with various educational backgrounds.

However, workers facing the risk of job loss (including Indonesia's approximately 250'000 workers in coal mining) are geographically concentrated, meaning that results vary widely by region. The geographic concentration of job losses in Kalimantan, the region of Indonesia specialised in fossil fuel extraction, is concerning. The profiles of workers who would be negatively affected by an energy transition are mostly men, wage employed in the formal economy, with higher earnings than the national average and good education levels. Still, a non-negligible 44% of them are in the informal economy, without social protection, indicating higher levels of vulnerability.

Source: (OECD, 2024[56])

Towards a just transition in Latin America and the Caribbean

A systemic green and just transition in Latin America and the Caribbean could help the region strengthen its resilience while improving well-being. This can help to reduce the disproportionate consequences of climate change on inequalities across countries, socio-economic groups, territories, generations and gender. Transforming the energy and production matrix is an opportunity to boost productivity, develop new and more sustainable economic sectors, and create more formal jobs. The region is endowed with high potential for renewable energy resources. Investing in renewable technologies can substantially reduce GHG emissions while also providing lower-cost power and, for some LAC countries, reducing reliance on imported fossil fuel products. Ensuring access to energy is a key element of a just transition, but remains challenging. A total of 17 million people still have no access to electricity, especially in rural areas. Securing universal access to energy could help to overcome inequalities in access to basic public services and stimulate local economic growth.

The green transition can potentially add 10.5% more net jobs in LAC by 2030. As in OECD countries, this transition will require the development of active labour market policies and well-targeted social policies to support workers and households. Securing additional public and private investments will be needed. The transition is also an opportunity to foster consensus and build a new sustainable social

contract. A large majority (68%) of LAC citizens recognise climate change as a very serious threat to their country in the next 20 years. The multiplicity of actors, sectors and constituencies affected by the transition requires participatory processes and transparent policy planning. Regional and international co-operation is also necessary to ensure climate goals are achieved in an equitable manner.

Source: (OECD et al., 2022[70]).

3 Policy tools and approaches for a just transition

Governments need to design and implement policy packages that ensure that the uneven impacts of climate policies are managed equitably.[13] These should include complementary measures that can address multiple challenges: for example, workers are constrained in their job choices by their skills profiles, while households may have limited consumption choices due to financial constraints. This section outlines some of the policy options available to governments to manage the impacts of the net-zero transition on labour markets and households, along with specific actions to support a just transition in developing countries.

Managing labour market impacts of the net-zero transition

Assessing labour market impacts

As a first step, governments should conduct thorough assessments of the likely impacts of climate policies on the labour market. Accurate information about structural shifts, which sectors are likely to experience increased or decreased demand, and which regions are most likely to be affected is essential to determine the best course of action. Impact assessments should include stress-testing existing policies to evaluate their effectiveness under different scenarios. Gathering input from social partners such as labour unions and employers' organisations will be important to these processes (OECD, 2024[14]). Mobilising local and regional actors is equally important to ensure that policies are effective across geographic contexts. In addition to directly affected jobs, assessments should consider induced and indirect jobs, for example those in companies providing services to coal miners' households (OECD, 2022[6]).

Skills assessment and anticipation (SAA) exercises are a key component of stress-testing existing climate policies. By integrating SAA exercises into policy-planning, governments can measure current and future skills needs against the existing skills supply to identify gaps (OECD, 2023[21]; OECD, 2025[71]). Digital technologies can facilitate data collection on workforce needs through matching skills and job demands.[14]

Identifying challenges and intervening early in sectors and regions at risk can both accelerate the net-zero transition and minimise its social costs. Governments could provide meaningful outplacement services, early interventions by public employment services (PES), social plans and transition initiatives (e.g. short-time work schemes) in at-risk sectors. Other timely and targeted support to workers at risk of or facing dismissal, along with measures to address the broader effects of collective dismissals, is key to limiting the consequences of job displacement and accelerating the transition to new employment (OECD, 2024[14]). Anticipating vulnerabilities in at-risk regions and addressing them quickly can help to prevent protracted economic decline (OECD, 2023[72]).

Preparing workers through education and training

Education and training policies are essential enablers of an accelerated, smooth and just transition. Analysis of labour market transitions in European countries has shown that education is the most important individual-level driver of transitions from non-employment to green jobs, based on a task-based definition. Transitions from non-employment to green jobs are more likely in countries where adults demonstrate high proficiency in numeracy and literacy and where a larger share of the population has attained tertiary education (Causa et al., 2024[73]). The speed and efficiency of the shift to a net-zero economy depend on individuals having the right skill sets to fill roles in the emerging low-carbon labour market and to develop and use the technologies needed to propel the transition (OECD, 2023[16]). Moreover, well-designed education and training policies can lead to improvements in working conditions, limit widespread job losses and minimise contractual instability (OECD, 2023[16]). Fostering environmental awareness and a sense of agency among populations is also crucial (OECD, 2023[74]).

The ability to transfer from GHG-intensive to green-driven occupations varies across skills levels and industries. Many high-skilled GHG-intensive and green-driven jobs share similar skills requirements, allowing high-skilled workers to transition from emissions-intensive to climate-friendly industries with relatively little retraining (OECD, 2024[14]). In the IEA's NZE Scenario, more than half of workers projected to be displaced from fossil fuel-related jobs from 2022 to 2030 can, with retraining, potentially transfer to industries such as renewable power, critical mineral mining, or electric vehicle manufacturing, particularly workers from the oil and gas industry or in internal combustion engine vehicle manufacturing. (IEA, 2023[34]). For example, the Norwegian solar cell industry was able to develop by drawing on workers with related know-how, scientific knowledge and technology from the oil and gas industry, particularly from the process industry used in new petroleum fields (OECD, 2022[6]). However, low-skilled workers will require more reskilling to transition out of GHG-intensive occupations (OECD, 2024[14]).

Addressing skills gaps and ensuring that workers are not left behind requires overcoming barriers to participation in upskilling and retraining. Across OECD countries, only around 40% of adults on average participate in formal or non-formal learning for job-related purposes (OECD, 2021[75]). Workers in GHG-intensive occupations and those with lower levels of education participate less in training programmes than other workers, despite their higher risk of job displacement. Barriers to participation may include time constraints; inconvenient training locations or learning modes; lack of interesting or relevant training; insufficient basic skills; or low awareness of available programmes. To overcome these barriers, some OECD countries have introduced measures such as financial support to workers; subsidies or tax deductions for employers offering green skills training; funding or other incentives for training providers to offer new programmes (including apprenticeships); and mechanisms to create and update existing curricula to include skills and competences for green jobs (e.g. by including social partners in the process). Career guidance initiatives can also encourage and facilitate workers' adaptation to labour market changes (OECD, 2024[14]).

Carefully designed education and training formats, curricula, and certifications can make a difference. Many high-skilled workers will already have most of the skills and knowledge needed for employment in the low-carbon economy, only needing "top up" training to adapt to evolving green job profiles and tasks. This suggests that short, flexible training programmes that can be combined to address learners' individual needs may be an efficient route to responding to rapid changes in skills demand (OECD, 2024[14]). Digital tools, such as those for remote learning, can support availability and flexibility. Using SAA results when updating curricula for adult learning programmes is key (OECD, 2023[21]). Rethinking education and training to emphasise environmental awareness, agency, collective action, and innovation is also important (OECD, 2023[74]; Nusche, Fuster Rabella and Lauterbach, 2024[76]). Training programmes and, where relevant, professional certifications or national qualifications frameworks (NQFs), should be created or adapted to reflect changing skills demand (IEA, 2023[34]).

Promoting women's participation in programmes relevant to the net-zero transition should be prioritised to ensure equal access to emerging job opportunities. Greater gender inclusion can also help to accelerate the transition by contributing to filling skilled labour shortages. Labour market data from European countries finds that women's odds of moving from unemployment to a green job is 60% relative to men (Causa et al., 2024[73]). This reflects, to some extent, the under-representation of women in STEM fields: for example, in Europe, only 18% of information and communication technology (ICT) specialists were women as of 2022, and women hold only 27% of jobs in computer and mathematical professions in the United States (OECD, 2024[77]). Evidence also shows that young individuals with medium STEM education are twice as likely to transition from unemployment to green jobs compared to peers with similar levels of education in non-STEM fields (Causa et al., 2024[73]). Policy actions here include expanding delivery options and funding for education and training to improve accessibility, partnerships with employers for post-training work placements, and targeted awareness campaigns to foster women's participation in transition-related programmes (OECD, 2024[77]).

Integrating migrant workers into the green labour market may require targeted action. Low-skilled migrants in particular are both potentially highly vulnerable to labour market transitions because of above-average adjustment costs and higher risks of job displacement, and less likely to access training in most OECD countries (OECD, 2022[78]; OECD/European Commission, 2023[79]). Support could include mainstreaming migration into green skills strategies; emphasising assessment and recognition of migrants' skills and qualifications; expanding and tailoring the offer for bridging courses; and facilitating retention and regularisation of migrants working in green-driven occupations (OECD, 2023[80]).

Social protection for displaced workers

Even with government intervention, some workers will face job loss as a result of the net-zero transition. Governments should support the livelihoods of displaced workers while steering them towards opportunities in expanding segments of the economy. Unemployment insurance (UI) and the wider social safety net will be important to support displaced workers' incomes (OECD, 2024[14]).

Job reallocation costs for workers in high-emission industries may be particularly high due to their characteristics. Accessible UI schemes with adequate replacement rates (i.e. the proportion of wages that income from these schemes represent) and durations are important, but may not be sufficient. Additional income support policies may be necessary (OECD, 2024[15]). Severance pay has a role to play, but longer notice periods may be more efficient than higher severance pay as they can allow employment services to intervene earlier to facilitate the transition to new employment. Wage insurance, a relatively underused instrument that covers the difference between pre-displacement and re-employment wages, may help ease workers' transitions (OECD, 2024[14]). Importantly, climate action will affect not only the need for, but also the funding of, social protection systems in coming decades (OECD, 2024[15]).

Active labour market policies

Active labour market policies (ALMPs) are pivotal in the job-search process and can help steer workers towards new opportunities. Such policies include job search assistance, training programmes and employment incentives provided by public employment services (PES). Evidence shows that countries with higher public expenditure on ALMPs tend to see lower average earnings losses for displaced workers (OECD, 2024[14]). Analysis by (Causa et al., 2024[73]) suggests that spending on ALMPs can support transitions from unemployment to green employment, especially among more highly educated workers. PES can help workers identify relevant training and reskilling opportunities based on current labour market skills demands, as well as offering financial support for such activities. To be effective, however, they must be sufficiently staffed with personnel aware of and with access to information on declining and emerging industries. Continuous upskilling of PES staff should therefore be supported through best practice-sharing, online learning modules, and comprehensive training programmes (OECD, 2024[14]).

Social dialogue to accompany the net-zero transition

Social dialogue, when aimed at finding solutions for all parties, can be crucial to ensure inclusive and diverse perspectives in climate policy design and implementation. Collective bargaining at company and sectoral levels can contribute to adapting the organisation of work to the net-zero transition. Involving various stakeholders in long-term transition planning, including PES, training institutions, unions and other organisations representing employers and workers, can ensure informed policy responses (OECD, 2023[17]). Some industries facing reduced labour demand are working with trade unions to develop long-term strategies, including early retirement packages (IEA, 2023[34]; OECD, 2022[6]). In some countries, however, reallocation of workers from emission-intensive activities to low-emission ones may imply jobs less likely to be covered by collective bargaining agreements (OECD, 2024[14]).

The coal phase-out in Germany's Ruhr region illustrates the importance of social dialogue in managing industrial transitions. Between 1957 and 2016, employment in the coal extraction industry declined from more than 600,000 to less than 6,000 workers. There were also significant job losses in heavy industry. Conversely, 801,000 jobs were created in the service industry between 1960 and 2001. By 2009, 24,000 people worked in one of the 3,400 companies specialising in renewable energy in the region (OECD, 2023[17]). Mass unemployment, out-migration and long-term economic decline were largely avoided, although workers who shifted from coal to non-coal sectors found less secure, lower-paying jobs on average (OECD, 2022[6]). Much of the region's industrial strategy depended on tripartite dialogue amongst coal companies, trade unions, and different levels of government, which led to measures including early retirement, reskilling, and worker relocation (OECD, 2024[15]). Much of the relative success of the Ruhr's transition is attributed to a bottom-up approach emphasising the active participation of local stakeholders, and a focus on education and training as part of its long-term strategy (OECD, 2023[17]).

Ongoing social dialogue remains essential to developing a more responsive and inclusive education and training system to enable low-skilled or underqualified workers to receive additional training more easily. Close co-ordination between governments, agencies, education and training institutions, industry and workers will be vital to meet evolving job and skills needs.

Targeted actions to support local economies in the net-zero transition

A place-based approach[15] is essential to achieve climate goals and prosperity for all ((OECD, 2025[81])). Involving local and regional actors in the development of climate policies can help ensure that the geographically differentiated implications of the transition are taken into account.

Regions affected by the downsizing of GHG-intensive industries require policies that promote local economic development. Regional assets, including existing skill sets, can be used to restructure local economies. Investment and targeted business incentives can generate alternative employment opportunities, including in clean energy, technology and innovation and cultural and creative industries, and contribute to rehabilitating affected areas. Career guidance, retraining policies, and adult learning strategies tailored to local conditions can help steer workers towards these emerging opportunities. Targeted support (including cash transfers) for vulnerable populations within local labour markets remains essential (OECD, 2023[17]; OECD, 2024[14]; OECD, 2022[6]).

Complementary policies to support geographical mobility may be needed to overcome barriers to relocation. These policies include information provision, job-search assistance, housing assistance and childcare support. Financial incentives to mobility alone may be insufficient and result in low-quality jobs in workers' new locations (OECD, 2024[14]).

Managing impacts of climate policies on households

An effective approach to managing the impacts of the transition on households depends not only on the choice of policy instruments but also their sequencing.[16] Households are constrained in how much they can change their behaviour and consumption choices. Low-income households in particular are often "locked in" to energy-inefficient homes or high-emitting vehicles without the financial means to upgrade to more efficient, low-carbon options. This indicates that, in addition to using revenues from carbon pricing or other climate policies to fund targeted subsidies for home retrofits or electric vehicles, or on investments in public transport, governments could consider providing targeted, means-tested cash support for households. The greater the lock-in factor, the more important these transitional cash transfers will be.

Income support for households

Recycling revenues from carbon pricing back to households can allow governments to shape distributional outcomes. Cushioning negative impacts on household budgets (e.g. higher energy bills due to carbon pricing) can enable governments to advance ambitious mitigation policies while making outcomes more equitable and maintaining public support (OECD, 2022[6]; OECD, 2024[38]). Carbon pricing revenues could also be used to lower other distortionary taxes, e.g. labour taxes (OECD, 2024[15]). While past studies have suggested that redistribution can increase overall emissions – if lower-income households spend more of their income on carbon-intensive goods and activities than better-off households – recent OECD research found small differences in carbon intensity between income groups, suggesting the potential for compensating households without increasing emissions (OECD, 2024[38]).

Targeted approaches to revenue recycling are key to ensuring cost-effectiveness. Simple compensation measures, such as uniform lump-sum transfers, may be insufficient to protect all low-income households. For instance, (OECD, 2024[38]) finds that, across four countries[17], while redistributing all carbon pricing revenue as uniform lump-sum payments would benefit or leave unaffected a large majority of households in the bottom income decile, there would still be net losers in this income group in all countries. Simple compensation measures are also not cost-effective, as they leave little to no room for financing other measures such as public investment, energy efficiency programmes, or programmes to help workers' job transitions (OECD, 2024[38]). These findings align with recent research on the 2021-22 energy-price crisis that showed that government support to households was largely untargeted and often fiscally costly, potentially weakening incentives to conserve energy and shift away from fossil fuels (Hemmerlé et al., 2023[82]). As such, revenue recycling should link transfer amounts to households' carbon price burdens and support needs.

Support for housing, home energy efficiency and low-carbon mobility

Higher-income households tend to benefit more from subsidies aimed at low-carbon housing and mobility. Improving housing quality and energy efficiency is essential to reduce emissions from buildings, and most OECD governments have programmes in place to support energy efficiency upgrades, e.g. subsidies or interest-free or subsidised loans (OECD, 2024[83]). Lower-income households are less likely to access these benefits, as they are more likely to be renters (and non-occupying owners are less likely to invest in energy efficiency due to split incentives) or because they are unable to finance the large up-front investments such renovations require (OECD, 2024[15]). Similarly, subsidies for the purchase of electric vehicles, which command a price premium on other cars, tend to favour higher-income households.

Programmes need to be means-tested to ensure that they reach households most in need. Governments should consider targeted initiatives to support investments by low-income households and renters, and embed energy efficiency standards into the construction of new social housing (OECD, 2024[15]).

Policies also need to address the unequal impacts of the net-zero transition on property values. For instance, the densification of cities to reduce car usage may raise property values in cities, while higher carbon prices or a ban on some vehicle classes is likely to depress the value of suburban or rural homes by making commuting more expensive. In addition, subsidies for energy-efficient building renovations ultimately increase a dwelling's value, therefore benefiting homeowners. These unequal gains and losses may need to be rebalanced, e.g. through a form of capital gains tax (OECD, 2024[15]).

Subsidies to promote electric vehicle adoption can also be targeted to lower-income households. An innovative subsidy for the lease of electric vehicles in France saw widespread uptake in 2024. The programme allowed low-income households to lease electric cars at a low cost, provided they met income eligibility requirements and could demonstrate professional need for a vehicle. Launched in January, the scheme had already benefitted 50,000 households by February 2024, double the target of 25,000 (Le Monde, 2024[84]). As part of a broader strategy set out in its National Energy and Climate Plan (NECP) 2023, Spain is developing a Social Climate Plan that aims to ensure that low-income households and renters benefit from energy efficiency upgrades and clean mobility investments. The plan combines direct financial support with investment incentives, using socio-economic indicators to identify vulnerable groups and tailor assistance accordingly (Ministerio para la Transición Ecológica y el Reto Demográfico, 2023[85]).

Housing policies need to ensure adequate support for workers and their families. Areas that experience widespread loss of GHG-intensive jobs may see local housing markets deteriorate or collapse. Declining housing prices can trap workers and their families in their current homes and mortgages, effectively limiting their mobility and preventing them from transitioning into new jobs elsewhere, such as those in growing green-driven occupations. Home buyouts may be necessary in some areas to enable relocations. Conversely, in areas with growing labour demand, demand for affordable and social housing may increase along with a need for increased public investment in housing, public transit, educational infrastructure and other social services (OECD, 2024[15]).

Targeted support strategies are needed for public services and those who rely on them in areas adversely affected by the transition. Especially in rural areas, where public services often depend heavily on local funding and tax revenue from industry, closure of GHG-intensive industries can lead to funding shortfalls for education, health, and social services. For instance, the loss of coal tax revenues, royalties and fees to state and local governments has severely negatively affected Appalachian communities in the eastern United States. National governments will likely need to intervene to prevent a "fiscal death spiral" related to the loss of tax revenues and fees from industries that had previously supported local public services (OECD, 2024[15]).

Actions to ensure a just transition in developing countries

Tackling challenges associated with informality and improving social protection

While many of the policy options described above also apply to developing countries, high levels of informality mean that specific actions are needed in these countries. Informal employment represents approximately 89% of total employment in low-income countries, 82% in lower-middle-income countries, and 50% in upper-middle-income countries, compared to only 16% in high-income countries (OECD, 2023[86]). High levels of informality create challenges for assessing the labour market impacts of climate policies, as data may not be readily available. This calls for a more localised approach to impact assessments. Qualitative methodologies, including the use of surveys and interviews, should be used to build detailed pictures of local impacts, as well as the extent of informality and social protection coverage (OECD, 2022[6]).

Efforts to formalise the workforce and develop social protection systems are needed. High rates of informal employment imply high levels of vulnerability for workers, particularly those at risk of job

displacement due to climate mitigation policies. For instance, in Southeast Asia, around 244 million informal workers lack labour and social protection, with higher rates of informality in jobs linked to the environment than in the broader economy (OECD, 2024[56]) (Box 7). There is an urgent need to achieve universal social protection, and leverage growing numbers of green-driven jobs to formalise the workforce, where possible (OECD et al., 2022[70])). In recent years, countries such as Kenya, Namibia, Nepal and South Africa have successfully extended basic pension coverage for all its citizens in old age by introducing tax-financed pensions. Short-term options for governments to finance social protection and public services, especially in fossil fuel-producer countries that rely heavily on revenue from these industries, include recycling revenue from carbon pricing policies, bond issuance and reallocating wasteful public expenditure, e.g. through fossil fuel subsidy reform (OECD, 2022[6])**.** In addition to expanding social protection in the formal economy, countries could make use of both contributory and non-contributory schemes to extend social protection to informal workers (OECD, 2024[87]). Developing countries can also support labour representation and collective bargaining agreements to secure better working conditions and protections for workers (IEA, 2024[33]).

The role of development co-operation in supporting a just transition

Official Development Assistance (ODA) has an important role to play in ensuring a just transition in developing countries. Members of the OECD Development Assistance Committee (DAC) have committed to supporting developing countries' transition to net-zero emissions as part of the 2021 DAC Declaration on a new approach to aligning development co-operation with the goals of the Paris Agreement on climate change (the DAC Declaration).[18] The DAC Declaration underlines that both energy and energy transitions are key for development, and that DAC members need to promote both to deliver on their development mandates.

A five-pillar DAC Approach on supporting developing countries' net-zero aligned energy transitions has been developed with the aim of integrating support within the specific contexts of developing countries while fostering international partnerships and leveraging finance. The DAC Approach highlights and systematises current practices, facilitates their recognition and serves as a model for further co-operation in the sector (Box 7) (OECD, 2025[88]).

Box 7. Pillars of the DAC Approach on supporting developing countries' net-zero aligned energy transitions

Pillar 1: Integrating net-zero aligned energy transition support into the development process

The energy transition should be approached as an integral part of the wider development process, to ensure coherence and long-term impact, and that international support is based on countries' needs and objectives. This requires ensuring complementarity between different levers of international support (e.g. policy support, capacity building). The DAC Approach emphasises backing and reinforcing energy transition leadership in centres of government in developing countries, and connecting the energy transition to key country systems and processes such as national budgets and fiscal policies.

Pillar 2: Enabling ambitious partner country action on their own net-zero energy transitions

The DAC Approach prioritises long-term co-ordinated support from donor countries, which should be well-aligned with partner countries' own national strategies. The DAC Approach emphasises investments in institutional and technical capacity so that partner countries can develop, implement and manage energy projects efficiently. Useful approaches for in-country capacity building include promoting peer learning among staff of energy ministries and energy sector stakeholders, embedding

experts, financing sector studies for relevant institutions, and delivering training. Direct funding can also help to resource key capacity. It is also important to promote policy and regulatory frameworks that facilitate renewable energy adoption, energy efficiency and private sector engagement.

Pillar 3: Covering core energy objectives of access, affordability, poverty, efficiency and security

ODA should address energy access, energy affordability and energy poverty as key elements of energy transitions. Supporting access to modern energy services is important for achieving net-zero transitions in developing country energy sectors, and can also improve gender equality by reducing the burden on women and girls, who often procure domestic energy and suffer from indoor air pollution due to use of biomass or other traditional cooking fuels. Access to modern energy services can also generate new employment opportunities. The DAC Approach emphasises promoting renewable energy sources and energy efficiency, and exploiting synergies between net-zero energy transitions and energy security.

Pillar 4: Designing energy transition support to unlock commercial capital

The DAC Approach underlines the importance of using ODA to catalyse private finance and investment. Development finance can be carefully calibrated to mitigate risk, address market failures, support market development and bridge viability gaps for clean energy projects with minimum concessionality. The DAC Approach emphasises the development and strengthening of developing countries' financial systems to enable green investments and improve access to finance. This can also help to reduce the cost of capital for clean energy projects, which is generally much higher in developing countries than in developed countries (see also (IEA, 2024[89]; Montague, Raiser and Lee, 2024[90])). Incentive structures in development finance delivery should be aligned with unlocking commercial capital at scale.

Pillar 5: Leveraging partnership to accelerate energy transitions

It is important for donor and partner countries to build partnerships based around partner countries' transition strategies. Multi-stakeholder partnerships, such as the novel Just Energy Transition Partnerships (JETPs), can be useful mechanisms in this regard for building a partnership between governments, private entities, and civil society. To date, JETPs have been concluded between the International Partners Group and South Africa, Indonesia, Vietnam, and Senegal. The agreements are backed by financial flows and specify power targets for the power sector. While some limitations exist, the JETPs represent a step forward in aligning energy systems with net-zero pathways through international support (Ordonez et al., 2024[91]). Effectively leveraging partnerships can involve pooling and connecting efforts beyond the country level, in order to achieve critical mass for progress. In this regard, the DAC Approach promotes efforts to harmonise energy markets across regions. Collective approaches can be valuable for systemic risk mitigation, in order to tackle high risks in developing countries that raise the cost of capital and discourage clean energy investment.

Source: (OECD, 2025[88]).

In particular, Pillar 3 of the DAC Approach highlights the importance of addressing the social aspects of the energy transition through development co-operation to ensure that the transition is just. Pillar 3 focuses on meeting energy objectives related to social equity, including ensuring access to affordable clean energy for all, addressing the various dimensions of energy poverty and creating employment opportunities through the energy transition. This pillar emphasises that enabling access to modern energy services (including electricity and clean cooking) is essential to the development process and can play an important role in improving gender equality. Support in this area needs to be designed with close consideration for local conditions and the modalities that people with limited access use to satisfy

their energy needs. For instance, this may include supporting the implementation of national bioenergy strategies.

Supporting fossil fuel-producer developing countries

Tailored approaches are needed to overcome the challenges faced by fossil fuel-producer developing countries and ensure equitable outcomes. This may require actions to decarbonise the oil and gas sector, mitigate the transition's impacts on fossil fuel workers and low-income households, and prevent high-carbon lock-in and stranded assets. It is important to account for short-term pressure to achieve energy security without compromising on climate objectives. Actions are also needed to help mineral-rich countries capitalise on the opportunities arising from the increasing demand for critical minerals.

The Equitable Framework and Finance for Extractive-based Countries in Transition (EFFECT) explores these challenges and provides key recommendations for by national and subnational governments, civil society organisations, industry, and development finance institutions (OECD, 2022[6]). The framework comprises three interrelated pillars:

- Pillar 1: Decarbonising extractives and managing uncertainties
- Pillar 2: Sustainable fossil fuel exit strategies and just transition plans
- Pillar 3: Systemic change and economy-wide decarbonisation

While all three pillars of EFFECT are important to supporting developing countries' transition to net-zero emissions, and therefore to ensuring equity between countries, Pillar 2 has particular relevance to efforts to pursue a just transition. Several policy options emerge from this pillar, as follows.

Fossil fuel-producer developing countries need to transition-proof fossil fuel infrastructure as far as possible. Enabling future repurposing of fossil fuel infrastructure for low-carbon re-use can help to reduce risks of stranded assets and high-carbon lock-in. This can avoid significant economic costs from decommissioning infrastructure, while also creating jobs and helping to accelerate the pace of decarbonisation (OECD, 2022[6]).

Countries should pursue cluster-based industrial decarbonisation where feasible. This involves connecting depleted oil and gas reservoirs with GHG-intensive industries via repurposed pipelines that sequester CO2 using carbon capture (utilisation) and storage, while clean energy renewables installations provide low-carbon feedstock to industry. Facilitating this requires policy frameworks that guide partnerships between industry stakeholders, fiscal terms that incentivise investment, a fair division of costs and risks between government and industry, and regulatory measures that clarify legal liabilities for decommissioning fossil fuel installations (OECD, 2022[6]).

4 Summary and conclusion

The net-zero transition must be just or it will not happen. The policy-driven nature of the transition means that its resilience depends on sustained public support. The ever-growing urgency of the climate crisis underscores the importance of governments proactively addressing concerns about the social impacts of climate mitigation policies. This means positioning the pursuit of a just transition as a central pillar of climate strategies.

Achieving a just transition requires identifying and managing the wide-ranging impacts of the net-zero transition. Labour market shifts will take place as countries decarbonise their economies. While the net effect on aggregate employment is projected to be modest, sizeable impacts are likely to be concentrated among certain industries and regions. These impacts are likely to fall disproportionately on disadvantaged groups, such as individuals with lower levels of educational attainment, and on regions that already underperform on socio-economic indicators. Beyond these labour market impacts, ensuring a just transition also depends on assessing and managing the effects of climate policy on households.

Reaching a global just transition means ensuring that developing countries are not left behind. This requires tackling the significant transition-related risks faced by developing countries, and enabling them to take advantage of the transformational opportunities, in order to achieve a more equitable system of benefit sharing. Development and climate action involve both significant potential synergies and trade-offs. Successfully leveraging their synergies can advance climate action and development simultaneously, in a well-aligned manner, with better socio-economic outcomes as a result.

A variety of policy options are available to governments in their pursuit of a just transition. To manage labour market effects; options include assessing impacts and stress-testing existing policies; preparing the workforce through education and training; implementing active labour market policies and social protection for displaced workers; and fostering and engaging in social dialogue. Managing impacts on households relies on measures such as income support (e.g. by recycling carbon pricing revenue), and well-designed programmes (e.g. subsidies) to support energy efficiency home improvements and lifestyle choices. In developing countries, a just transition requires tackling the challenges created by informal labour markets and achieving universal social protection; aligning development co-operation with climate goals; addressing social impacts of climate mitigation policies; and providing support to manage the significant transition risks faced by developing countries highly dependent on fossil fuels.

Given the evolving nature of both climate policies and approaches to a just transition, future work in this area would be valuable. Such work could include further development of indicators that capture interactions across economic performance, well-being and sustainability. For example, standardised indicators to map disparities in income and access to resources across regions could be integrated with skills transferability and health-related well-being indicators to improve policies aimed at equitable transitions (OECD, 2021[9]). Expanding the integration of digital tools is another important area for further research. Work could also target the development of more comprehensive gender-disaggregated data on labour market and education and training participation, and the socio-economic impacts of the transition (see also (OECD, 2024[92])). Additional examination of challenges and opportunities in energy-intensive sectors would be useful.

Notes

[1] Estimating the cost of inaction is challenging, due to a wide range of estimates and a lack of comparability between them. The United Nations Environment Programme (2024[93]) projects that under current mitigation policies, global warming in 2100 will range between 1.9°C-3.8°C compared to pre-industrial levels, with a median forecast of 2.9°C. Bilal and Känzig (2024[94]) estimate that warming of 3°C would lower global output in 2100 by 50%. Van der Wijst et al (2023[95]) project global damages by 2100 in a scenario with 3°C of global warming to range from 10% to 12% of GDP (medium estimate) and 18% to 22% of GDP (high estimate).

[2] See, for example, discussion in (OECD, 2025[96]).

[3] The transition to a circular economy, which also contributes to climate mitigation, can also have employment effects. Such policies can lead to job creation in recycling, remanufacture and repair, along with job destruction in sectors heavily dependent on primary materials. Chateau and Mavroeidi (2020[97]) project relatively marginal total net creation of jobs globally, but with large variations across countries and sectors. Well-designed circular economy policies could also be leveraged to foster social inclusion by integrating informal workers into waste management and materials recovery sectors and could bring additional co-benefits, included lower reliance on imports of raw materials in resource-poor countries.

[4] For further information, see https://www.onetcenter.org/database.html

[5] The IEA's Stated Policies Scenario (STEPS) reflects current policy settings.

[6] Uncertainties remain over how geopolitical tensions and energy security concerns will impact these trends.

[7] The IEA's Net Zero Emissions by 2050 Scenario (NZE Scenario) reflects a trajectory consistent with reaching net-zero emissions globally by 2050.

[8] The manufacturing sectors studied in (OECD, 2023[37]) are coke and oil refining, chemicals, basic metals (including steel and aluminium), non-metallic minerals (including cement), paper and pulp and motor vehicles.

[9] While not focused on carbon pricing, OECD research on the distributional impact of recent high inflation in EU Member States has found that energy for housing is the main contributor to effective inflation disparities that have seen a greater relative burden from inflation for low-income households, those headed by older or retired people, and those with lower levels of education (Caisl et al., 2023[98]) (see also (Sologon et al., 2022[99]) and (Causa et al., 2022[100])).

[10] The analysis utilises data from the OECD's Effective Carbon Rates (ECR) database, which presents carbon prices arising from carbon taxes, emission trading systems, and fuel excise taxes. ECRs account for implicit fossil fuel support or subsidies when delivered through preferential excise or carbon tax rates. They do not account for government measures that lower pre-tax prices of fossil fuels. See also (OECD, 2023[101]; OECD, 2022[102]; OECD, 2016[103]).

[11] France, Germany, Mexico, Poland and Türkiye.

[12] For further discussion, see (Montague, Raiser and Lee, 2024[90]; IEA, 2024[104]).

[13] For further discussion see (OECD, 2025[106])

[14] See further examination of these issues in the OECD-Cisco Digital Well-being Hub.

[15] For further discussion see (OECD, 2025[81])

[16] For further discussion see (OECD, 2025[106])

[17] France, Germany, Mexico, and Poland.

[18] For further information on aligning financial flows with Paris Agreement goals, see (OECD, 2024[105]).

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NET ZERO+
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The world is at a crucial juncture, where ambitious action is urgently needed to tackle climate change. However, in the absence of consideration for distributional concerns there is the potential for the costs associated with climate mitigation policies to disproportionately fall on jobs in certain sectors, or on certain socioeconomic groups, exacerbating existing inequalities and undermining popular support for climate action. Embedding the principle of a just transition into climate strategies is crucial to address these fears and to accelerate action. A just transition entails transformative, systemic change within and between countries, ensuring that the distributional impacts of the transition are well managed, and costs and benefits are shared fairly. Drawing from recent OECD work, this paper examines the development of and different approaches to the concept of just transition, including how it is put into practice by both public and private actors. It addresses the impacts of the net-zero transition, in terms of effects on labour markets and households, and the specific issues faced by developing countries. The paper outlines several of the policy tools and approaches available to governments to successfully manage the impacts of climate policies and achieve a just transition.

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