

# **Climate Change Mitigation Policies for Developing Countries**

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## **Abstract**

*Following the Paris Agreement, many low and middle-income countries (LMICs) have adopted climate change targets. They will need climate policies that are suited to their socio-economic and institutional contexts. Conventional policy prescriptions are geared toward high-income countries with entrenched high-carbon structures, universal energy access, deep financial markets, formal economies, privatized power markets, a capable public sector, and relative macroeconomic stability. Not all these assumptions generalize to LMICs. Here, we synthesize what is known about emissions reduction policies in LMICs. We find a strong emphasis on finance interventions and regulatory measures, including the need for power sector reform. Current scholarship focuses heavily on removing existing price distortions, with less emphasis on carbon pricing. Carbon pricing is discussed mostly for middle-income countries, where some pilot schemes exist and institutional capacity constraints are less severe. Prescriptions for skills-related policies focus on capacity building and preparing a young population for a changing labor market, rather than re-skilling the existing work force.*

JEL classification: Q48, Q54, Q58, O10

## **1. Introduction**

Reaching global net-zero carbon emissions by the middle of the century, the agreed goal of the Paris Agreement, requires action from all emitters. This includes low and middle-income countries (LMICs), which are the main sources of growth in business-as-usual emissions.

LMICs do not need to move at the same speed as high-income countries, which bear the brunt of historical responsibility. The Paris Agreement makes clear that its climate goals should be achieved ‘on the basis of equity’ and in the context of ‘sustainable development and efforts to

eradicate poverty’. For example, access to electricity is limited in many LMICs. Decarbonization strategies should be tailored to ‘different national circumstances’ (Article 4(1)).

Different national circumstances have implications not only for the speed at which emissions come down. They also determine the choice of policy instruments through which decarbonization is realized. This paper reviews what the literature has to say about this latter question. Whatever the right path of decarbonization in LMICs may be, we are interested in the policy mix that will deliver this outcome, tailored to the national circumstances of LMICs.

The question of LMIC-specific climate policies is gaining in salience. Like all parties to the Paris Agreement, LMICs had to define their ‘nationally determined contribution’ to the Paris temperature objective and are now beginning to devise the associated strategies (Hallegatte et al. 2024). At the same time, development agencies are debating how to incorporate climate change into their aid programmes.

Although we find significant scholarship on climate policy in LMICs, the academic discourse is dominated by the analysis of, and recommendations for, high-income economies (Peñasco et al. 2021; Blanchard et al. 2023). Policy prescriptions assume the presence of deep and sophisticated financial markets, a well-regulated and largely private energy sector that provides reliable energy access for all, and a capable public sector that is able to raise taxes and provides relative macroeconomic stability.

The institutional and socio-economic context in LMICs is often different. LMICs are not a homogeneous group. Some of them, like China and India, are significant global emitters in

absolute terms, while others have barely contributed to the atmospheric carbon stock. Some LMICs are fossil fuel-rich or have large high-carbon industries, while others have mostly agrarian economies. But there are important commonalities, which will shape the approach to climate policy, including limited state capacity, thin financial markets, a large informal economy and, above all, pressing development needs and poor access to modern forms of energy. Land-use emissions play a larger part than energy-related emissions, although the focus of this paper is on the latter. Table 1 lists some of the main contextual features that climate policy in LMICs must contend with.

**Table 1: The development context of emission reduction policy**

Economic context	Business environment	Public institutions
<ul style="list-style-type: none"> <li>• Urgent development needs</li> <li>• Aid dependence</li> <li>• High informality</li> <li>• Resource dependence</li> <li>• Demographic shifts (young population)</li> <li>• Weak exchange rate</li> <li>• Indebtedness</li> </ul>	<ul style="list-style-type: none"> <li>• Infrastructure gaps</li> <li>• Rule of law gaps</li> <li>• Administrative barriers</li> <li>• Access to finance gaps</li> <li>• High real interest rates</li> </ul>	<ul style="list-style-type: none"> <li>• Limited state capacity</li> <li>• Influential state-owned enterprises</li> <li>• Low tax base</li> <li>• Corruption</li> <li>• Political instability</li> <li>• Short-term horizons</li> </ul>

*Source: Authors based on an expert workshop with development economists.*

The aim of this paper is to identify LMIC-specific challenges, and also opportunities, that can guide decarbonization policy in these specific contexts. We group policy interventions into four broad categories. For each policy vertical, we develop a narrative, based on key papers, about the relevance and feasibility of this group of interventions:

- **Finance:** Measures to increase finance flows, both domestic and international, and redirect them from high-carbon to low-carbon activities, including the mobilization of dedicated climate finance.
- **Pricing:** Policy interventions to change the relative price of polluting and clean activities through carbon pricing, clean subsidies, or the removal of fossil fuel subsidies.
- **Regulation:** Regulatory interventions to set (and enforce) emissions standards for buildings, cars, or energy use, as well as wider regulatory reforms that influence decarbonization, such as energy market regulation.
- **Capacity and skills development:** Interventions to strengthen institutions and prepare labor markets for climate-compatible development, both to reduce emissions and exploit green growth opportunities.

We use a snowballing approach to identify relevant scholarship. Starting with the most seminal papers, we identify related contributions by conducting a backward and forward search of these papers' reference lists and investigating the network of these papers with LitMaps. Snowballing is complemented by a systematic literature search using Publish or Perish software to generate a bibliography of the most influential LMIC papers on each policy vertical. See Table 2 for our search strategy. The systematic search ensures that the policy narrative does not suffer from major omissions.

**Table 2: Detail of the systematic search approach**

Keywords		Title	Year	Citation
“Climate policy” OR “Mitigation”	“Developing countries” OR “emerging economies” OR “economies in transition” OR “low and middle income countries” OR “LMICs” OR “Africa” OR “South East Asia” OR “BRICs” OR “ASEAN”	“finance” OR “investment(s)”	2010 - 2023	If older than 2022, keep if citations > 50
	“pricing”	“carbon tax” OR “subsidies” OR “emissions trading scheme(s)” OR “ETS”		
	“regulation”	“energy markets” OR “standards”		
	“capacity” “skills”	“just transition” OR “training” OR “technical assistance” OR “capacity building”		

For the most part, we restrict the analysis to papers published since 2010 with more than fifty citations (except for post-2022 papers). While this keeps the focus on influential writing, it may overlook insightful case studies in smaller countries, which enjoy less academic attention

(see Hallegatte et al. 2024 for examples). We prioritise the peer-reviewed literature, but include well-cited working papers and influential reports from international organizations such as the IMF, OECD, and World Bank, recognizing the thought leadership of these institutions.

In what follows, we devote a separate section to each of our four policy verticals (sections 2 to 5) before drawing overall conclusions in section 6. We refer readers to the online appendix for the full systematic bibliography, classified by sub-topics. The search programme written to generate the online bibliography is available on github<sup>1</sup>.

## **2. Finance-related interventions**

### **2.1. Rationale**

Overhauling the existing stock of high-carbon capital and financing the upfront costs of low-carbon solutions will require extensive investment, even if the rapid decline in clean technology costs will shave off some of those capital needs. In theory, core climate policies such as carbon pricing should be sufficient to guide an efficient, well-informed financial sector in its capital allocation.

In practice, financial market interventions are seen as an essential additional tool, in part to overcome financial market-specific barriers (e.g., access to finance) and in part to compensate for the inadequacy of those core policies. Financial regulators also recognize the systemic risks that climate change may pose for their sector.

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<sup>1</sup> <https://github.com/JulietteCx/Climate-Change-Mitigation-Policies-for-Developing-Countries/>

In a LMIC context, finance-related interventions have added salience, making them one of the most prominent tools of climate policy. This reflects the significance of additional climate finance in the international climate negotiations, where financial support for developing countries is a key objective. Underdeveloped local financial markets and the weak fiscal position of many governments further enhance the need for international finance, both from development agencies and, in sectors with a sufficient business environment, private investors.

Within the category of finance-related interventions, we can distinguish between measures to (i) scale up official climate finance; (ii) de-risk and mobilize private finance; and (iii) regulate climate transition risks for the financial sector.

## **2.2. Climate finance**

There is a vast literature on global, regional, and national decarbonization pathways (Riahi et al. 2022). Translating them into investment needs, particularly in LMICs, is often left to the grey literature. Estimates are in the trillions of dollars, much of it for sustainable infrastructure (Songwe et al. 2022; World Bank 2022). Providing these funds is a key objective of international climate diplomacy, and progress is tracked carefully (CPI, 2023; OECD 2023; Timperley 2021). It also makes a difference on the ground. Studies show that access to finance is positively correlated with the production of renewable energy (Brunnschweiler 2010; Le et al. 2020) and contributes to decreases in emissions or environmental degradation (Lee et al. 2022; Leal et al. 2023; Zhang et al. 2022).

There is an active debate on how additional climate finance may be raised (Songwe et al. 2022; Banga 2019; Essers et al. 2021; Bhutta et al. 2022). Proposed solutions range from new financial instruments (e.g., green bonds, debt-for-climate swaps) and new institutions (e.g.,

green investment banks) to reforming existing ones (e.g., better leveraging the balance sheets of multilateral development banks).

Perhaps the most controversial source of clean finance, and one of the best researched, is carbon offsets. The sale of carbon offsets has been a source of finance for many LMICs. This occurred initially under the Clean Development Mechanism and currently is on the Voluntary Carbon Market. However, their environmental integrity has been questioned in a series of critical studies on both energy-related (Calel et al. 2021) and nature-based offsets (Guizar-Coutiño et al. 2022; West et al. 2020, 2023). Regulatory reform will be needed to make them a sound source of clean finance (Allen et al., 2020; Michaelowa et al. 2019).

The provision of new finance needs to go hand in hand with measures to improve the business environment for clean investment, in order to unlock additional funding (see also section 5 below). Some authors have argued that this should be the primary concern of development agencies, given the systemic benefit of such interventions, compared to financing individual transactions (Steckel et al. 2017; Polzin et al. 2019).

### **2.3. Risk mitigation for private finance**

Development institutions have considerable experience mobilising private finance in support of development objectives. However, when it comes to mobilizing climate finance, the standard apprehension about LMIC risks combines with additional concerns about clean technology risks.

LMIC country risks affect all foreign investment, but can be particularly salient for low-carbon projects, given their high upfront capital needs (Schmidt 2014). Frequent concerns

include political stability, administrative barriers (e.g., planning), the rule of law (e.g., corruption), and regulatory predictability (e.g., energy tariffs). Key macroeconomic concerns are currency availability and foreign exchange risks, as well as energy affordability. Technological risks are related to the adoption, use, development, and maintenance of clean technologies. Project developers are also worried about supply chain risks (Fankhauser et al. 2023a).

These risks all increase the cost of capital (Shrimali et al. 2013) and may even deter investment (Halimanjaya 2015). Systematic analysis across forty-six countries has found that the cost of capital for renewable energy projects in LMICs is higher than in industrialized nations (Steffen 2020), affecting the otherwise high social returns to such projects (Ameli et al. 2021).

The development finance literature lists several ways to de-risk socially beneficial projects. International financial institutions can provide blended finance, dedicated credit lines, and currency hedges, and can take first loss positions for clean energy investments (Fankhauser et al. 2023a). National development banks may play a similar role at the local level (Bhandary et al. 2021).

Another key concern is access to finance, which especially affects small and medium-sized enterprises (Dong and Men 2014) and poor households (e.g. Pode 2013). Here, policy makers can draw on literature outside the climate context, which has extensively studied instruments such as micro-finance banks (Karlan and Morduch 2010). Most development banks also have experience with dedicated energy efficiency or renewable energy credit lines.

## **2.4. Transition risks**

Financial regulators in LMICs are increasingly aware of the micro- and macro-prudential risks of climate change. The Network of Central Banks and Supervisors for Greening the Financial System (NGFS) has a substantial LMIC membership, mostly from middle-income countries. Studies show that, in LMICs with substantial coal and oil sectors, fossil fuel assets may have to be written off prematurely (Ansari and Holz 2020; Monasterolo et al. 2018).

NGFS makes available a suite of scenarios and tools, which can assist LMIC regulators in conducting stress tests and identifying systemic risks. They are also encouraged to strengthen disclosure requirements, which are seen as essential in managing transition risks.

Only a small number of LMIC financial institutions have signed on to sustainable finance initiatives, such as the principles for responsible investment (see Volz 2018 for Asia). So far, the merits of these initiatives in LMICs have not been evaluated, although there is a growing literature on the broader subject of environmental, social and governance (ESG) investing (e.g. Agrawal and Hockerts 2021; Sinha et al. 2021). An important concern in an LMIC context is the compatibility of these approaches with wider social objectives, including the ability to respond to context-specific development needs (Fankhauser et al. 2023b).

## **3. Pricing interventions**

### **3.1. Rationale**

Fixing relative prices is a cornerstone of climate policy. Internalising the climate change externality, or making polluters pay, exposes emitters to the full social and environmental costs of their actions, incentivizes them to manage their carbon emissions (static efficiency), and encourages the search for cheaper abatement options (dynamic efficiency). However,

adopting such schemes can be difficult politically, not least because of their distributional impacts.

Pricing interventions in LMICs are no less difficult. Widespread energy poverty makes clean subsidies (which reduce prices) more attractive than carbon prices (which increase them), but they may be difficult to afford fiscally. The drive to get prices right will often have to start with the politically difficult removal of harmful fossil fuel subsidies. LMICs account for three-quarters of global energy subsidies (Coady et al. 2018, 2019).

There are also practical barriers. A good deal of economic activity in LMICs occurs outside the formal economy. High levels of informality mean that achieving comprehensive coverage is difficult. The main emitters are likely to be integrated into the tax system, but some will be state-owned and driven by different incentives than price signals. Emissions trading requires a level of institutional capacity, on the part of both the regulator and emitting firms, which is available only in advanced LMICs such as China.

Nevertheless, price-based measures are an important climate policy tool in LMICs. We distinguish among three categories of interventions: (i) removing harmful subsidies; (ii) pricing carbon through either taxes or emissions trading; and (iii) subsidizing clean technologies.

### **3.2. Fossil fuel subsidies**

There is broad consensus among economists that reforming fossil fuel subsidies is the first step in getting prices right. Such subsidies are costly in both fiscal and environmental terms (Coady et al. 2018, 2019; Rentschler and Bazilian 2017; Solarin 2020).

Removing fossil fuel subsidies has been shown to reduce carbon emissions by incentivising fuel switching and reducing the consumption of high-carbon goods (Burniaux and Chateau 2014; Mundaca 2017; Burke and Kurniawati 2018). It can also result in significant government savings, although the effect on other macroeconomic variables is not clear (Dennis 2016; Lin and Ouyang 2014).

The distributional effect of subsidy removal can be either progressive or regressive, depending on the type of subsidy (Jiang et al. 2015 for China). There is evidence that fossil fuel subsidies predominantly benefit higher-income groups in LMICs (Arze del Granado et al 2012). However, when focused on the fuel-poor, subsidies contribute to important social objectives, and their removal may affect poorer households disproportionately (see Siddig et al. 2014 on Nigeria; Dartanto 2013 on Indonesia; Li Shi and Su 2017 on Malaysia).

Fortunately, experience is growing on how to reform energy subsidies successfully. The literature offers important practical recommendations, based on case studies in Africa (Alleyne and Hussain 2013; Laan and Beaton 2010; Siddig et al. 2014), Latin America (Schaffitzel et al. 2020), South Asia (Anand et al. 2013), and South-East Asia (Beaton and Lonton 2012; Bridel and Lontoh 2014).

A number of key strategies have proven important (Coady et al. 2018; Inchauste and Victor 2017). They align strongly with the policy recommendations that have been put forward to improve the public acceptability of carbon taxes (Carattini et al. 2018; Gevrek and Uyduranoglu 2015; Vogt-Schilb et al. 2019).

One recommendation is to take maximum advantage of windows of opportunity, such as periods of low global energy prices. Another is to introduce reforms gradually and make them part of a wider economic reform package. An additional recommendation concerns the

need for extensive stakeholder consultation and transparency about the size of energy subsidies and who benefits from them (e.g., Alleyne and Hussain 2013 in Ghana). The last recommendation concerns the need for compensation. For example, when Malaysia removed subsidies to diesel and petrol, the government increased cash transfers to mitigate the impact on poor people (Beaton and Lonton 2012; Bridel and Lontoh 2014). Using tax revenues for other purposes or distributing them to households and firms is known as ‘recycling’ revenue.

### **3.3. Carbon pricing**

There are few active carbon pricing schemes in LMICs. China’s emissions trading system is perhaps the most prominent cap-and-trade example, while carbon taxes are in place in South Africa and several Latin American countries (World Bank 2023).

Although LMIC experience is limited and few systems fully adhere to best practices, there is evidence that pricing interventions can improve environmental outcomes. Emissions trading in China has been effective at reducing emissions, although it is not clear whether the mechanism is reduction in energy intensity or reduction in industrial output (Hu et al. 2020; Zhang et al. 2019). Carbon taxes can also be successful in reducing emissions (Alton et al. 2014; Guo et al. 2014) and incentivising the shift to cleaner technologies (Ding et al. 2019).

As with harmful subsidy reform, a key reservation with carbon pricing is their social impact and, relatedly, their public acceptability (Aldy and Stavins 2012). However, unlike high-income countries, carbon pricing in LMICs is often progressive, at least in terms of consumption. Low-income households in LMICs tend to consume little fossil fuel-based energy. Health co-benefits associated with reduced air pollution also heavily benefit low-

income households (Shang 2023). Some papers argue that a carbon tax targeting informal firms may create welfare gains by encouraging entry into the formal economy (Bento et al. 2018; Timilsina et al. 2023).

Ultimately, distributional impacts depend on how revenues (from taxation or sales of emissions allowances) are recycled (Dorband et al. 2019; Yusuf and Resosudarmo 2015; Gonzalez 2012). Here, LMICS may face limits. Social protection systems are often patchy and unable to target needy households effectively (Missbach et al., 2024). Countries with weak fiscal bases will be reluctant to recycle revenues. Indeed, carbon taxes are sometimes promoted as an attractive source of revenue for LMICs that is easier to administer than income taxes or value-added taxes (Fay et al. 2015).

### **3.4. Clean energy subsidies**

Clean energy subsidies in LMICs are widespread on both the consumer and producer side. They are justified mostly by emissions-related externalities, rather than as a way to encourage innovation. As such, they are primarily a substitute for, rather than a complement to, carbon pricing. On the consumer side, a prominent example is clean cookstoves, which also provide many health benefits. On the producer side, the most common scheme is feed-in tariffs, where producers of renewable energy are guaranteed payment for their contribution to the electricity grid. Feed-in tariffs are both a price subsidy and a risk-reduction instrument, since they guarantee above-market prices over a long time horizon. There are fewer cases of clean-tech subsidies aimed at stimulating innovation. While Brazil, China, and India have notable technology sectors, most LMICs are technology adopters.

The evidence suggests that clean subsidies can encourage technology adoption and alleviate liquidity constraints for households that are unable to meet the upfront costs of clean solutions (e.g., Bensch and Peters 2015; Berkouwer and Dean 2022; Bensch et al. 2015). However,

some reviews report low take-up rates or low long-term effectiveness of subsidy programmes (Hanna et al. 2016; Malla and Timilsina 2014). This is explained by a mismatch between the actual and perceived effectiveness of products or a failure to maintain them properly. Studies emphasize the need for subsidy programmes to be mindful of local habits and contexts, provide training, and address consumer perceptions (Mobarak et al. 2012; Jeuland et al. 2018).

Concerns also have been raised about the potentially harmful effect of lowering (clean) energy prices. The arguments echo those raised against fossil fuel subsidies. They disincentivise energy conservation and may create notions of electricity as a right (Fowlie and Meeks 2021; Burgess et al. 2020).

## **4. Regulatory interventions**

### **4.1. Rationale**

Globally, regulatory interventions have been effective in reducing carbon emissions from buildings, cars, and household appliances, although not necessarily efficient in terms of overall compliance costs. Furthermore, how the heavily-regulated energy sector is designed will influence the effectiveness of decarbonization strategies.

The LMIC context adds important nuances, both positive and negative. On the one hand, the existing stock of high-carbon assets is much lower in these countries, which reduces the risk of asset stranding and may create regulatory opportunities for technology to ‘leapfrog’ dependence on fossil fuel (Fetter 2022). On the other hand, there are challenges around the implementation and enforcement of regulatory standards, which are hampered by low state capacity, high levels of informality, and sometimes corruption.

The public management of energy, often in the context of dominant state-owned enterprises, has led to a complex gamut of subsidies and rigidities that distort market operations and deter competition (Srivastav and Singh 2022 on India; Clark et al. 2023 on China). Where there are private operators, they are often protected by long-term power purchase agreements, which lock in high-carbon generation (Alova et al. 2021).

We distinguish two broad categories of regulatory measures that can help advance decarbonization: (i) broad reforms to the way energy markets are regulated and (ii) specific regulatory measures to mandate low-carbon or energy efficiency standards.

#### **4.2. Energy market regulation**

Energy market structure as an impediment to emissions reduction is a relatively new topic in climate economics. The issue is acknowledged in advanced energy markets (e.g., Joskow 2019), but in LMICs the emphasis has been on advancing social outcomes or private sector development, rather than decarbonization (Bagnoli et al. 2023; Foster and Rana 2019).

A popular way to meet these objectives is by offering power producers contractual certainty. As a result, most electricity in LMICs is supplied under power purchase agreements that span decades. This creates a trade-off. The same structures that provide risk mitigation for private power producers also generate structural rigidities that slow down energy decarbonization. A carbon price will fail to perform in a setting where most power is sold through very rigid contracts that insulate generators from market dynamics.

Injecting more private competition in energy markets also means breaking the dominant role of state-owned power producers. These firms do not necessarily respond to profit motives, but may instead focus on maximising employment or increasing the affordability of power (Benoit et al. 2022; Victor and Heller 2007).

The literature offers some recommendations on how to decarbonize state-owned companies. Standard remedies include firm restructuring or unbundling to allow the state-owned enterprise to respond more to market signals (Chandra 2018) and reshaping government priorities so that low-carbon development is on the agenda (Benoit et al. 2022).

### **4.3. Carbon and energy efficiency standards**

Regulatory interventions can ensure that new assets are efficient, climate-compatible, and resilient. Regulators may require that cars meet minimum standards for fuel efficiency, that power plants install pollution control equipment, and that new buildings meet high energy efficiency standards.

There is evidence in LMICs that standards can be effective in improving environmental outcomes. Greenstone and Hanna (2014) estimate that environmental regulation in India has led to notable air quality improvements. Policies such as emissions standards (Karplus et al. 2018), high-quality gasoline standards (Li et al. 2020), and ultra-low emissions zones (Viard and Fu 2015; Tang et al. 2019) have yielded similar results.

There is an extensive debate on the international impact of environmental regulation. Some papers argue that following internationally accepted energy efficiency standards may open up international markets for domestic industries (Brown et al. 2010). However, the broader evidence about such competitiveness effects is mixed (Dechezleprêtre and Sato 2017; Ambec

et al. 2013). An alternative narrative emphasizes an environmental race to the bottom as the more likely outcome (Akbostanci et al 2007).

The effectiveness of environmental regulation depends on the quality of implementation, which can be uneven in some LMIC contexts. Studies of pollution regulation often find a limited impact. This can result from corruption (Duflo et al. 2013; Oliva 2015), from poor enforcement, or because agents' rewards are designed in a particular way (Burgess et al. 2012; Ghanem and Zhang 2014; He et al. 2020).

Greenstone et al. (2022) show that introducing automatic reporting mitigates “hidden action” issues by providing information on the extent of misreporting by local officials. As a co-benefit, it provides citizens with reliable information, which enables them to make better decisions in buying protective equipment. Leveraging the advances in objective monitoring, via satellites or automatic sensors, can also provide reliable information and improve enforcement (Browne et al. 2022). As suggested by Duflo et al. (2013), third-party monitoring can solve principal-agent issues, where the parties responsible for operating industries, reporting emissions, and enforcing regulations have different interests.

## **5. Building skills and capacity**

### **5.1. Rationale**

Managing the employment impacts of the net zero transition is important for both equity and effectiveness. Mitigating any negative impacts on high-carbon workers and their communities is at the core of a “just transition” (Newell and Mulvaney 2013). But understanding and meeting the labour demands of a zero-carbon economy also avoids skills bottlenecks. The zero-carbon economy poses higher demands on cognitive abilities and workers will have to be trained to a higher level.

The labour market context in LMICs is different from high-income countries. Although there are countries with entrenched high-carbon sectors and associated jobs, such as India and South Africa, the risk of stranded labour is lower. Most LMICs have a young workforce, which is only now entering the labour market. For them, the move to a net zero future could be a welcome job creator (Megersa 2021). Jobs may emerge directly in zero-carbon industries and indirectly in relevant supply chains, and could be induced through consumption and spending by zero-carbon workers (Bowen et al. 2018).

The most significant competence gaps in LMICs are arguably in terms of institutional capacity. They must be addressed by strengthening entire organizations, rather than individual workers. Weak institutions and insufficient administrative capacity have been common themes of this review and are a key constraint to decarbonization policies.

We therefore distinguish between (i) general employment policies that prepare workers for the demands of a zero-carbon economy; (ii) just transition policies, specifically aimed at supporting high-carbon workers, and (iii) technical assistance measures aimed at strengthening entire institutions.

## **5.2. Employment policies**

A labour market that is undergoing a structural shift from high-carbon to low-carbon skills requires flexibility, an adaptable work force, and training programmes that prepare job seekers for the demands of a zero-carbon economy. Many of these are generic features of an effective labor market, particularly in countries with a growing workforce. However, there is very little literature on the effects of the net zero transition on the labour markets of LMICs.

The few available LMIC studies find a broadly positive effect of climate mitigation on job numbers (Cai et al., 2011; Ge and Zhi, 2016; Mu et al., 2018). Their findings are consistent with those of studies in high-income countries, where there is more evidence (Georgeson and Maslin 2019, and Vona et al. 2019 for the US; Lehr et al. 2012 for Germany; and Meyer and Sommer, 2016 for a cross-country review). Potential reasons include a higher labour intensity in clean industries compared to their fossil fuel counterparts and the possibility of larger multiplier effects through greater upstream and downstream connections. However, all studies are at pains to point out that results depend on model assumptions and that there is heterogeneity in the findings.

Because there will be market adjustments, it is important to study employment effects in a broader labour market context (Bowen 2012). Apart from direct green jobs, induced or indirect jobs that support emergent green sectors are also important to consider (Bowen et al. 2018). Examples include solar panel installation and maintenance, and software support for households or firms engaged in net-metering (i.e., selling power back to the grid). Indirect and induced jobs are likely to leverage skills that already exist in the economy and are complementary to green sectors.

Evidence on the skills requirements in the zero-carbon economy is almost exclusively for high-income countries. While the need for some skills will be lower, others (such as electrical engineers) will be in higher demand (Vona et al. 2019). Overall, green jobs appear to have higher skill requirements (Consoli et al. 2016; Popp et al. 2022). This points to the need for a flexible workforce, on-the-job reskilling, and the reform of existing training and apprenticeship schemes. As such, the green skills challenge goes beyond the specific aspect of

adapting skills to the net-zero economy. It also includes broader structural policies to enhance labour market flexibility and induce youth participation in the labour market (Ahn et al. 2019).

### **5.3. Just transition**

Although decarbonization is not expected to be detrimental to job numbers, the short-run labour market adjustments may be substantial. Just transition interventions seek to assist high-carbon workers and communities in their transition into zero-carbon jobs. This may include demand-side policies to bring new jobs to affected areas, as well as supply-side policies aimed at retraining and re-skilling high-carbon workers. Once again, the available evidence is mostly from high-income countries (Walker, 2013; Bluedorn et al., 2023; Carley and Konisky, 2020).

Many reports recommend retraining and education policies (He et al. 2020; Kayahan 2016; Valero et al. 2021; Rosemberg 2010). In an analysis drawn from the United States, Louie and Pearce (2016) argue that ‘a minor investment in retraining would allow the vast majority of coal workers to switch to PV-related positions.’ This suggests that retraining may be a cost-effective way of supporting individual workers.

A just transition for entire high-carbon communities, such as the coal communities of South Africa, India, and Indonesia, will be more challenging. There are only a few examples of successful energy transitions (Rosemberg 2010, Green and Gambhir 2019, Atteridge and Stambo 2020). All emphasize the need for a coordinated, collaborative approach that brings together policy makers, businesses, and trade unions, and for policies to support workers and communities affected by the transition. They also highlight the need to compensate losers, either by reinforcing social safety nets (Hanson 2023 in the US) or setting up retraining

programmes. Also mentioned are the need to communicate proactively (Zhang et al. 2022), provide technical assistance (Wang et al. 2023), and maintain social dialogue throughout the process (Rosemberg 2010).

Some of these approaches have been piloted in LMICs. Megersa (2021) provides examples of green jobs programmes from Zambia, Egypt, Kenya, Rwanda, and Senegal, based on reports from the International Labour Organization, and qualitatively argues that they were successful. However, given the dearth of empirical evidence, some authors have called for an explicit just transition framework as a key component of the net zero transition (Harrahill and Douglas, 2019; Healy and Barry, 2017; Pollin and Callaci, 2019; Newell, 2010).

#### **5.4. Capacity building**

Technical assistance, institutional strengthening, and capacity building have been central components of development assistance for many decades (Kacou et al. 2022). Despite this, the terms are surprisingly vague, referring to a broad aspiration to equip decision makers (often government agencies) with the capabilities to achieve their objectives (Andrews et al. 2017).

With respect to climate policy, the need for institutional strengthening tends to come up in the contexts of ineffective regulatory enforcement (Burgess et al. 2012), poor planning regimes (Hallegatte et al. 2024), weak fiscal processes (Fay et al. 2015), and the need for stronger climate governance (Dubash 2021).

Calls for climate-related capacity building tend to be less specific and refer to a general need for support in meeting countries' climate ambitions (Khan et al. 2019). The international

community has responded with extensive technical assistance programmes through agencies like the Global Environment Facility (GEF). They often support international reporting requirements, rather than on-the-ground delivery, and their ability to build local capacity is still unclear (Stender et al. 2020).

## **6. Conclusions**

The UN Framework Convention on Climate Change explicitly acknowledges the different national circumstances of low- and middle-income countries (LMICs) in contributing to net zero global emissions. National circumstances determine not just the speed of decarbonization, but also the way in which it is pursued. The climate policies deployed in LMICs must reflect their economic, social and institutional contexts.

This paper has identified a notable amount of scholarship on emissions reduction policies for LMICs. Yet, overall, the evidence base on this essential question is still thin. This is particularly the case for research on employment and skills in relation to a just transition. In part, this reflects the LMIC context. Their young populations are only now entering the labour market, which means fewer existing workers are locked into high-carbon occupations. However, even new workers need to be prepared for a zero-carbon labor market.

More has been written on access to finance, reflecting the priorities of international climate diplomacy, and on fossil fuel subsidies, a long-standing concern of multilateral financial institutions. Correspondingly, a fair amount of relevant writing on these topics has originated in international institutions. Academics have been more interested in carbon pricing, in particular the workings of the Chinese emissions trading system. Regulatory reforms and capacity building are again a relative blind spot.

The largest body of work by far is on China and other middle-income countries, much of it by local scholars. We found less research on low-income countries. In part, this reflects our focus on highly-cited scholarship, which favours large-country studies, but it is not a surprise. The carbon footprint of the poorest countries is very low and their climate priority is rightly on adaptation. Agricultural and land use emissions often dominate, while the focus of our review is on energy. Low-income countries do face pressing energy challenges, and their concerns about accessing energy – rather than decarbonising energy – are better reflected in the literature. In particular, there is notable scholarship on clean cooking.

It is difficult to draw firm policy conclusions. As is the case in high-income countries, there are no “silver bullets”. Decarbonization requires a portfolio of policies, each addressing different aspects of the problem. Measures to attract international, but also domestic, climate finance are clearly a priority. Regulatory measures, including energy market reform, and redirecting energy subsidies from dirty to clean may have more traction than comprehensive carbon pricing schemes. However, lessons are emerging on how carbon pricing can work in a context of urgent electrification needs, widespread informality, and dominant state-owned enterprises.

LMICs are not just implementing their own decarbonization plans; they are also responding to the climate and energy strategies of others jurisdictions. For example, LMICs are exposed to plans for carbon border adjustments – essentially, tariffs on imported goods produced with high carbon emissions – by the European Union and others. At the same time, LMICs could benefit from a growing demand for minerals, carbon removal, and clean energy sources such

as hydrogen. It is important to understand the decarbonization efforts of LMICs in this global context.

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