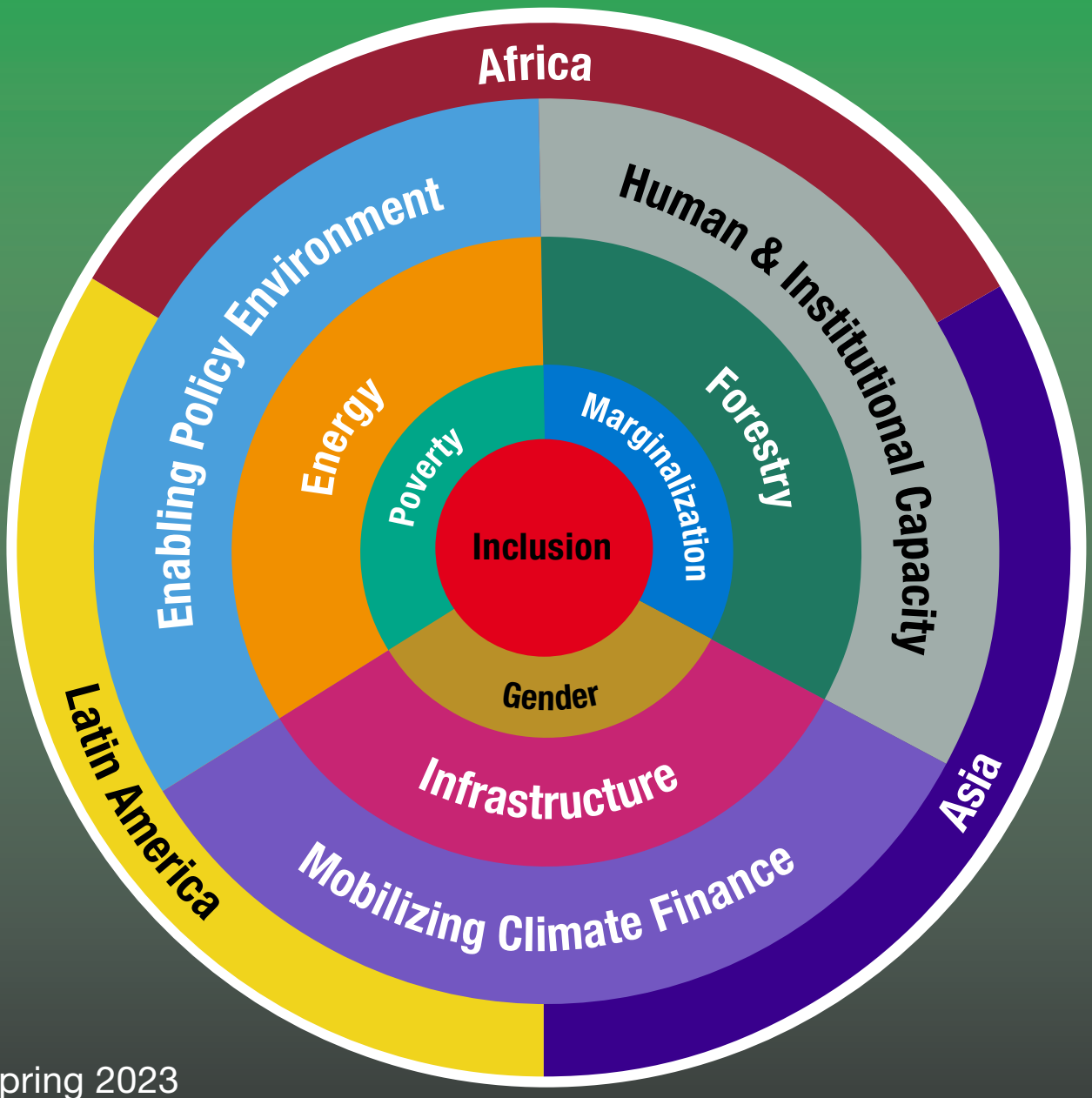
HIGH-LEVEL RESEARCH AGENDA FOR

Inclusive Low-Carbon Transitions for Sustainable Development in the Global South

EfD
Environment for Development

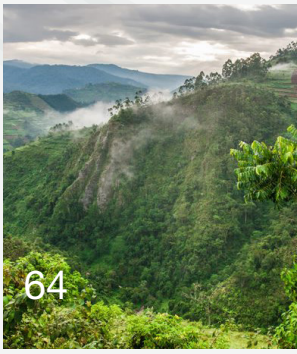
FUNDED BY:
IDRC · CRDI
Canada



Spring 2023

Contents

Contents (continued)



XX

Acronyms and Abbreviations

AFCFTA	African Continental Free Trade Area
AfDB	African Development Bank
AFOLU	Agriculture, Forestry, and Other Land Uses
AGN	African Group of Negotiators
AI	Artificial Intelligence
AOC	Actor, Objective, Context
ASEAN	Association of Southeast Asian Nations
BAU	Business as Usual
BRTS	Bus rapid transport systems
CAF	Development Bank of Latin America
ccGAPs	Climate Change Gender Action Plans
CIPESA	Collaboration International ICT Policy for East and Southern Africa
CO2	Carbon dioxide
COP	Conference of Parties
COVID –19	Coronavirus disease -19
CPI	Climate Policy Initiative
CSR	Corporate Social Responsibility
ECBC	Energy Conservation Building Code
ECLAC/ CEPAL	Economic Commission for Latin America and the Caribbean
ECOWAS	Economic Community of West African States
EfD	Environment for Development
ESG	Environmental, social, and governance
ETS	Emissions Trading Systems
FAO	Food and Agriculture Organization
FDI	Foreign Direct Investment
FFSR	Fossil Fuel Subsidy Reforms
FinTech	Financial Technology
GBA+	Gender-based analysis +
GCA	Global Center on Adaptation
GCF	Green Climate Fund
GDP	Gross domestic product
GE	Green Economy
GE	General equilibrium
GEF	Global Environmental Facility
GFMA	Global Financial Markets Association
GGCA	Global Gender and Climate Alliance
GHG	Greenhouse Gas
GIIN	Global Impact Investing Network
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit

GRIHA	Green Rating for Integrated Habitat Assessment
HEIs	Higher Education Institutions
HLRA	High-Level Research Agenda
ICRW	International Center for Research on Women
ICT	Information and Communications Technology
IDB	Inter-American Development Bank
IDRC	International Development Research Centre
IEA	International Energy Agency
IFC	International Finance Corporation
IIED	International Institute of Environment and Development
ILO	International Labour Organization
IMF	International Monetary Fund
IPCC	Intergovernmental Panel on Climate Change
IPU	Inter-Parliamentary Union
IRENA	International Renewable Energy Agency
ITF	International Transport Worker's Federation
ITU	International Telecommunication Union
IUCN	International Union for Conservation of Nature
JETP	Just Energy Transition Partnership
LAC	Latin America and the Caribbean
LCT	Low-carbon transition
LEAP	Long-Range Energy Alternatives Planning
LICs	Low-Income Countries
LMICs	Lower-Middle Income Countries
LPG	Liquefied Petroleum Gas
MARKAL	Market Allocation
MCFs	Multilateral climate funds
MENA	Middle East and North Africa
MESSAGE	Model of Energy Supply Strategy Alternatives, and their General Environmental Impacts
MRV	Monitoring, reporting, and verification
MTEE	Market Transformation for Energy Efficiency
NAPs	National Adaptation Plans
NBS	Nature-based solutions
NDCs	Nationally Determined Contributions
NGO	Non-Governmental Organization
ODA	Official Development Assistance
OECD	Organization for Economic Co-operation and Development
PAT	Perform, Achieve and Trade
PES	Payments for ecosystem services
RE	Renewable Energy

RECAI	Renewable Energy Country Attractiveness Index
REDD+	Reducing emissions from deforestation and forest degradation + sustainable management of forests including conservation and enhancement of forest carbon stocks.
REEPS	Residential End-Use Energy Planning System
RPO	Renewable Purchase Obligations
RPR	Regional Policy Review
SA	Southeast Asia
SBTi	Science-Based Targets initiative
SDGs	Sustainable Development Goals or Global Goals
SIE	Sustainable Inclusive Economies
SLCP	Sloping Land Conversion Program
SMEs	Small and Medium Scale Enterprises
SSA	Sub-Saharan Africa
STEM	Science, Technology, Engineering, and Mathematics
TA	Technical Assistance
UMICs	Upper-Middle Income Countries
UN	United Nations

UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UNFPA	United Nations Population Fund
UNHCR	United Nations High Commissioner for Refugees
USA	United States of America
USAID	United States Agency for International Development
VCM	Voluntary Carbon Market
WEAI	Western Economic Association International
WEDO	Women's Environment and Development Organization
WEF	World Economic Forum
WHO	World Health Organization
WOCAN	Women Organizing for Change in Agriculture and Natural Resource Management
WRI	World Resources Institute
WWF	World Wide Fund for Nature

List of Figures

List of Tables

Preface

COMPARED TO COUNTRIES in the Global North, countries in the Global South are more vulnerable to climate change, but have less capacity to adapt (AfDB, 2022). As in the North, a low-carbon transition (LCT) needs to be implemented in the South, as reflected in most countries' ratification of the Paris Agreement and in their Nationally Determined Contributions(NDCs). A LCT must include both mitigation (reducing greenhouse gas, or GHG, emissions) and adaptation (making changes to adapt to a warming climate). This is an inherently knowledge-intensive process, but there are substantial gaps in the knowledge needed to achieve this transition in the South and in the capacity to generate tailored solutions. This is why the Sustainable Inclusive Economies (SIE) Division of the International Development Research Centre has identified research in this area as particularly important. This report is commissioned by SIE to develop an actionable research agenda that can inform and support a LCT in the Global South.

One of the greatest challenges in a LCT is the risk that dramatic transformations can make existing inequities, including gender inequality, even worse. Marginalized ethnic groups, rural women, and underemployed youth are some of the groups who are most vulnerable to both a changing climate and a changing economy. In this report, special attention is given to gender and poverty dimensions, including the intersectionality of gender with other vulnerabilities. The ambition is to identify research that can help combine a LCT with increased equality. In this respect, the transition is not only a threat, but a major opportunity.

The consortium that has written this report is global. It consists of over 60 researchers (see the acknowledgements) from a multitude of universities and institutions. The report has been coordinated by the Environment for Development Global Hub, with sub-contracts involving Duke University, the International Institute for Environment and Development, Mercator Research Institute on Global Commons and Climate Change, Universidad de Concepción, Universidad de los Andes, University of Cape Town, University of Economics – Ho Chi Minh City, University of Ghana, University of Nigeria – Nsukka, and the World Resources Institute.

This High-Level Research Agenda is a synthesis of a series of papers in which each of the research themes presented here is expanded. The full set of reports also has extensive coverage of the experiences and ambitions with respect to low-carbon transition in Africa, Asia and Latin America. The ambition is that these reports will be useful for both donors and research institutions in supporting an even greater contribution by research to a much-needed low-carbon transition with gender equity in the Global South.

Gunnar Köhlin
Director, Environment for Development

> **In this report, special attention is given to gender and poverty dimension including the intersectionality of gender with other vulnerabilities**

Acknowledgements

This report was conceived and commissioned by the Sustainable Inclusive Economies Division of the Canadian International Development Research Centre (IDRC). The implementation has been guided by Bhim Adhikari, Senior Program Specialist, under the leadership of Erin Tansey, Director of the Sustainable Inclusive Economies Division, and with many valuable inputs from colleagues throughout the SIE Division.

This report has been developed by a large global consortium of research institutions and individual researchers (more than 60 researchers have made contributions). The implementation was led by Gunnar Köhlin from the EfD Global Hub at the University of Gothenburg, Sweden. The EfD Global Hub team contributing to the report also includes Alejandro Lopez Feldman (supporting the energy, infrastructure and land-use teams), Daniel Hernandez and Daniel Slunge (supporting the regional teams), Anjali Ramakrishnan, Balasurya Sivakumar, Franklin Amuakwa-Mensah, Grace Zhe Gu, Helena Svensson, Karl Kaddu and Susanna Olai. The coordination has also benefited from the support of Herbert Ntuli at the University of Cape Town, South Africa. Professor Subhrendu K. Pattanayak, Duke University, made indispensable contributions to the formulation of the proposed research topics.

AFRICA: The contributors for this section are Lydia Chikumbi and Amin Karimu from the University of Cape Town, Nnaemeka Chukwuone, Ebele Amaechina and Innocent Ifeluin from the University of Nigeria-Nsukka, and Wisdom Akpalu, Nkechi Owoo, Anthony Amoah and Rexford Kweku Asiama from the University of Ghana.

ASIA: The contributors for this section are Quang Nguyen, Pham Khanh Nam and Tran My Minh Chau from the University of Economics, Ho Chi Minh City, Vietnam.

LATIN AMERICA: The contributors for this section are Jorge Garcia and Mateo Herron from Universidad de los Andes, Bogotá, Colombia, and Santiago Arango and Clara Villegas from National University of Colombia, Medellín.

GENDER: The section contributors are Victoria Plutshack and P.P. Krishnapriya from Duke University, Durham, North Carolina (USA), Maria Del Pilar Lopez Uribe and Johana Castañeda from Universidad de Los Andes, Bogotá, and Sejal Patel and Tracy Kajumba from the International Institute of Environment and Development (IIED).

SUSTAINABLE ENERGY TRANSITIONS: The section contributors are Marcela Jaime, Mauricio Oyarzo and Cristóbal Vasquez from Universidad de Concepción, Marc Jeuland from Sanford School of Public Policy, Durham, Carlos Chávez and Adolfo Uribe from Universidad de Talca, Chile, Walter Gómez from Universidad de La Frontera, Temuco, Cesar Salazar from Universidad del Bío-Bío, Chile, Marta Talevi from Vrije Universiteit, Amsterdam, and Erin Litzow from the University of British Columbia, Canada.

INFRASTRUCTURE: The section contributors are Franklin Amuakwa-Mensah from the EfD Global Hub, Gothenburg, Philip Adom from the Ghana Institute of Management and Public Administration, Accra, Amin Karimu from the University of Cape Town, and Jabir Ibrahim Mohammed from the University of Ghana.

FORESTRY AND LAND-USE: The section contributors are Yuanyuan Yi and Jintao Xu from Peking University, Randall Bluffstone from Portland State University, and Courtney McLaren from WRI-Hague.

ENABLING POLICY ENVIRONMENT: The contributors for this section are Anjali Ramakrishnan from the EfD Global Hub, Gothenburg, Jan Steckel and Farah Mohammadzadeh Valencia from Mercator Research Institute for Global Commons and Climate Change, Berlin, and Thomas Sterner from the University of Gothenburg.

MOBILIZING NEW CLIMATE INVESTMENT: The contributors for this section are Jonathan Phillips, Victoria Plutshack, Ipsita Das, Jackson Ewing and Abhay Rao, all at the Energy Access Project, Duke University, Durham, North Carolina, USA.

HUMAN AND INSTITUTIONAL CAPACITY: The section contributors are Edwin Muchapondwa from the University of Cape Town and Michael Boulle, Leigh Cobban, Kent Buchanan, and Anthony Dane from Change Pathways.

THE GENDER HELPDESK provided valuable support and comments to all consortium researchers related to gender issues. The helpdesk consisted of Maria Del Pilar Lopez Uribe and Johana Castañeda from Universidad de Los Andes, Victoria Plutshack and P.P. Krishnapriya from Duke University, Durham, and Sejal Patel and Tracy Kajumba from IIED.

The project consortium has benefited from the active participation by colleagues at the International Institute of Environment and Development (IIED) and the World Resources Institute (WRI). Valuable comments and edits have been made by the following experts from WRI: Haileselassie Medhin, Courtney McLaren, Celina Salcedo-La Viña, Giuseppe Tesoriere, Anjali Mahendra, Laura Malaguzzi Valeri and Kathleen Kelly. Similarly, we are grateful for the many contributions by Paul Steele, Sejal Patel, Tracy Kajumba and Kevin Johnstone from IIED.

Valuable editorial services were provided by Cyndi Spindell Berck, Gloria Helfand, and Tony Leiman as well as copy editing by Judith Lipsett, Sara Arditti, and Lisa Lieberman.

Executive Summary

THE OBJECTIVE OF this report is to develop an actionable high-level research agenda (HLRA) that supports a low-carbon transitions (LCT) and also promotes gender equity. In this Decade of Action, universities and research and policy institutions can contribute to efficient solutions that combine a transition to net-zero emission of greenhouse gases with economic growth without resulting in increased inequity and marginalization of vulnerable groups. This agenda shows how.

Climate change has a disproportional impact on women, for reasons related to their heavy reliance on agriculture and forestry-based livelihoods, their greater vulnerability to climate-related disasters, and their unequal access to economic and political resources. At the same time, the active involvement of women in sectors affected by climate change means that they are in a position to change their activities in using such resources. It is essential to develop strategies to empower women to contribute their knowledge and efforts to the LCT. Research can contribute evidence, data, comparative analysis, and evaluations of the impacts of policies on women and other marginalized groups, with the goals of reducing their vulnerability and increasing their role as active agents of change.

A key research topic is to assess a just and efficient role for the Global South in addressing a climate crisis that is primarily the result of activities in the much wealthier North. Low-income countries are also contributing emissions that are harming their economies and people, and this will increase as their incomes rise. However, there are huge opportunities for developing countries to embark on the LCT. These include the economic opportunities that come with switching to a cleaner economy, such as additional employment, exports and growth. Combined with this are the co-benefits of energy access and energy security, cost savings, health benefits, and environmental benefits for natural resources. Finally, there is the more structural opportunity presented by climate change as a major driver of political, economic and social reform to bring about changes such as gender equity and, reduced corruption. This report will identify the research that is needed to determine which LCT strategies can address these multiple needs of developing countries.

The recent geopolitical events of the COVID –19 pandemic and Ukraine war have created new political priorities, but also potential new research avenues and implications for earlier research trajectories. As fossil prices have shot up, fossil fuel exporters have greater incentives to avoid a LCT, whilst fossil fuel importers have faced greater incentives to go low- carbon. A carbon tax may become less politically palatable with such high fuel prices and general inflation concerns. The rise in debt due to the resulting economic crises has led to even more concern around loans for climate mitigation and a growing interest in debt for climate and nature swaps.

There are large knowledge gaps to realize inclusive LCTs in the Global South. These gaps limit the design of sensible policies and investments based on hard field evidence. Unfortunately, there is a persistent "know-do gap" – that is, a massive gap between what has been evaluated by scholars, on the one hand, and all the programs, projects, and policies actually implemented, on the other hand.

Overcoming these knowledge-policy traps requires investing in a critical mass of scholars in policy research institutions in the Global South who can produce new policy-relevant evidence. This calls for investments in shifting the locus of research toward Global South institutions.

The choice of implementation modalities will be important for successful implementation of the HLRA. Given the multiple challenges of ensuring the necessary and relevant research to guide a rapid and inclusive LCT in the Global South, the modalities for implementing this HLRA become very important.

There is a need to invest in relevant data and data repositories. As economies in the Global South also adapt toward net-zero greenhouse gas emissions, researchers will need to analyze this process in real-time impact assessments, to make the transition as efficient as possible. The limitations in data availability present a clear challenge for research on LCTs in the Global South. This holds for most analyses but is particularly challenging when it comes to gender analysis. In the gender section, it is noted that future LCT research must make efforts to collect data that does

not sit within the gender binary and to include the study of gender-diverse persons. It is conceivable that special data collection efforts or repositories may need to be considered.

Research methodologies need to be conducive to analysis of inclusion. This could imply the need for multi-disciplinarity, as well as harmonization of qualitative and quantitative methods. The methodologies will need to be chosen carefully in order to guide interventions and discern distributional effects. To increase the targeting and quality of future research calls, methodological considerations should be spelled out in the call and considered in the selection.

Traditional capacity building needs to be combined with innovative approaches targeted to a wider audience, given the need for a global transition that encompasses all professions and sectors. Future research should take a holistic and multidisciplinary approach because of the strong linkages among themes such as policy development and implementation, gender, and human and institutional capacity.

Finally, future research agendas should be developed in an inclusive way, with active participation of local institutions and target groups. As was the case for this HLRA, future knowledge gaps need to be validated and prioritized based on local conditions.

This report builds on three regional policy reviews for Africa, Asia, and Latin America. Seven specific reports have been written that address research needs and knowledge gaps in order to create a gender-responsive low-carbon transition that is at the edge of the frontier of knowledge. These are (i) gender analysis and women's economic empowerment, (ii) transformation of the three key sectors of energy, infrastructure, and land use, and (iii) conditioning factors such as enabling policy environments, mobilization of new climate investments, and human capital, and institutions. The following are summaries of the research priorities of these seven themes:

Mainstreaming gender into LCT. Shifts in technologies and policies impact genders in different ways. Gender is a cross-cutting theme across all sectors – policy, finance, energy, infrastructure, and land use. Important research gaps exist in available literature linking gender and LCTs. There is no clear methodological approach that integrates gender issues and priorities and the empowerment of women in the analysis of risks and vulnerabilities of climate change, or in the framework of financing to face climate change. An analytical risk assessment framework is needed to focus on women's exposure to risks from climate change and severe weather events. This can help ensure that climate finance responds appropriately to gender-differentiated risks and vulnerabilities (UNDP, 2011). There is limited knowledge about the relationship between a LCT and gender, the gendered impacts of a LCT, how gendered decision-making impacts LCT policy, and the role of finance in supporting a LCT alongside gender equality. The mainstream gender and climate change debate and literature has almost exclusively focused on women's vulnerability and fails to account for women as agents of change. Few studies look at the diverse and nuanced ways in which boys and men also impact and are impacted by climate change, including as heads of large corporations, as energy consumers, as victims of environmental degradation, and as agents of change alongside women and girls. There is little recognition that men's diversity – according to social class, ethnic group, sexuality, and other intersecting factors – also affects not only the way that they live, but the way that they drive or respond to climate change. Some of the studies reviewed explored identity elements, such as whether trends held across ages, income, and region. However, few studies explicitly explore the intersection between gender and other elements of identity such as race, ethnicity, indigeneity, gender identity (outside the binary), sexual orientation, and caste or class. Further work is needed to unpack the different ways in which genders will be affected by climate change's impacts on weather, migration, key economic sectors, and access to resources, among other factors. Little research covers the gendered impacts of low-carbon practices in specific climate-vulnerable sectors such as the textile industry, agriculture, or transportation. Understanding these impacts will help policymakers understand the trade-offs and synergies between LCT policies and gender equality. Employment in key sectors – from the care economy to textile manufacturing – will also be shifted in the pursuit of a low-carbon economy, and this will have gendered repercussions. There is a need for greater analysis and modelling on the expected impacts of a low-carbon transition on employment by sector, and what that will mean in terms of gendered jobs. Despite the expectation in many sectors that women are more likely to support LCT transitions, women are generally underrepresented in decision-making roles. As a result, there is more research needed on the contexts and conditions in which women in

decision-making roles improve environmental outcomes or enact LCT-friendly policy.

Sustainable energy transitions. Energy is at the core of the low-carbon transition. This presents both opportunities and risks. Moving away from traditional energy sources could exacerbate the existing deep inequalities in access, reliability, and affordability of energy in many developing countries. This is of particular concern to rural women, who are responsible for household energy. But the clean energy transition can also provide new opportunities for gender equity, employment, health, and energy security.

There is an urgent need for research on ways to overcome the challenges to an inclusive and sustainable energy transition in low- and lower-middle-income countries. These challenges vary widely, depending in part on the development level of countries. For instance, some nations in the South have achieved extensive rural electrification and are developing emissions trading markets. For others, the challenge is to avoid being locked into high-carbon infrastructure while extending modern energy services to rural areas.

Little is known, for example, regarding issues of governance and cost-recovery of electric utilities, and their role in energy transitions in developing countries. Missing markets and/or regulatory policy uncertainty limit investment in modern renewables and decentralized solutions, and public investment becomes uneconomic when end-use energy prices are distorted by subsidies. There is therefore a need for research on leveraging innovative sources of inclusive finance, and the potential role of public financing models that can support the private sector.

Access to modern energy services does not always improve environmental and development outcomes. Too little is known about the specific mechanisms that explain divergent outcomes. For example, existing research documents how rural poor women are harmed by dependence on traditional fuels; they spend hours and face personal safety risks collecting wood and other biomass, and their health is harmed by breathing in particulate matter when cooking. Other research has offered improved stoves to households and documented obstacles to their use, including supply chains, information, affordability, and gender inequality in household decision-making. However, this body of research has failed to show how to uniformly overcome those obstacles at scale. Research is needed on how to make clean stove interventions effective for the environment and for women and men (as men often are involved in the decisions on what technology to use).

> “
>
> **Digital infrastructure can support a green economy agenda in multiple way**

Overall, research should be centered on identifying and scaling effective public, private, and non-governmental sector actions that advance the sustainability of energy use while also addressing intersecting inequalities in gender, ethnicity, and other vulnerable populations. An intersectional agenda should consider both an inter-country approach (prioritizing the tackling of common challenges) and an intra-country approach (prioritizing particular country concerns). This distinction could help disentangle cultural and institutional issues impeding/favoring LCTs and economic empowerment of disenfranchised populations.

Infrastructure for adaptation and sustainability. Most countries in the Global South face a deficit of soft (digital) and hard (transportation) infrastructure. Digital infrastructure can support a green economy agenda in multiple ways – for example, reducing energy demands by improving the efficiency of production, distribution and consumption of goods and services. It can also have unintended consequences such as rebound effects, in which more energy is used when it becomes cheaper. Nonetheless, studies that estimate the overall effect of digital technologies on energy consumption and production in the Global South are few and have often used insufficient data and limited empirical approaches. Furthermore, even though access to both digital technology and energy resources differ significantly across women and men, youth and elderly, and urban and rural dwellers, research that examines the intersection of gender with vulnerable populations within the digitalization-energy nexus is very scarce.

Equally important to understand is the limited use of low-carbon transportation modes (e.g., public transport system

and electric vehicles), particularly in Africa. This can be explained partly by a lack of infrastructure and partly by consumers' choices. There are also political economy reasons, such as low levels of political concern by dominant elites. Thus, as with energy, there is a need for more political economy analysis of energy demand and supply. Given the financing gaps that many countries in the Global South face, public-private partnerships (PPP) emerge as a potentially relevant financing option. Despite this, there is a lack of studies that evaluate either the challenges or the effectiveness of PPPs as a financing option to provide low-carbon transport infrastructure in the Global South.

At the same time, behavioral attitudes towards various transport modes in the region are not well understood. More research is needed to understand which groups in society are more likely to adopt low-carbon transport modes and what are the barriers that low adopters face, including the effects of gender discrimination and gender violence on the use of mass transportation. Improving accessibility to public transportation tends to benefit the urban poor the most, since it is the group that typically spends more time and resources commuting. The effects that a transition to low-carbon transport infrastructure can have on employment and time use in the Global South are not fully understood. The automobile and transport sectors are male-dominated and a transition to electric vehicles and mass transportation could have mixed effects on employment levels. Additionally, women's experiences in mobility related to their family caretaking responsibilities is an important research direction which is lacking in the Global South.

Forestry and land use. Forest and land use can be cost-effective ways to address both climate mitigation and adaptation challenges. Existing research has emphasized that the costs and benefits and risks – as well as the different impacts on different populations – vary greatly depending on specific policies and local conditions. Research with a focus on women, indigenous people, or youth is limited; research with an intersectional approach is almost non-existent. Scaling up afforestation and reforestation is necessary to achieve the level of carbon reductions compatible with international objectives. Substantial scaling-up will require serious political commitment and engagement by the public and private sectors. Research on public and private investments and financing in afforestation is needed to understand the conditions required to unlock the great potential of forestry and land use change as a tool in low-carbon transitions. However, promoting afforestation is not without risks for rural communities, and in particular marginalized populations, who depend on these lands. Research on how forest restoration can be balanced with food production, income generation, and development needs is necessary to avoid unintended negative consequences such as "green land grabs". Finally, there is a need for research on the interrelationship between forest and other land-based responses to climate, such as using marginal agricultural land for forest restoration, and rural-to-urban migration.

Enabling policy environments. Policies, including price and market incentives, are amongst the strongest tools available to drive the low-carbon transition. Enabling policy environments in developing countries will be essential to identify entry points for an effective policy portfolio and impacts. So far, there is limited evidence of policy impacts in the Global South, due to only a small number of countries implementing climate policies such as emission pricing mechanisms. There is also limited availability of public data on various policies and their specific details, particularly for some West African countries, parts of East Asia, and many countries in Latin America. The absence of enabling policy environments in the Global South is symptomatic of three key things on the supply side and challenges on the demand side. On the supply side, there is, first, a lack of detailed research on what needs to be done for LCT – when, where and how – a gap which could be addressed by more applied and detailed analysis. Second, there is a lack of capacity in the Global South for (a) doing relevant research and (b) using the evidence from that research to guide policies – a gap which could be addressed by appropriate capacity development programs. Third, there is a gap in effective institutions and institutional frameworks to manage the whole LCT value chain. On the demand side, there is the wider challenge of the lack of actors willing to respond to evidence-based research.

Research to accelerate the application of policy instruments should focus on political economy, including gender-disaggregated analysis. There is a need for research on the link between public support and political acceptance of climate policies in the Global South, achieved through assessment of different interest groups and what matters for policymakers. There is very limited evidence on the political economy of energy transitions in general, and climate policies in particular. Such gaps include how carbon pricing would work given the political realities of the Global South, such as high levels of the informal sector, a low tax rate,

high shares of informal fuel use, and vested interests. While policy impacts have been assessed from economic, social, and environmental perspectives, important gender dimensions – such as equality and empowerment – have been engulfed within socio-demographic characteristics and thus not received independent assessment. For example, there has been insufficient analysis of gender across sectors such as industrial, renewable energy and transport, and urban demographics, including differential impacts of climate policies on men and women.

Mobilizing new climate investment models. Low- and lower-middle income countries have received far too little climate financing to address the impacts of climate change and to make the necessary investments in a LCT. Increasing climate investment will require a massive mobilization of national and international private capital, the alignment of Nationally Determined Contributions (NDCs) with the realities of climate investment instruments and institutions, and connections among government spending, development finance, export credit, and philanthropic resources. Research is needed to design, implement, and evaluate such instruments, with attention to scaling up low-carbon technologies and business models and enabling Global South-led innovation. Climate finance should be aligned with the specific climate mitigation and adaptation needs of different regions, countries, and localities. Researchers have an important role to play in diagnosing the effectiveness of different approaches to overcome investment barriers, identifying key variables across geographies that determine outcomes, and helping policy-makers and investors develop effective financing strategies. Investment should be designed with a gender lens – such as targeting women-led businesses and ensuring that investees embed gender equality in their own practices – but to date there has been limited rigorous research on how to ensure that these approaches are effective.

There is also a lack of evidence on what a just transition could look like for developing countries at a local level. The impact of business models on household-, firm-, and community-level resilience is still not well understood, especially in key sectors like agriculture. This makes it challenging to align public-private investment around private-sector led approaches. Ultimately, climate finance follows well-articulated bankable climate projects within a supportive enabling policy context. As these need to be specific for countries or regions, there need to be human capacity and requisite institutions for developing and implementing bankable projects and attracting climate financing. Here again, suitable capacity development programs and institutional setups are needed to carry out such research, put the findings into practice, and evaluate the impacts in terms of both effectiveness and equity.

Human and institutional capacity. Global challenges demand not only global responses but also local capacity and action. Achieving low-carbon transitions demands new capacity (knowledge regarding the challenges and the skills to design appropriate measures to deal with them) targeted at policymakers, regulators, and practitioners of today and tomorrow. Most importantly, a new generation of climate and development experts must be trained in every country. Examples of world developments requiring new institutions include the need for updating NDCs in 2023 and submitting new NDCs in 2025. The slow pace of achievement of the Sustainable Development Goals in some parts of the world presents another motivation for rethinking institutions. Extensive appraisals on inclusive low-carbon transitions in the Global South confirm capacity and institutional gaps. Career paths are currently shifting because of the emerging needs presented by the unfolding transition, and this shift in career paths is indicative of capacity demands and the future job market. The job market in the science-policy-practice interface is also facing rapid change as a result of multiple drivers. NDC cycles provide windows of opportunity for building capacity and driving change.

A key cross-cutting capacity need is intersectional capacity development. Researchers and governments need to work with women, youth, local and indigenous communities to draw on the knowledge and abilities of those who will be impacted by policy. A critical mass of skilled individuals equipped to communicate and effectively support policymakers, finance experts, and other partner organizations working within and across sectoral thematic areas and contexts is lacking. Examples of specialists that are needed are climate scientists, finance specialists, economists, political economists, and gender and urban specialists. Generalists with transdisciplinary skillsets are also key to working with the diversity of knowledge areas to contribute to the low-carbon transition. Scientific, technical, academic, and business capacity are all needed to promote inclusive and equitable low-carbon transitions. Institutional capacity requires trained professionals and enabling environments to mobilize innovation and coordination for a green transition. To further improve capacity at this level, policy should be incorporated in all academic training.

1. Introduction

ACCORDING TO THE United Nations Intergovernmental Panel on Climate Change IPPC (2020), the decade of action is upon us, and all forces need to be deployed to accomplish the commitments in the Paris Agreement to limit global warming to 1.5 °C. IPCC (2018) states that humans have already caused approximately 1 °C of global warming above pre-industrial levels. At the COP 20 in Paris in 2015, the world community decided to limit the impact of climate change to below 1.5 °C by committing to a rapid decarbonization of world economies. This commitment would limit the worst potential damages from climate change that are otherwise expected across the globe, especially amongst the most vulnerable groups in developing nations.

Climate change has a more significant impact on women, which increases observable gender inequalities. First, women depend more on natural resources that are vulnerable to climate change and at the same time have less access to natural resources such as land. Second, agriculture is the main employment sector for women in low-income countries; in addition, in rural areas in these countries, women carry the primary responsibility for getting food, water and fuel. This means that, during droughts or floods, women have to work more for their livelihoods. Third, due to disparities in information, mobility and access to resources, women are less likely to survive natural disasters and more likely to be injured. Fourth, the indirect impacts of climate change are also more substantial for women. They are more vulnerable to social, political and economic tensions in fragile states after intense climate shocks, and their health is also more endangered by climate change, especially the increasing risks related to maternal and child health.

While the historical responsibility for greenhouse gas emissions rests unequivocally on the industrialized world, today's developing and emerging countries also need to transform their economies in a way that conforms to the 1.5 °C goal. Never in human history has there been such a need for a rapid and elaborate set of transformations of societies, especially in poorer countries that need to combine rapid economic growth with new carbon-neutral technologies and behaviors. This is not just a challenge but also an opportunity. With adequate research and financing, countries in the Global South can use their late-comer advantage and aim for transformative leapfrogging to build green, resilient and inclusive economies that advance gender and social equity (Mebratu, 2020). There is now solid evidence that such inclusive and low-carbon development pathways are preferable and feasible, provided that the right policies, institutional capacity and finance are in place. Low-carbon transitions (LCTs) can unlock significant investment potential for developing countries.[1] The experience of a low-income country like Ethiopia in the past decade, with its Climate Resilient Green Economy strategy, demonstrates that this is indeed promising, but requires strong policy commitment, investment in the innovative potential of youth and women, active learning by doing, and access to finance. This is an inherently knowledge-intensive process where academia needs to step up its roles in terms of identifying solutions, reducing the costs of trials and errors through real-time impact evaluations, and ensuring that the necessary capacity is available among all sectors.

The need to accelerate inclusive and low-carbon transformation is also coming at a time when developing regions, and especially Africa, are seeking strategies to recover from the economic devastation created by the COVID-19 pandemic and the implications of the Ukraine war. Reducing poverty, creating jobs, and tackling exposure to price swings for food and energy are top priorities for policy-makers. There is also growing frustration that developing countries face continued hurdles in accessing finance for economic recovery, as well as the fact that

1 A recent study by the International Finance Center (IFC) estimates that there is a US$ 23 trillion potential for climate-smart investment in emerging markets until 2030. Investment in clean energy in just four countries in Africa alone (Côte d'Ivoire, Kenya, Nigeria, and South Africa) can open a total investment potential of nearly US$783 billion, which is spread across renewable energy generation (US$123 billion) and buildings and transportation (US$652 billion).

developed countries have not delivered on their climate finance commitments.

To effectively achieve the daunting task of green transformation given these multi-faceted challenges, there is a need to intensify efforts on developing:

1. the evidence base for actionable, context-specific inclusive and low-carbon development pathways, which can guide national policy and budgeting;
2. policy instruments, systems and incentives that ensure that all actors contribute to building an inclusive green economy;
3. revamped efforts to widen the access to finance for strategic investments in key sectors, including climate smart agriculture, renewable energy, and resilient infrastructure;
4. targeted efforts to support innovation and entrepreneurship of youth and women in the green economy and nature-based solutions; and
5. the development of human capital in institutions tailored to implement inclusive and low-carbon transformations with gender and social equity at the center.

These efforts to advance inclusive, resilient and low carbon transformation call for active partnerships among governments, the private sector, multilateral banks, development partners, civil society and knowledge institutions. Active investment in research and continued learning will be central for success. This high-level research agenda is informed by a series of more specific analyses of knowledge gaps and research needed to (i) create enabling policy environments and transform key sectors such as (ii) energy, (iii) infrastructure and (iv) forestry, as well as cross-cutting themes such as (v) gender equality and women's economic empowerment and (vi) human capital and institutions. All of these need to be supported by (vii) a mobilization of new climate investments.

1.1 Objectives of the high-level research agenda

This HLRA sets out to support the countries in the Global South by suggesting an actionable research agenda that supports an inclusive and resilient low-carbon transition, with explicit focus on ensuring gender and social equity. The general objective will be approached by the following specific objectives:

a. To identify research needs for a gender-responsive and inclusive low-carbon transition based on expressed demand in national policies (including Nationally Determined Contributions, or NDCs) in support of evidence-based policy implementation;
b. To review policy instruments to identify the potential for research on these to support an enabling environment for inclusive low-carbon transition;
c. To deepen the research needs analysis by considering the key sectoral (e.g., energy, infrastructural, land-use, financial, etc.) conditions for a low-carbon transition;
d. To identify ways to mobilize new climate investment models and better align climate finance with national policies through research;
e. To conduct a needs assessment for capacity development on gender-responsive and inclusive green transitions for sustainable development and to propose strategies tailored for current and future policy actors; and
f. To engage policymakers and stakeholders at national and regional levels to validate the identified knowledge and capacity gaps and finalize research agendas.

1.2 Motivation

It is indisputable that climate change due to greenhouse gas emissions poses a grave threat to human welfare. Rising temperatures increase the threats of severe heatwaves, sea level rise, forest fires, vector-borne diseases, floods, and droughts. In general, developing regions are highly vulnerable to climate change. This vulnerability is amplified by inequality, poverty, population growth and density, land use change (e.g., deforestation and associated biodiversity loss), soil degradation, and economic dependence (national and local) on natural resource commodities.

Since the historical burden for emissions rests solidly on the industrial world, financial compensation and technological support for Global South LCTs are integral parts of the UNFCCC negotiations. However, as Figure 1.1 shows, poor countries are also emitters, and their emissions are growing along with their development. Given how devastating the implications of climate change can be for the Global South, there are strong reasons why poor countries should also consider a low-carbon transition.

In Figure 1.2, we see five scenarios of future CO_2

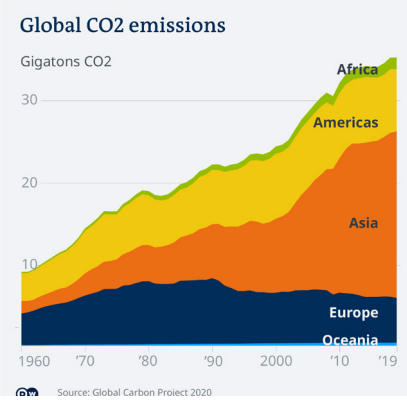
emissions and their implications in terms of mean temperature increase. The lowest scenario is the one that is most consistent with the Paris Agreement. It presupposes a rapid reduction in CO_2emissions now and net-zero around 2050. Thus, the fundamental motivation for this HLRA is the combination of Figures 1.1 and 1.2 – the only development trajectory for the Global South that is consistent with global warming below 2 °C is along the lower blue line in Figure 1.2. This implies a rapid LCT for the Global South. But decarbonizing policies vary greatly in potential impacts on particular countries and vulnerable groups, such as poor rural women. Empowered local research capacity is expected to be instrumental in guiding this LCT to achieve
efficiency in implementation combined with attention to the intersecting gender and poverty impacts.

> **Poor countries are also emitters, and their emissions are growing along with their development**

1.2.1 Who needs to act?

China, the USA, the EU, and India are the world's largest emitters, contributing about 60% of global emissions. However, they cannot address climate change on their own – all countries must participate. As highlighted earlier, Global South countries are both greatly affected by climate change and are emitting an increasing proportion of greenhouse gases. Two of the largest emitters are in the Global South; this provides researchers with opportunities to evaluate LCT policies. While lessons learned in China and India may be useful to less-developed countries in the South, country-by-country research is also essential, because local conditions vary greatly.

Figure 1.1 Global CO_2 emissions and b. CO_2 emissions from Africa



▲ *Global CO_2 emissions*
CO_2 emissions from Africa ▶

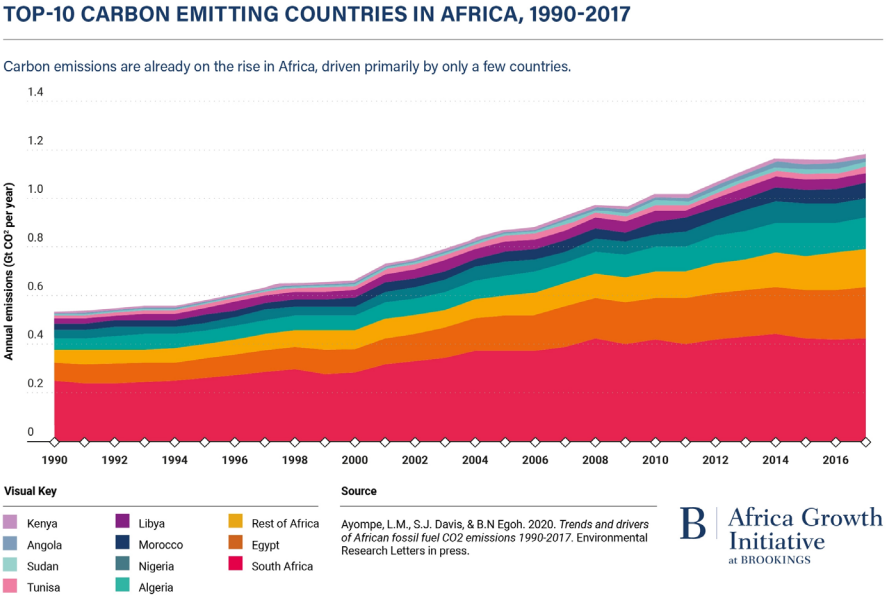
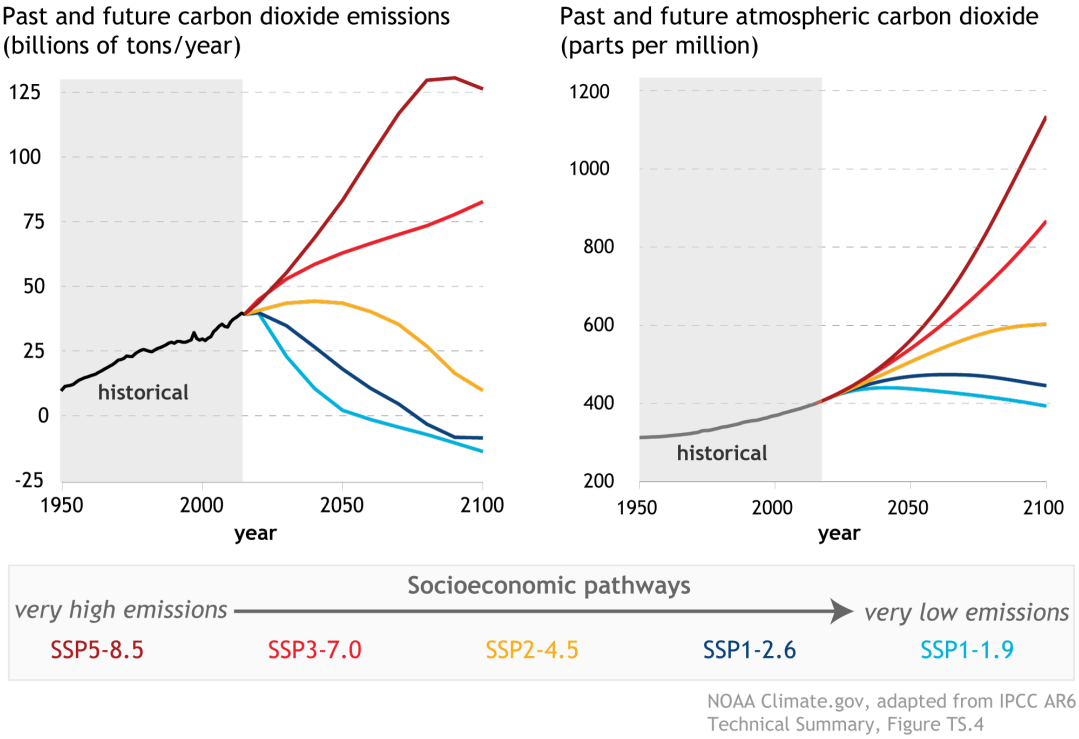


Figure 1.2 Climate change scenarios from IPCC



NOAA Climate.gov, adapted from IPCC AR6 Technical Summary, Figure TS.4

The world has growing opportunities for ambitious action. China has committed to be carbon neutral before 2060. The EU has reaffirmed and strengthened its commitment to be carbon neutral by 2050 (European Commission, 2020). The current USA administration has committed to battling climate change domestically through its Inflation Reduction Act of 2022 and to building international collaboration on this and other issues. The new climate goals articulated in the NDC recently submitted by the USA are more ambitious than expected, aiming for carbon neutrality by 2050 (UNFCCC, 2021). These large economies are committing to massive development of renewable technologies and have committed to collaborating to meet the Paris goals (IEA, 2020).

Even with this progress, climate change is a global threat that needs a global response. This HLRA sets out to support the actions of countries in the Global South so that they can also be part of an inclusive and gender-equitable low-carbon transition.

1.2.2 What action is required?

The necessary LCT implies the most profound and purposeful transformation of the global economy that has ever been attempted. The transition goes beyond phasing out fossil fuel use in the energy sector and replacing it with renewables. Without careful design of strategies, policies, and business models to facilitate a LCT, climate policy could inadvertently lock in existing inequalities, damaging economic well-being for generations, especially for the poorest and most vulnerable populations.

Even so, a major part of the solution will need to be the rapid scaling of renewable energy sources, entailing modifications in energy storage, batteries, transmission, tariff design and business models. Such changes must be deeply integrated into a fair and equitable development strategy in a context where many people still lack access to electricity (IEA, 2022).

What is required is an array of instruments – a "Whole of Government" approach that includes how to formulate

goals for national and regional economies, educational programs, electricity tariffs, financing, integration of energy prices and taxes, and monitoring of revenues and expenditures. Government policies need to be coordinated and coherent so that energy sector plans are consistent with those in the finance, transport, residential, and industrial sectors, and are synchronized with national ambitions and commitments, e.g., as expressed in countries' NDCs. Policies for accounting and (green) taxation need to be harmonized with credit policies, banking regulations, export credits, and green loans. Additionally, climate change policy must be consistent with other political goals such as democracy, gender equality, and inclusion of the poor, as well as with international agreements, private sector initiatives and popular engagement. This way it can translate to a "Whole of Society" approach that includes all relevant sectors and stakeholders.

During this Decade of Action, there is not enough time to rely on trial and error. All policies, interventions, and investments must be state-of-the-art and will need real-time monitoring and evaluation for efficient and equitable implementation and improvement. Since the necessary transitions are extremely knowledge intensive, academia needs to be mobilized. As yet, far too little of the global climate research has permeated to research institutions in the Global South. Overland et al. (2022) find that at most 3.8% of global funding for climate-change research is spent on African topics; out of these, African institutions only received 14.5%. This report aims to map the most crucial knowledge gaps and propose a research agenda that supports transitions to sustainable and inclusive economies to be implemented by researchers in these countries.

1.3 Regional perspectives[2]

1.3.1 Strategies for the Low-Carbon Transition

ased on an analysis of NDCs from 22 countries, mitigation ambitions seem to be increasing in comparison with the pledges made in the Paris Agreement.[3] Most NDCs cover multiple sectors and consider gender inequality as well as the inclusion of youth and indigenous people.

The lowest-income countries are reliant on international funding, whether it is from multilateral climate funds, bilateral development assistance, or regional funds. Domestic sources of funding (such as green banks, green bonds and other forms of climate investment at the local level) are limited but growing.

The gap between available funding and needed funding is a major roadblock for LCT implementation. More than a decade after the 2009 pledge to mobilize US$100 billion annually from high-income countries to support mitigation and adaptation in low-income countries, this goal is still not being met. In India alone, funding needs for mitigation and adaptation are estimated at US$2.6 trillion. A deeper discussion on climate finance can be found in section 8, Mobilizing New Climate Investment Models.

Many of the lowest-income countries have gaps in their NDCs and have not submitted Long-term Strategies or Net-Zero Targets. NDCs from many of these countries have weak GHG reduction targets (often set with respect to Business as Usual (BAU) projections and conditional on funding from high-income countries), lack specific sectoral targets, and have gaps in their sections about adaptation. Despite this, among the low-carbon strategies reviewed, those from Vietnam, Armenia, Uzbekistan, Ethiopia, Kenya, and Nigeria seem to be the most developed. In addition, there are indications that Ethiopia, Kenya, Nigeria, and Nepal are working to execute actions that are close to being compatible with the 1.5°C goal of the Paris Agreement (Climate Action Tracker, 2022)

While the increased ambition in the NDCs is a positive sign, the existence of comprehensive NDCs and other strategic documents does not always translate into effective climate action. For example, actions from Chile (insufficient), Colombia and China (both highly insufficient) do not match the comprehensiveness and ambition of their strategic documents (Climate Action Tracker, 2022). Besides inadequate funding, common roadblocks for a successful LCT across regions include constraints in terms of human capital and technology, public awareness and support, and political will from governments. Moreover, the

2 Further detail on regional perspectives can be found in the Regional Policy Reviews for Africa, Asia and Latin America.
3 This is based on eight countries in Africa, nine in Asia, and five in Latin America.

thoroughness of the plans and strategies for the LCT varies greatly among countries. For example, there is a low level of ambition from top emitters such as India, Indonesia and Brazil.

1.3.2 Policy Instruments for the Low-Carbon Transition

Policy instruments can be classified as "command-and-control" (for example, emission standards) or market-based (such as carbon pricing). Two types of carbon pricing are emissions trading systems (ETS, in which emitters buy and sell emissions permits) and carbon taxes. Carbon pricing is a cost-effective tool to encourage producers to reduce emissions. However, implementation is still limited in the Global South. Across the regions, carbon pricing tends to be found more often in middle- and upper-middle-income economies, possibly due to the institutional complexities of adopting carbon pricing systems. Even though it is a mechanism being considered in several NDCs and policy documents (e.g., in India, Senegal and Egypt), only China and Mexico have emission trading schemes currently in place. Meanwhile, carbon taxes have been adopted in South Africa, Indonesia, and four countries in Latin America (Argentina, Colombia, Chile and Mexico), and are being considered in several countries in South-East Asia (Vietnam, the Philippines and Thailand).

Policy instruments that affect fuel prices, while not labelled as carbon taxes, also have an important impact on carbon emissions. Fuel taxes can take many forms (for instance, excise taxes, tariffs, or taxes on different economic sectors) and are common across all three regions.

A fuel subsidy is the opposite of a fuel tax. Fuel subsidies have been common in the Global South, but there is a downward trend. With a few exceptions, such as South Africa, Venezuela, and Trinidad and Tobago, the fuel subsidization rate is low in Africa and Latin America. According to a recent IMF study, energy subsidies represented, on average, 4.7% of GDP in Latin America and the Caribbean in 2022 (Parry, Black and Vernon 2022).

Increased use of fuel taxes and subsidy removals could have a massive impact on emissions reductions. However, the implementation of these policies is challenging. Even when there is political will from policy-makers (which is not often the case), they often face strong opposition from fossil fuel companies and other stakeholders. In addition, there is a need for research on how taxes or subsidy removals affect poor populations, and on how to increase public acceptance of these policies. In particular, research is needed on revenue recycling, in which fuel taxes are increased (or subsidies are removed) and the revenues are returned to the public or used for green investment. Further discussion is found in section 2, Enabling Policy Environment[4].

There is a strong interest in policies fostering renewable energy across the three regions. In Africa, these policies are found at regional, national, local and even community levels. In Latin America, clean energy auctions are a common mechanism to incentivize renewable energy. The first auctions in the region took place in 2006 in Brazil and Uruguay, and have since been replicated by several countries.

In addition, command-and-control regulatory policy instruments, such as environmental and emissions standards, are frequently used across the three regions to reduce carbon emissions in the energy, transportation and agriculture sectors.

The effects of LCT policies on energy access need to be carefully considered. With 2.6 billion people lacking access to clean cooking technology and 800 million without access to electricity worldwide (IEA et al. 2021), the attainment of universal energy access is a major challenge parallel to the LCT, and one of the largest equity concerns of decarbonization policies. The outlook is different in each region. Around 60% of the people without access to clean cooking devices are in Asia; 75% of the people without access to electricity are in Africa (about half of them in the Democratic Republic of Congo, Ethiopia, Nigeria and Tanzania). Even though the figures in Latin America are much lower, the region still has significant urban-rural gaps.

Lack of energy access can have gender-differentiated effects. In the absence of access to modern energy, there is

4 The Regional Policy Reviews contain an analysis of fuel subsidy reforms in China, India and Indonesia as well as an analysis of the Indian Coal Cess.

a wealth of evidence of women's greater exposure to indoor air pollution, a larger share of time spent in fuel collection, and impacts on education and economic opportunities for women and girls. However, a coal phase-out could have a negative and disproportionate impact on men's employment, which in turn could disturb intra-household dynamics. Policies to foster women's capacity development and to address gender norms would be needed to have a more egalitarian green jobs sector. In Latin America, for example, less than 10% of leadership roles and 17% of senior management positions in the renewable energy sector are held by women (Latin American Energy Organization, 2018). A deeper discussion on energy access, the low-carbon transition, and the gender nexus can be found in section 3, Sustainable Energy Transitions.

1.3.3 Knowledge gaps and recommendations for Africa, Asia and Latin America and the Caribbean

AFRICA

Limited experience and knowledge from carbon pricing and other LCT instruments. Besides the carbon tax in South Africa, there is very limited experience with carbon pricing policies in sub-Saharan Africa (SSA). However, alongside economic growth, there is a growing interest in such policies, and, therefore, a need for country-specific studies to better understand their effects and the institutional arrangements required to design, implement, and monitor such policy instruments within different country contexts. There is limited knowledge on how to develop such carbon taxes for countries currently implementing many different taxes and levies on petroleum products with revenue collection as the primary goal, which is the case for several SSA countries. There is a large informal sector, characterized by micro-entrepreneurs. Research is needed on how to design effective carbon taxes within the context of the informal sector, as well as how to make carbon pricing socially inclusive. As fossil fuels are used for both transport and cooking, there can be many different effects of a carbon tax; more knowledge is needed on the effects on different income groups and how this intersects with gender.

> **Less than 10% of leadership roles and 17% of senior management positions in the renewable energy sector are held by women**

U***sing revenues from carbon taxes and subsidy removals to manage the low-carbon transition.*** Fuel taxes generate significant fiscal resources in many African countries. In other countries, fuel subsidies constitute a large fiscal cost. Researchers can contribute modeling and evaluation tools to manage revenues and the political economy of tax and subsidy reforms. There are indications that public support of reforms increases when the public knows how the revenue is used, and such public support is critical to adoption of taxes or removal of subsidies. However, it is important to determine how such support differs between different revenue uses as well as the trade-offs between earmarking revenues (for green projects or distribution to the public) versus strengthening fiscal accounts (permitting more expenditures on public projects). One fruitful research area would be comparative studies between countries which have succeeded or failed in implementing carbon taxes or subsidy reforms. This could generate important insights on sequencing the steps in implementing a tax or subsidy removal; mechanisms to compensate those who are harmed by such policies (and the intersecting factors such as gender, ethnicity and youth that are related to the harm); and other factors that can generate social acceptance and political support for low-carbon transitions. The systematic review presented in section 2.4.2 of this agenda provides a framework for revenue recycling experiences in the Global North, which could provide some structure for the discussions in the Global South.

Mainstreaming gender and marginalized groups in climate policies. Though there are some gender dimensions

incorporated in the NDCs in some countries, most of the gender aspects tend to focus on adaptation issues and less on mitigation. Furthermore, gender aspects are more focused on male-female issues, with limited studies on other socially excluded groups, such as youth, children, and displaced people, especially in rural areas. More knowledge is needed on the implications of a low-carbon transition for these groups and the intersection with gender in SSA, not least since environment and natural resources are essential for the livelihoods and economic activities of most marginalized groups. Additionally, there is limited information on the implications of LCT on the future of work, especially for those jobs that once were predominantly fed by carbon-intensive industries, and whether the transition will be fair for women, youth and other marginalized groups. The large share of young people excluded from the job market in many African countries merits special attention when analyzing LCT transitions.

Lack of disaggregated data for analyzing gender inclusiveness and effects on marginalized groups. There is generally little disaggregated data available to perform good intersectional analysis. The availability of gender-responsive monitoring, evaluation and learning systems that provide sex-disaggregated data is crucial for tracking, monitoring and evaluating gender and climate expenditure, as well as determining the effectiveness of adaptation responses for the groups most vulnerable to the impacts of climate change.

Involving the large informal sector in the low-carbon transition. Policy documents as well as research on LCT in SSA generally do not pay sufficient attention to the role of the informal economy. Given the great importance of the informal sector to African economies, jobs and livelihoods, more knowledge is needed on the interplay between formal LCT policies and informal institutions and incentives.

Mobilization of domestic and international climate finance. Lessons from across Africa point to the following challenges in mobilizing domestic and international climate finance: (1) securing capital from funding sources, particularly in debt-distressed countries; (2) obtaining funding for the necessary technical assistance for designing and structuring the work of green banks and national climate funds, and (3) overcoming the uncoordinated approach to forming green banks (AfDB, 2021). Research on better ways to tackle these challenges is needed.

Tracking of climate finance and measuring its impact on the ground. Climate finance instruments and mechanisms for the region are structured at the international level (i.e., OECD, n.d.), and are not designed to track how finance reaches local actors, nor do they consider how effective implementation is supported in the UNFCC biennial climate finance assessment report; this makes it difficult to track the actual effects of climate finance in the region (UNFCC, 2019). As a knowledge gap, there is a need to explore the practicality of tracking climate finance to the local level if transformative adaption is to be attained, especially for women and other vulnerable groups, i.e., youth, children, disabled and displaced people.

Mobilizing private sector investments in the low-carbon transition. More attention should be paid to potential partnerships between the private sector and the public in funding large LCT transition projects related to transport infrastructure, renewable energy systems, climate-smart irrigation systems, and so on. Increased private sector participation faces several barriers in Africa.

First, there is limited knowledge on climate change, e.g., climate risk and vulnerability data, as well as on the actors and institutions in the climate finance landscape in SSA. This increases the risks for private sector investments in mitigation projects.

Second, because many mitigation projects are public goods, private actors might not fully capture the economic benefits of their investments.

Third, the inherently long-term horizons of many climate change projects dissuade private actors, as they would find it hard to make a business case for potentially high up-front costs against long payback times in an uncertain future. More knowledge is needed on how to deal with these challenges.

ASIA

Potential for peer learning on policy instruments for low-carbon transition. Insights on how to adapt effective measures in curbing emissions and fighting climate change to a developing country context are of great importance to Asia. The success of China in introducing carbon markets

shows substantial potential for market-based instruments, which has attracted interest from various countries such as Indonesia, Vietnam and India. These countries have been rather proactive in establishing emissions trading systems, but their progress varies widely. Research is needed to support the design and implementation of ETSs in these cases. Initiatives that support policy learning between Asian countries on the design and implementation of ETS and other carbon pricing instruments have a high potential importance.

Understanding the roles of public support for LCT policy-making. Dealing with low political will and opposition toward climate action or specific policy instruments requires raising public awareness and support, as well as having effective alternatives that can harmonize political incentives. Improved estimations of climate costs and damages, coupled with efficient dissemination to a public audience, will be helpful. With respect to the energy transition, a framework supporting inclusive planning and co-design processes with the participation of all relevant stakeholders is a promising tool to reduce political barriers coming from powerful actors.

Understanding the gender impacts of LCT policies. Research is needed to develop mechanisms to monitor and evaluate policy gender mainstreaming. The gender impacts of LCT-related policy instruments should be a key element of impact analysis when policy evaluations are being conducted, to ensure that the increasing considerations of gender equality in national climate visions are soon translated into reality.

Exploring sources of finance for climate actions and gender-inclusive design of funding mechanism. The large funding gap in Asia calls for new understanding on innovative funding, together with capacity building and technology transfer, particularly in promoting green loans and green bonds. For countries that have advantages in attracting Foreign Direct Investment (FDI), low-carbon FDI can be a source of finance that makes up for limited domestic finance. Careful assessments of financial needs are required to enhance funding effectiveness in these countries. Given the currently modest consideration of gender in climate funding, research is needed to promote gender targeting in climate finance. In addition, the risks associated with LCT need to be addressed to boost climate financing in developing Asia. As in the case of carbon pricing, new understanding is needed to promote green financing in the region, given the current limited capacity of banks and financial institutions, as well as the ambiguity and weak enforcement of corporate compliance.

Understanding roles of digital technologies in facilitating the low-carbon transition in various sectors. Many countries in Asia, including China, India and those in the ASEAN, are making large investments in a digital transformation of their economies and societies. The transition to a low-carbon economy can potentially gain immensely from this digital transformation and other technological advances, but research is needed on how to create synergies between these transformations. Research is also needed on unintended consequences, costs, and trade-offs, including the effects of digitalization on men and women in informal employment and what type of policies and investments are needed to make the transformations inclusive.

Improving data availability and ease of use. This review raises a need for data that serve the analysis of LCT in developing Asia. Analysis to improve current policies and establish new instruments will require systematic and accessible data on the ongoing implementation of instruments such as fuel taxes, subsidies (or their removal), and the allocation of the resulting revenues. On the gender aspect, data availability and limited gendered impact evaluations have been an important hurdle to drawing implications for inclusive policies. The gender binary confinement and limited analyses on the intersection between gender and other social identities, such as race, ethnicity, socioeconomic status, age, and disabilities, also constrain the inclusion of the most vulnerable and marginalized groups in low-carbon transition policies. With regard to climate finance, research to promote domestic climate financing would benefit from the establishment of publicly accessible climate finance databases.

LATIN AMERICA AND THE CARIBBEAN

Climate mitigation discourse and policies should be better aligned with country emission profiles. In Latin

America and the Caribbean (LAC), GHG emissions from land use, i.e., the Agriculture, Forestry, and Other Land Uses (AFOLU) sector, clearly exceed those from fossil fuels (Lamb 2021), but this is not reflected in current climate policy. Given the importance of land use as an emission source and the inherent difficulties of monitoring and enforcement, most mitigation efforts in the region should focus on the AFOLU sector. In practice, however, most climate mitigation policies implemented in the region typically follow a northern tendency of focusing on emissions from the transport, electricity, and industrial sectors. There are many differences in emissions profiles among the different countries in the region. While a focus on energy and transport makes sense in countries such as Chile and Mexico, where emissions from the energy and industrial sectors account for two-thirds of total emissions, it is less relevant for countries such as Brazil and Colombia, where more than half of emissions come from AFOLU.

Payments for Ecosystem Services and carbon offsets. Payments for ecosystem services (PES) are financing mechanisms in which beneficiaries, e.g., the international community, pay for conservation. Given their rich ecological capital, countries like Vietnam, China, India, Indonesia and the Philippines are operating and refining payment schemes for environmental services. PES schemes are also in fairly widespread use in Latin America and Africa. There is an urgent need for research to determine whether carbon offsets (a type of PES) can be an effective strategy to reduce Amazon deforestation. The Amazon is a key component of the Earth´s climate system (Steffen et al 2019) which is fast approaching a tipping point (Boulton et al 2022). According to the FAO, between 2015 and 2020, South America lost 3 million hectares of forest every year, the second-highest total for any of the world's regions (Blackman et al. 2020). There is a clear need to develop effective strategies at the national and subnational levels to reduce Amazon deforestation and to connect these strategies with international forest carbon offsets, whereby industrialized nations can meet some of their obligations to reduce emissions by paying for forest protection.

Mainstreaming gender and intersectionality in climate policies. Although there are several policies and plans addressing gender across the region, the relationship between LCT and gender is not very clear in these documents and national policies. Energy Transition Guidelines in LAC do not consider gender equality: 68% of public policy documents related to energy transition do not mention gender (Hub de Energía América Latina y el Caribe a, n.d.). It is key to consider the role of intersectionality (in particular, the intersection between gender and ethnicity/ indigenous communities) in mitigation of land-based emissions. In Latin America and the Caribbean, women are disproportionately affected by climate change's effects, because they have less secure land tenure (only 25% of landowners are women) and less access to economic subsidies and other incentives (Climate Diplomacy, 2020). Additionally, indigenous women who have fought to defend the environment in Latin America and the Caribbean have suffered from gender-based violence (Inter-American Development Bank (IDB), 2022). Women are also more vulnerable to adverse economic effects of natural disasters. More research and improved access to gender disaggregated data is needed to mainstream gender and intersectionality in climate policies in the region.

Impact evaluation of existing mitigation policies: The region has already implemented several instruments such as carbon pricing and taxes, renewable energy subsidies, technology standards, payment for ecosystem services, forestry, and land use. But very few countries have evaluated these policy instruments, making it difficult to compare them and understand their impacts. For instance, the number of ex post evaluations (especially peer-reviewed ones) of the effectiveness of carbon pricing initiatives in reducing emissions is rather limited worldwide and, as far as we know, non-existent for LAC (García and Sterner 2021). Academic research can help fill these gaps, while working with local researchers and practitioners to build up local analytical capacity. With regard to payments for environmental services, Moros et al. (2020) identified a total of 17 impact evaluations performed in the region, but most of them correspond to case studies from Costa Rica and Mexico, where these schemes have been popular.

Estimating the economic costs and benefits relating to a low-carbon transition. There are several types of economic assessments that could add valuable information to decision-making on LCT. First, there are no updated studies that

provide estimates of the cost of mitigating climate change through different technological options. Without such assessments, including country-specific Marginal Abatement Cost Curves, it is difficult to project the effectiveness of proposed climate policies. In addition, there are few studies that estimate the rate of return on climate investments. This knowledge gap, constitute a barrier for climate investments, as the absence of this information increases investors' uncertainty (Cárdenas, M. et al., 2021). Second, the benefits of regional LCT policies vis a vis national policies should be evaluated. Despite the fact that LAC countries share a common history and, to some extent, cultural background, there is a high degree of fragmentation in climate policies implemented in the region. Integration may lead to higher economic efficiency and lower risk of displacement of environmental harm from one place to another – known as leakage– although this would entail costs of coordination. Third, research is needed on the economic co-benefits of climate mitigation. This will require, for example, extending current efforts to place monetary values on non-marketed environmental goods and services. For example, preserving the Amazon has the potential to reduce biodiversity loss, affect changes in the water cycle throughout South America, and improve air quality.

T*he political economy of climate mitigation policies.* Corruption poses a major challenge in LAC with respect to regional efforts for LCT. There is weak political will to enact climate action plans, which means enforcement and compliance policies are inefficient and imperfect. For instance, carbon taxes in Latin America have low rates and large exemptions, which limits their GHG emissions reductions (Cárdenas, M. et al., 2021). Therefore, there is a potential knowledge and research gap regarding the relationship between politics and LCT, as well as the different factors that might affect political will in relation to LCT. It is also important to research the role that lobbying, especially anti-climate lobbying, has played in climate legislation in Latin America and the Caribbean. Lobbying has had an impact on climate legislation in other countries, such as the United States. Closing such knowledge and research gaps will help in better understanding the barriers and limitations that policy instruments for LCT might face in the future.

Private finance – Thematic Bonds: Despite great potential to redirect private funding from brown to green investments, green bond issuance in LAC has been somewhat limited, and contributed only 2% of global Green Bonds in the period 2004 – 2019. Most funds raised through green bonds in LAC financed renewable energy projects, followed by transport projects, although emissions from land-use dominate those from fossil fuels across the region. A notable exception of use-of-funds is Brazil, where a relatively large proportion of green bonds issuance (25%) finance projects related to land-use and land-use change. An explicit research program may be put in place in order to help the region leverage Brazil´s experience in directing private finance to sectors that are of utmost climate mitigation importance for the region, such as agriculture. Agriculture is one of the most important sectors of the LAC economy and has a great potential for poverty reduction as well as emissions reduction.

Just as with green bonds and blue bonds(which invest in marine resources), other thematic bonds, such as social and gender bonds, have been developed and applied in order to finance programs, projects, and policies with social and/or environmental impact. Gender bonds are relatively new, innovative investment instruments for investors interested in promoting gender equality and gender equity. In Latin America and the Caribbean, the private sector has been the main issuer of gender bonds. The first gender bond was issued in 2019 by Banistmo bank in Panama (subsidiary of Bancolombia - Colombia), for a total amount of US$ 50 million; it had the objective of financing small and medium-sized companies headed by women (ECLAC, 2021).

Renewables and energy access in off-grid areas. Access to electricity is still a challenge in Latin America, even though nearly 97% of the population had access to electricity in 2021 (IEA, 2022). However, the goal of closing the gap in 10 years would require more than US$ 570 billion, according to IDB, not only for new infrastructure, but also to replace the existing capacity (Valencia, 2022). Research is needed into the potential for community management of off-grid electricity. Off-grid areas in Latin America are highly reliant on fossil fuels. While most LAC countries have set a goal of 100% electricity access, the operational management models do not consider the local conditions. The normal way to reach off-grid areas has been with investment from

the Government; however, alternative models should be tested and implemented to increase the use of renewable energy sources (Montoya-Duque et al, 2022). For instance, the model called "pay-as-you-go" has been tested in different countries as a mechanism to allow private investment to solve the problem (Montoya-Duque et al, 2022). Further research is needed on these issues.

Social acceptance of wind-farming: Whereas there is widespread public support for increasing renewable energy supply generally, renewable energy projects are often met with local resistance. In LAC, indigenous communities have opposed the development of wind-farming in areas of great generation potential. There is thus a need to better understand the relationship between renewable energy companies and local communities in the region. Some examples are located in Colombia, where La Guajira region has been the focus of the energy transition due to the huge potential for wind and solar generation. The region is largely populated by a very poor indigenous community, with very strong opposition to energy projects in general (Vega-Araújo and Heffron, 2022). This situation is very common. Furthermore, there is evidence that renewables require an appropriate technology adoption plan that is conditioned on local factors, as has been observed worldwide, for example, in Switzerland (Stadelmann-Steffena and Dermont, 2021), and in other countries in Latin America (e.g., Ecuador (Barragán-Escandón et al, 2021) Research is needed to bring an equity and inclusiveness lens to the communities in which potential exists to develop renewable energy.

1.4 Structure of the high-level research agenda

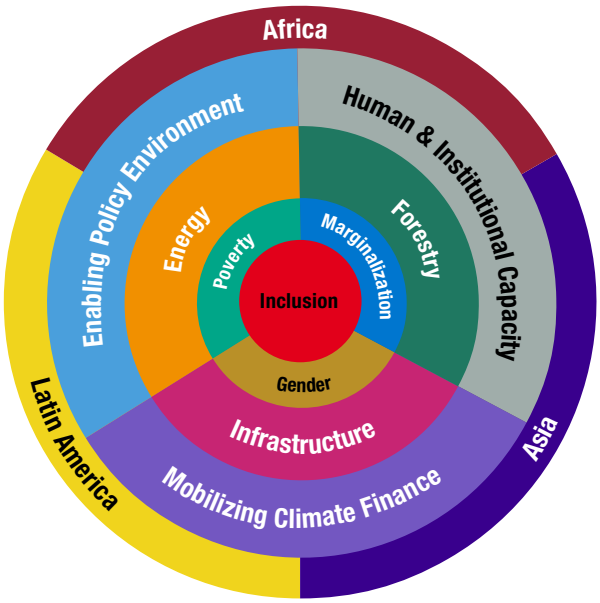
Figure 1.3 brings out the structure and logic of this HLRA. At its core, the objective of a LCT in the Global South should not only be to reach net zero greenhouse gas emissions. It is also necessary to reduce poverty and make the development agenda more inclusive for women and other marginalized groups. This should be the target not only for interventions, but also for research. It is the reason we have made inclusiveness the "bull's eye" for the research agenda.

To achieve this goal of inclusion, sectors such as energy, infrastructure (digital and transport) and forestry must act in tandem to design and deliver sensible and cost-effective interventions (as shown in the next band). But the success of such sectoral interventions will ride on finance, human and institutional capacity, and an enabling policy environment (the next band).

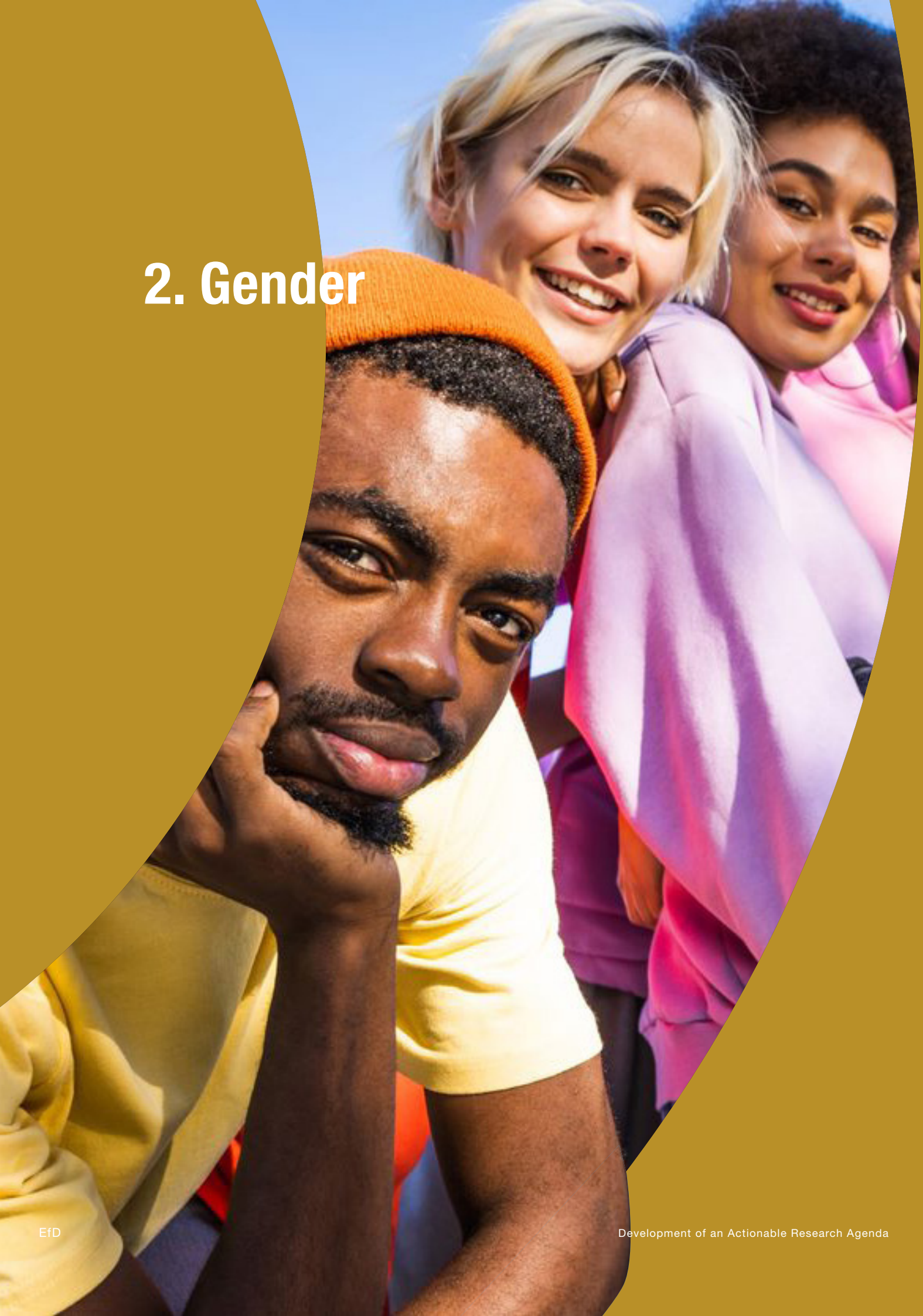
Finally, all these factors – the inclusion goal, the sectoral transformations, the enabling institutions, and finance – differ between countries in Africa, Asia and Latin America (the outer band). These differences require tailored solutions and research that only locally enabled and regionally based researchers can deliver.

Throughout the HLRA, examples are provided of research and policy-driven transitions. The report also identifies important research gaps, missing knowledge or data gaps, and opportunities for high-impact research under the different themes.

Figure 1.3: The LCT High-Level Research Agenda focusing on inclusion



2. Gender



2. Gender

2.1 Introduction

A LOW-CARBON TRANSITION has implications for gender equality, as shifts in technologies, practices and policies impact genders in different ways. This section outlines what we know and what we do not know about the relationship between a LCT and gender, the gendered impacts of a LCT, how gendered decision-making impacts LCT policy, and the role of finance in supporting a LCT alongside gender equality.

Gender represents "the socially constructed roles, behaviors, expressions, and identities of girls, women, boys, men, and gender diverse persons," and recognizes that gender is not binary (IDRC, 2019). Gender is also not monolithic, that is, all women (or all men) do not share the same experience, as gender intersects with other elements of identity, such as race, caste, income, and age. These intersections, as well as the experiences of gender diverse persons, are woefully understudied in the LCT literature.

Reviewing the research on the likely impact of LCT transitions across various sectors, including energy, transportation, agriculture, forestry, and textile manufacturing, it is clear that a low-carbon transition will impact men and women differently. Men make up the majority of workers in many high-carbon sectors, such as energy (78% of oil and gas jobs) and transport (85% of public transport jobs), which may anticipate job losses in a LCT (Godfrey and Bertini, 2019; IRENA, 2021). Meanwhile women are critical parts of forest economies, agriculture and textile manufacturing, but studies of impacts on these sectors rarely acknowledge the gender dimension. Throughout, women's central role in the care economy is critical to gender equality. This is especially the case given that climate change is expected to increase care work as men migrate to urban areas in search of jobs, extreme weather events cause negative health impacts, and subsequent shifts in demographics disrupt social services (MacGregor et al., 2022).

Where women are in positions of power in low-carbon transition sectors, there is some evidence that they enact more sustainable policy or improve environmental, social, and governance (ESG) reporting, but the literature is limited to corporate governance and national parliaments. High-level policies rarely go beyond acknowledging the impact on, and role of, gender, while a few sector-specific policies try to mainstream gender into LCT-relevant sectors. However, gender mainstreaming has yet to achieve its aims – promoting gender-responsive and gender-transformative policy – and a lack of gender-related policy impact data curtails meaningful lessons learned.

Climate finance is a critical means for supporting gender equality alongside the LCT, but there is limited data on how much climate finance flows to gender-related programming, outside of the OECD. Even within that set of transactions, little climate finance is categorized as gender-responsive, despite interest in social returns on investment. In part, this is because the gender equality impacts of projects have been generally unmeasured, and, therefore, unmonetized. In terms of gender impacts, a heavy focus on loans has increased country-level debt, with links to social spending cuts, which have disproportionately negative impacts on women. Women remain underrepresented in climate funds and across financial decision-making bodies.

2.2 Motivation

Gender equality is a critical component of the low-carbon transition for two reasons. First, in many cases, improving gender equality and implementing the low-carbon transition can mutually support one another. For example, improving access to public transportation can improve women's access to jobs while also reducing the need for single household vehicles. Or else, women on corporate boards may increase Corporate Social Responsibility (CSR) and ESG reporting. Second, where gender equality and LCT are not currently in alignment, enacting low-carbon transition policies without considering their gender dimensions may reinforce existing inequalities. For instance, increasing digitization can improve access to many services but, since women have less access to smart phones or internet services, programs that rely on that access may leave women behind.

Therefore, research is required to untangle the relationships between gender and aspects of the low-carbon transition, as well as to test possible solutions and offer policy recommendations. These relationships will, of course, vary by region, country, and locality, as gender

roles and relations vary by context. Addressing that variety will require research across contexts. In all cases, a major constraint to knowledge is a lack of capacity in gender analysis – both in terms of knowledge and resources – at the ministry level, and specifically in gender budgeting and gender auditing.

Employment in key sectors – from the care economy to textile manufacturing – will also be shifted in the pursuit of a low-carbon economy, and this will have gendered repercussions. Evidence is already growing that points to how shifts in agricultural technologies, for example, can inadvertently reduce women's employment opportunities, where women have been performing low-skilled labor that is replaced by new practices (Afridi et al., 2022). Anticipating those sectoral shifts is critical to implementing a just low-carbon transition, which will require training, re-training, and capacity building to support all genders in taking advantage of employment opportunities in a LCT. This training should be gender-sensitive, taking into consideration the different constraints and circumstances facing different genders and their differentiated needs in terms of content and procedure.

2.3 Gender and the LCT

2.3.1 The Care Economy

Care work is defined as both direct and indirect acts of care, whether paid or unpaid. Direct acts include bathing, feeding, and engaging with people in need of care, whereas indirect acts cover necessary activities for engaging in direct care, such as cooking, cleaning, and shopping (MacGregor et al., 2022). Care workers are predominantly women in all countries across the world. On average, women perform 76.2% of total care hours and there is no country in which men and women perform an equal share of care work (ILO, 2018a).

As MacGregor et al. (2022) outline, climate change is likely to increase unpaid care work, as people must manage climate-related health impacts (Aguilar et al., 2015; FAO, 2016; IPCC, 2014; UNFPA, 2015; UNHCR, 2019), make greater efforts to secure food, water and energy sources (FAO, 2016; Meyiwa et al., 2014; Otzelberger, 2014; Oxfam, 2019; UNFPA, 2015), and manage the loss of care infrastructure (UN, 2019), including breakdown of personal networks and support, leading to women and even other children taking over care work alone (Oxfam, 2020, 2017; UNFPA, 2015). Climate impacts are already causing large-scale migration, leaving more work for women caregivers left behind when family members (mostly men) migrate for paid work, including caring for dependents left behind (Babugura, 2019; Rao et al., 2020; Richards and Bradshaw, 2017; UNFPA, 2015). Finally, there is the ongoing risk of losing technical, indigenous and agricultural knowledge as people are displaced or knowledge-holders migrate (Aguilar et al., 2015; Rao et al., 2020; Richards and Bradshaw, 2017; Slavchevska et al., 2016; UN, 2019). Balancing all these needs means prioritizing some over others (Resurrección et al., 2019).

Paid care work represents a growing sector of the global economy, which will be expanding in the coming years as climate change increases its impact on local economies. As of 2015, 151 million care worker jobs existed in education, health and social work (ILO, 2018a). By 2030, even without additional support for these sectors, it is expected that the number will increase to between 189 and 299 million workers. If additional support is given, it is expected that care workers in those sectors will represent 251-400 million jobs by the end of the decade (ILO, 2018a). However, women's participation varies across different sectors of the care economy and in different regions. Globally, women make up 69.6% of health and social workers, 60.6% of educators and 70.2% of domestic workers. Looking just at education, in Africa women make up 54% of educators, while in Eastern Europe women make up 77% of educators (ILO, 2018a). This does not consider that men may hold higher-paying positions across these sectors, and evaluations of the impact of climate on employment in these sectors must take this dynamic into account.

Even interventions in low-carbon sectors that aim specifically to engage women may end up further burdening them if unpaid care labor is not accounted for. In particular, programs that have aimed to increase women's incomes are limited by access to childcare (Folbre, 2018). Answering questions about the care economy – how it functions alongside key LCT sectors, how interventions can reduce unpaid labor, and identifying opportunities to support paid labor roles (Espinoza Trujano and Lévesque, 2022) – will require researchers to employ mixed methods and to include time-use survey data alongside qualitative, interview-based

findings to assess how care labor can be more equitably distributed and compensated (Folbre, 2021).

2.3.2 Future of Jobs in LCT Sectors

A low-carbon transition will impact sectors that act as major sources of carbon emissions or as carbon sinks, and patterns of employment in these sectors will change (Pross et al., 2020). A just transition will recognize where different genders work within these sectors and anticipate what training, education or support will be needed to offer equal opportunities to all genders to participate in the new jobs and key sectors of the LCT.

The energy sector is regularly cited as a promising opportunity for green jobs. There were 12 million renewables jobs worldwide in 2020, and it is anticipated that the global energy sector will grow to 114-122 million total jobs by 2050, with approximately 43 million in renewables (IRENA, 2021). Because women hold proportionately more jobs in the renewable sector than they do in other energy sectors, there is a common narrative that women can be more easily integrated into the sector (Nelson and Kuriakose, 2017). Certainly, recent research has found that women perform as well as men in off-grid renewable energy enterprises (Barron et al., 2020; Klege et al., 2021). However, recent evidence found that women make up only 23% of the renewables sector in Kenya and 27% in Nigeria (Shirley et al., 2019).

Women face both vertical segregation (into particular sectors) and horizontal segregation (into particular roles within sectors). Women represent 32% of the renewables sector as opposed to 22% of the oil and gas sector (IRENA, 2021). Across the sector, they are predominantly found in administrative (45%) and non-STEM positions (35%), which tend to be lower-paid than STEM positions (IRENA, 2021). Other aspects of identity can also constrain access to these jobs, such as caste or class-based social status (Stock, 2021).

The expectation is that growth in the sectors will focus on male-dominated, medium-skill positions, where women will only have access to a small number of new jobs unless they are trained in relevant fields. Of the 25 million new jobs that the ILO anticipates a sustainable energy transition will create by 2030, it is anticipated that 19 million will be held by men and only 6 million by women (IRENA, 2021). More research is needed to understand how this gender breakdown will manifest by sector, and by region or locality. This is a first step to identifying what training or re-training will be needed to support a gender-just transition in the sector. Training would have to sit alongside additional enabling environment support, such as family or child care policy, improved access to grants, and financing for training and education.

There is far less information about the impacts of reduced deforestation, reforestation, and afforestation on employment in the sector. The formal timber industry employs over 13 million people worldwide (World Bank, 2016). Logging is a heavily male-dominated field and therefore changes to logging practices are most likely to impact men's work. Women's engagement in non-logging forest work is much more heterogeneous (Aguilar et al., 2007; Westholm and Arora-Jonsson, 2015). Reforestation has the potential to add jobs to the economy. In the US context, researchers found that every US$1 million invested in forest management and reforestation could create nearly 40 jobs, but it is unclear whether these jobs are likely to accrue to women or men (Rudee, 2020).

Women make up an average of 43% of agricultural labor, with two-thirds of women employed in farming in the least developed countries (CGIAR, 2021). There is some evidence that climate-smart agricultural practices may have unintended consequences for jobs. An example is Vietnam, where the adoption of plastic row seeders eliminated the need for rice planting labor, which was a critical income source for half the women in poor farming households (Beuchelt and Badstue, 2013; R. Paris and Chi, 2005). However, only a few studies have considered the impacts of these practices on jobs and who has access to them.

The transport sector is also male-dominated across its various subsectors (see section 5.3.3) (ILO, 2020). Evidence is mixed on whether electric vehicle manufacturing will increase or decrease jobs in the sector (Dawson et al., 2019; Miller, 2020; OECD, 2022a)(ILO, 2020). Women make up only 15% of public transportation employment, despite the fact that women are highly dependent on public transportation for access to employment opportunities (Godfrey and Bertini, 2019; ITF, 2019)(Martinez et al., 2020; Matas et al., 2010).

Finally, the textile industry – clothing and footwear production – generates 10% of global greenhouse gas emissions (European Parliament, 2022). Women represent

80% of the world's garment workers. Women in the industry tend to be segregated into low-paying, low-skilled sectors and have little negotiating power or voice within their workplace (ILO, 2018b). As the industry shifts to low-carbon practices and technologies – including greater automation – it is unclear what the impact will be on available jobs in the sector and their working conditions, and how those jobs and conditions will break down by gender.

2.3.3 Gender and Policy

Policies that address a low-carbon transition can impact populations differently depending on gender. These types of policies can also be responsive to the needs of different segments of society, including different genders. Finally, gender can also influence the support that policymakers have for a specific policy, especially given the narrative that women are more likely to support environmentally friendly actions.

In the latest round of NDCs, countries have been encouraged to consider the gender dimensions of climate change following the Enhanced Lima Work Programme on Gender and its Gender Action Plan (IUCN, 2021). There had been a general consensus that gender was not adequately considered in the first round of NDCs (UNDP, 2017; Women Gender Constituency, 2021). Even in the second round of NDCs, analysis has found that only about 30% of countries were actively engaging in processes to integrate gender into NDCs and climate-relevant policy (WEDO, 2020)(IUCN, 2021). Within the NDCs, gender is most associated with agriculture (mentioned in 33% of NDCS), energy (25%) and health (21%), and appears least in sections about transport (10%), the green economy (10%), tourism (7%) or the blue (marine) economy (2%) (IUCN, 2021). In terms of National Adaptation Plans, there are concerns that, while adaptation policy recognizes gender vulnerability, planning and implementation to address that issue are missing (Shabib and Khan, 2014).

Increasingly, gender is being explicitly considered in other low-carbon transition policies, but typically attention is focused on trying to bring women into male-dominated sectors, which is only one dimension of a just LCT. One major issue is a lack of coordination between gender ministries and other LCT-relevant government bodies. For example, Gender Equality Plans exist across Africa, Latin America and Asia – with most countries having a gender plan or policy, typically drafted in the last two decades (CEPAL, 2019; Government of Uganda, 2007; Republic of Ghana, 2015). The challenge is that these policies are developed by Departments or Ministries of Women, Gender or Social Inclusion, who typically are not considered core stakeholders of climate policies and may be underfunded (Chasukwa, 2016).

Gender-specific policies do exist to address sectors interested in a low-carbon transition. Since 2010, IUCN has partnered with countries to develop Climate Change Gender Action Plans (ccGAPs). There are 13 ccGAPs, developed between 2010 and 2018 (IUCN, 2012a). They cover a range of topics, responsive to the priorities of countries, including but not limited to sustainable agriculture and food systems, forests and REDD+, water, energy, health, urbanization, Tourism and comprehensive disaster management (IUCN, 2018, 2013, 2012b). There are also specific gender and energy policies in Kenya and West Africa (ECOWAS, 2017; Government of Kenya, 2019).

It is becoming more common to include gender in policy impact analyses. There is evidence from the World Bank on how the impacts of carbon pricing policy may be distributed differently across genders (World Bank, 2021). In the case of large-scale hydropower, there is evidence of projects in Laos and Vietnam leading to displacement of populations, which makes it harder for women to find new jobs in comparison to men (Hill et al., 2017). In India, there is evidence that land loss from a large hydro project led to increased alcoholism and domestic violence (Levien, 2017).

Increasingly, the literature is recognizing that women are not just impacted by climate change or a low-carbon transition, but are active stakeholders in these phenomena. The UN collects data annually on local, national, and economy-wide gender diversity in leadership. Findings show that national leadership roles for women vary within SSA, from 16.9% women in parliaments in West Africa to 31.8% in East Africa. In Latin America, 29.5% of parliamentary positions are held by women in Central America, 30.1% in South America and up to 39.7% in the Caribbean. According to the UN Environment Program, 6 out of 33 (18.1%) of environmental ministries in Latin America and the Caribbean are led by women. Finally, in Asia, the percentage of women in parliament ranges from 16.7% in South Asia to 26.1% in Central Asia (IPU, 2022). Data

on representation in low levels of government is limited – although evidence suggests that women's representation in local government is higher than in parliaments (UN Women, 2022). As decentralization is increasingly promoted as potentially able to better reflect local needs, more evidence is needed to determine whether women are also represented in this space.

There is a general expectation that women are more sensitive to environmental harms, and, therefore, that women in positions of power will enact more sustainable policy. This viewpoint sees women as "efficient environmental managers within the development process" (Braidotti et al., 1994; Noguchi, 2011). Findings on corporate leadership suggest that gender diversity does at least lead to greater ESG or CSR reporting, if not always better environmental policy (Arayssi et al., 2016; Fernandez-Feijoo et al., 2014; Galbreath, 2011; Glass et al., 2016; Li et al., 2017). There is also some evidence that greater female representation in national parliaments leads to the adoption of more stringent climate change policies, resulting in lower emissions (Mavisakalyan and Tarverdi, 2019). However, this analysis does not consider more nuanced measures of representation, such as speaking time or legislation proposed.

2.3.4 Gender and Finance

At the 15th Conference of Parties (COP15) of the UNFCCC in 2009, developed countries committed to increase the mobilization of climate finance for developing countries to US$100 billion per year by 2020. In spite of that US$100 billion goal, by 2020 only US$83.3 billion had been mobilized (OECD, 2022b). OECD (2022) analysis finds that the total volume of development finance (ODA) for climate action was US$ 33.1 billion,[5] and climate ODA integrating gender equality accounted for 57% of that (US$ 18.9 billion). However, climate ODA dedicated to gender equality as the "principal" objective was only US$ 778 million in 2018-2019 – that is, a little over 0.04% of all climate-related ODA (OECD, 2022c).

These figures only give us a small snapshot of the finance gaps for gender-related climate finance. Further work is needed to determine how much finance is gender-related as opposed to gender-responsive, and to move beyond exploring gender in climate-related ODA (only US$33.1bn) to look at gender's role in the global scale of climate finance (US$632bn). More research is needed to determine which other gendered indicators should be collected within all climate finance governance structures, programs, and procedures.

Current climate finance approaches focus on sectors, projects and approaches that often leave women behind. In 2020, 58%% of the US$83.3billion in climate finance flowed to mitigation projects, and half of that was to the energy and transport sectors (OECD, 2022b). This split between mitigation and adaptation finance is not gender neutral. Digging in a little deeper, within climate-related ODA (US$33.1bn), over 60% of adaptation programs integrated gender objectives, compared to only 46% of mitigation programs (OECD, 2022c). Greater research is needed to identify the gendered impact of these uneven financial flows. Gender typically plays a small role in climate mitigation financing and policy (Zusman et al., 2016). More mitigation financing has gone to energy efficiency or renewable energy projects than to projects in water filtration plants, mass transportation, and agroforestry – which are all areas that tend to primarily benefit women while also delivering mitigation benefits (UNDP and GGCA, 2016). Instead, energy mitigation projects are more likely to be large, utility-scale deployments that are implemented in a top-down manner and lack considerations of and engagement with local people, communities and actors beyond their role as 'beneficiaries,' which can leave women out of mitigation projects (Colenbrander et al., 2018).

Eighty-two percent of the finance mobilized from developed countries towards the US$100 billion goal was public finance, 71% of which was in the form of loans (OECD, 2022b). Loans as instruments are not conducive to supporting climate activities that do not harness financial returns – meaning that they are unsuitable for a majority of climate adaptation activities. This consideration is critical

5 This figure just tracks climate-related development finance or ODA and, as such, only partially overlaps with climate finance tracked by the OECD towards the US$100 billion figure.

for supporting sectors where women work and which may have greater impacts on women, such as agriculture and forestry. Providing the majority of climate finance in the form of loans also adds to the growing debt burden of countries. If fiscal consolidation is undertaken, particularly through cutting social spending and increasing regressive taxes, this can generate unequal and undesired outcomes. Past international debt relief packages linked to IMF agreements have impacted women more adversely than men and disproportionately disempowered women because debt management policies effectively rely on the unpaid and underpaid work of women to cushion the impacts of fiscal austerity (Ghosh, 2021). More research is needed on the gendered impacts of high debt burdens, on how these can be mitigated, and on how gender responsiveness can be built into countries' economic recovery policies.

Where women have less access to land and capital, climate projects can also entrench traditional power structures and keep women removed from the benefits of climate financing (Wong 2016; Schalatek 2020). Women typically have less access to financial resources, fewer assets, and different business networks, which means that women's businesses tend to be smaller-scale and rely on family funding (Schiff et al., 2013; WEF, 2022). Addressing these issues will require finance that is predictable, patient, and comfortable with smaller transaction sizes, different criteria for collateral, and different expectations for what growth and success look like (Idriss and Patel, 2021). As it stands, there are only a handful of case studies on how this can be achieved.

In Multilateral Climate Funds (MCFs), there are three lenses through which to consider gender mainstreaming in MCFs: gender representation, the gender breakdown of investees, and the gendered impacts of investments. Although the Green Climate Fund has put in place a mandate for gender balance for its staff and board, the majority of MCF gender policies have focused on investment procedures and evaluating gendered outcomes of investments (GCF, 2017; Schalatek, 2020). However, these policies are still in need of strengthening, as evidenced by a review of the Adaptation Fund, which showed that less than half of surveyed Implementing Entities, board members, Designated Authorities, and NGOs thought that policies and programs sufficiently consider gender (Adaptation Fund, 2019).

For investors, there have been calls for more gender lens investing, which is an investing process or strategy that accounts for gender-based factors throughout the investment process to enhance gender equality and inform improved investment decisions (GIIN, 2019). There is some evidence that makes the case for gender lens investing – from reducing poverty to adding US$12 trillion to the global economy (Acumen and ICRW, 2017; Woetzel et al., 2015). In response, private investors are increasingly adopting gender policies and protocols and highlighting women in their investee companies (Calvert, n.d.; G-SEARCh, n.d.; Root Capital, 2021). There is some evidence that supporting investees with technical assistance programming geared toward improving women's employment within companies or better meeting the needs of women clients can improve business outcomes (G-SEARCh, 2022).

Gender lens investing has also been incorporated into domestic finance regimes. An example of national-level gender lens investment in the developing world is that between Indonesia's OCBC NISP Bank and the International Finance Corporation. As of March 2020, the bank had issued US$200 million for both gender and green bonds, where the proceeds from the gender bonds went directly to increasing lending to women-ownedsmall and medium-sized enterprises (SMEs) (Uzsoki, 2021). Further research is needed on the outcomes of such gender bonds have resulted in outcomes for women and men, and the barriers to scaling such solutions.

However, although investing in women-led businesses is a key objective of gender-lens investing, less evidence has focused on how private investors target women-led businesses – for example, whether that would require more outreach to women entrepreneurs or smaller ticket sizes. There are a handful of examples of best practices, such as maintaining quotas for women-led investees in early decision rounds or creating separate funds for women-led businesses (Phillips et al., 2022), but little rigorous analysis has identified the most effective approaches to increasing investments in women-led companies. Further research is needed on the effectiveness of adjusting decision processes, reevaluating collateral requirements, or shifting financial and social expectations or targets.

2.3.5 Intersectionality

Intersectionality describes overlapping or intersecting forms of discrimination related to gender, sex, ethnicity, age,

socioeconomic status, sexuality, geographic location, and disabilities. Gender identities, norms, and relations both shape and are shaped by other social attributes (Buolamwini and Gebru, 2018; Crenshaw, 2018). This is also captured in Canada's framework for Gender-based analysis + (GBA+), which "acknowledges that within a gender based analysis grounded on biological (sex) and socio-cultural (gender) differences there are many other intersecting identity factors" (Government of Canada, 2021). A large body of literature now documents how social divisions based on gender, race, age, (dis)ability or class determine who is vulnerable to climate change and who has greater ability to adapt.

Many of the studies reviewed in this section also explored other elements of identity, particularly considering whether trends held across ages, income and region. However, few studies explicitly explore the intersection between gender and these identities. In terms of age, surveys on sustainable textile manufacturing do find that young women, and particularly young, educated women, cared more about sustainability in fashion (Gazzola et al., 2020). On public transportation, young women face harassment while older women face mobility issues (Hoor-Ul-Ain, 2020; Infante-Vargas and Boyer, 2022). Age also impacts migration trends in the Amazon, where deforestation drives young men deeper into the forest and young women into urban centers as they look for jobs (Barbieri and Carr, 2005). In OECD countries, evidence suggests an over-representation of older workers in "brown" industries, where they face displacement challenges that result in longer durations of unemployment spells and larger wage losses once re-employed. In addition, cultural bias against learning in old age and the shorter remaining professional life to recoup investment in skills upgrading may limit the participation of older workers in education and training programs (OECD, 2015).

Looking at income, in India, higher incomes are correlated with longer travel, and the wealthiest women use paratransit while the wealthiest men use private motor transportation (Mahadevia and Advani, 2016). In studies on climate-smart agriculture, low-income participants are often the inadvertent victims of the project's success. In Bangladesh, poor and landless women had their work replaced by mechanical threshers but could not leave their homes to look for alternative work and therefore lost income (Paris and Pingali, 1996). In Nepal, a program to adopt new technology left out women who were underprivileged and of a lower caste (Khapung, 2016). In terms of decision-making roles, research is lacking on who typically ends up in positions of power, although it is clear that education and wealth are big factors (Ferreira, 2001).

Other forms of marginalization are also mentioned, but rarely measured. International reviews of the care economy note disproportionate impacts on marginalized women, particularly women of color and immigrants in the US context, but data is lacking on migration and care in the context of lower-middle income countries (LMICs). Studies on deforestation often address indigenous communities, but these communities receive less attention in other low-carbon transition sectors (Dhali, 2008). There is limited research on how gender intersects with populations with disabilities (Johnson et al., 2020). Finally, one study implied that the social exclusion of gender-diverse persons, such as hijra in Bangladesh, could also be related to access to services, in the context of social stigma as it relates to the digital divide (Aziz et al., 2020; Aziz, A. and Azhar, S., 2019). This is already several degrees removed from actually studying gender-diverse persons and their inclusion in or exclusion from a low-carbon transition, and represents the greatest gap in the research that purports to study gender.

2.4 Examples of research and policy driven transitions

In order to identify where the low-carbon transition has trade-offs and synergies with gender equality, there is a need for greater data on markers of that equality, such as women's empowerment. Women's empowerment is a complex, multidimensional concept, which is usually measured as an index of a number of measures, all of which are proxies for access to power. While there are a wide range of women's empowerment indices available, and some – like WOCAN's W+ Standard (WOCAN, 2021) – can be flexibly used across project types, the Women's Empowerment in Agriculture Index (WEAI) is a great example of how such indices can help decision-makers evaluate their programming.

The WEAI is a measure, developed by USAID, the International Food Policy Research Institute, and the Oxford Poverty and Human Development Initiative, to measure women's empowerment, specifically in the

agricultural sector (Feed the Future, n.d.). It can be used to measure both men's and women's experience across five areas: production, resources, income, leadership, and time use. By also measuring men's experiences, the WEAI allows researchers to measure women's empowerment relative to men within their household.

The measure was first launched in 2012 in order for USAID to track the impacts of Feed the Future initiatives on women's empowerment, either directly or indirectly, across its 19 focus countries (USAID, 2020). The index has been implemented across these geographies every two years, in order to build up an evidence base that the US government can use to evaluate the effectiveness of different program approaches and how they impact women and men, in order to improve their programming (Ahmed, Akhter U. et al., 2018). Both the data from these surveys and the index methodology itself are made publicly available for use by other researchers and decision-makers. Other, similar opportunities exist to provide gender empowerment data and analysis to improve programming across low-carbon sectors.

2.5 Research and data gaps

Addressing men: In a study on men, masculinities, and climate change, Söderström, (2015) notes that the mainstream gender and climate change debate and literature has almost exclusively focuses on women's vulnerability. In areas where there is research, boys and men have mostly been analyzed as a monolithic group responsible for the negative effects of climate change due to their patterns of consumption and the associated modern industrialization. Few studies look at the diverse and nuanced ways in which boys and men also impact and are impacted by climate change, including as heads of large corporate sector organizations, as energy consumers, as victims of environmental degradation, and as agents of change alongside women and girls. There is little recognition that men's diversity – according to social class, ethnic group, sexuality, and other intersecting factors – affects not only the way that they live their lives, but the way that they drive or respond to climate change (Men Engage Alliance, 2016).

Intersectionality: Many of the studies reviewed also explored other elements of identity, particularly considering whether trends held across ages, income, and region. However, few studies explicitly explore the intersection between gender and these identities. The identities most commonly covered were age, income, and education, but other elements of identity, such as race, ethnicity, indigeneity, gender identity (outside the binary), sexual orientation and caste or class, were far less studied.

Moving beyond the gender binary: The research that explores the links between gender and LCT strategies is mostly confined to gender binary definitions. Studies that consider gender-diverse persons and climate policies remain rare (Baxter et al., 2022). This gap in the literature underscores the need for more inclusive gender definitions besides gender mainstreaming, which would allow researchers and practitioners to identify the impacts of climate change on these underrepresented populations. The OECD Toolkit for mainstreaming and implementing gender equality (OECD, 2018), WHO's gender mainstreaming manual (WHO, 2022), and the Bill & Melinda Gates Foundation's Gender Equality Toolbox (Bill & Melinda Gates Foundation, n.d.), are some of the few recent publications that provide instruments to facilitate more inclusive gender mainstreaming into development studies and policies.

Intrahousehold power relations: Not all household members have the same preferences and, therefore, these different individuals may disagree over choices to be made. Typically, household decisions follow from intrahousehold power relations among members. Although bargaining power is not directly observable, there is an extensive literature on ways of measuring intrahousehold power relations using various analytical and experimental approaches. Most empirical studies use variables that proxy for intrahousehold power, such as labor force participation or income earning potential, asset ownership, or educational attainment (Doss, 2013). Because a LCT will include household-level technology adoption, understanding intrahousehold power dynamics will be key.

Gendered impacts of climate change: There is an understanding that climate change will affect genders differently, and that women will be disproportionately impacted, given their work in affected sectors – like agriculture and tourism – or access to fewer resources (Sirker, 2021). However, research is still limited outside of a handful of review papers on the care economy or specific sectors. Further work is needed to unpack the different ways in which genders will be affected by climate change's

impacts on weather, migration, key economic sectors, and access to resources, among others.

Gendered impacts of LCT: Across technologies and practices, there is still a dearth of analyses that consider the gendered impacts of a LCT, especially across geographical contexts. From clean cooking to electricity access, the impacts on gender equality will vary depending on gender roles and local context. Further work is also needed on the impact of deforestation on women and men, and on the gender aspects of the subsequent migration.Little research covers the gendered impacts of low-carbon practices in the textile industry, climate-smart agriculture, or low-carbon transportation. Understanding impacts will help policymakers understand the trade-offs and synergies between LCT policies and gender equality. Assessments on the distribution of costs and benefits that account for intersectional gendered impacts could be an important area for future work. Achieving this will include addressing the need for sex and gender-disaggregated data on asset ownership, participation, and agency across key value chains in key sectors.

Gendered employment: There is a need for greater analysis and modeling on the expected impacts of a low-carbon transition on employment by sector, and what that will mean in terms of gendered jobs. For instance, what will be the impact of low-carbon forestry practices, such as reforestation and afforestation programs, on employment and livelihoods? Who will hold these jobs? What are intentional and unintentional impacts on jobs, labor (amount, physical effort, and timing), and resources involved in LCT technology and practices? How do these impacts break down by gender? How can negative, unintended consequences for men or women be mitigated through training or education?

Gendered leadership and decision-making: Finally, women are generally underrepresented in decision-making roles, despite the expectation in many sectors that women are more likely to support LCT transitions. However, there is insufficient information on the gendered make up of decision-making bodies, outside of national governments, which could be used to test where that narrative holds true, such as local government representation. In general, there is more research needed on the contexts and conditions in which women in decision-making roles improve environmental outcomes or enact LCT-friendly policies. Questions include: which intersecting factors - age, race/ethnicity, wealth, etc. - have an impact on who reaches positions of political power? How might these backgrounds influence LCT policy-making?

2.6 Opportunities for high-impact research for gender inclusion in low-carbon transition

What is the impact of LCT policies on genders and intersecting identities? How could these policies be adapted to ensure inclusiveness?

What will be the gendered landscape of employment in a low-carbon transition scenario? What are effective models for training, re-training, or educating women to participate in LCT programs? In particular, how can women's access to STEM training and jobs be increased, particularly in those Asian nations that have active technology sectors? How can women's labor force participation be increased, particularly in Latin America? How can girls' access to education be increased so that they will be ready for jobs in a lower-carbon economy? What are the different roles that government, communities, companies, and other stakeholders can take in these programs and solutions?

How can policymakers and NGOs encourage greater adoption of cleaner cooking stoves? Particularly in sub-Saharan Africa, how can women and girls be relieved of the drudgery of fuel collection and the health risks of inhaling smoke from traditional stoves? How can the barriers to clean stove adoption – including financial barriers, lack of access to repair services, and women's unequal decision-making power over household purchases – be addressed ?

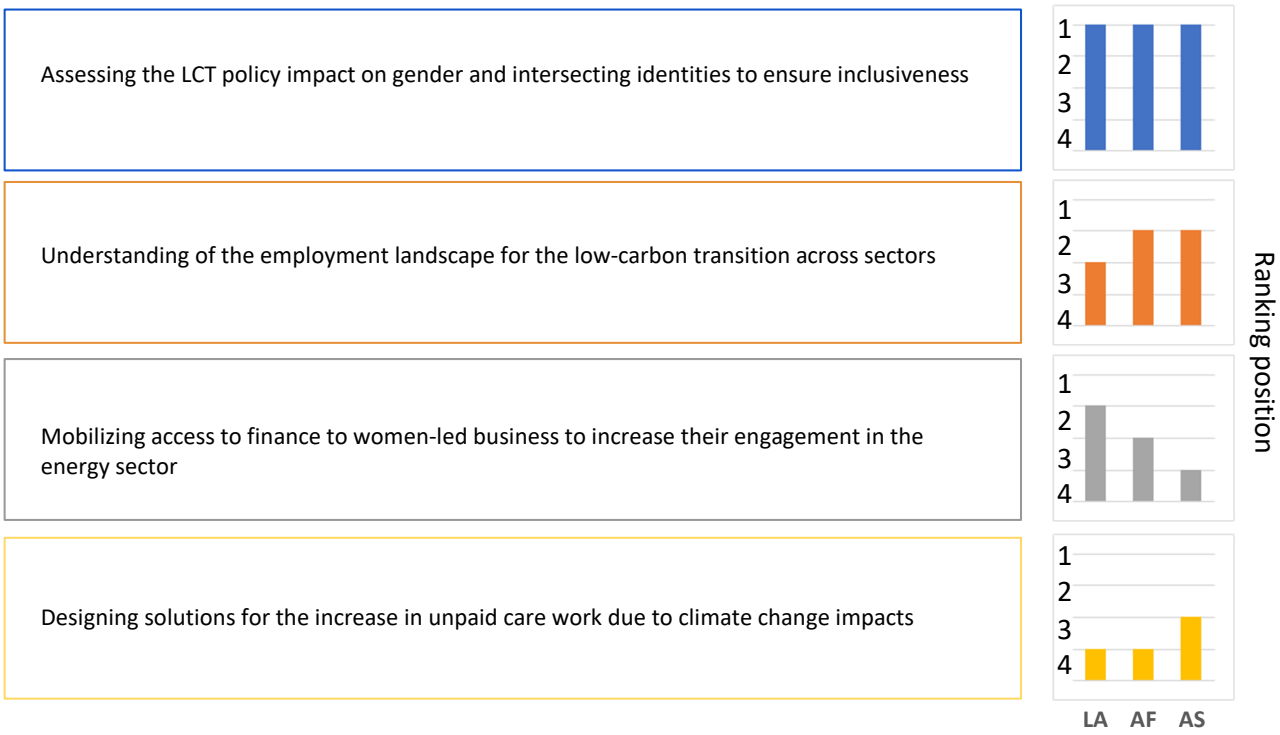
How can women's access to finance be increased? What are the impacts of projects and technologies in sectors with women-led SMEs (e.g., agriculture, forestry, energy)? What are the impacts that investment can have, not just on women with respect to access to finance, but also on their families and communities?

What is the impact of LCT programs and policies on the care economy or care labor, particularly as it impacts women and men of different education, age, income and marital status? What are effective policies in different contexts? Across sectors, how can the low-carbon transition support the care labor – in health, education, childcare, etc. – that is anticipated to increase as a result of climate change? What are effective models for LCT programs that marry care labor interventions to LCT activities?

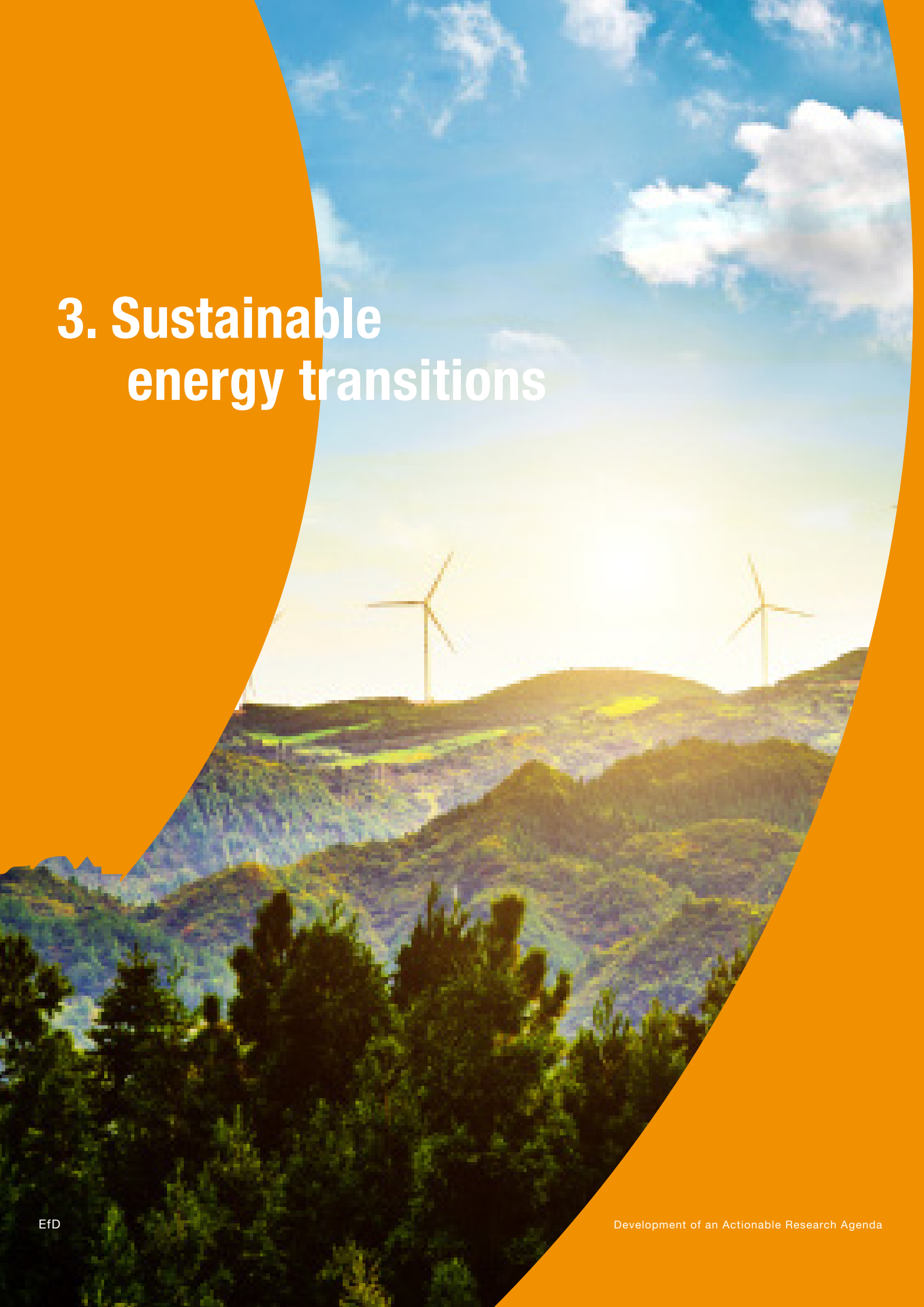
2.7 Regional priorities for gender inclusion

As part of the regional validation workshops , the participants were asked to rank a selection of the opportunities for high-impact research on gender. Of the research opportunities considered in this exercise, "Assessing the LCT policy impact on gender and intersecting identities to ensure inclusiveness" was ranked as the top priority opportunity across regions. In contrast, "Designing solutions for the increase in unpaid care work due to climate change impacts" had a consistently low ranking across regions. The opportunities and results of the ranking exercise are presented in Figure 2.1.

Figure 2.1 Ranking of high-impact research opportunities on gender at validation workshops



3. Sustainable energy transitions



3. Sustainable energy transitions

3.1 Introduction

REACHING UNIVERSAL ACCESS to energy by 2030 while moving towards net-zero emissions in developing and emerging economies is a daunting challenge. Globally, 800 million people still do not have access to electricity, 600 million of whom live in sub-Saharan Africa (IEA et al. 2021), and many more have only intermittent supplies and low consumption (Nordhaus et al. 2016). A considerably larger number, 2.6 billion people globally, lack any access to clean cooking technology, and stacking (combining) the use of clean and dirty fuels remains common among many others (Masera et al. 2000, Price et al. 2021). Even as these deficiencies in access persist, countries are setting out ambitious actions to advance clean, affordable energy for all by 2030 in their NDCs and Long-Term Strategies (LTSs), with the goal of achieving net zero emissions by 2050. Indeed, energy is at the core of a low-carbon transition . Unsurprisingly, many NDCs have identified renewable energy as a top priority, as well as improvements in energy efficiency. International investment initiatives, such as the Global Environmental Facility (GEF), and the UN's Climate Promise, are supporting these actions across the Global South.

At the outset, there is a need to acknowledge that a LCT in developing countries risks exacerbating an already deeply unequal global energy situation. Renewable energy generation may now be cost competitive with carbon intensive technology, but that does not mean that it is on an equal footing, given financing challenges and the political economy and institutional advantages of incumbent technologies and distribution systems (Sergi et al. 2018, Agutu et al. 2022). Moreover, investment decisions are based not only on cost considerations but also on revenue generation. Energy consumption and economic growth increase in tandem (Jeuland et al. 2020). One of the greatest research challenges will be finding ways for developing countries to leapfrog the fossil fuel energy that industrialized countries used to achieve their present wealth (van Benthem 2015, Fetter 2020). (Jenkins et al. 2018). Renewable energy generation may now be cost competitive with carbon-intensive technology, but that does not mean that it is on an equal footing, given financing challenges and the political economy and institutional advantages of incumbent technologies and distribution systems (Sergi et al. 2018, Agutu et al. 2022). For instance, while solar electrification can provide lighting, phone charging, and television, grid electricity is generally required for other needs such as cooking, and grid electricity is still fairly carbon intensive (Jeuland et al. 2020). An energy justice and inclusion lens demands more than access that only fulfils basic needs.

There is thus an urgent need for research that clarifies ways to overcome the challenges to inclusive and sustainable energy transition in low- and lower-middle-income countries. Such research would support the generation of new and timely data and evidence, leveraging methodologies appropriate for the task of confronting the multiple constraints holding back progress today. It should be centered on a goal of identifying and scaling effective public, private, and non-governmental sector actions that advance the sustainability of energy uses while also addressing structural inequalities of opportunity. Such research should also speak to the unique challenges of this moment, considering the continuing effects of the COVID-19 pandemic and supply chain vulnerabilities, similar problems with global interconnections (e.g., geopolitical and climate-related shocks), and the need for coordinated recovery. The costs and drivers of such challenges are many, and, increasingly, have environmental dimensions.

3.2 Motivation

An analysis of the links through which the energy sector could promote/impede LCT in the Global South — and the subsequent identification of knowledge and policy gaps—should take into account the interlinked challenges determining energy access, energy use, affordability, and reliability from the demand side; the roles of technology-supplying institutions and complementary infrastructure enabling better and more productive use of energy from the supply side; and their linkages with the local policy environment, which ultimately determine the design and implementation of policy interventions and instruments to support LCT.

The energy-gender nexus is a cross-cutting issue at the core of LCT. First, there are clear connections between SDG 5 (gender equality) and SDG 7 on (universal access to modern energy) (Fukuda-Parr 2016). However, with a few exceptions (IDS and GIZ, 2019; ENERGIA, 2019; Johnstone et al., 2019; Johnstone and Perera, 2020), relevant theory and evidence remain incomplete and poorly organized. Critical knowledge gaps lead to missed opportunities for progress from interventions promoting energy access and to trade-offs that may be unintended or underappreciated (e.g., asymmetries in decision-making power that could affect the choice of modern energy services in ways that may harm development and reinforce existing inequities).

Second, the connections between energy access and gender empowerment go in both directions. On the one hand, empowerment may be furthered by energy access and usage, giving rise to a virtuous circle. Access to clean energy has the potential to reduce drudgery, shifting women's time in favor of activities supporting personal development, such as education. Time savings also enhance women's access to information and communication, which could in turn challenge social norms (and gender stereotypes) in relation to women's disproportionate responsibilities for care activities and unpaid work inside the house. Changes in social norms enhance women's reproductive rights, increasing empowerment, and ultimately contributing to gender equality. Moreover, gender empowerment can increase adoption of cleaner energy sources (Jensen and Oster 2009; Clancy et al. 2012). On the other hand, there is evidence that energy poverty and marginalization prevent the adoption of cleaner energy sources, generating a vicious circle (Pachauri and Rao 2013; Fingleton-Smith 2018). Marginalized women are especially disadvantaged in terms of intra-household decision-making power, which translates into all domains, including households' energy related choices. Thus, the lack of women's decision-making power further impedes LCT.

> **Critical knowledge gaps lead to missed opportunities for progress from interventions promoting energy access.**

Third, gender is intersectional, interlocking with multiple axes of power and inequality such as class, ethnicity, age, and race (Cho, Crenshaw et al. 2013, Azocar and Ferree 2016, Lieu, Sorman et al. 2020). Lack of access to renewable energy among these marginalized groups may be the result of structural discrimination and policies that favour an unequal distribution of the needed investment capital for the transition to clean energy.

Regional differences can be an important source of heterogeneity in the impacts of energy access; such differences can lead to incorrect extrapolation of study results to other regions. This heterogeneity can be due to variations in geography, agro-ecological conditions, settlement patterns and density, general economic conditions, institutions, culture, and/or appropriateness of different energy technologies. A recent review by Jeuland et al. (2021) points out that such regional differences are correlated with differences in income levels. As an illustration, traditional stoves, relying on biomass such

as wood or dung, are universally found to have negative impacts on air quality and health, but there is substantial regional heterogeneity in the impacts of improved stoves. Specifically, evidence of positive impacts of improved cookstoves on health is much weaker in South Asia and Sub-Saharan Africa, relative to higher-income regions. This may reflect a tendency to promote more rudimentary improved technologies (so-called "transitional" options), which are less likely to deliver health benefits, in lower-income countries or locations (Bensch and Peters 2015, Gebreegziabher et al. 2018), relative to middle- and upper-income countries (Shen et al. 2015, Coelho et al. 2018, Pattanayak et al. 2019). It may also reflect differences in how beneficiaries at different income levels use improved technology – for instance, stacking it alongside traditional alternatives – and whether they are able to keep using the new technology over time (e.g., obtaining repairs or purchasing fuel). The latter highlights the importance of understanding the main obstacles and challenges in determining a LCT based on countries' development status.

We first revisit gaps identified in prior work, especially as summarized in Jeuland et al. (2021). Second, we identify local policy processes and priorities of a sample of 13 EfD network countries, whose development status was classified based on the World Bank's definition (2022)[6]. These countries span the lower, lower-middle, and upper-middle income country categorizations of development status and represent all major developing regions.[7] This approach allows identification of a broader set of gaps, and comparison of research priorities across regions and development levels.

3.3 The drivers and paths of energy transitions

Here, we discuss key lessons on the drivers and impacts of energy transitions.[8] Our literature review suggests four areas where evidence is especially scarce: (i) intra-household and gender implications of energy interventions, policies, and transitions; (ii) the appropriate role of distributed (non-centralized) sources of renewables for electrification; (iii) the importance of supply chain improvements and enabling conditions; and (iv) the urgency of finding robust solutions for making progress in the lowest-income countries, including "last mile settings" where research is sparse and energy access goals are lagging, especially in Africa. We focus particularly on what is known about LCT dynamics, as well as how those dynamics intersect with concerns about inclusion and equity.[9] To take account of the bidirectional link between energy access and economic empowerment and the factors that may mediate this link, Table 4.1 classifies the identified research gaps/areas into demand (beneficiaries) and supply (energy promoters or retailers), highlighting considerations for policy-making.

6 The development status of these countries was classified based on the World Bank's definition (2022, retrieved from https://datahelpdesk.worldbank.org/knowledgebase/articles/906519
7 We acknowledge that the chosen sample of countries leads to some bias in the types of locations that are represented; particularly notable omissions include countries in Francophone Africa, and those in the Middle East.
8 For a review of the state of the art on what is known, and the areas that deserve further attention see the accompanying report on "Inclusive Green Transitions for Sustainable Development in the Global South: Development of an Actionable Research Agenda."
9 See section 7.3 of the report mentioned in the previous footnote for the main insights from this review.

Table 3.1. Identification of research gaps and mediators from demand and supply persectives

Dimension	Demand (beneficiary)	Supply (promoter/retailer)	Policy
Intra-household and gender aspects of LCTs	• Understanding how time-saving technologies and modern energy services adoption may stimulate employment outside the home, and vice versa.	• Understanding the role of women and marginalized identities in producing, promoting and disseminating locally-appropriate modern energy solutions.	• Creating development finance instruments that recognize reduction of energy poverty burdens.
	• Linking modern energy services access to long-term, human capital development.	• Documenting the harms resulting from persistent inequalities in wages and employment status in the energy sector.	• Advancing innovative policies to leverage the potential of wome to reach more and different customers.
	• Testing approaches to increase energy access among credit-constrained marginalized sub-groups.		• Creating policy supports for entrepreneurs who suffer structural barriers.
Distributed renewables for LCT electrification	• Finding ways to improve the quality of electricity access provided by off-grid renewables, while maintaining affordability.	• Identifying business models that support development and economic sustainability.	• Balancing the pros and cons of energy subsidies, for access and empowerment.
	• Understanding how quality of electricity access affects agency and development.		• Countering the political economy challenges (i.e., vested interests) that impede clean energy development.
Supply chain improvements and complementary conditions	• Finding ways to give energy poor customers more agency to express their dissatisfaction when service delivery is subpar.	• Leveraging trust in local suppliers to boost adoption of clean technologies.	• Identifying the policy supports needed to establish the conditions and infrastructures on which inclusive LCT depends
	• Understanding the benefits of coupled interventions that improve energy access and incentivize investment in human capital (e.g., cash transfers).	• Identifying the conditions and infrastructures needed to support LCT service providers.	
		• Understanding the complementarities, for empowerment, of reducing dependence on polluting production processes.	

Both energy access & empowerment | Energy access | Empowerment

Source: Own summary based on the review.

Similarly, to account for regional differences in research gaps and priorities, Table 2 displays the main issues identified when distinguishing between the poorest countries in Africa and other countries in the Global South. This categorization makes clear that: (i) while lack of any modern energy access is a defining characteristic of energy poverty in low-income countries (LICs), (ii) energy poverty also exists and remains a significant threat in many lower-middle income countries (LMICs) and upper-middle income countries (UMICs). This classification also sheds light on some factors that may create inconclusive or paradoxical results in the literature, which can be understood as potential mechanisms explaining why interventions promoting LCT can be successful in some settings but fail to produce results in others.

Table 3.2. Main insights from the literature by countries' development status

Dimension	Low-income countries	Middle-income countries in the Global South
Intra-household and gender aspects of LCTs	• Addressing the lack of representation of these countries in research, given particularly low access and low consumption levels of modern energy services, and low empowerment of people living in poverty.	• Understanding the role of the quality of energy access, transition and efficiency in enhanced productivity and welfare.
	• Understanding the role that differences in culture, wealth, and natural environments play in energy poverty - empowerment dynamics.	• Managing growing needs for energy in light of the high cost of LCT trajectories.
	• Tackling the acute affordability challenges with accessing even basic modern energy services in these contexts.	• Finding the right balance between affordability for the disenfranchised and sustainability of modern energy services.
	• Understanding the policy tradeoffs of lower versus higher quality energy access, that arise from a focus on basic access versus quality access.	• Tackling the political economy and social challenges impeding LCT, given market power and interests of the energy sector in these settings.

Both energy access & empowerment Energy access Empowerment

Source: Own summary based on the review.

3.4 Examples of research and policy-driven transitions

The examples of research and policy-driven transitions presented in this section emerged from a data collection process undertaken with applied policy researchers in the EfD network.[10] Comparing the behavior of the countries provides a view of existing knowledge, local capabilities of researchers, and perceptions of the impact of their work, while identifying views on inclusive LCT research needs. To leverage differences in ongoing policy processes that affect both access to low-carbon energy sources and the decision to use them, we use the World Bank country classification (2022) to split our sample of countries into three groups: low-income countries (Ethiopia, Uganda), lower-middle income countries (Ghana, Nigeria, Kenya, Tanzania, India, Vietnam) and upper-middle income countries (South Africa, China, Colombia, Costa Rica, Chile). These groups cover a range of country development statuses while allowing for regional comparisons, which can support prioritization of identified gaps and subpopulations of interest.

Recent research discussed by these stakeholders has focused on four main topics: (i) off-grid electricity, (ii) renewable energy, (iii) grid electricity, and (iv) energy and climate change. Their research is perceived to be demand responsive, i.e., addressing policy issues identified by researchers as relevant in their countries. Several topics were flagged as warranting more attention, including: (i) the gender and human capital dimensions of energy use and transitions, (ii) the energy aspects of an evolving transportation sector, (iii) household air pollution (i.e., indoor pollution generated by the combustion of solid or fossil fuels in dwellings), and (iv) ambient air pollution. More research is needed to address multiple gaps related to grid electricity. Research in these domains exhibits not only policy relevance, but also academic relevance through a growing number of scientific publications.

Research conducted in all countries is in agreement on the importance of transitioning towards a low-carbon economy. (See Figure 3.6 in the related paper on Sustainable Energy Transition.) However, the cost of accessing cleaner sources – and reliability concerns – may impede this process. Air pollution arises as a major environmental problem in most countries regardless of development level, and fuel use has implications for forests. On the other hand, when accounting for country development status, there is great variation in the factors that drive energy access problems. In LICs, access to basic electricity services and to cleaner energy sources remains imperative. While access issues remain important in LMICs as well, affordability and reliability issues arise as the main impediments for the adoption of low-carbon technologies, especially in the African region. Another important issue relates to pollution exposure due to heavy use of polluting energy sources, often produced with old technologies and from the transport sector. Finally, the most important policy issues in UMICs relate to inequality in access to cleaner energy sources, affordability issues, and high rates of energy poverty, which accentuate existing inequalities.

The LCT challenges described above, and their impacts on local populations, are borne differently by subgroups of individuals within the various countries. Women and children in both rural and urban (slums) settlements, and people living in poverty, remain the most vulnerable groups of the population, regardless of country development status. In specific countries (LICs especially), charcoal users, as well as men and women participating in the agricultural sector, exhibit higher vulnerability. In LMICs, intersectional aspects affect fuel collectors, individuals inhabiting conflict areas, those with low education, people with disabilities, people who are marginalized through social constructs such as a caste system or ethnic status, and users of motorbikes. Finally, poor individuals, indigenous or ethnically marginalized communities, those in non-grid connected areas and migrants, are among the more vulnerable groups in UMICS.

10 Insights from the studied countries were grounded in the following activities: (i) Design and implementation of a center's survey, and (ii) semi-structured interviews targeting EfD centers.

3.5 Research gaps, missing knowledge, or data gaps

The correlation between energy and economic opportunity or growth is well established in the literature (Jeuland et al. 2021), but unresolved questions remain about the extent to which energy access is the key driver that enables new economic opportunities, whether such opportunities are equivalent with grid-based and decentralized electricity, and under what conditions (Morrissey 2017, Lee et al. 2020). Research proposals must articulate how and why the new project will overcome the limitations of prior research on the linkage between energy access and economic development. The relative share of gains flowing to different disenfranchised populations, is highly contextual and must be clarified (Standal and Winther 2016).

While basic energy access problems continue to affect LICs, a broader energy poverty construct is at the core of challenges in both LMICs and UMICs. Despite structural differences between these groups of countries, problems in all countries, regardless of development status, appear to be mediated by common intersectional factors. This suggests that universal access to energy that guarantees a minimum of energy services is compatible with economic empowerment. Transitioning away from a path that prioritizes basic access would leave certain subpopulations behind, forcing continued reliance on polluting technologies, exacerbating income poverty, and inhibiting empowerment. How to best allocate limited resources to this endeavor, and the extent to which addressing these problems contributes to economic empowerment, are important points of the proposed research agenda.

A holistic understanding of the impacts of energy access that goes beyond direct economic and financial impacts is especially warranted in the context of a low-carbon energy transition. This broader conception of welfare impacts encompasses enhanced rural community resilience in the face of weather and climate disruptions (Shammin and Enamul Haque 2022); upgraded public service provision; increased individual choice about time use, empowerment, and psychological well-being (Gray et al. 2019); intangible quality-of-life benefits (Jensen and Oster 2009); and improved health and human capital (Wickramasinghe 2011). Further research is especially needed to determine the varied pathways leading from welfare impacts to women's and other groups' economic empowerment. Long-term impacts are a critical knowledge gap, particularly as they transfer across generations. Of particular interest are the implications for youth employment, entrepreneurship, and community resilience and adaptation to climate change.

Considerable research relates proxies for women's economic empowerment to increased adoption of improved cookstoves and clean fuels, noting that women's agency and decision-making power remains limited, which constrains households' willingness to pay for improved technology (Das et al. 2020). Evidence for other energy technologies (such as Standal et al. (2020) in a developed world context) and sub-populations is much more limited. Still, women within households have been found to have less say in how electricity is used and which appliances should be purchased (Winther et al. 2020), with profound implications for household welfare and the dynamics of energy transitions. In general, prior literature has focused much more on resources than on the agency and process aspects of empowerment (Das et al. 2020).

Limited work shows that women's engagement in the energy sector may result in increased adoption of cleaner technology, but the gender balance in this sector remains highly inequitable. Other dimensions of diversity and inclusivity have scarcely been considered. Various barriers limit involvement by disenfranchised groups, including social norms, limited networks and information, the care economy, glass ceilings, counterproductive workplace policies and practices, low availability of time, lack of education, and limited access to finance and capital (Kabeer 2002). In this sense, there is a need for work on leveraging innovative sources of inclusive finance, and the potential role of public financing models that can be deployed to support the private sector. In addition, the potential of women's or other types of interest groups to aid in dissemination of energy technology is worthy of researchers' attention (Cho et al. 2013).

Existing research shows that constraints in access to financial services prevent many marginalized people from building businesses, improving productivity, or entering into contracts with others in society (De Mel et al. 2009, McKenzie and Woodruff 2014, Bernhardt et al. 2019, Bardasi et al. 2021). A lack of independence and ownership over assets (collateral) constrains these groups more than

those who are economically and socially favored. In this regard, it is important to ensure improved access to productive resources, such as finance, sustainable energy, and entrepreneurial capacity, and to explore how this is linked to a wider policy framework that contributes to empowerment and at the same time promotes energy transitions. Advancement of this agenda will depend on improved capacity in governments in reformulating policies and programs that enhance businesses owned and led by women and other disenfranchised groups, by supporting participation and strengthening these groups' roles as rights holders and key actors in the development and expansion of markets and value chains.

Much research emphasizes the importance of awareness-raising, training, and capacity building as aids to general economic development, as well as empowerment (McKenzie and Woodruff 2014). Though limited work has examined such interventions in the context of the gender-energy nexus (Shankar et al. 2015, Dutta 2020), there is a clear need for more such work, in order to clarify technical, management and business skills and business opportunities; the capacity of women's organizations and other interest groups; and specific energy end uses (e.g., irrigated farming) or enterprises (energy-intensive micro- and medium-sized enterprises). The role of gender and other mainstreaming policies and efforts by national and local governments has rarely been evaluated critically in existing work (Quintero 2006).

While in some countries of Africa and Latin America, women, ethnic minorities, and rural populations are more vulnerable in terms of energy access, local communities within the same countries/regions also impede access to energy because of social norms and cultural considerations. In other countries of Africa, women and children are more exposed to both indoor and outdoor air pollution because gender norms dictate that they are typically responsible for the lion's share of household chores. Women and children who spend more time on fuelwood collection, due to deforestation, are also more exposed to the risk of violence (e.g., sexual and gender-based violence and wild animals). In contrast, more men benefit from gender norms that allow them to devote their time to more productive activities outside the house, which reduces their exposure to the risk of violence related to the collection of fuelwood. In South Asia, the main intersecting factor is rurality, which is often correlated with poverty. An intersectional agenda should consider both an inter-country approach (prioritizing the tackling of common challenges) and intra-country approach (prioritizing particular country concerns). This distinction could help disentangle cultural and institutional issues that impede or favor both LCT and economic empowerment of disenfranchised populations.

Access to modern energy services does not always improve environmental and development outcomes. Technologies, implementation approaches, policies, and local contexts all matter. Too little is known about the specific mechanisms that explain divergent outcomes. A key problem emerges in the cooking energy domain, where barriers to adoption of clean technology are well understood, but effective interventions have proven difficult. Many studies on cooking services provide only marginal value relative to implementers' needs for evidence, adding to a body of evidence that already shows that traditional stove use harms air quality and health through exposure to pollutants, or documenting household-level barriers to adoption of improved stoves. Such studies do little to show how to effectively overcome serious supply chain, information, and behavioral obstacles that inhibit improved stove use and impacts. Effective ways to enhance affordability and complementary conditions (robust supply chains, market connectivity, access to financing) warrant particular attention. Similarly, though electricity access in general appears strongly linked both to increased income and productivity and to negative environmental consequences, a closer look at this evidence reveals that causal evidence does not extend consistently to all regions, technologies, and solutions. Whether the "off-grid solar ecosystem" can boost incomes is a particularly critical question, with an orientation that identifies which specific appliances help produce the greatest improvements in development and well-being.

Turning to electricity, there are large gaps in knowledge about governance and cost-recovery of electric utilities in developing countries. Missing markets and/or regulatory policy uncertainty prevent investment in modern renewables and decentralized solutions, while public investment becomes untenable when end-use energy prices are distorted. This problem is exacerbated by low willingness to pay for electricity access and use. Although some studies have focused on these problems (see, e.g., Fowlie et al.,

(2021); Blimpo et al., (2017)), they mainly focus on access, while the LCT part is largely missing.

The issues of conflicts and fragility are gaining more traction in light of numerous recent events culminating in the Russian-Ukrainian war. Rising food and energy input prices are likely to severely hamper energy transition progress, as are direct effects of conflict, such as destruction of critical infrastructure and human capital, and policy uncertainty preventing post-conflict investment. Natural disasters are expected to increase in frequency due to climate change; this is a particular concern in flood-prone parts of Asia.

High-quality, disaggregated data (by gender, ethnicity, rurality, class, etc.) are key to supporting policy formulation that is responsive to structural disadvantages, and then monitoring and evaluating the outcomes of such policies. It is therefore important to improve the mainstreaming of private- and public-sector initiatives, projects, and policies. Indeed, sensors and smart monitoring technologies are being introduced, especially in the private sector, to provide alternative financing options (e.g., pay-as-you-go or use of energy technology as collateral in loans) and post-sale services (e.g., timely repair in case of malfunctions or fuel refills delivery).

These hold enormous potential as sources of data for research that is appropriate for analyses of various sub-populations of interest. In addition, validation workshops and definition of key actors in both the academic and policy arenas (governments, communities, NGO's and key stakeholders) arise as important venues of work to provide an accurate prioritization of the need to fill specific knowledge gaps to support the process of transitioning towards low carbon economies.

Research and policy needs differ by development level. For example, countries that have extended electricity to most of their populations can evaluate pricing mechanisms and set up emissions trading systems; this describes, for example, China and India. Countries whose rural populations lack connection to the electric grid should take into account the experience of countries that are farther along in electrification, in order to avoid being locked into fossil fuel-based power generation; this describes much of sub-Saharan Africa. In sub-Saharan Africa, rural households' reliance on biomass for cooking creates a poverty trap for the women and girls who spend hours collecting wood; research is needed on barriers to adoption of affordable, clean cooking equipment. Although electrification and clean cooking are more widespread in Asia and Latin America, they are not universal, and country-specific research is needed to address barriers to clean, affordable and reliable energy.

3.6 Opportunities for high-impact research for sustainable energy transitions

How can the low-carbon energy transition create economic opportunities for marginalized populations, and support their economic empowerment? How can these groups benefit as users of renewable electricity and clean cooking energy? What are the specific mechanisms and pathways that explain these impacts? What are the main energy services needed? Can inclusivity stimulate the low-carbon energy transition? For instance, do women own companies that are better in reaching users? How can marginalized groups gain increased access and control over sustainable energy products and services? What are the main barriers that prevent marginalized groups from leveraging a LCT for economic gain? How can these barriers be addressed through policy?

What policies, incentives, strategies, and complementary initiatives (e.g., training programs, investment in infrastructure, or behavior change campaigns) are both efficient and cost-effective in supporting economic opportunities for marginalized people during a low-carbon energy transition? Conversely, can empowerment and improved equity or inclusivity stimulate the low-carbon energy transition, through empowering marginalized people as change agents? How can marginalized groups gain increased access and control over sustainable energy products and services, including participation in decision-making?

What are the broader benefits and social welfare implications of the resulting energy-related improvements in equity and inclusivity? Are there notable synergies with other development objectives, or across locations? What are the specific mechanisms and pathways that explain these broader impacts? What are the implications for youth employment, entrepreneurship, and community resilience and adaptation to climate change?

How can governments and the private sector promote better access to productive resources (finance, sustainable energy, entrepreneurial capacity, business development services) to support energy-related businesses owned and led by women and marginalized groups? What government and donor policies, incentives (subsidies, rewards, etc.), pathways, strategies, and complementary initiatives (e.g., training programs, investment in infrastructure, or behavior change campaigns) are both efficient and cost-effective in supporting economic opportunities for marginalized people arising from the low-carbon energy transition, while also promoting their involvement in policy- and decision-making discussions? What types of policies are counterproductive to these goals?

How can the low-carbon energy transition create economic opportunities for marginalized populations, and support their economic empowerment? How can these groups benefit as users of renewable electricity and clean cooking energy? What are the specific mechanisms and pathways that explain these impacts? What are the main energy services needed? Can inclusivity stimulate the low-carbon energy transition? For instance, do women own companies that are better in reaching users? How can marginalized groups gain increased access and control over sustainable energy products and services? What are the main barriers that prevent marginalized groups from leveraging the LCT for economic gain? How can these barriers be addressed through policy?

How can private sector actors in the energy sector be incentivized to incorporate equity considerations? At present, which private sector actors seek to incorporate equity into their general objectives, business models, and day-to-day operations? How do such aspects vary across sub-sectors, and which private sub-sectors are most inclusive and why? Are interventions needed to support more inclusivity in the private sector; if so, which interventions can do so effectively? Is there a role for financing to elevate such objectives?

What are the broader benefits and social welfare implications of the resulting energy-related improvements in equity and inclusivity? Are there notable synergies with other development objectives, or across locations? What are the specific mechanisms and pathways that explain these broader impacts? Of particular interest are the implications for youth employment, entrepreneurship, and community resilience and adaptation to climate change, but other types of changes can also need investigation.

How can governments and the private sector promote better access to productive resources (finance, sustainable energy, entrepreneurial capacity, business development services) to support energy-related businesses owned and led by women and marginalized groups? What government and donor policies, incentives (subsidies, rewards, etc.), pathways, strategies, and complementary initiatives (e.g., training programs, investment in infrastructure, or behavior change campaigns) are both efficient and cost-effective in supporting economic opportunities for marginalized people arising from the low-carbon energy transition, while also promoting their involvement in policy- and decision-making discussions? What types of policies are, in contrast, counterproductive to these goals?

What, if any, are the inherent trade-offs in more inclusive approaches to a low-carbon transition? In particular, are there trade-offs between energy access targets due to differences in targeting, rates of penetration, or the longevity and stranding of obsolete assets? How can such trade-offs be characterized, in the short and long term? Are there trade-offs with environmental objectives, or across definitions of inclusivity (across groups, geographies or other dimensions of marginalization)? Can these trade-offs be managed, and, if so, what are effective approaches to measure and manage them?

Why do modern energy interventions, such as connection to electric grids and subsidies for clean cook stoves, benefit households in some cases, but not in others? What are the mechanisms behind these diverse impacts? For instance, can the currently limited ability of off-grid solar devices be extended to provide services in addition to phone charging, lighting, and television? What disaggregated data are needed to design better policies for energy access and empowerment? How can the data best be made available? Are there needs for particular compilation mechanisms and tools in order to provide data of adequate quality? How can governments and the private sector assist by providing disaggregated data of high quality while maintaining confidentiality? How can knowledge gaps need to be validated and prioritized based on the factors that determine heterogeneous outcomes?

What are the best strategies for governance and cost-recovery of electric utilities in the Global South? What

are the challenges of managing electrification in developing countries? What strategies exist to correct missing markets and/or regulatory policy uncertainty? How can policies encourage investment in modern renewables and decentralized solutions? How can distortions in end-use energy prices be addressed in order to improve the feasibility of public investment? How do these issues differ between nations that are approaching universal connection to the electric grid and nations that are seeking to extend the reach of electrical grid connection to all communities?

What are the links between infrastructure complementarities and energy transition? How can reliable internet access be promoted, so that digitalization can facilitate penetration of modern flexible generation technologies? How can market access be improved in order to promote investment in modern technologies, in the presence of economic returns that currently are too low to justify public investment and financial incentives that are too low to justify investment by the private sector?

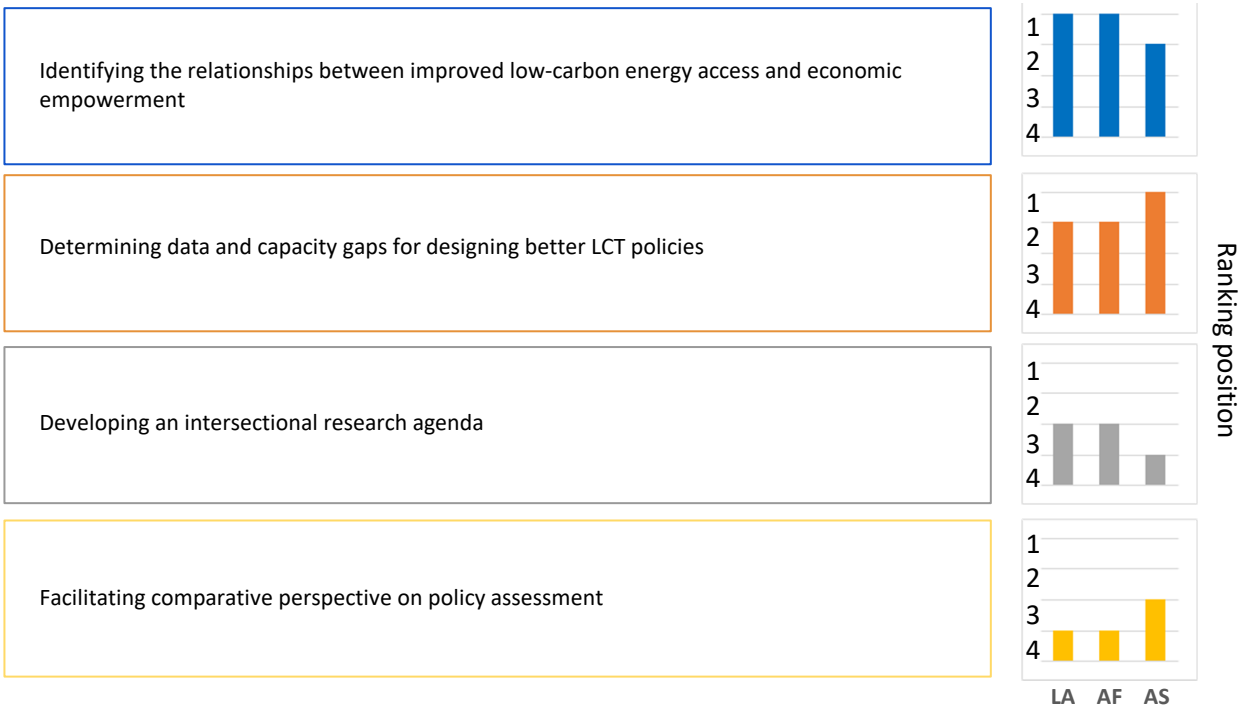
What are the effects of conflicts and natural disasters on energy transition? The issues of conflicts and fragility are gaining more traction in light of numerous recent events culminating in the Russian-Ukrainian war. With the increasing frequency of natural disasters due to climate change, how can damage from such disasters be mitigated?

3.7 Regional priorities for sustainable energy transition

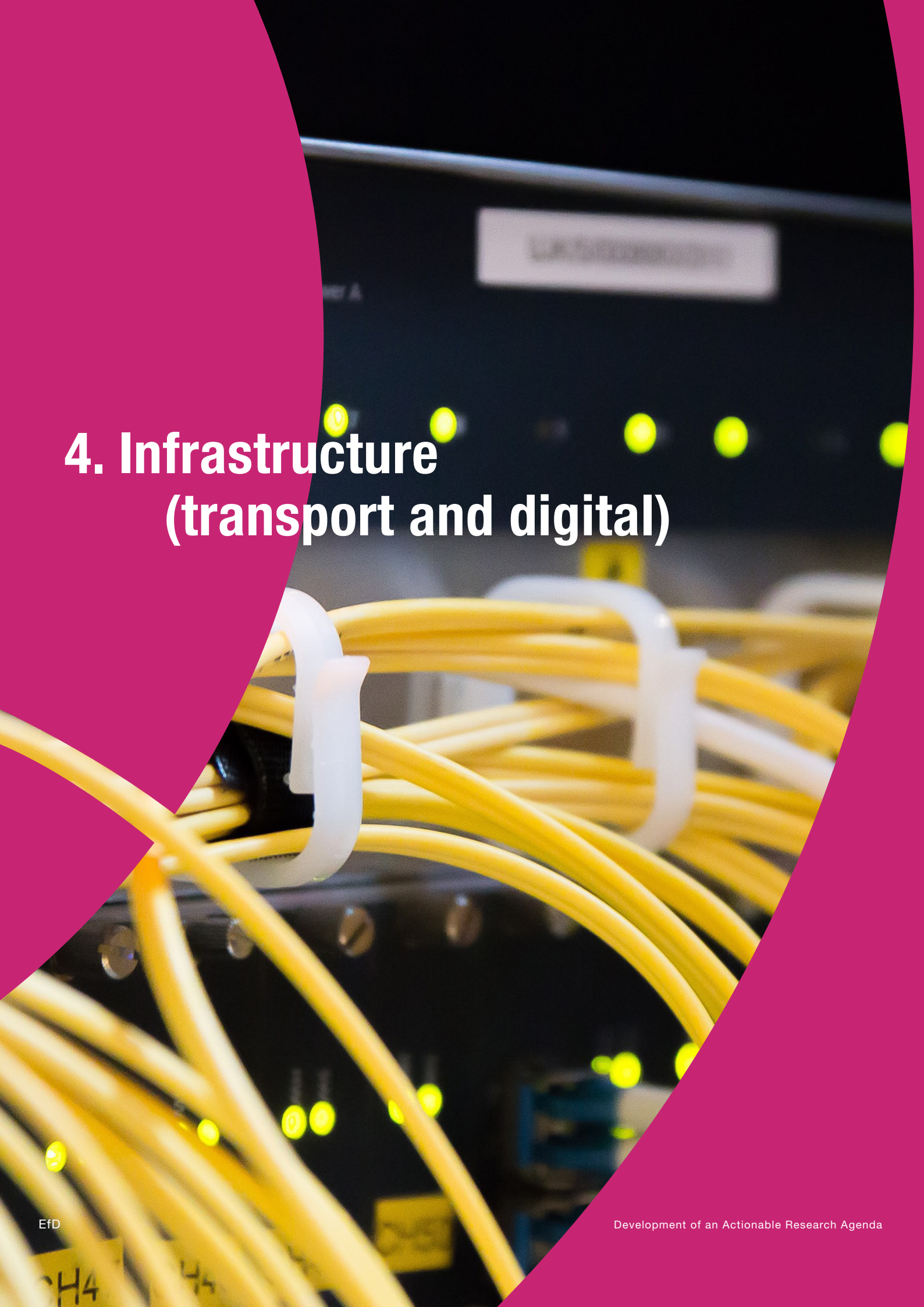
As part of the regional validation workshops[11] , the participants were asked to rank the opportunities for high-impact research on Sustainable Energy Transitions. Of the selected research opportunities considered in the ranking exercise for energy, "Identifying the relationship between low-carbon energy access and empowerment" and "Determining data and capacity gaps for designing better LCT policies" were the highest-ranked research opportunities across regions. In contrast, "Developing an intersectional research agenda" and "Facilitating comparative perspectives on policy assessment" were lower-ranked research opportunities across regions. The opportunities and results of the ranking exercise are presented in Figure 3.1.

11 The findings from this research agenda were validated by stakeholders from the public and private sector and civil society in regional workshops in Africa (South Africa), Asia (Vietnam) and Latin America (Colombia) in March 2023.

Figure 3.1 Ranking of high-impact research opportunities on Sustainable Energy Transitions at validation workshops



4. Infrastructure (transport and digital)



4. Infrastructure (transport and digital)

4.1 Introduction

THIS SECTION PROVIDES a systematic literature review of i) the impact of digital technologies on the energy system, social inclusion and household welfare; and ii) the impact of public-private partnerships (PPP) on low-carbon transport infrastructure on social inclusion in the Global South. The aim is to identify research gaps in these two thematic areas. Closing these gaps could inform actionable research in transitioning to a low-carbon economy in the Global South.

Infrastructure, whether hard or soft, is a catalyst of economic growth. Most developing countries face an infrastructure deficit. Moreover, the existing infrastructure has either deteriorated or been exposed to the adverse effects of climate change. The Global Center on Adaptation report (2020) suggests that developing countries should incorporate adaptation to climate change when planning new infrastructure. Examples include investment in climate-resilient infrastructure, such as low-emission energy generation and transport, nature-based solutions (NBS), and the digital economy, especially in urban centers (GCA, 2020).

Digital technology is being embraced by many emerging and developing countries, including those in Africa. Globally, investment in digital infrastructure rose during the COVID-19 pandemic era. It was hoped that this would reduce the negative impacts of the pandemic and assist the recovery of the world economy (Oldekop, et al., 2020). Digital infrastructure generates multiple effects. It can stimulate economic growth (Roller and Waverman, 2001), increase productivity (Hawash and Lang, 2020), foster knowledge spillovers and agglomeration economies (Tao et al., 2019), promote employment (Hjort and Poulsen, 2019), and improve the quality of life (Munoz and Naqvi, 2017). Arguably, digital infrastructure may help women create new businesses; more research is needed to understand under which conditions this will happen. Digital infrastructure has the potential to both reduce energy footprints and increase the consumption of energy; determining the net results requires context-specific research. According to Jones (2018), Information and Communications Technology (ICT) consumes significant energy, and it is estimated that it will consume more than 20% of the world's electricity by 2030. However, by improving operational efficiency, digital technologies can improve energy efficiency.

The low levels of electrification in the Global South raise a few key questions: (i) what is the impact of digital technology on the energy system (both demand and supply-side)? (ii) as energy consumption rises, how can the Global South use digital technologies to assist its transition to a low-carbon energy structure and (iii) how do the energy-related effects of digital infrastructure affect poverty, inequalities, social inclusion, and women's empowerment?

4.2 Motivation

4.2.1 Digitalization and Energy Systems in the Global South

Energy sector constraints can neutralize efforts to achieve sustainable economic growth. These constraints are likely to be particularly severe in the Global South, where inadequate investment in the energy sector has limited access to energy, with adverse socio-economic implications both for households and industries.

An emerging concern is whether investment in digital technologies (e.g., AI, sensors, home automated systems, smart meters, etc.) can hasten LCT and improve social inclusion and welfare. The current empirical literature is limited, particularly for countries in the Global South, and the available results are inconclusive, indicating that several factors might influence the way digital technologies impact different energy outcomes. For example, women and men, youth and elderly, and urban and rural dwellers differ significantly in their access to both digital technologies and energy resources. These heterogeneities reflect two ideas. First, the existing heterogeneities in digital technology access could account for differences between different groups in energy access and poverty. Second, the idea that digital technologies can hasten the transition to low-carbon energy and improve sustainable energy use suggests that addressing the potential digital divide within and among groups could play a critical role in promoting social inclusion and hence general welfare in societies. Specifically, this review discusses the general trends, challenges and opportunities in digitalization and energy systems in the Global South; the effect of digitalization on energy systems

(i.e., demand- and supply-side); and the implications of the energy-related effects of digitalization for welfare and social inclusion.

4.2.2 Public-Private Partnership, Gender, and Low-Carbon Transportation in the Global South

The fossil fuel-based transport sector contributes significantly to carbon emissions in the Global South, especially in countries such as China and India, both of which have an increasing middle class and increasing demand for personal vehicles, as increasing income has a strong impact on car dependency (Errigo and Tesoriere, 2018). The transport sector accounted for about 60% of global oil demand in 2020 (IEA, 2021) and about 20% of global carbon emission in 2020 (Statista,2022), driven largely by emerging economies in the Global South, such as China, Brazil, South Africa, Malaysia, Chile and India. This, coupled with the fact that the middle class is expanding in most of the emerging economies in the Global South, suggests that more research is needed on transport infrastructure and behavioral attitudes towards various transport modes, for any policy aimed at achieving a low-carbon economy to be successful in countries in the Global South.

In addition to the high dependence of the transport sector on fossil fuels, both for moving people and goods, there is low adoption of transportation modes that are less carbon intensive, such as public transport (coaches), electric vehicles, and others. To achieve some of the Sustainable Development Goals (SDG), such as reduced inequality (SDG 10), sustainable cities and communities (SDG 11), and climate change mitigation and adaptation (SDG 13), there will be a need to transform transport infrastructure systems in the Global South, which has the potential to act as a catalyst to achieve sustainability and inclusiveness (UN, 2021). Achieving such a transformation requires significant financing. However, countries in the Global South face financing gaps for their infrastructure development in general and specifically transport infrastructure. There are limited revenue-generating sources and increasing public debt levels driven by a significant dependence on borrowing to finance infrastructure projects. This suggests the need to find other financing options. One such financing option is public-private partnerships. The advantage of such a financing option, relative to traditional public-only or private-only financing, lies in three key areas. First, a PPP financing scheme shifts part of the financial burden of the project from the public sector to the private sector, and in the process frees some resources that could be invested in other areas of the economy. Second, the risks of the project are shared with the private sector, with performance rewards that promote efficiency. Thirdly, if the PPP scheme is well designed, it promotes transparency in the bidding process. These are all important requirements in delivering a low-carbon transport infrastructure in the midst of other important competing needs, such as better mobility options for under-served populations (Mahendra et al., 2021).

> **Transitioning to a low carbon transport infrastructure in the Global South will have social, economic and environmental impacts.**

4.3 Transportation transition

Transport infrastructure in the Global South comprises roads, rail, air, water, and sea, consistent with the types of transport infrastructure globally. Transport infrastructure in the Global South, especially in sub-Saharan Africa (SSA) and the Middle East and North Africa (MENA) is poorly developed relative to other developing regions. Data from Calderón et al. (2018) suggest that road density, expressed as kilometers of road per square kilometer of land area, was about 0.11 for both SSA and MENA in 1990, compared to 0.13 for Latin America and the Caribbean (LAC), 0.16 for East Asia and the Pacific (EAP) and 0.31 for Southeast Asia (SA). These values reflect spatial density and suggest a huge road transport infrastructure gap in these developing regions in terms of spatial density, generating socioeconomic divides between core and lagging areas (Scuderi et al. 2021).

Transitioning to a low-carbon transport infrastructure in the Global South will have social, economic and

environmental impacts. These will be determined by the rates of growth in motorization, demand for paved roads, and possibly less dependence on public transportation modes as countries develop. These will be discussed in terms of three broad areas: economic growth, improvement in environmental resilience, and strengthening social inclusion.

4.3.1 Economic growth

Transport plays a key role in economic activities through facilitating movement of people and goods. It is also a significant contributor to pollution and environmental degradation, especially in the existing transport system that heavily depends on fossil fuels. The OECD (2015) "projects that in the absence of further action to tackle climate change, the combined negative effect on global annual GDP could be between 1.0% and 3.3% by 2060, and as much as 10% by the end of the century". Such costs will have negative consequences on government finances that could otherwise be available to promote health, education, and employment. Investment in clean public transportation, vehicle efficiency, and a shift to electric vehicles with renewable electricity systems could create up to 23 million additional jobs a year globally. However, the growth benefits for the Global South are not certain, as several economies in the region depend heavily on export revenues from coal, oil and gas resources.

4.3.2 Environmental resilience

Transitioning to transport modes that are less carbon intensive, such as rail infrastructure that is powered by clean electricity, can reduce carbon emissions, as well as improving air quality, as shown by studies on India (Pangotra Prem and Shukla PR, 2012; Pathak Minal and Shukla P R, 2016). Investing in electric vehicle and the associated infrastructure, including decarbonizing electricity generation, can have a long-term positive impact on carbon emission reduction. Furthermore, improving public transport infrastructure, such as bus rapid transport systems (BRTS), has a significant potential to reduce carbon emissions, especially in urban areas. Sarkar Debasis and Sheth Anal (2021) provide some evidence on the positive environmental consequence of BRTS on emissions. Beside the environmental quality improvement of such low-carbon transport infrastructure, there are co-benefits such as improved air quality (which has positive consequences for health) and greater energy security (through less dependence on fossil fuels, especially for countries that are net importers of such fuels, as demonstrated during the current Russia-Ukraine war).

4.3.3 Strengthening social inclusion

Low-carbon transport infrastructure has the added advantage of promoting access to affordable clean energy, if part of the transition process also includes decarbonization of the electricity sector and making it affordable. The transition to such an energy system is likely to require policies such as support for technologies that reduce the unit costs of renewable power, removal of fossil fuel subsidies, and the imposition of carbon taxes.

Increased public transport provides more equal access to jobs, education, services and other economic opportunities, particularly to people without private vehicles and in underserved areas (WRI, 2022). For instance, in Mexico City, someone living in one of the wealthiest neighborhoods has 28 times better access to jobs in a 30-minute trip by public transit and walking, compared to those living in the poorest areas (WRI, 2019). To ensure a just transition, job opportunities should be integrated into low-carbon transport infrastructure to balance the jobs lost in the "old" technology sectors and provide some inclusivity in the transition process. Transition to a low-carbon economy may contribute to developing local economies, which could help enhance local job opportunities, if well-designed to cater to all groups in society.

A low-carbon transition must take into account gender differences in order to improve women's employment opportunities (Martinez et al., 2020; Matas et al., 2010). Transportation preferences vary by gender and income (Mahadevia and Advani, 2016). For instance, harassment of women on public transport is a pervasive global issue (Chowdhury and van Wee, 2020; Hoor-Ul-Ain, 2020; Infante-Vargas and Boyer, 2022.). Women perceive a greater risk of cycling than men do, and poor women are less likely to cycle, while poor men are more likely to cycle (Aguilar-Farias et al., 2019; Montoya-Robledo and Escovar-Álvarez, 2020).

The automobile and transport sectors are male-dominated (ILO, 2020). Therefore, as the share of electric vehicles increases, any associated job losses are likely to hit men's jobs the hardest. However, evidence of the impact of

increasing electric vehicles on jobs is mixed, with some analysis expecting EVs to cause job losses and other analysis expecting net gains (Dawson et al., 2019; Miller, 2020; OECD, 2022, ILO, 2020). This represents an opportunity to encourage women to enter the automotive industry, but more research is needed on what barriers women face in LMIC contexts and how to overcome them (ILO, 2020; Lytle et al., 2019). In terms of public transportation, women represent only 15% of global jobs, even though women are highly dependent on public transportation (2019; ITF, 2019).

4.4 The digital transition

Digitalization has recently emerged as one of the key instruments for the green economy agenda. The World Summit on the Information System +10 in 2015 and the launch of the Partnership for Measuring Information, Communication and Technology (ICT) in 2004, to improve ICT penetration in the Global South, are some of the critical policy-level discussions that emphasize the need to integrate digital technologies in the implementation of the sustainable development goals.

Digital technologies can decrease environmental effects through dematerialization, virtualization and demobilization (Berkhout and Hertin, 2001). Digital technologies can also improve the efficiency of production, distribution, and consumption of goods and services. They can help reduce material or energy demand through partial or whole substitution of virtual products and services for physical equivalents and can help decentralize human activities and interaction, with attendant effects on transforming behavior, attitudes and values of individuals, economic and social structures, and governance processes.

The African Union's Africa SMART initiative, in 2013, proposed introducing e-products (i.e., electronic IDs, e-applications, e-education, e-commerce, e-agriculture, e-health, etc.), unifying communication and cloud-based infrastructure, and strengthening broadband connections within the continent (Sausen, 2020). Elsewhere on the continent, the African Continental Free Trade Area (AFCFTA) also committed to expand the digital sphere by pursuing digital trade (i.e., e-commerce) across countries (Africa on the Rise, 2019). Within the financial sector, there has been introduction of e-money, mobile money platforms, and other electronic payment platforms. In the energy sector, SMART pre-paid meters and electronic payment platforms for energy bills are being introduced.

As of 2019, about 88 % of the African population lived within the reach of a mobile cellular signal, 78 % were within the reach of a 3G signal, and 44 % were within the reach of a mobile broadband signal (ITU, 2021). The number of individuals with access to the internet increased from 25 % to 29% between 2017 and 2019. The percentage of the population with internet access using mobile broadband increased from 26 % to 33% between 2017 and 2019 (ITU, 2021). Total investment in telecommunications in Africa amounted to US$ 6.7 billion in 2018; about 50% of this investment occurred in South Africa and Nigeria (ITU, 2021).

Whilst Asia and the Pacific and South and Central America boast some of the world's top economies in terms of digital technologies, internet speed and internet usage, these regions are very diverse, and there is a considerable digital divide. In Asia and the Pacific, while 90 % of the developed economies have access to the internet, only 15% of the least developed economies have access to internet usage (ITU, 2021). Similarly, in South and Central America, 90% of the developed economies have access to the internet, while 30% of the least developed economies have access to the internet (ITU, 2021).

4.4.1 Explicit and implicit constraints to digitalization in the Global South

Digital divide/exclusion: Digital divides by gender and age are greater in Asia and the Pacific and Africa than in Central and South America (International Telecommunication Union, 2021). A digital divide exists for different classifications (i.e., gender, location, and age) but appears starker for youth versus the rest of the population and urban versus rural. Generally, youth (aged 15-24) are better connected to the internet than the rest of the population, while urban areas are better connected than rural areas. In the case of gender, the disparity is generally narrowing for all regions, as demonstrated by the gender disparity score in internet access (see data presented in the related report on Infrastructure). While gender parity seems to have been achieved in the Americas, the disparity remains wide in Africa, the Arab states, the least-developed countries, and landlocked developing countries (see the report on infrastructure for the data).

Lack of local content: Digital technologies used in the Global South are mainly built by a few technology giants in the United States and China (Wakunuma, 2019). According to Michael (2018), proprietors of digital platforms, through their monopolistic nature, can deprive users of due process, equal protection, privacy, and other expressive liberties. As noted by Kwet (2019), digital monopolies give technology giants power over the users of their technologies. This creates a culture of dependency or digital colonialism (Kwet, 2019), and impacts significantly on the civil power of the technology's users (Moore, 2016). For example, the banning of Chinese technology giants – Huawei technologies and ZTE – by the Five Eyes Intelligence Alliance (which includes Canada, the United Kingdom, the USA, New Zealand and Australia) reflected fears that these telecommunication companies might gain access to useful information in those countries and, if pressured, release it to the Chinese government. Whilst digital technology gives users tools to support their economic activities, it also gives national governments digital power over users of technology; for example, governments may choose to shut down internet connections (Wakunuma, 2019).

Cost: The high cost of digital tools or technologies impedes general access and generates differentials by gender groups and social classes (ITU, 2021; Rizal et al., 2020; Maxwell and Maxwell, 2014). Within the Global South, there exist significant differences in internet access and quality, cost of internet, and ICT adoption (Keja and Knodel, 2019). The cost of importing material, the high cost of reaching remote areas, unregulated monopoly, and the introduction of digital taxes in Global South countries, such as Ghana, Uganda, Kenya, Nigeria, Rwanda, and Senegal, are emerging as key drivers of the cost of digital tools (Collaboration International ICT Policy for East and Southern Africa [CIPESA], 2022). Digital taxes, if not set equitably and efficiently, can negatively influence the rate of penetration of digital technologies. Countries that have implemented digital taxation have experienced a decline in access to the internet and in the use of internet and other ICT-related services (CIPESA, 2021).

Digital literacy: Segla (2019) found that, in the Yoruba community in Nigeria, illiterate people found it very difficult to use ICT. According to the Web Foundation (2016a), in Africa and Asia, women with secondary-level education are more likely to be online than women with a primary or lesser education level. Another study by the Web Foundation (2015) reports that women are 1.6 times more likely than men to report a lack of skills as a barrier to internet use. This has been confirmed by several other studies (Web Foundation, 2016b). Narrowing the existing digital illiteracy gap can be a recipe to reduce inequality to technology based on gender and other factors. Establishing what the nature of this nexus might look like is an interesting research agenda.

Structural barriers: Weak infrastructure systems, structural barriers, and low expectations of citizens in the Global South are other important constraints to using digital tools (Mahrenbach, 2018). The Dalberg Report (2013) cites core infrastructure and conditions of usage as the two key pillars for the successful functioning of the internet economy. In the Global South, the introduction of digital technology has outpaced the establishment of state institutions and legal regulations. These weaknesses continue to breed cyber insecurity issues, especially in economies where development is sluggish and poverty is high, providing opportunities for ill-intended cyber users (Schia, 2018).

4.5 Examples of research and policy driven transitions

This section summarizes the findings of a systematic review focusing on i) the impact of digital technologies on the energy system, social inclusion, and household welfare; and ii) public-private partnership (PPP) in low-carbon transport infrastructure and social inclusion in the Global South.

4.5.1 Digitalization

Applying various inclusion criteria to the dataset resulted in 68 studies, suggesting a nascent and not comprehensively developed research area. There is a paucity of research on how digitalization affects energy systems (demand and supply) in the Global South. The results are not conclusive. The results were found to be generally sensitive to the type of digital technology used, the context analyzed, and the method of analysis used.

Digitalization and Energy Supply

Despite several benefits of digital technologies to the energy supply chain, little is known regarding the potential impact of digital technologies on energy supply, particularly in the Global South. Banales (2020) analyzed the extent to

which digital technologies enable the decentralization of renewable energy generation. Similarly, Priya and Rekha (2020) underscore the importance of digital technologies (i.e., Software Defined Networking) in optimizing the use of renewable energy in Tamil Nadu in India. Shahinzadeh et al. (2019) explored the role of the internet in coordinating renewable energy supply and energy storage. In the case of Nigeria, Chukwuorji et al. (2019) suggest that the use of smart grids and distributed generation can improve the generation, transmission, and distribution of electric power.

Digital technologies and energy demand

Digital technologies exert both direct and indirect effects on energy consumption, but studies that estimate the overall effects of digital technologies are severely limited. In terms of the direct effects of digital technologies on energy demand, two key ecological footprints have been used, namely, carbon dioxide emissions and energy consumption. Studies using the former are premised on the assumption that energy consumption increases carbon dioxide emissions. Irrespective of the measure of ecological footprint used, the studies produced mixed results. A number of factors including context heterogeneity, differences in digital technology intervention, methodological robustness, and sample range-account for the heterogeneity in results.

Digitalization and sustainable energy consumption

The review shows that there is a paucity of studies on how digital tools influence energy efficiency in the Global South, and the results are not conclusive. Gains in energy efficiency related to ICT can also induce rebound effects, i.e., an increase in energy use in response to reduced energy prices. Depending on the relative size of energy efficiency versus rebounding use, these effects can compromise initial gains in energy efficiency. Therefore, a good assessment of the energy efficiency effects of digital technologies should also compute the associated rebound effects.

Social inclusion and welfare

Technological advancements have been linked to promoting social inclusion. Different technologies have been developed to help vulnerable groups, such as women, girls, the young and elderly, and persons with disabilities, to gain meaningful access to public, social and economic services (Hayes et al., 2008; Ashraf et al., 2017). With the aid of technological innovation, countries can make significant progress in reaching out to disadvantaged groups who lack proper access to energy services (World Development Report, 2019).

Geographical distribution of studies

For both the demand and supply side, in terms of regional focus, the bulk of the studies focused on countries in Asia (representing 40.6%), leaving a significant literature gap, particularly for Africa (representing 13.5%) and Central and South America (representing <1%). The impacts of different types of digital technologies on energy systems have been examined in the literature, ranging from digital infrastructure to use, access and skills/knowledge. Others, to a limited extent, have used monetary-based measures such as ICT trade (exports and imports) and ICT investment. We note that the choice of which digital technology to examine is informed first by the availability of data and second by the focus of the study. Studies interested in specific aspects of the digital process tend to focus on specific types of digital technologies, while studies interested in the whole digital process use more comprehensive measures that cover infrastructure, use, access and knowledge or skill. Studies examining the impact of the whole digital process are limited. A significant number of the reviewed studies examined the impact on energy consumption of mobile and landline phone ownership and, to a lesser extent, computer ownership.

A large number of the studies reviewed examined the impact of internet usage and access (mobile phone and fixed broadband) on energy consumption. As measures of digitalization, about 60% of the studies reviewed used ICT/electronic devices, internet connectivity, mobile phone and fixed telephone connectivity, and personal computers. Generally, the results appear inconclusive, as none of these digital technologies (i.e., mobile phone subscription, fixed telephone subscription, and internet connection) show a definite impact on ecological footprints such as energy consumption, energy supply and carbon emissions. A large part of these heterogeneities may be driven by the context, method of inquiry, and model specification. One important implication is that no single digital technology so far has proven to be effective in helping countries transition to a low-carbon economy. However promising the digital technology concerned may be, there is always a price to pay as countries adopt low-carbon technologies.

4.5.2 Transport

PPP and low-carbon transport

Research on the PPP in low carbon transportation in the Global South can be broadly grouped into four themes: (i) PPP and infrastructure provision, (ii) PPP and road transport provision, (iii) low-carbon transportation, and (iv) emissions and low-carbon transport infrastructure provision in large cities. Most of the studies on PPP and low-carbon transition were focused on road and rail infrastructure transport modes, with very little or no evidence for air transport. While most advanced economies are shifting from fossil fuel transport modes to electric vehicles, electric trains, and other modes, studies on the adaptation, financing and use of such transport modes are lacking in the Global South.

Passenger transportation demand in urban areas in most countries in the Global South is increasing due to rising population, income, and urbanization. These developments impose significant pressures on energy demand and emissions intensities associated with conventional transport and create issues of sustainability and energy security concerns. Policy-makers are seeking alternative transportation options that could jointly mitigate these risks. Nevertheless, there is a lack of literature on the quality of institutions in ensuring environmentally friendly PPP and transport infrastructure financing.

Gender and low-carbon transport

The few studies that exist have focused on gender inclusion and low-carbon transport while ignoring the PPP aspect. This is key in the provision of shared benefits in financing infrastructure, especially low-carbon transport infrastructure, where the inclusion of the marginalized in society is important to generate the expected environmental benefits.

Research gaps in public-private partnerships

Most of the studies on the PPP and low-carbon transport infrastructure provision in Asia are dominated by case studies on China and India, with very few studies on other countries in Asia. The same is true in the case of SSA, where most of the studies on road transport are in Kenya, Nigeria, and South Africa. In the case of Latin America and the Caribbean, Brazil, Chile and Colombia tend to have more case studies.

> **The role of digital technologies in facilitating the transition to low-carbon economies in various sectors is an important research area.**

4.6 Research gaps, missing knowledge or data gaps

4.6.1 Digitalization

Future research could include a thorough investigation of different internet traffic systems – fixed and mobile networks – and how that is influencing peak energy demand and supply in the Global South. Additionally, there is a need for research on the role of digitalization in facilitating low-carbon transition for sustainable natural resources management, consumption, substitution for energy-intensive materials, etc. Deeper investigation and pilot surveys into the sector dynamics of the energy-related effects of digitalization are vital, given that technology deployment and development are diverse across sectors. The role of digital technologies in facilitating the transition to low-carbon economies in various sectors is an important research area. In this regard, the transportation, building, and industrial sectors, which are key consumers of energy, deserve special focus.

There are technical limitations to quantifying the indirect effects of digitalization – in particular, the absence of well-developed methods that are capable of capturing the complex nature of the various relationships. Studies analyzing either the demand or supply side have relied on observational techniques that are low in internal validity. Studies adopting experimental-based design were found to be very limited. At best, the current literature presents evidence on association, not causal relationships, between digitalization and energy systems.

Rebound effects

Digital technologies continue to exert opposing effects on energy use, and it is not clear from the literature which effect dominates. One effective way to appreciate the actual overall effects of digital technologies on energy indicators is the ability to ascertain the digital rebound effect. However, the methodological requirement is complex, and the data is limited. There is a need to address database requirements and technical limitations in designing system-based dynamic approaches capable of handling the complexity involved.

Social inclusion

While there are studies examining the link between digitalization and social inclusion on one hand, and between digitalization and energy outcomes on the other, there is a lack of studies connecting the energy-related effects of digitalization on social inclusion and welfare. Important gaps exist in the literature on how social digital inclusion can promote gender equity in energy service delivery and, by extension, social inclusion and household welfare. Furthermore, an important knowledge gap exists on the role of government policies, such as taxation, on social digital inclusion, as well as equity in energy service delivery. Because digital technologies mostly originate from other cultures, there is a risk of digital colonization. Consequently, it is vital to understand the important role that local content and cultural values and norms can play in the design and implementation of digital technologies and the way they influence the energy service delivery gap between male and female, young and old, and rural and urban in the Global South. Studies that examine the intersection of gender, age, race, ethnicity, and so on within the digitalization-energy nexus are rare.

Tax and fiscal implications

Successful implementation of public policy depends on the fiscal regime, to the extent that it can impact the economic and social environment in which firms and individuals operate. With the need to improve the fiscal position in most developing countries, most governments are instituting digital taxes. While this might boost domestic revenue, there are concerns that such taxes can discourage innovation as well as the adoption of innovative technology (Kriechel and Ziesemer, 2006). Given that implementation of digital taxes in the Global South is at the experimental stage, more evidence is needed based on the ex-post assessment of digital tax policy.

Geographical distribution of studies

The limited number of studies in places such as Africa and some parts of Central and South America underscores the importance of data challenges and low adoption rate of digital technologies in these economies. Consequently, collecting good data and boosting the uptake of digital technologies in the energy sector will be the key to advancing knowledge on the role of digital technologies on energy systems in the Global South. Very few of the studies reviewed examined the impact on energy consumption of specific digital technologies such as Artificial intelligence (AI), teleworking, SDN, e-materialization, digital smart meters and sensors and automated processes. In the case of AI, we did not find any study, which is an important research gap. In the case of digital platforms such as Uber,

Airbnb, Netflix, and FinTech, we did not find studies examining how these digital platforms influence energy consumption in the Global South, nor whether there are distributional consequences in terms of gender and other factors.

Methodological challenges and capacities

The current literature is based on methods that are not robust in terms of drawing causal relationships. Quasi-experimental approaches (i.e., studies that take advantage of natural experiments, such as the introduction of new policies in selected locations) should be key for future studies that aim to draw causal inferences on the effects of digital tools on energy systems. For example, important questions for future research include how the introduction of digital technologies is impacting low-carbon transition in the energy sector and how that might promote social inclusion of different groups. Designing rigorous, integrated methods will be key to unravelling the complex relationship existing between energy efficiency and digitalization. This may require a more inter-disciplinary approach.

Existing studies have shown that some sizeable rebound effects are associated with digital technologies, but the empirical literature remains scarce and subject to technical constraints. No well-defined methods have emerged that accurately capture the exact magnitude of the digital rebound effect. First, it will be critical to develop a methodological approach that takes into account the complexity involved in quantifying rebound effects. Second, estimating the size of the digital rebound effect and what drives it are critical questions to consider in future research. Quantitative assessment of the impact of digital technologies on energy will be useful to ascertain the energy-related effects of different digital technologies. Moreover, with the deployment of renewable energy technologies, it has become necessary to look at the best ways to integrate such technologies into the energy system. In this regard, it is important to understand the important role that different digital technologies can play in ensuring the integration of renewable energy technologies into national energy systems.

Promoting the digitalization process would require, in addition to building competencies and capacities, creating the environment for the core infrastructure needs in electricity, education, and legal frameworks (to address the risk of e-fraud and internet crime). This opens a research avenue into how to close the infrastructural gap to promote the process of digitalization in the Global South.

4.6.2 Transport

Infrastructure modes: Most of the studies were focused on roads and rail infrastructure, with little attention to PPP and low-carbon air transport. Air transport infrastructure is becoming more important in the Global South countries due to increasing trade and integration. Therefore, studies are warranted on how PPP can help provide air infrastructure, bearing in mind climate mitigating measures.

Travel modes: We note a gap in the literature on the shift in travel mode towards low-carbon infrastructure at urban scale, such as electric vehicles and trains, with a few pioneering studies from Latin America and Asian cities (WRI, 2022). Sub-Saharan Africa lacks such studies. Thus, there is a need for rigorous analysis on PPP investment in such areas and how such investment may influence the demand for such transport modes. Policy-makers will be interested in studies that provide comparative analysis on the cost and benefits of such transport modes versus the traditional fossil fuel transport modes.

Infrastructure finance: Studies are lacking on the evaluation of PPP in low-carbon infrastructure investments relative to other investment models in providing such infrastructure in the Global South. The few studies that exist only evaluated low-carbon transport scenarios with a focus on rail transport for freight, and did not evaluate different transportation modes or assess either the economic or environmental returns of such investments. More analysis is needed on green finance and low-carbon transition in the Global South. The few studies that exist focus on Asian countries, such as those published under the NDC Transport Initiative for Asia, which aims to decarbonize the transport sector in the region. Empirical literature is needed on how banks and other financial institutions can raise green capital to finance low-carbon transport transition in low-income and developing countries, especially in cities, which contribute to 75% of energy-related greenhouse gas emissions (Satterthwaite, 2008). The focus can be on how banks can raise syndicated green finance for low-carbon transition transport in the Global South.

Institutions: Studies are lacking on the quality of institutions and political framework in ensuring environmentally friendly PPP in transport infrastructure. Such studies are important for the Global South , given the significant funding gap for adaptation associated with climate change for some regions, such as SSA.
Gender: There are few studies on the gender inclusion perspective of the PPP in low-carbon infrastructure provision. Women's mobility as it relates to their caretaking responsibilities is an important research direction which is lacking in the Global South, especially in SSA and other developing countries. For instance, recent analysis from two cities in the Global South – Mexico City and Johannesburg – finds that up to half of urbanites experience restricted transportation access, leading to high travel burdens and/or exclusion from opportunities (Venter et al. 2019). The studies reviewed did not consider the low-carbon transport network in rural areas, such as links between farming areas and market centers and the local economy in general.
Geographical disparity: There is a need for more country case studies in the Global South, comparative studies from different countries in the Global South, and some comparative studies between Global South countries and some Global North countries. More country case studies would allow us to build more evidence across different systems and needs in various contexts and allow countries to learn from each other's unique circumstances.

4.7 Opportunities for high-impact research

4.7.1 Digitalization

How does social digital inclusion impact equity in energy service delivery and, by extension, promote social equity and sustainable outcomes? How can digital inclusion be achieved? What are the implications for closing the social digital exclusion and energy service delivery gap?

What factors explain the different rates of adoption of digital technology in different countries and by different groups? What is the effect of digital colonization on digital transition and how does it influence the low-carbon transition agenda? How can culture and local context be integrated in the digital revolution?

What are the impacts of digital taxation? To what extent are digital taxes and social digital exclusion connected, and what is the implication of such connection on energy service delivery gaps and welfare? What is the optimal digital taxation regime that promotes social digital inclusion and helps address gender energy inequality?

What is the role of sector-specific digital technologies in term of an efficient transition to low-carbon? How are digital technologies impacting internal and external processes in industries' transition to low-carbon processes?

What are the impacts of digital taxation? To what extent are digital taxes and social digital exclusion connected, and what is the implication of such connection on energy service delivery gaps and welfare? What is the optimal digital taxation regime that promotes social digital inclusion and helps address gender energy inequality?

How does social digital inclusion impact equity in energy service delivery and, by extension, promote social equity and sustainable outcomes? How is digital exclusion in the Global South impacting inequality in energy service delivery? How can digital inclusion be achieved? What are the implications for closing the social digital exclusion and energy service delivery gap?

What is the extent of digital rebound effects? What factors drive digital rebound effects? What factors could explain how the digital rebound effect affects the transition to a low-carbon state?

4.7.2 Transport

What policies can incentivize widespread use of low-carbon transportation options? What are the behavioral responses to transformational low-carbon transport modes in the Global South? Which groups in society are most likely to adopt low-carbon transport modes and which groups are less likely to adopt these modes? Among the various low-carbon transport modes, which ones are more likely to be accepted by the population in the various countries in the Global South and by diverse groups in each society?

What are the implication of a transition to low-carbon finance in terms of gender and equity? Are women less likely to adopt mass transportation modes in the Global South and why (especially in urban centers)? How can all social groups be represented in the design, development, and operation of low-carbon transport infrastructure?
What are the financing and investment needs for a low-carbon transport system in the Global South? What financing options are best for specific low-carbon transport models in the Global South? How effective are public-private partnerships (PPPs) in financing option low-carbon

transport infrastructure in the Global South? What are the key challenges of the PPPs as a financing option in low-carbon transport infrastructure provision in the Global South? What are the key investment needs for low-carbon transportation infrastructure in achieving both development and climate objectives in the Global South? What are the effects of freight corridor projects on carbon emission? Are these effects conditional on the financing option? Are electric vehicles a viable low-carbon transportation alternative in the Global South, especially in the short to medium term? If so, in what form?

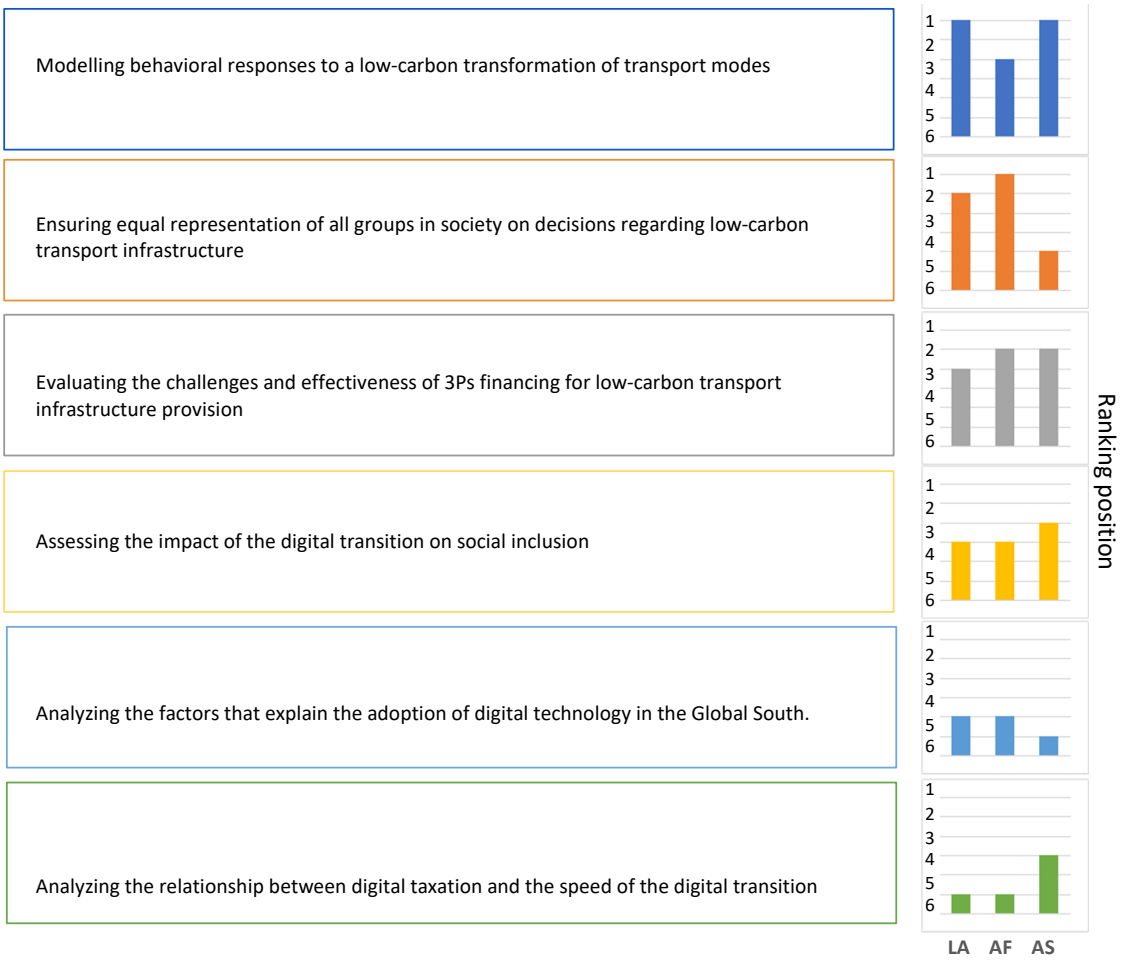
What are the implication of a transition to low-carbon finance in terms of gender and equity? Are women less likely to adopt mass transportation modes in the Global South and why (especially in urban centers)? How can all social groups be represented in the design, development, and operation of low-carbon transport infrastructure?

4.8 Regional priorities for infrastructure

As part of the regional validation workshops[12] , the participants were asked to rank the opportunities for high-impact research on Transport and Digital Infrastructure. Of the infrastructure research opportunities selected for the ranking exercise, "Modelling behavioral responses to a low-carbon transformation of transport modes" was ranked as the top priority opportunity in Asia and Latin America and was ranked third in Africa. The top priority opportunity for Africa was "Ensuring equal representation of all groups in society on decisions regarding low-carbon transport infrastructure", which ranked second in the Latin America workshop, but was ranked fifth in Asia. In contrast, "Analyzing the factors that explain the adoption of digital technology in the Global South" and "Analyzing the relationship between digital taxation and the speed of the digital transition" had low rankings across regions. The opportunities and results of the ranking exercise are presented in Figure 4.1.

12 The findings from this research agenda were validated by stakeholders from the public and private sector and civil society in regional workshops in Africa (South Africa), Asia (Vietnam) and Latin America (Colombia) in March 2023.

Figure 4.1. Ranking of high-impact research opportunities on Transport and Digital Infrastructure at validation workshops



5. Forestry and land use

5. Forestry and land use

5.1 Introduction

FORESTS PURIFY WATER, prevent erosion and floods, and provide food, cooking fuel, medicinal plants, building material, and saleable products. Furthermore, forests are responsible for much of the carbon removal by terrestrial ecosystems, which together remove 29% of annual CO2 emissions (~11.5 PgC; Friedlingstein et al., 2019). At the same time, an estimated 23% of total anthropogenic GHG emissions during 2007-2016 derived from agriculture, forestry, and other land use (AFOLU) (IPCC, 2019a). Therefore, it is critical to identify which forest and land use activities result in net reduction of GHG and which result in a net increase. Forest loss not only releases a large amount of carbon to the atmosphere, but also significantly diminishes a major pathway for carbon removal long into the future (Houghton and Nassikas, 2018). Tropical forests, which hold the greatest amount of aboveground biomass and have one of the fastest carbon sequestration rates per unit of land area (Harris et al., 2021), face the greatest deforestation pressure (FAO, 2020).

Land and nature-based approaches in the agroforestry and forestry sectors have the potential to generate win-win outcomes toward achieving environmental goals and the Sustainable Development Goals, particularly SDG 15 (Elias et al., 2021). Forests are home to more than three-quarters of the world's life on land; some 13.2 million people across the world have a job in the forest sector and another 41 million have a job related to the sector (WWF, 2015). Forests are also home to many indigenous peoples and local communities who steward their resources and rely on them for their survival and well-being.

In the past 15 years, there has been growing interest in the potential of nature-based solutions (NBS) to help protect human beings from climate change impacts while slowing further warming, supporting biodiversity, and securing ecosystem services (Cohen-Shacham et al., 2016; Nature, 2017). NBS have been defined by the International Union for Conservation of Nature (IUCN) as an umbrella concept that embraces a number of different ecosystem-based approaches and a set of general principles (Cohen-Shacham et al., 2016). The approaches include (1) restoration, (2) issue-specific (such as ecosystem-based adaptation and disaster risk reduction), (3) infrastructure, (4) management, and (5) protection. The general principles emphasize that NBS should embrace nature conservation norms and cultural contexts, and should be integrated with other solutions to societal challenges – for instance, forest-based solutions should be incorporated with norms and rules of indigenous groups and pastoralist communities, who, in most contexts, are vulnerable, with weak or insecure land and resource use rights. Most importantly, NBS recognize and address the trade-offs between the production of a few immediate economic benefits for development, and future options to produce the full range of ecosystem services. In addition, there is great potential to foster synergies among climate, biodiversity, and land conservation agendas, as well as gender equality, through nature-based approaches (Elias et al., 2021).

Forest and land use pathways account for 69% of the aggregated climate mitigation potential of the top 20 natural pathways of NBS identified by Griscom et al. (2017).

Forests are the largest carbon pool in the terrestrial ecosystem, and forest policies have low-cost and technological advantages as NBS pathways, whilst facing challenges in science-based designs in tree planting, to meet multiple goals of mitigating CO2 emissions and other impacts on biodiversity, landscapes and livelihoods (Di Sacco et al., 2021). However, studies quantifying this potential in low- and middle-income countries, and identifying the necessary institutional and policy support, have been scant (Osborne, 2021; Edwards et al., 2021).

5.2 Motivation

NBS can reduce poverty and inequalities, due to their low cost and supply of co-benefits, such as income-generating activities and health improvements. To ensure that these benefits accrue across marginalized populations, research is needed to better understand the conditions under which NBS can be successful at both environmental and inclusion levels.

However, NBS pose possible risks to gender equality if climate policies are not responsive to gender issues (Elias, 2021). Women, especially rural women, are disadvantaged in access to land and forest resources, as well as related management rights and access to markets (Jost et al., 2016).

Men and women in forest and rural areas have different roles within households and in their labor activities. Women usually have to take care of children, and are also responsible for harvesting fuel and collecting water; at the same time, they may be responsible for farming, stall-feeding livestock (which may also graze in the forests), and production from non-timber forests products (Kristjanson et al., 2019). In rural areas, women have less ability to adapt or migrate in response to climate-related disasters; this is due to discriminatory norms, mobility constraints, and the lack of education, which could increase their opportunities outside of the natural resource sectors (Wong 2016). Women coming from minority ethnic groups (including indigenous groups) may confront further disadvantages compared to their counterparts coming from the majority ethnic groups or urban areas (Torres et al., 2018). Though women play critical parts in forest economies and agriculture, the existing impact studies on these sectors rarely acknowledge the gender dimension.

5.3 The potential roles of forestry and land use in low-carbon transition

5.3.1 Carbon sequestration

Forests' role in removing carbon dioxide from the atmosphere, and storing it, cannot replace emission cuts, but it can help offset emissions, and enable countries to achieve net-zero sooner. Between 1990 and 2007, the world's forests captured as much as 30% of the total yearly emissions of GHGs generated by fossil fuel combustion, cement production and land-use change (Pan et al., 2011). Making full use of the potential of NBS is an empowering opportunity to help lower-income countries meet net-zero goals, especially in places where large shares of emissions come from the land sector (Anderson et al., 2019).

The global terrestrial C sink has been increasing over time (–0.2±0.9 Pg C yr–1 source in the 1960s to a sink of 1.9±1.1 Pg C yr–1 in the 2010s) (Friedlingstein et al., 2020). Recent analyses demonstrate that NBS pathways could be deployed at the scale of billions of metric tons of CO2 equivalent (CO2e) per year, at costs below US$100 per metric ton CO2e (Griscom et al., 2017). Such pathways include both decreasing emissions and increasing carbon sinks on agricultural land, forests, grasslands, and wetlands. Afforestation and reforestation are well-established approaches which can store carbon as well as enhance biodiversity (Catching carbon, 2022). However, the benefits of afforestation are constrained by land availability. Successful implementation of any carbon dioxide removal approach will require careful consideration of other land-use needs. About half of the world's habitable area is currently devoted to agriculture (Ritchie, 2019). One way to expand capacity is through agroforestry, whereby trees are incorporated into agriculture such that the land can support food production, carbon uptake, and increased biodiversity (Catching carbon, 2022).

“

Successful implementation of any carbon dioxide removal approach will require careful consideration of other land-use needs.

5.3.2 Co-benefits beyond mitigating climate change

A major attraction of NBS is the potential co-benefits beyond carbon sequestration, including improved biodiversity, forests, croplands, grazing lands, and wetlands that support human health and well-being. In some places, especially in rural areas of low- and middle-income countries, the co-benefits of NBS may be more valuable than the carbon mitigation benefit. The prospect for alignment between climate and other goals increases the attractiveness of NBS and the motivation for rapid deployment, especially where policy and governance frameworks support inclusive and participatory NBS approaches with a reasonable level of monitoring (Anderson et al., 2019).

Prior forest restoration studies are at global or tropical scales (Bastin et al., 2019; Brancalion et al., 2019; Busch et al., 2019; Griscom et al., 2020, 2017; Strassburg et al., 2020), and have neglected inclusivity – the potential importance of restoration by smallholders and the potential impacts on women and ethnic minorities.

Focusing on smallholders and inclusion of disadvantaged

population groups in designing and implementing forest restoration projects provides a vital opportunity to advance the objectives of inclusive low-carbon transitions. These groups of people tend to live in highly biodiverse and threatened landscapes (Erbaugh et al., 2020; Samberg et al., 2016) and are exposed to multiple hazards, including climate change (Cohn et al., 2017). Their demographic strength, role in rural land-use decisions, poverty, and exposure to food insecurity make them key stakeholders in determining where and how to restore tree cover, as well as the success of forest restoration projects.

Forest restoration activities can have tremendous effects on community economics by generating regional employment, income, and other economic impacts, often in places that have experienced widespread reductions in logging and milling infrastructure over the last three decades (Hibbard and Karle 2002; Hjerpe et al., 2021). For example, ecological restoration is an alternative in Latin America and Argentina, not only to reverse the ecological degradation trend, but to promote socioeconomic development that is better integrated with nature (Echeverría et al. 2015; Zuleta et al., 2015). Forest restoration also yields community benefits in terms of reducing catastrophic wildfire risk, protecting local water supplies, and enhancing a broad set of ecosystem services (Dubay et al. 2013).

Forest restoration influences and also is influenced by human population dynamics, particularly migration (Vincent et al., 2021). Forest restoration projects may lead to human migration, and it can also be the case that rural-to-urban migration opens up space for forest expansion. There is an emerging recognition that out-migration from original communities might change demand for land and lead to forest restoration (Oldekop et al., 2018). In some cases, government investments in forest restoration projects have displaced populations (Leblond et al., 2014). China's Sloping Land Conversion Program (SLCP) was launched in 1999 in response to catastrophic flooding, and is found to have induced households in many locations to shift their income sources first from crops to livestock, and then to off-farm work (Gutiérrez et al., 2016).

5.4 Examples of research and policy-driven transitions

Over 40 developing countries designated forestry policies to mitigate climate change during the period 2015-2022. Positive examples in the South include Costa Rica in Latin America and Nepal in Asia. Brazil illustrates the risks associated with political factors. While Brazil's National Congress altered the country's Forest Code in 2012, resulting in increased deforestation and emissions (Roriz et al., 2017), the government elected in 2022 has announced its intention to protect the Amazon. In African nations' NDCs, AFOLUs are noted as among the key sectors with potential to reduce GHG. Africa has many successful PES projects (see examples in the regional paper on Africa), some of which successfully promoted the inclusion of vulnerable groups and reduced poverty.

Carbon trading markets allow for forest carbon offsets and the trade of carbon credits. Some developing countries have been involved in the climate mitigation mechanism of the United Nations known as reducing emissions from deforestation and forest degradation in developing countries (REDD+) (Angelsen et al., 2014).

A growing number of countries have decentralized forest governance (RRI, 2018; Agrawal et al., 2008). Almost 30 % of all developing countries' forests are now managed by local communities, well over twice the share for protected areas (RRI, 2020; Chape et al., 2005). Equally important, but largely ignored by researchers and policymakers in other low- and middle-income countries with rich forest resources, is evidence that reforms that decollectivize communal lands – i.e., reforms that convert communal farmland or forestland to private or quasi-private smallholdings – can boost investment in forest management and increase forest area through reforestation (Vincent et al., 2021). Vietnam (Quang et al., 2015; Nguyen et al., 2010) and China (Yi et al., 2014; Liu et al., 2017) provide leading examples of this effect.

A few countries of the Global South have incorporated gender considerations in their plans and strategies for using forest and land-based ecosystems for low-carbon development (RRI, 2017). For instance, Bangladesh, in its Climate Change and Gender Action (ccGAP, 2013), has emphasized women's role in the agricultural sector, creating an environment to lease land or water bodies to women

and provide financial support, such as crop insurance, and training, such as improving capacity to take up alternative technologies. Cambodia's Climate Change Strategic Plan (2013) recognized that women are most vulnerable to climate change impacts because of their high dependence on agriculture and natural resources. Ethiopia, Gambia, Tanzania, and Uganda recognize this vulnerability too (Fisher and Mohun, 2015).

Case studies offer lessons for inclusivity in the process of low-carbon transition, climate change mitigation and adaptation. In Mozambique, Tanzania, and Nepal, community-based natural resource management and climate change adaptation plans took into account the needs of the local resource-dependent people and helped reduce pressure on fisheries, forests, and freshwater; these approaches have helped women – almost to the same extent as their male counterparts – earn income, feed their families, and lift themselves out of poverty (CARE-WWF Alliance, 2019). In India and Nepal, regulatory reforms introduced quotas and membership rules to increase local women's participation in community forest user groups, thereby opening spaces for women in community forestry (Wagle et al., 2017).

REDD+ processes have highlighted the need for more secure rights to land and resources among women and marginalized groups as a precondition for more sustainable land management decisions. Gender-responsive REDD+ can lead to inclusive low-carbon transitions (Larson et al., 2015; Vallenjos, 2020). A number of studies have provided positive links between tenure security – especially women's rights to land – and incentives and capacities to invest in sustainable land, soil, and environmental management (e.g., Etongo et al., 2018; Meinzen-Dick et al., 2019). Tseng et al. (2021), in their global review of 117 studies, found a positive relationship (in 32 studied cases) between improved land tenure security and environmental outcomes, including more sustainable agricultural practices, improved forest condition, and investments in agroforestry and forest conservation. They identify both trade-offs and win-win situations among human well-being and environmental outcomes. Specifically, they examine women's empowerment across nine countries (Ethiopia, Kenya, Rwanda, Tanzania, Zambia, India, Nepal, Vietnam and Peru). The distribution of effects indicates positive effects of enhanced land tenure security (72% positive). In Uganda, Ekesa et al. (2020) link improved tenure security for women and men with an increased diversity of species grown on those lands. However, the positive outcomes should not be taken for granted, and the value of secure land rights and/or other conditions is worth investigating.

5.5 Research gaps, missing knowledge or data gaps

5.5.1 Systematic understanding of social and economic costs, benefits, risks and uncertainties of land-based NBS

Achieving the potential of climate change mitigation by land-based ecosystems will depend on a systematic understanding and quantifications of social and economic costs, benefits, risks and uncertainties of using NBS. Investors weigh expected benefits against opportunity and establishment costs, assessment of risks and uncertainties when deciding whether to adopt a NBS that aims at decarbonization and/or low-carbon transition. Case studies should uncover precise data while investigating the factors that determine successes or failures of land-based NBS. These factors include costs, benefits, risks and uncertainties, as well as the distributional patterns of these factors – either by location, context, culture, or population group, such as youth/poor/women/indigenous – which will have important implications for future planning of forest and land-based programs for inclusive low-carbon transitions for different contexts.

5.5.2 Roles of different forest policies in low-carbon transition

Any forest policy must consider impacts on climate change mitigation through human activities. Of special importance are the following three potentially inter-related arenas, all of which have important implications for the welfare of women, youth, and other vulnerable groups. We find scant research in these three areas:

Sustainable forestry through better forest institutions. In principle, forest sector reforms can improve forest management—and as a result, forest ecological health, potentially carbon sequestration and local livelihoods. Drivers of such improvements include empowering forest users who may have the best understanding of local conditions and constraints; strengthening these actors' incentives to manage forests for long-term returns; and facilitating the flow of technical assistance to local levels

(Blackman et al., 2017; Somanathan et al., 2009; Ribot, 2008). Chhatre and Agrawal (2009) find that community forests with more autonomy supply more carbon sequestration while also supporting local livelihoods. This implies the need for research that identifies the conditions and forest institutions in which devolution of forest management to local communities produces positive outcomes in terms of both environmental and societal goals.

In the past two decades, several studies have examined the links between forests and rural livelihoods (de Sherbinin et al., 2008, Hogarth et al., 2013, Porro et al., 2015, Sunderlin et al., 2005, Thanh et al., 2015, Yemiru et al., 2010, Zenteno et al., 2013), but few have examined how these factors affect success or failure of forest-related climate adaptation policies. They are of crucial value because forest-dependent communities may need special market or social incentives to change their livelihood strategies.

Constructing markets and pricing that support climate change mitigation.

People in rural areas of low- and middle-income countries depend on a variety of products from forests, perhaps the most important being biomass fuels, which are used on a daily basis by over 1 billion people worldwide, often collected by women (Jeuland et al., 2015; Cooke et al., 2008). This dependence is expected to decline relatively little in the coming decades (IEA, 2020). While there are many concerns about dependence on biomass for cooking, it does create an economic incentive to increase forest area and invest more in forest management (Favero et al., 2020; Vincent et al. 2021). A necessary condition for positive environmental outcomes is that market demand –and prices for timber (and other wood and non-wood products) increase at rapid rates, combined with policies that reward forest carbon sequestration. This could propel scaling-up substantial forest restoration in low- and middle-income countries (Vincent et al. 2021).

Economic incentives for forest conservation are needed because of the competing uses for land, including both subsistence and commercial agriculture. Case studies and quantitative evidence focusing on this necessary condition and the supply- and demand-side incentives in specific Global South countries and other important conditions – such as technological innovation in extending the lives of wood products, and industrial policies for replacing energy-intensive materials by wood products– are currently scant and worth continued study.

Forest policy with gender dimension.

The literature has had a limited focus on gender and intersectional elements of identity. They are of crucial value to investigate because certain populations may need specific incentives to adapt during the process of low-carbon transitions. For example, ethnicity and wealth level in terms of physical asset holdings determine rural households' forest-based living strategies among indigenous and migrant settler populations in the Ecuadorian Amazon (Torres et al., 2018). It is natural that age, ethnicity, and social conditions could determine rural households' consumption preferences and constraints in time/labor supply, and their access to markets for factors of production, including land, labor, and capital. Hence, case studies focusing on distributional patterns of impacts of forest-related policies – and, in particular, these population groups' willingness to transition to a low-carbon economy – will inform policymakers. Without understanding how impacts may be distributed, we will not be able to facilitate an inclusive transition.

5.5.3 Gender equality

There is a lack of awareness at the institutional level of the importance of paying attention to the roles of women and/or youth in forestry and land-based solutions to low-carbon transition. However, a few low- and middle-income countries (e.g., Zambia's ccGAP in 2018) explicitly aim at women's empowerment and gender equality in setting national climate targets.

Gender disparities in climate change vulnerability not only reflect pre-existing gender inequalities, but also reinforce them (Panitchpakdi, 2008). Inequalities in the ownership and control of household assets and rising familial care burdens due to male out-migration, declining food and water access, and increased disaster exposure, can undermine women's ability to achieve economic independence, enhance their human capital, and maintain health and well-being. These effects appear to be most salient in states that are relatively less democratic, with greater dependence on agriculture, and lower levels of economic development (Eastin, 2018).

There are high research needs in understanding whether land-based policies to meet climate change mitigation and adaptation targets have reinforced gender inequality and what lessons can be learned. There exists a base of studies in

this area (see Choma et al, 2016 for example). Still, further investigations relying on rigorous methodology in providing causal impact estimates are crucial for policy-makers to make appropriate decisions. This type of research will offer critical evidence and more knowledge on the necessary conditions for low-carbon transitions to be gender-responsive.

5.5.4 Investment and financing

The cost of forest restoration of a vast area usually exceeds the financial resources available from governments and international development organizations. Scaling up restoration requires engaging the private sector as a source of capital, labor, and land. In turn, private-sector participation requires that investments earn a return from timber harvests, carbon payments, and other revenue streams (e.g., from payments for ecosystem services). The return must exceed the return from competing land uses, or else landholders will have insufficient incentive to invest in restoration.

Almost all such investment has come from institutions in OECD countries (Binkley et al., 2020). In the past two decades, forestry investment has shown that it can offer financial as well as environmental, social, and governance benefits due to its nature as a truly long-term asset and its ability to provide both cash flow and duration matching. However, these markets are merely emerging, and challenges exist in understanding how careful reforestation, afforestation, and sustainable management activities are planned, conducted, and maintained.

Forest bonds, pension fund plans investing in forestry, and timberland investment have been studied in a few countries – mostly limited to OECD countries – and shown to have attractive risk-adjusted total returns, so that they can be used as an effective hedge against inflation (Binkley et al., 2020). Research is needed to evaluate their applicability in specific developing-country contexts.

5.6 Opportunities for high-impact research on forest and land use

WhatWhat are the most cost-effective and cost-beneficial land-based NBS for low-carbon transition?
Do these solutions vary by global, national, and regional scale? What is the carbon sequestration potential of land-based pathways of NBS? What are the co-benefits of using land-based pathways of NBS, including wood fuel harvest and forest employment? What are the opportunity costs of land and labor for land-based NBS pathways? What other risks and uncertainties exist for land-based NBS pathways, including risk of deforestation, population change, exchange rate fluctuations, conflicts, accessibility to cities, etc.?

How will forest carbon pricing and carbon market work in LMICs?
Will the evolution and implementation vary across and within different types of LMICs? What lessons can be learned from research on policies designed to increase the use of renewable energy sources for electricity generation? For example, how can comparisons of pricing instruments and other climate policy instruments (e.g., carbon trading markets or carbon tax versus carbon emission standards or renewable portfolio standards) offer insights for forest carbon pricing? What interactions exist between direct comparisons of pricing vs. other command-and-control instruments in terms of impacts on environmental effectiveness, economic efficiency, market outcomes, revenue generation, and stakeholder engagement?

What are the investment and finance flows for land-based NBS, including forest restoration, to unlock the potential of forestry and land use change in LCT?
What financing is needed, on a country-specific basis, with attention to cross-country comparisons on private investments and financing?

What are the impacts of forest restoration in LMICs?
Does forest restoration create jobs and increase supply of woody biomass and wood products? How can forest restoration be balanced with food production, income generation and development needs, based on systematic understanding of the competition for land with food production and other land uses? How can land-based solutions in marginal agricultural land be designed for forest restoration? How will this contribute to climate mitigation and population migration?

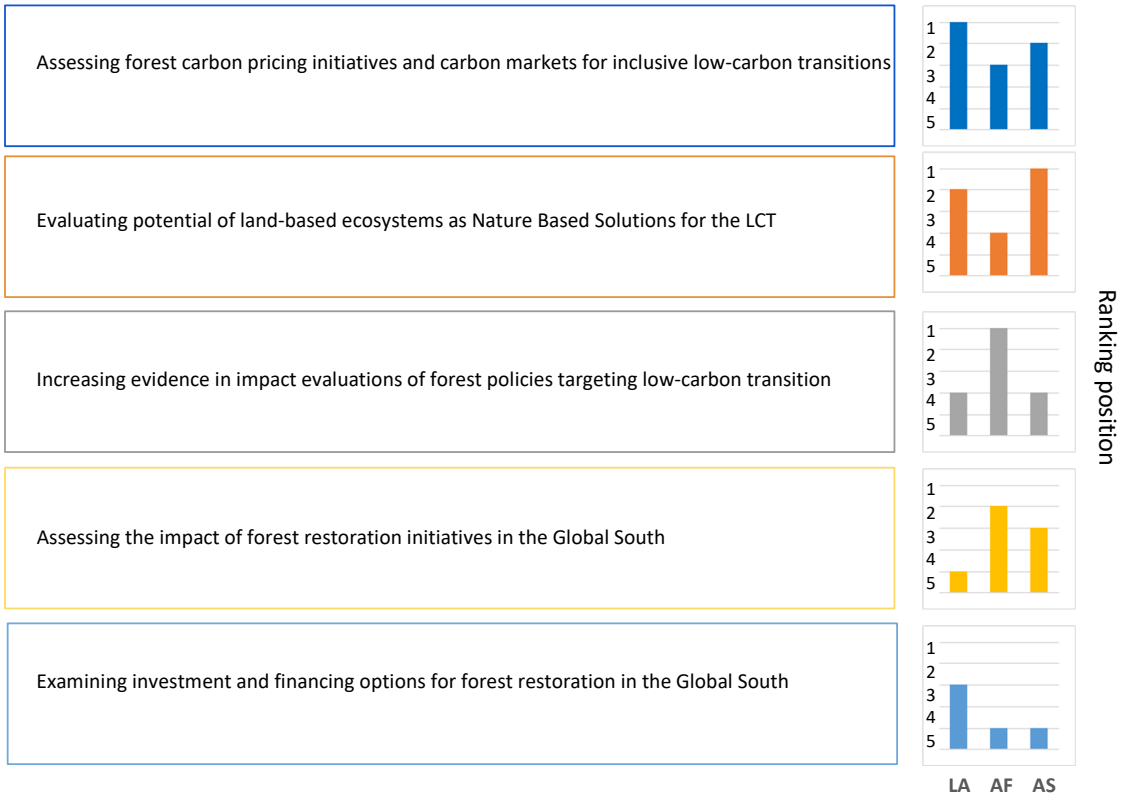
What are the impacts of forest policy instruments?
How do the impacts vary by population groups? In particular, how do the impacts of land and forestry based NBS vary by gender and its intersection with other characteristics? What lessons can be learned from various policy instruments aiming at development and low-carbon transition in low- and middle-income countries?

5.7 Regional priorities on forestry and land use

As part of the regional validation workshops[13], the participants were asked to rank selected opportunities for high-impact research on forestry and land use. "Assessing forest carbon pricing initiatives and carbon markets for inclusive low-carbon transition" and "Evaluating potential of land-based ecosystems as NBS for the LCT" were ranked as high priority research opportunities in Asia and Latin America. For Africa, the top ranked opportunities were "Assessing the impact of forest restoration initiatives in the Global South" and "Examining investment and financing options for forest restoration in the Global South". "Examining investment and financing options for forest restoration in the Global South" was the lowest ranked research opportunity in Asia and Africa, while "Assessing the impact of forest restoration initiatives in the Global South" was the lowest for Latin America. The opportunities and results of the ranking exercise are presented in figure 5.1.

13 The findings from this research agenda were validated by stakeholders from the public and private sector and civil society in regional workshops in Africa (South Africa), Asia (Vietnam) and Latin America (Colombia) in March 2023.

Figure 5.1. Ranking of high-impact research opportunities on Forestry and Land Use at validation workshops



6. Enabling policy environments

6. Enabling policy environments

6.1 Introduction

THE FIRST PRIORITIES of the emerging economies of Asia, Africa, and Latin America are generally to secure conducive economic conditions for their populations. This is often interpreted as promoting economic growth (e.g., as specified in the target of 7% growth in GDP per year in the Sustainable Development Goal target 8.1). However, when economic growth is simply measured as GDP (the sum of production of goods and services in a year), it leaves out both changes in the stock of natural capital and the distributional or equity outcomes of growth. GDP was not designed as a welfare measure, and neither is it a good indicator of a successful LCT. Efforts to reduce climate change can impose costs, but also can be seen as an opportunity for industries and utilities to innovate, develop and venture into newer markets. Ultimately, the welfare cost of climate change will necessitate a LCT. The international and national policy environments will affect the speed and cost of the LCT. A coordinated effort by all sectors and institutions to develop an enabling policy environment for the necessary actionsto implement a successful LCT.

This section highlights the role of research in enabling such a policy environment, with a focus on the energy sector. We first review the role of agents (political, economic, social, etc.) in the various energy sectors, and how they can accelerate (or try to hinder) energy transitions in low- and middle-income countries (LMICs). We focus on coal as a key sector, given the high dependence in many LMICs and the urgent need to transition away from coal to achieve overall climate goals. Following that, a review of policy instruments lays out the scope of policies and their potential impacts. Finally, a review of the methods to assess policy impacts will help identify best practices.
Policy relevance and its impact on climate targets vary across country contexts, and so there is no one-size-fits-all strategy. Developing countries continue to strive for better institutional capacities, ease of doing business, policy coordination, and political will. All of these will impact the design, implementation, and continued effectiveness of energy and climate policies. Policy instruments such as carbon pricing can slow the increase in emissions, but politicians in developing countries typically dislike them, citing their potential to negatively affect long-term growth (Steckel et al., 2017). A broader understanding of what policies are in action, how they interact with the actors involved, and how their impacts are measured, can provide guidance on what more is needed to accelerate the transition to a low-carbon society in the Global South.

6.2 Motivation

To grow their economies and eradicate poverty, developing countries need to build on the key comparative advantages at hand. For some countries, this may be minerals or tourism, while for others it can be trade, agriculture, or industry. Those with large endowments of fossil fuel often develop this sector for exports. Others have relied on fossil fuel imports to meet their energy needs. However, the impact of climate change will be felt the most strongly by the same countries. Most developing countries thus see the need for climate policy but contend that they need fossil fuels so they can industrialise quickly and cheaply. For instance, Sub-Saharan Africa has contributed the least to GHG emissions but suffers the most from the impacts of climate change. The African Group of Negotiators (AGN) failed to secure several key demands at COP26., including developed nations' primary responsibility for climate change, obligations to mobilise adequate financing (both existing commitments and long-term financing), and commitments to provide technology transfer.

However, to avoid the worst effects of climate change, developing countries will need to transition, because they are expected to account for most future emissions. For instance, although Africa currently has the world's lowest per capita GHG, its emissions are likely to increase substantially due to projected population and economic growth, fossil fuel consumption, and agricultural expansion (UNEP, 2021). Consequently, agriculture, forestry, electricity, transportation, mining, construction, and manufacturing are all at risk of becoming locked into high-carbon development pathways if no actions are taken. In addition, although it may appear simpler to buy diesel generators and coal-fired power plants, countries that follow this path may find themselves with stranded assets, i.e., outdated machinery.

The varying levels of economic and social development across the Global South, as well as differences in legal and political traditions when it comes to property ownership, economic structure, and social relations, will determine the applicability of different policy instruments in different countries. For instance, tradable emission permits should not be the first step in countries with little experience of markets or private property.

Pulling their citizens out of energy poverty, by providing access to reliable and affordable energy, is often the priority for poorer countries. However, this does not mean that low-income countries need to repeat the technology sequence experienced in the OECD. Leapfrogging to modern renewable technologies may have many co-benefits in terms of cheap access to communication and, relevant skills and knowledge. Research is needed to promote development that is sustainable, increases employment and reduces poverty, and has positive equity effects.

6.3 Analysis of economic interests affecting decarbonization

One of the first steps in assessing policy options is to understand the socioeconomic forces that have formed the status quo in each country. LCT policies often interfere with powerful interest groups. To determine feasible policies, it is necessary to systematically study various interests, their specific objectives, and their power and resources. Agent analysis needs to consider the objectives of specific policy-makers. For instance, specific ministries might prioritize employment or economic growth over sustainability targets, while some NGOs might lobby for specific environmental targets but lack a comprehensive perspective on the policy-making processes. There are major differences between countries that are dominated by fossil fuel interests and others that import fossil fuel (and may have alternative energy resources as hydro).

Political economy is challenging to disentangle from other economic constraints. For example, fossil industries might be an important source of state revenue or key for providing regional employment. It is crucial to understand which actors are key for fostering (or blocking) specific policy goals and related instruments.

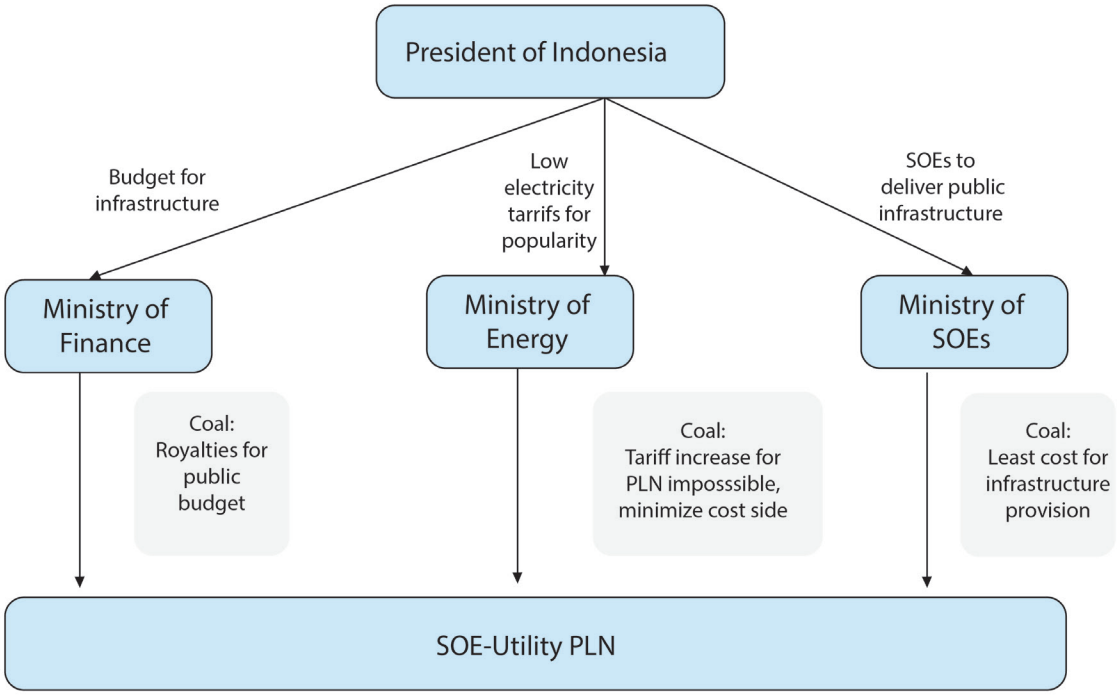
The actor, objective, context (AOC) framework (Jakob et al., 2020)Objectives, Context' provides a way to systematically analyse the role of actors in energy transitions. Based on this framework, with a focus on countries that still invest in coal, Ohlendorf et al., (2022) find that ministries of energy, heads of state, and ruling parties are consistently the most important political actors for energy policy, while ministries of the environment are generally less important. Elite groups as well as industry associations – utilities, mining companies and heavy industry – are among the most important societal actors, while unions, international organizations, and environmental NGOs play a smaller role in p0olicy-making. Yet, the importance of specific actors in the policy making process varies starkly between countries. In many countries, local actors (e.g., in coal mining regions) are very important. Country-specific analysis is needed to unravel the interconnections among political actors and other societal and economic actors. For instance, coal dependence is high in China, India, Indonesia, as well as South Africa. These countries are exploring varying options, and encountering various barriers, to phase out coal.

The objectives of powerful interests are often highly varied. While utilities and heavy industry are interested in low electricity prices, regardless of the energy source, mining companies depend on coal. Political strategies to counterbalance specific actors' resistance to climate and energy policies hence differ dramatically. Research in specific countries can guide policy-makers in leveraging the political power of actors that can benefit from LCT.

There are countries in Africa, Latin America, and Asia where powerful fossil fuel interests pose a challenge to LCT. Indonesia is presented as one of many possible examples. Figure 2.1 illustrates how actors in Indonesia and their specific objectives (e.g., to keep electricity tariffs low or to deliver public infrastructure) align for a specific policy outcome (here, to build more coal-fired capacity). Policy packages aimed at LCT in Indonesia would need to take those specific constraints into account.

For the case of phasing out coal, taking into account

Figure 6.1: Schematic overview of actors and their incentives (in this case: to build more coal-fired capacity) for the example of Indonesia



Notes: SOE stands for "State-owned enterprises"; PLN is the Indonesian electricity utility. *Source: Ordonez et al. 2021*

specific actor constellations and the related political economy, Jakob and Steckel (2022) (based on 15 case studies) propose differing strategies for various country groups. Countries that already are phasing out coal (mostly OECD countries) usually have liberalized energy markets in place, which would allow for pricing instruments to effectively accelerate the transition. In established coal-using countries, such as India or China, structural reforms of the electricity markets might be necessary before pricing instruments can become effective. Coal-mining countries (such as Indonesia, South Africa, and Colombia) will need to find ways to deal with potential losers of a phase-out policy, including coal workers. For countries that currently are thinking of phasing in coal, such as Bangladesh or Pakistan, it is important to support the introduction of cleaner alternatives; these, however, will require additional capital and technological and institutional capacities to work effectively.

There are analogous interests when it comes to countries that are endowed with oil or gas. Research is needed to determine LCT strategies that distinguish between countries that use their limited resources for their own consumption and those that export oil and gas.

In all countries and fossil fuel sectors, research is needed to identify the effects on poverty and equity, from indigenous coal miners to female rural household heads who rely on remittances from those coal miners.

6.4 Policy instruments for de-carbonization

This report reviews the landscape of policy instruments available across sectors using two review methodologies: systematic review and (traditional) literature review of reviews. We start with policy instruments for decarbonization and turn then to research on political acceptability.

6.4.1 Review of policy instruments for decarbonization and associated impacts

Climate policy can take many different forms. In some countries, adaptation or agricultural and forestry policies are most important. Prevalent policy instruments are often concentrated in the renewable energy (RE) sector. Yet, many accompanying policies play a crucial role in moving toward low-carbon economies. This section focuses on specific policies and their efficiency for outcomes such as emission levels and environmental sustainability, while also including effects on gender equity, economic growth and income distribution, and other social and technical outcomes. Three major focus areas are policies for renewable energy, for energy access, and for energy efficiency.

Renewable energy is of particular interest to developing countries. A two-way causal relationship has been found between economic growth and renewable energy (Acheampong et al., 2021), with the effects of renewable energy on economic development and vice versa depending heavily on the development level of the country.

For obvious reasons, countries in the tropics generally have an advantage for solar energy, while appropriate conditions for wind energy vary. Africa has great potential for renewable energy, including solar, as well as geothermal potential from the Rift Valley. African nations are increasingly adopting renewable energy subsidies; eventually, much of the continent's electricity could come from green sources. As of 2018, renewables accounted for 26% of power generation in Africa (IRENA, 2020). Green energy could create jobs for those displaced from the fossil fuel sector.

Whether renewables play an important role in a given country also depends on financial capital and technological capacity. China and India have significant opportunities for investments in renewable energy (RECAI, 2020). In India, the National Solar and Wind Missions and various schemes such as Renewable Purchase Obligations (RPO) have resulted in increased RE capacities, but not so strongly in the share of RE electricity over 2007-14 (Government of India, 2015). China has added the most RE capacity in the world due to several national Energy Development plans (strategy, action, and five-year plans) and financial instruments such as tax relief and feed-in-tariffs (Government of China, 2018).

Some studies have also found that income growth and institutional quality have positive impacts, while urbanization has negative impacts, on the growth of renewable energy (as tested for Bangladesh by Islam et al., 2022). Chinese investments in RE projects in sub-Saharan Africa are found to have 'bounded economic benefits' in terms of new job opportunities, production and training activities, and linkages with local systems, among other impacts (Lema et al., 2021). Further, hybrid renewable energy systems (with batteries or diesel generators as backup) are found to perform better in Asian countries than in African nations because of access to mini-grid maintenance and productivity.

Energy access tends to be a paramount objective in low-income countries. Electrification marks the initial access to sufficient electricity for a household to power a basic bundle of energy services. A review of the climate and development implications of electrification projects in the Global South reveals a concentration of studies from India and a small set of literature from Sub-Saharan Africa, Latin America, and East and Southeast Asia (Jeuland et al., 2020). Using the multi-tier framework for energy access from the World Bank (Bhatia & Angelou, 2015), lower-tier access is supplied by off-grid or solar technologies and provides basic energy services such as lighting, phone charging and basic entertainment; this entails lower emissions, unless the services are powered by diesel generators. High-tier access allows heating, cooling, and cooking, which is predominantly provided by grid-electricity, and is highly emission intensive (Jeuland et al., 2020).

The effect of electricity interventions on socio-economic factors has been most studied in South Asia (India, Bangladesh) and Sub-Saharan Africa (Kenya, Ghana) (Moore et al., 2020). Effects were positive (but moderate) for education, household welfare, health, work-leisure time allocation, environment, and female decision-making. Given

that energy access is a key Sustainable Development Goal, a review of the impacts of modern and traditional energy use finds that shifting towards modern energy services is an important step in economic development but may also cause environmental and even development challenges. Policies around cooking as an energy service are the most reviewed in the literature, with its impacts on household health and climate effects examined more than its impacts on gender equity, household income, or local environmental quality (Jeuland et al., 2021). In terms of the impact of energy interventions on SDGs, evidence is consistently positive on poverty alleviation but largely negative on climate, ecosystem and forest outcomes and mixed for health outcomes. Comparative and country-specific research is needed to understand these mixed outcomes and to gain insights to steer energy policy in a direction that is equitable with respect to poverty, gender, and vulnerable populations.

Energy efficiency measures can be adopted in industry, building, and transport sectors or at the national economy-wide level. India and China, as high emitters, have a particular interest in such policies (Fekete et al., 2021). India implemented the National Mission on Enhanced Energy Efficiency, which contained the Perform, Achieve and Trade (PAT) scheme for industries, Market Transformation for Energy Efficiency (MTEE) for appliances, and additional frameworks for financial instruments development. In the buildings sector, India implemented the Energy Conservation Building Code (ECBC) and Green Rating for Integrated Habitat Assessment (GRIHA) to establish and promote minimum requirements for energy efficient buildings (Ministry of Power, 2018). In the transport sector, fuel efficiency, GHG emissions standards, and the National Electric Mobility Mission are instrumental in driving energy efficiency efforts.

China's goal of industrial energy efficiency and reduction in energy intensity is facilitated by standards, subsidies, financial policies, and government-backed investment funds under its Climate Change Action Plan (2014). Mandatory green building codes and retrofitting standards promote energy efficiency in China's building sector (IEA, 2019a, 2019b), while the 100 Energy Efficiency Standards Promotion Program supports energy efficiency in the appliance sector (Government of China, 2011).

Transport energy efficiencies are met through fuel efficiency standards, quotas and financial incentives that support electric vehicle development (Bloomberg, 2017). An assessment of energy efficiency policy instruments for emission reduction in buildings found appliance standards, building codes, tax exemptions and voluntary labelling to be the most effective, as compared to Kyoto Protocol flexible mechanisms or energy/carbon taxation (Ûrge-Vorsatz et al., 2007). The assessment also noted that a portfolio of instruments, rather than single instruments, were necessary for utilizing synergies and reducing drawbacks. Further, it is important to support sectoral regulations with economy-wide policies that raise the price of emissions and make efficiency profitable.

6.4.2 Revenue recycling and public support for carbon pricing policies

Less than 10%[14] of the countries in the Global South have explicitly implemented an emission pricing mechanism (World Bank 2022). At the same time, several countries implicitly price carbon through fuel taxes, excise duties, pollution charges, or reducing or eliminating fossil fuel subsidies. Since all these market-based instruments involve increasing the price of fossil fuels for the final consumer, they are sometimes met with strong opposition. An understanding of how to gather public support to successfully implement a carbon pricing policy thus becomes imperative. In addition, the distributional consequences must be studied in specific contexts; for instance, changing kerosene subsidies is likely to affect women differently than men, and rural households differently than urban households.

Revenue recycling – earmarking the proceeds from carbon pricing for alternative purposes such as cash transfers, environmental projects, or tax exemptions – can make carbon pricing more acceptable for the public. This

14 Countries with carbon taxand /or ETS in the Global South: Argentina, Chile, China, Columbia, Kazakhstan, Mexico, and South Africa.

review[15] aims at examining public attitudes for different revenue recycling mechanisms and the level of support for carbon pricing policies. The review focuses on studies that use surveys – primary or secondary data – to assess these relationships. Fourteen studies were finalized for the review based on full text screening. The studies comprised 16 surveys (datasets) capturing different carbon pricing policies – carbon tax, fossil fuel tax, environmental/green tax – and analysed 46 revenue recycling (RR) schemes representing 34 unique schemes; see Table 1 in the separate paper on Enabling Policy Environment. They include, for instance, refunding to all citizens or targeting to the poor, green spending of various kinds (transport, infrastructure, renewables, etc), and green spending targeted to the poor.

Carbon pricing policies have mostly been implemented in developed countries, and these studies were concentrated amongst developed countries.[16] While a few countries in the Global South are considering introducing similar pricing/taxation policies, studies on revenue use from such taxes, have not yet been much developed. Although some studies have examined the willingness to pay for a carbon tax (in the case of India - Gupta, 2016) and the economic and distributional effects of a carbon tax with revenue recycling (for Peru - Malerba et al., 2021, and China, Cote D'Ivoire and Ethiopia - Timilsina, 2022), there are few studies that look at public support for these policies in the presence of a revenue recycling scheme.

The surveys in the study elicited opinions from the general public for carbon or fuel pricing, using representative population samples in most cases. The surveys were either experiments, stated preference, or generic household data surveys.

Most of the studies in this sample showed an increase in public support for carbon pricing policies, relative to earlier studies. Most of the earlier studies did not explicitly state how revenues would be used, and the increased approval in the more recent studies was more pronounced when revenue recycling was included as a package within carbon pricing policies. However, in many countries, some respondents see government revenues lost to inefficiency or corruption. A research agenda to assess public attitudes in developing countries should explicitly describe options for spending the revenue from carbon taxes.

The preference for green spending is reflected in the real world, with 70% of the revenues collected through the sale of emission permits under various cap-and-trade systems spent on 'green spending' such as support for energy efficiency or renewables while only 9% of the revenues was directly returned to taxpayers or individual consumers. By contrast, 44% of the revenues from carbon taxes are returned to taxpayers through other tax cuts and rebates, while 28% are tagged as being used to supplement government general funds (Carl & Fedor, 2016).

When revenue recycling is not considered, the cost of carbon pricing tends to fall more heavily on lower-income people in higher-income countries, but it tends to fall more evenly (or more heavily on higher-income people) in lower-income countries (Verde & Tol, 2009; Q. Wang et al., 2016). There are several reasons for this, including the fact that the poorest people in developing countries are unlikely to own cars.

Regional insights: distributional effects of carbon pricing and energy subsidy reform schemes: distributional effects of carbon pricing reveal that the effects are highly country-specific (Price, 2020; Steckel et al., 2021). A meta-analysis on the distributional effects of carbon pricing finds increased probability of progressive impacts within lower-income countries and for transport policies (Ohlendorf et al., 2021; see also Sterner, 2012). The impact depends on the consumption patterns of energy (Dorband et al., 2019), as well as on the carbon intensity of a country's energy system (the amount of carbon emitted per unit of energy), the use of revenue from carbon pricing, and the level of development. For carbon-intensive sectors (with above-average capital-labour ratios), carbon pricing reduces the returns to capital more than the returns to labor (Goulder et al., 2019). The estimated analysis of the distributional incidence of carbon

15 The review followed the Population, Intervention, Comparison, Outcome (PICO) framework and used SCOPUS or Web of knowledge databases. See the related paper on Enabling Policy Environment for fuller explanation.

16 The review covered 11 countries, including Australia, Canada, Germany, Italy, Norway, Spain, Sweden, Switzerland, UK, and USA, with Turkey as the only somewhat lower-income country.

pricing (a carbon price of US$ 40/tCO2) for nine LMICs – Argentina, Bolivia, Ethiopia, India, Indonesia, Nigeria, Peru, South Africa, and Vietnam – finds little support for systematic distributional effects. In fact, the variation in the effects of carbon pricing was more within expenditure quintiles, than across quintiles (Steckel et al., 2021). An estimation of carbon price incidence on different income groups in 87 LMICs found that a carbon price of US$ 30/tCO2 displayed a progressive effect on countries with a per capita income of below US$ 15,000 per annum (Dorband et al., 2019).

A review of distributional impacts of fossil fuel subsidy reforms for different developing countries finds that welfare losses are significant for all households on average (Arze del Granado et al., 2012; Coady et al., 2015). Distributional effects of a subsidy reform depended on the energy carrier and the nature of subsidies, amongst other factors. For instance, for Indonesia, progressive distributional effects were found in the case of gasoline subsidy cuts, while the impacts were marginally regressive for electricity, LPG, and kerosene (Renner, 2018). In China, the distributional effect of transport fuel (oil products) subsidy removal had the strongest and the coal subsidy removal had the weakest progressive effect (Jiang et al., 2015). While Ecuador faced public protests for its subsidy reform policy, which led to a reversal of the reform, an analysis of distributional effects found the subsidy removal to be regressive for diesel and LPG, progressive for gasoline, and neutral for electricity (Schaffitzel et al., 2020). A case study analysis of energy subsidy reform in Indonesia, Iran, Dominican Republic and Ecuador, where subsidies were regressive and often favored the rich, found that the success of any energy subsidy reform hinged on a well-structured revenue recycling program – in terms of targeted cash or lump-sum transfers programs – and in some cases depended on creating an enabling environment by informing the public of the reforms well in advance (Moayed et al., 2021). Comparing just the two categories of emission pricing, the evidence still lacks support for a hypothesis that subsidy reforms are inherently more progressive than carbon pricing (Ohlendorf et al., 2021).

Market experiences: Political and Institutional realities: Political struggles and institutional (and administrative) incapacities are found to play a significant role in hindering policy implementation or the rolling back of carbon pricing policies. Amongst the developing countries where emission pricing (tax or ETS) has been implemented, there are numerous examples of political and institutional barriers before and during the implementation. In Indonesia, there was a lack of commitment to considering a carbon tax, specifically by the powerful Ministry of Finance (Dyarto & Setyawan, 2021). This was compounded by engagement of business players in the political arena to protect their investments in fossil energy. Similarly in China, climate policy is partially opposed by business interests and insufficiently protected by levels of government that lack institutional capacity (P. Wang et al., 2019). In Kazakhstan, Kazenergy (2017) showed how climate policies were hindered by non-transparency in pricing of allowances, which in turn was related to the development of an oligopolistic allowance market and issues related to the fairness of the emission certificate allocation.

In the case of Latin America, a case study analysis was directed at the nature of the political system, including the presidential system and the centralisation of the budgetary process, that promoted the implementation of carbon taxes. By combining a carbon tax with other fiscal policies under the revenue acts, passing carbon taxes resulted in lower administrative and capacity building costs (Stevens, 2021). The political will and use of institutional power of the governments to strategize energy as a transformation in the national interest further facilitated speedy approval. Chile has played a somewhat pioneering role; see Coria and Sterner 2010.

6.5 Methods and approaches to policy assessment

A range of methods can be used to assess the policy implications in ex-ante as well as ex-post analyses. The appropriate techniques for impact assessment depend, first, on what the impact assessment is trying to achieve, and, secondly, on the data and resources available. Our review of studies on impact assessments of low-carbon policy instruments shows that scenario-based assessments (at an

economy level) of low-carbon policies on emissions levels and socio-economic indicators are seen to largely use energy modelling approaches. These include:

- ***Energy system models*** – that use simulation, optimization, accounting and hybrid models as methodological approaches (Mundaca et al., 2010). Examples include the Residential End-Use Energy Planning System (REEPS), Market Allocation (MARKAL) model generator, Model of Energy Supply Strategy Alternatives, and their General Environmental Impacts (MESSAGE), and Long-Range Energy Alternatives Planning (LEAP), amongst others.
- ***Economy-wide models*** – include partial equilibrium models, general equilibrium (GE) models (such as CGE), macroeconomic models, static and dynamic models (varying in the time dimension), and agent-based modelling (Davies & van Seventer, 2019)
- ***Social-economic microsimulations*** – estimates at the disaggregated scale of household and individual business impacts of macroeconomic policy choices and shocks. These generally use estimated elasticities of demand and/or supply.

At the sectoral level, there are more methods for assessment that are discussed at greater depth in the separate paper on Enabling Policy Environments.

In addition, both econometric and qualitative methods of analysis are required to assess the effects of different policies on important issues such as income distribution, gender equality, and democratic and participatory values.

It is important to point out that countries need their own domestic capacities for policy assessment and that many of these methods are complicated. While handy "off the shelf" programs do exist, there is no short-cut to painstaking development of robust and useful methodologies that really can be useful within the different socioeconomic and cultural contexts that uniquely characterize each country.

6.6 Examples of research and policy driven transitions

Transition to a low-carbon society is at different stages across the Global South regions and countries. Various policies across energy sectors have contributed to this, some positively, providing evidence for best practices for replicability, and others negatively, providing lessons for better policy-making.

As the backbone of the low-carbon energy transition, renewable energy (RE) development policies in the three regions have been the clearest evidence of policies implemented; they offer a host of development implications that favour growth, employment, and the environment. The surge in renewable energy has been helped by the Sustainable Development Goals, notably SDG 3 (health and well-being) and 7 (affordable and modern energy) (Goldthau et al., 2020). The capacity addition of renewables has been driven by financial incentives, discounted lending, and tax preferences aimed at reducing the high fixed (capital) costs for setting up the capacities. Other policies that have accelerated the market penetration of renewables at grid and off-grid levels have included feed-in-tariffs, tax credits, tradable certificates, and production quotas (Zhao et al., 2013). Energy efficiency policies – in the industrial, transport and residential sectors – have contributed to emission reduction from production and consumption processes. These policies mostly cover urban consumers and commercial businesses that receive sufficient electricity and have more than average consumption levels. These have included efficiency labelling for appliances, fuel economy standards for passenger and freight transport systems, energy efficiency lighting (LED bulbs) in homes, and energy-efficiency requirements in building codes and housing and public sector retrofits. Alongside emission reduction, the policies have provided net economic benefits to the users in terms of cost savings, energy security, energy access, and emission savings.

Research and policies on energy access have focused on promoting off-grid electrification options and clean cooking technologies that shift energy use away from traditional cooking methods. The policy push is driven not only by the goal of GHG reduction, but also by the co-benefits of energy security, health benefits (less fuel burning means less air pollution), gender empowerment (pulling women and children out of drudgery) and escaping energy poverty (access to energy for productive use). With the focus on rural areas and least developed countries (LDCs), this sector has received engagement in terms of policy pushes from governments and investments from international donors. Research in evaluating the impact of policies for micro-financing projects, solar lanterns, micro-grids, and improved cookstoves has highlighted the positive but also more problematic impacts of the policies across regional

contexts (Anser et al., 2021; Goldthau et al., 2020; Göras & Mohajer, 2016; Ilskog & Kjellström, 2008).

Each policy must be evaluated closely – at different points in time – to ensure that it is having the intended benefit. In sub-Saharan Africa, for instance, the pandemic-induced economic slowdown and the invasion of Ukraine are among the reasons that households recently connected to the grid lost the ability to pay for electricity, and that owners of LPG stoves could not pay for LPG refills (Africa Energy Outlook, 2022). It is important, therefore, to note that each policy must be evaluated closely to ensure it is having the intended benefit. Despite the success stories mentioned, it is also important to be clear that nowhere near enough is being done to achieve a timely exit from fossil fuel and avoid the worst consequences of climate change. To redesign policies and to achieve more, it is important to learn from both successes and failures, and not least to understand the structure of those special interests that still have an interest in blocking climate policy.

6.7 Research gaps, missing knowledge, and data gaps

Public (social) and political acceptance studies: There is a need to undertake more studies that create a link between social or public support and political acceptance of climate policies in the Global South. These can be achieved through assessment of voter behaviour, analyzing what matters and has priority for policymakers, etc. Given the small number of Global South countries that have implemented emission pricing mechanisms, any analysis of the distributional impacts of carbon pricing have been ex-ante (Koh et al., 2021). Similarly, ex-post analysis of revenue recycling options, as ways to gain public acceptance, has so far concentrated on developed country experiences. Those studies are largely lacking in the Global South. This limits the understanding of whether and how inclusion of revenue recycling in policy design would affect the social and political acceptability of carbon pricing in a developing country context.

Political Economy: Much of traditional policy analysis is overly naïve, as if following a cookbook recipe for optimal policy-making for social planners. However, the real world is governed just as much by raw jostling for economic benefits as it is by objective considerations of optimal governance. Taking the political economy into account can alter first-best considerations for climate policy-making. Yet, in countries of the Global South, only limited evidence is available that contributes to understanding the political economy of energy transitions in general and climate policies in particular. Conceptually, limited knowledge is available as to how carbon pricing (and other climate policies) would work given the political realities of the Global South, including high levels of the informal sector, a low tax rate, and high levels of informal fuel use. Empirically, understanding existing actor networks and vested interests, which is key for successful policy design, is largely lacking in country-specific contexts. This lack of knowledge also prevents a profound discussion of how to deal with the potential losers of an energy transition (including workers, incumbents, and shareholders) and how to effectively compensate those actors, in order to gain public and political acceptance. Another crucial aspect is the moral obligation and practical ability of the rich countries to pay a fair share of global climate efforts by providing much needed assistance to developing countries struggling to transition to sustainability.

Gendered impacts: Policy impacts across sectors and regions have predominantly been assessed from an economic, social, welfare, and environmental perspective. The aspect of gender in terms of equality, equity or empowerment has been engulfed within socio-demographic characteristics and has not received independent assessment. Gender roles and their interaction with energy and development policies are commonly studied among urban poor and rural population studies, and in the context of energy poverty and access to improved cooking and lighting energy sources. Analysis in other sectors – industrial, renewable, transport – and urban demographics is more limited. Moreover, the differentiated impact of policies on men and women is also heavily understudied. In Africa, for example, social impact assessments for electrification projects have not been consistently monitored or disaggregated by gender. Consultations, policy planning, and decision-making in the energy sector do not always consider gender and social inclusion issues and stakeholders. Since women and other vulnerable groups are left out of energy plans and surveys, baselines for measuring development benefits usually do not exist. In cases where gender has been examined, the factor has been narrowly defined as, for instance, decision-making power in the

household, or access to finance.

Comparative assessments across regions: Studies on impact assessment of similar policies differ in research design, methodology and data characteristics used for the analysis. On a broader policy level, energy-economic models permit comparability, but this is not possible for specific policy instruments targeted in sectors and implemented on a sub-national level. This limits the insights that can be gained from comparing political processes, policies, or outcomes. The variety in infrastructure, institutional capacity, and growth levels across countries and regions determines the characteristics of the policy portfolio suited for implementation in those regions. However, the comparison of policies across similar impact categories can highlight the best practices, common challenges, and lessons on what worked where, while also providing the scope to explore replicability of policy design and processes or business models.

Data availability at regional levels: Publicly available data on various policies and their specific details is limited, particularly for some West African countries, parts of East Asia, and many countries in Latin America. Detailed survey data for empirical analysis can be difficult to obtain and may not always be open access. This reduces the scope of comparative policy assessments to scenario- and assumptions-based modelling practices, with less practical, on-the-ground relevance. Academic research can contribute to gathering data to fill these gaps.

6.8 Opportunities for high-impact research in enabling policy environment and policy instruments

How can the evidence base on LCT be expanded through ex-ante and ex-post evaluation of policy instruments? What are the distributional impacts of carbon pricing?

What does regional comparative analysis highlight regarding best practices, common challenges, and lessons learned? Can the policy design and processes or business models be replicated in other areas? What factors drive the different impacts across regions?

How can public preference and political acceptance be linked with policy instruments? How is political feasibility modified over time in the context of sequenced choices? Does revenue recycling increase public acceptance?

How do the political and institutional actors within the political context determine which energy policies will be pursued by the country? What are the barriers to coordination among ministries that have different objectives?

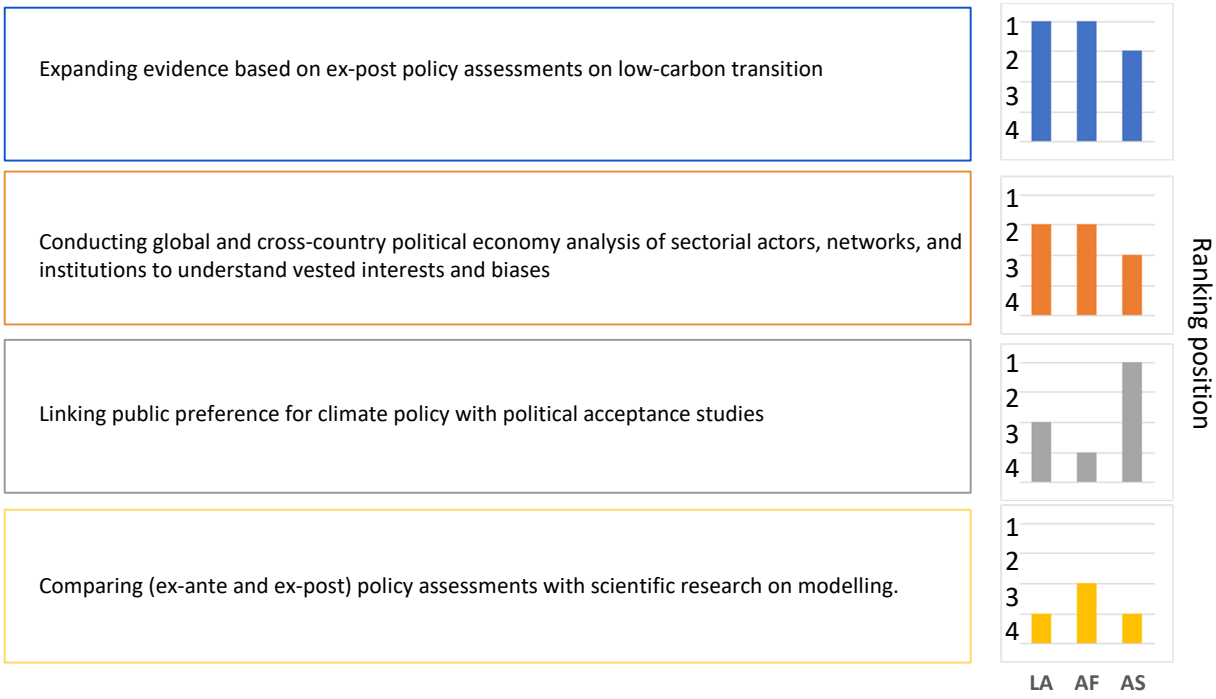
What are the existing actor networks and how do their vested interests influence policy-making in country-specific contexts? How can we deal with and compensate potential losers of an energy transition (including workers, incumbents, and shareholders)?

How differentiated are the impact of policies on men and women? How do these impacts vary when gender intersects with other identities?

6.9 Regional priorities on enabling policy environments

As part of the regional validation workshops,[17] the participants were asked to rank selected opportunities for high-impact research on Enabling Policy Environments. "Expanding evidence base on ex-post policy assessments on low-carbon transition" was the most highly ranked research opportunity for Africa and Latin America, while "Linking public preference for climate policy with political acceptance studies" was the top ranked opportunity in the Asia Workshop. "Comparing policy assessments with scientific research on modeling" had a low ranking in all regions. The opportunities and results of the ranking exercise are presented in Figure 6.2.

Figure 6.2. Ranking of high-impact research opportunities on Enabling Policy Environments at validation workshops



17 The findings from this research agenda were validated by stakeholders from the public and private sector and civil society in regional workshops in Africa (South Africa), Asia (Vietnam) and Latin America (Colombia) in March 2023.

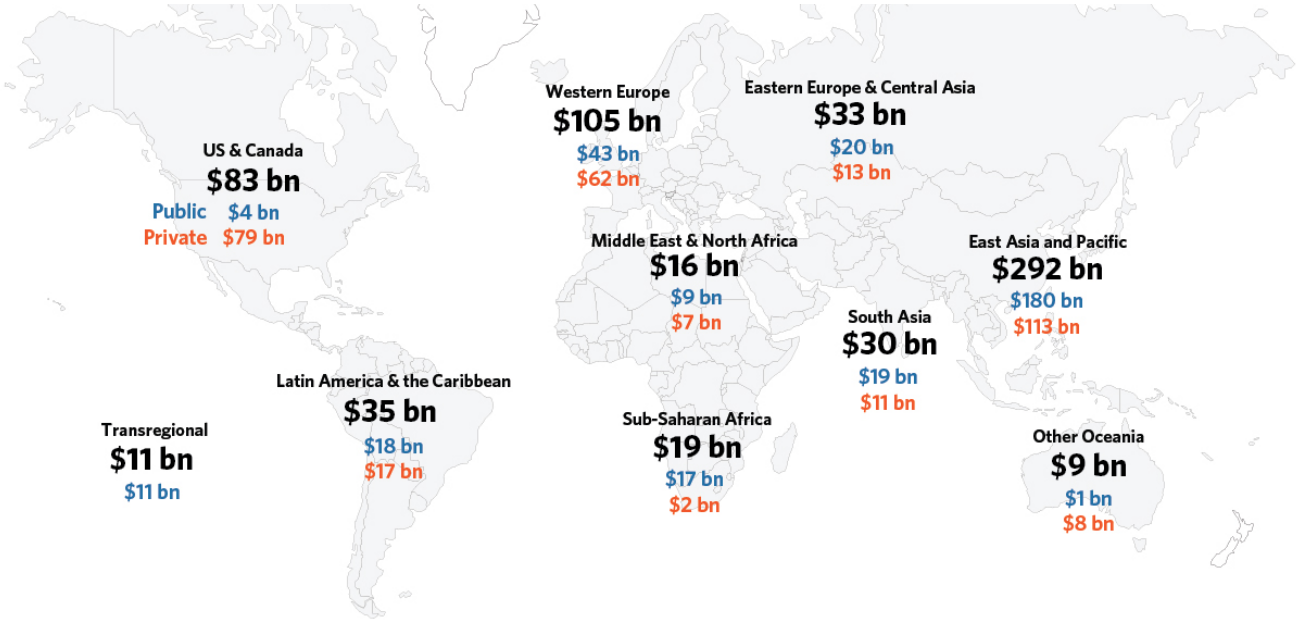
7. Mobilizing new climate investment models

7. Mobilizing new climate investment models

7.1 Introduction

IN 2020, GLOBAL climate finance flows represented US$632 billion annually. These investment flows differ dramatically by region, by the extent to which the private or public sector is providing the finance, and by whether it is sourced domestically or internationally. A vastly smaller share of total investment flowed to lower-income regions of the world, including just US$19 billion to sub-Saharan Africa and US$30 billion to South Asia (see Fig 1). Considering only finance flowing from developed to developing countries, the OECD estimates that about US$83 billion in climate-dedicated and climate-related investments flowed in 2020, through bi-lateral Development Finance Institutions (DFIs), multilateral development banks (MDBs), export credit agencies, and private investment mobilized by those public investments (OECD, 2022). To identify potential pathways for scaled-up climate finance for LMICs and the knowledge needs associated with those pathways, there is a need to unpack where finance is currently flowing, for what purpose, and what the barriers are to greater investment into key sectors and geographies. This section focuses on the supply of climate finance, its major players, and future scope for innovation. An overarching theme is that, for climate finance to be impactful, efficient, and scalable, it must be aligned with the specific climate mitigation and adaptation needs of different regions, countries and localities. The bottom-up processes and evidence building needed to identify and build consensus around those needs—as opposed to letting politics and external forces drive them—are nascent in most LMICs.

Figure 7.1: Destination region of climate finance, by public/private (US$ billion, 2019/2022 annual average)



Source: (CPI, 2021a)

7.2 Motivation

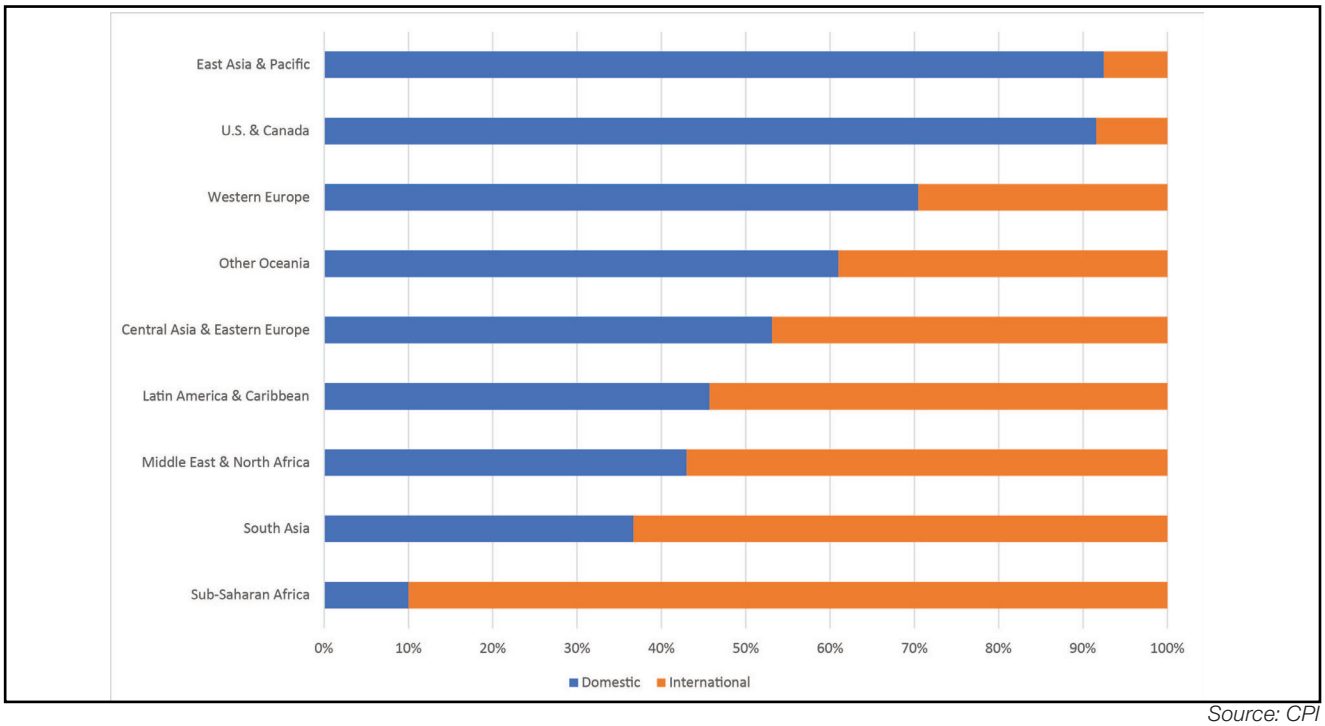
At the UNFCCC Copenhagen Conference of Parties (COP) in 2009, parties agreed that developed countries would mobilize US$100 billion annually for developing countries by 2020 to help mitigate and adapt to climate change (UNFCCC, 2009). Later enshrined in Article 9 of the Paris Agreement in 2015, this financial commitment, and financing for low carbon development more broadly, has since become a central issue of negotiation in the UNFCCC process (UNFCCC, 2015).

Developed country investments in developing countries reached US$83 billion in 2020, falling short in the first compliance year (OECD, 2022). However, the challenge of financing low-carbon development runs far deeper than whether advanced country governments are providing US$50 billion or US$100 billion or even US$200 billion—the latter figure representing fulfillment of the call included in the 2021 Glasgow Climate Pact for developed countries to double their investment commitments to developing countries (a doubling was "urged" but not required) (UNFCCC, 2022). It is estimated that LMICs will need an additional US$800 billion annually by 2025, and close to US$2 trillion a year by 2030 to address climate change mitigation, adaptation and resilience (Bhattacharya and Stern, 2021). How much of that finance will need to come from public versus private sources depends on the climate needs of each country and on the commercial attractiveness of climate mitigation and adaptation projects (Franks et al., 2018).

The overwhelming majority of climate financing does not come from the multilateral climate funds (MCFs), which, as financing mechanisms of the UNFCCC, have a mandate to invest in country-led climate strategies reflected in NDCs. In fact, MCFs – such as the Green Climate Fund, Global Environment Facility, and Adaptation Fund – are the only climate funds that are specifically tied to NDC priorities, yet they only represent 4% of global climate finance. Rather than utilizing the MCFs, roughly three-quarters of climate finance for LMICs is delivered through DFIs and MDBs, which have their own mandates and national agendas. Developed countries have opted to direct the vast majority of their financing through these institutions, where there is a deeper history of working together, and where they exert greater control as shareholders and board members.

Realizing the vision of increasing LMIC climate investment "from billions to trillions" will require the mass mobilization of private capital, the alignment of NDCs with the realities of climate investment instruments and institutions, and connections among government assistance, development finance, export credit, and philanthropic resources in ways that demonstrate and rapidly scale low-carbon technologies and business models while enabling Global South-led innovation (African Development Bank et al., 2015). Domestic policy and resource mobilization can be accelerated and complemented through international partnerships and leveraging institutional strengths. In addition to mass mobilization of private sector capital to reach the targets, there is also a need for reform of MDB or DFI architecture, including greater alignment between NDCs and financing instruments or packages. Researchers have an important role to play in diagnosing the effectiveness of different approaches in overcoming investment barriers, identifying key variables across geographies that determine outcomes, and helping

Figure 7.2: Domestic and international climate finance flows by region of destination (US$ billion, 2019/2020 annual average)



Source: CPI

policymakers and investors develop effective financing strategies.

7.3 Innovation and alignment of climate finance with national policies and private sector

7.3.1 International Climate Finance

Some LMICs, especially in sub-Saharan Africa, rely on overseas capital for 90% or more of climate investments, as seen in Figure 2. While the priorities of these financiers—namely DFIs, MDBs, bi-lateral donors, MCFs, philanthropy, and the private sector—vary widely, their collective investments are weighted heavily towards middle-income countries. OECD data shows the stark difference between climate finance provided for MICs (69%) versus LICs (8%) (OECD, 2021).

MICs tend to have relatively more and larger commercial firms, higher household incomes, stronger institutions and greater regulatory certainty; ultimately, these regions carry higher expectations of financial returns. This MIC investment environment, characterized by relatively higher commercial opportunities than in LICs, better aligns with the dominant financial instrument available through foreign investors, which is non-concessional debt. This form of capital is unworkable for many climate projects and national strategies, especially adaptation projects, where public benefits may be high but financial returns may be low. This dynamic also puts LICs at a distinct disadvantage in attracting financing, as projects in these markets tend to have higher levels of overall risk and lower likely returns. LMICs have recently faced additional challenges in attracting investment, as huge debt loads due to the pandemic and the Ukraine war, along with sharply higher food, fertilizer, and energy prices, are contributing to rising interest rates, currency depreciation, and capital outflows (Patel et al, forthcoming).

Aligning climate finance with national climate priorities will require innovative risk mitigation approaches to reach LMICs, especially in less developed sectors. A key barrier to low-carbon development in LMICs is the high cost of capital, which can be seven times higher than in developed countries (Agutu et al., 2022). Public sector capital can be deployed in various ways to reduce some of the risks and mobilize private sector investment. In particular, loan guarantees are one area where experimentation could

prove valuable, as they can be used to target risks that are particularly difficult for the private sector to mitigate (Convergence, 2021). Foreign exchange guarantees or direct lending in local currencies, for example, can protect a private investment against losses that may result from currency fluctuations. Public financing can also be used to bear the "first loss" in an investment vehicle, in order to catalyze the participation of private investors that otherwise would not have entered the deal because of excessive risk or a lack of experience in the sector or market.

Blended finance is an application of this approach that aims to "crowd-in" capital to projects and companies that would otherwise be too risky for commercial investment. It achieves this through leveraging concessional development funding (public and philanthropic) to draw in market-rate private capital. However, 96% of blended finance is mobilized in countries with a credit rating, which most LICs do not have (Attridge and Engen, 2019). Poor credit ratings – or the lack of a credit rating – are a major impediment to foreign investors who face fiduciary duties to shareholders (Meyer and Mothibi, 2021).

There is also a need to better understand which risk-mitigation features work best in which context and the level of additional finance (additionality) that each represents (Andersen et al., 2019). Major DFIs assume that any private finance that is mobilized would not otherwise have been deployed in the transaction, but that is unverified (Attridge and Engen, 2019). While some social outcomes are measured over the course of project implementation, few if any funds assess social outcome additionality with any rigor (Bhattacharya, D. and Khan, S. S., 2019; Pereira, 2017). Without this data, it is impossible to evaluate whether blended finance is indeed unlocking additional social outcomes or private investments in LMICs. It is likewise impossible to determine whether specific blended finance models are more or less effective. Similarly, many types of potential interventions in critical sectors such as agriculture, energy and transport suffer from a lack of data related to impacts—especially with regard to adaptation, which hinders effective policy-making and investment prioritization (CPI, 2021a).

Putting a price on carbon is also an opportunity to move additional capital into key sectors. The 2021 agreement on a framework for implementing Article 6 of the Paris Agreement establishes rules for international compliance in carbon markets, where countries can trade carbon credits. This has the potential to unlock investment in LMICs, to the extent that LMICs have relatively cost-effective potential for emissions reductions, or emissions reduction potential that is coupled with other development co-benefits. Unleashing the potential of mitigation across much of the Global South hinges on connecting carbon markets to agriculture, forestry and other land uses (AFOLU). An array of programs are underway to support LMIC engagement in carbon markets, including creating carbon credits through existing MDB lending programs; building capacity in LMIC governments to better understand how carbon credits can be monetized, structured, traded and reported; and sector-specific initiatives related to energy access, forestry and land use.

The existing voluntary carbon market (VCM) also represents a potentially valuable financing source for climate projects; it is expanding as a result of organizations implementing Net Zero targets (Ecosystem MarketPlace, 2020). Although renewable energy projects have historically dominated the VCM, non-energy projects are gaining momentum due to an increased focus on carbon removal (such as carbon captured from the atmosphere through reforestation) as opposed to carbon reduction (such as carbon mitigation through renewables). Two key voices – the Science Based Targets initiative (SBTi) and the Net Zero Investment Framework – only allow for removal to count towards Net Zero (World Bank, 2021). At the same time, major standards organizations have begun excluding renewable energy projects in non-LDCs in an attempt to ensure that finance is additional (Forest Trends' Ecosystem Marketplace, 2021). These trends have implications for project developers in LMICs, where carbon removal projects are likely to be in demand, perhaps capitalizing on the fact that carbon removal credits were roughly five times more valuable than carbon reduction credits in 2021 (Forest Trends' Ecosystem Marketplace, 2021; GFMA & BCG, 2021). Consequently, GHG removal projects in the AFOLU space could represent a key growth opportunity (Smith et al., 2014).

Small and Medium Scale Enterprises (SMEs) are largely left out of such carbon credit schemes because certifying projects requires significant upfront investment and technical capacity, which is beyond the scope of most small businesses in LMICs (Phillips et al., 2022). Recently, some

project aggregators have been working to reduce transaction costs for individual SMEs and to sell carbon credits (Aera, 2022). Little research exists on how carbon markets can be better designed to support SMEs' participation in carbon markets, and there are only a handful of older studies on how SMEs' low-carbon activities could count towards carbon credits (Kalimunjaye et al., 2012; Sarkar, 2016).

There is very little gender-disaggregated evaluation and monitoring of climate projects, despite the historical focus on women in adaptation (Schalatek et al. 2021). Quantifying gendered outcomes has generally been the purview of academia and one-off impact evaluations. However, standards organizations that work in the voluntary carbon market are expanding into other SDG co-benefits. Gold Standard is now offering certification on gender equality impacts and improved health outcomes (Gold Standard, 2022). Likewise, Verra's SDG VISta Program is providing verification and registration for benefits attached to the SDGs through co-developing their own SD VISta asset methodology for benefits such as time savings from improved cookstoves or coastal resilience benefits (Verra, n.d.).

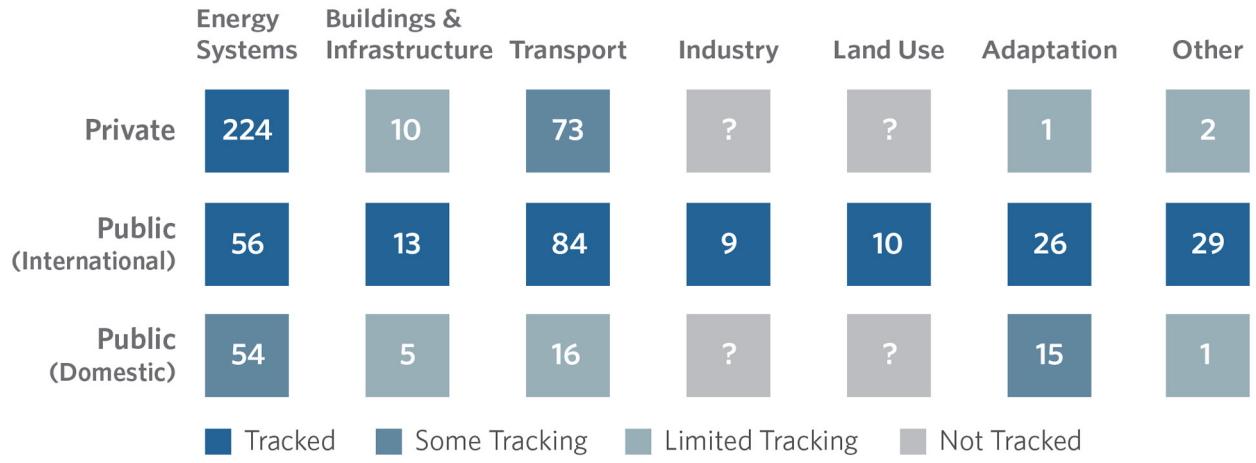
7.3.2 Domestic Climate Finance

Domestically mobilized climate finance—through Green Banks, green bond issuances, and other domestic programs—also have a critical role to play. Globally, domestic climate finance is the most abundant source of capital and is most prevalent in the energy sector (US$54 billion), followed by transport (US$16 billion), adaptation (US$15 billion) and infrastructure (US$5 billion), as seen in Figure 3 (CPI, 2021a). However, tracking domestic finance is especially challenging due to limited public reporting and inconsistent norms in climate tracking (CPI, 2021b).

"Green Banks" typically use public capital and innovative financing to leverage private funds and to invest in domestic low-carbon businesses, technologies and approaches. Green Banks can target sectors that local commercial banks tend to ignore and, in some cases, offer more favorable rates than commercial banks, making them an ideal investor for green businesses. In Africa, Green Banks represent a promising avenue, with more than 70% of African banks seeing green finance as an attractive lending opportunity, and several countries developing domestic climate funds (Convergence, 2019; European Investment Bank, 2021).

In Asia, new green banking guidelines have been

Figure 7.3: Tracked and untracked climate finance by actors and sectors



Note: *Numbers in the boxes represent currently tracked annual climate finance flows in each sector (2019/2020 annual average in USD billion)*

Source: (CPI, 2021a)

developed in China, Indonesia, Vietnam and Bangladesh; by the end of 2020, 21 major Chinese banks had green loans totaling US$1.8 trillion (IFC, 2021). Latin American banks have been slower to adopt the Green Bank model, but, at COP 26 in Glasgow, the Development Bank of Latin America (CAF) announced that it aimed to be the green bank of the region, and planned to mobilize US$ 25 billion over the next five years to promote green growth (CAF, 2021).

Another option is green bonds, which are fixed-income instruments issued by governments that are designed to support climate and environment projects. In 2020, the green bond market represented around US$280 billion, with emerging markets representing 14% of issuances (Dembele et al., 2021). In Africa, however, green bonds issuances are minimal, representing only 0.3% of all global green bonds (Bloomberg NEF, 2021). Several barriers to the uptake of green bonds have been identified for Africa: a lack of alignment with national guidelines on green finance, a lack of capacity and technical expertise within regulatory agencies, insufficient supporting regulation, smaller project sizes, the costs of external verification, limited evidence of green bond benefits, and a lack of fiscal incentives (Marbuah, 2021). In China, by contrast, a strong green bond market is driven by high-level political buy-in and prioritization within the central bank, the People's Bank of China (Escalante et al., 2020). In both India and China, renewable energy and low carbon transport are the two sectors that receive the largest proportion of green bonds capital (Climate Bonds Initiative, 2022, 2017). Brazil, Mexico and Chile lead green bond issuance in Latin America, although the region has focused less on this instrument and represented only 2% of the global green bond market between 2004 and 2019 (Cárdenas et al., 2021).

Nearly half of total climate investment in Latin America is sourced from private sources – the highest share of any of the regions examined in this report (CPI, 2021a). Many countries in the region – Argentina, Brazil, Colombia, Costa Rica, Ecuador, El Salvador, Mexico, Paraguay, and Peru – have developed private sector initiatives to measure environmental and social risks linked to climate change, a key step towards an evidence-based regulatory environment that builds the level of certainty needed to facilitate greater private sector investment (Semmler et al., 2021). In Asia, private finance ranges between 37-39% of total climate investment across the East Asia and Pacific, South Asia, and Eastern Europe and Central Asia regions (CPI, 2021a). Africa has seen comparatively little investment from the private sector, with private finance representing just 11% of climate investment (CPI, 2021a). Public finance makes up the majority of climate investment across all of these regions. This is a stark contrast to the US, Canada, and Western Europe, where private investment constitutes 59-95% of total climate finance.

7.3.3 Connecting National Priorities to Finance

One emerging opportunity to connect finance and national-level policy priorities is through high-level national agreements between developed and developing countries. In 2021, at COP26, South Africa unveiled the Just Energy Transition Partnership (JETP), a deal between the United States, Britain, France, Germany, and the European Union to provide South Africa US$8.5 billion in loans and grants over the next five years to support a transition away from coal. The agreement was designed to support the early retirement of coal generation assets, build cleaner power sources, and provide support for coal-dependent regions, which will help achieve the lower bound of South Africa's emissions targets under the Paris Agreement (Kumleben, 2021). The US and G7 allies are developing JETP approaches with counterparts in Indonesia, Vietnam, Senegal, Nigeria, India, the Philippines, and beyond.

However, JETP-type agreements will necessarily be country-specific, and will require regional-, country- and local-level research along a number of dimensions. First, it is critical to understand the dynamics of climate-vulnerable populations in order to determine which resources are available to them, and how an agreement would improve access to resources. There is also a need for greater research on low-carbon development options at regional, country, and local levels, to ensure that such agreements are responsive to the needs and opportunities of recipient countries.

Top-down agreements like the JETP are not the only way to more tightly link policy and finance. NDCs and National Adaptation Plans (NAPs) should also consider financing in their design and implementation. This intent is certainly reflected in these documents, with roughly 90% of NAPs mentioning expected financing sources and over

half including an entire section dedicated to financing. Over 80% of NAPs anticipate that both international climate finance and domestic budgets will be available to finance adaptation efforts, while 63% of NAPs expect finance from the private sector (NAP Global Network, 2022). However, domestic climate policy-making processes often fail to generate workable financing strategies. Reviews of NDCs find they are not inherently designed to be portfolios of bankable projects for investment, nor should they be. They are intended to identify and quantify national climate priorities. Yet, their development in isolation from capital providers, the common failure to even estimate the levels of investment needed, and the deferral of essential financing and implementation strategies for later have created a chasm in which bankable projects all too often fail to materialize.

While international climate finance institutions also bear responsibility for adapting their programs to the needs of NDCs and making clear what they intend to finance, LMICs may be leaving climate capital on the table by divorcing NDC development from financing strategy. As new approaches emerge for targeting and delivering technical assistance (TA) to support climate policy and financing linkages, it will be critical to extract lessons on best practices. The combined impact of technical assistance and direct investment may be multiplicative rather than additive, as it ensures that financial support is adequately embedded in national action and can be replicated beyond a single project (Vivid Economics, 2020). There is an opportunity for researchers to help inform how these TA programs can be optimized and how climate policy and climate finance can best be approached in parallel, through evaluating the impacts of current programming and extracting lessons learned.

7.4 Research gaps, missing knowledge or data gaps

Investment data gaps. There are two key data sets that help us understand climate investment flows in LMICs. The first is the OECD's annual report, "Climate Finance Provided and Mobilised by Developed Countries." The second is the dataset that accompanies the Climate Policy Initiative's flagship annual report, "Global Landscape of Climate Finance," which pools data from over thirty sources, including Bloomberg New Energy Finance, Convergence, IPCC, UNFCCC, MDBs, OECD and UNDP.

A lack of standardized definitions and accounting methodologies for what constitutes climate finance, as well as limited access to certain data, limit the understanding of climate capital flows, especially those pertaining to private sector investment, domestic finance and adaptation investments (CPI, 2021a). A major limitation of the CPI data is that, due to the pooling of over 30 different datasets, the investment destination is limited to the regional level as opposed to the country level, which prevents country-level analysis and comparisons between "developed" and "developing" countries – the categories on which UNFCCC commitments are predicated.

Tracking domestic finance is particularly important. To date, a few dozen countries have implemented one of several domestic climate tracking methodologies. A careful accounting of domestic funding, rather than just relying on international finance, would provide a more complete view into how governments are supporting NDC implementation and what they are prioritizing. This is especially relevant for adaptation investment, since these projects usually take the form of infrastructure or local economic development, areas where domestic budgets are critical (Allan et al., 2019).

Defining "just transition" locally and building the evidence to support decision-making. Two elements of the JETP approach that merit careful examination are, one, the process by which "just transition" elements of the strategy are identified and funded, and, two, the local evidence gaps that are laid bare once rapid investment and policy decisions must be made. Firstly, as evidenced in South Africa throughout 2022, the JETP is driving participatory and inclusive processes with the private sector, small businesses, women and women-led enterprises, indigenous peoples, youth, and other traditionally marginalized groups. The goals are to identify how catalyzing grant capital should be deployed across the economy to build skills in the workforce, support regional development strategies, protect and incentivize consumers, and advance other essential ingredients of a just transition. Regardless of the presence of a JETP, researchers across LMICs can play a role in identifying local visions of a just transition while highlighting trade-offs, synergies, and/or unintended consequences related to implementation. Particularly, there is a lack of evidence on how sectoral shifts will impact local employment and well-being, and how public works or education programs could support segments of the

population or bring marginalized groups, including women, into priority low-carbon sectors. Without local definitions of a just transition, there may be the assumption that what programming is effective in one context is appropriate for other localities.

Similarly, it is clear that the financial incentives inherent in these investment partnerships are driving important dialogues within the countries regarding where investment should focus, what it will take to mobilize private investment, the institutions that will be involved, and—critically for researchers—what evidence is needed to support related decision making. Optimizing investments requires detailed energy scenario modeling, technology and project development roadmaps, and regional economic development strategies. Many of these tools do not exist in JETP countries, but they are essential for all nations planning complex power sector transitions or green industrialization strategies.

Improve knowledge of project impacts to align public-private investment. At COP26 in Glasgow, more than 450 private firms representing US$130 trillion in financial assets committed to net zero investment portfolios by 2050. This could lead to a large influx of investment channeled into climate-related projects and firms. However, despite the increasing popularity of the concept, there is mixed evidence on how much additional social impact is actually created through these investments. In the climate space, there have been efforts to move beyond avoided GHG emissions as the sole impact criterion; an example is the Acumen Resilient Agriculture Fund, which supports SMEs based on the climate resilience benefits delivered, and the African Development Bank's Adaptation Benefit Mechanism, which markets private sector-led projects with high public resilience benefits to donors. But the impact of business models on household-, firm-, and community-level resilience is still not well understood, especially in key sectors like agriculture. This makes it challenging to align public-private investment around private-sector led approaches (Phillips et al., 2022).

Gender lens investing. Gender lens investing describes a set of practices related to channeling investment to improve gender outcomes – from targeting women-led businesses for investment to ensuring that investees embed gender equality in their own practices. However, there is limited rigorous research on the efficacy of these approaches. Gender lens investing can mean a lot of things – from ensuring gender diversity among investment decision-makers, to identifying that climate finance flows to women-led as well as male-led businesses, to understanding the gendered impacts of investment projects. Therefore, it is challenging to make statements about its efficacy or compare strategies across investors. More research is needed to articulate the impact of each strategy and the trade-offs that investors may encounter. This evidence can support workable investment strategies that pursue climate change solutions with explicit gender objectives such as women as leaders, managers, entrepreneurs, consumers and employees.

Optimizing the tools of development finance. MDBs and DFIs sit at the center of a global development finance architecture designed long ago and employ tools and methods that, in many cases, have changed little over time. Institutional shareholders and policy circles are rightly considering whether new approaches are needed to equip these institutions to lead the low-carbon transformation in LMICs, especially with regard to how these institutions approach private sector mobilization. The last 70 years have seen a massive shift in who owns capital and how it is deployed, with private capital under management growing from US$250 billion in the 1950s to more than US$111 trillion today. Institutional investments through pension funds, insurance companies, endowments, and other structures are now roughly 900 times larger than the holdings of all the development banks combined. Public capital alone is simply insufficient to fund the low-carbon transition in LMICs.

Researchers have an opportunity to help development banks redefine success to reflect this reality of capital markets. Performance indicators based on parochial operations (loan volumes, technical assistance delivered, etc.) are being replaced with metrics that orient institutions around broader transformation: aggregate investment volumes, private sector mobilization, and climate and development outcomes. As new financing approaches are being piloted in response to these shifting goal posts, it is critical that lessons be clearly captured and distilled to support institutions in their modernization efforts. There are many instruments designed for green domestic financial systems that can be climate and development winners. These

include capitalizing green banks and supporting investment-grade green bond issuance, efforts to capitalize climate SMEs through new intermediaries and instruments, targeted products such as outcome-based conservation bonds, and carbon credits that deliver adaptation and other co-benefits. Research is needed to understand the benefits and trade-offs in these new approaches and the circumstances under which they should be deployed to advance national climate and development goals.

Effective models for countering North-South tech transfer bias and supporting Global South-led innovation. A theme emerging from JETP dialogues is that LMICs wish to be more than just markets for deployment of green technology developed and built in advanced countries. Yet, there is strong North-South tech transfer bias inherent in the western development finance model, which poses challenges for investment in locally-developed solutions. A number of platforms have identified this problem and are deliberately targeting investment to innovative, locally-tailored climate solutions in LMICs, often with the flexible concessional capital needed to pilot higher risk/reward approaches, which might never receive approval through traditional DFI investment committees. Climate Investment Funds are an example of one such approach, where the multilateral fund helps governments, private sector, NGO, and MDB partners pilot and scale projects developed through transparent, inclusive, and country-led processes.

Further, there are limited evaluations in the low-carbon technology literature on whether public sector funding is "crowding-in" or "crowding-out" investment, with few methodologies to assess various public and private programs in deploying low-carbon technologies and the micro- and macro-level impacts of LCT interventions funded by both the public and private sectors (Owen et al., 2018). A better understanding is needed of the firm-level and temporal aspects of industries' development of absorptive capacity (i.e., an entity's ability to understand external knowledge, and to integrate and apply it to its key commercial processes) (Rai and Funkhouser, 2015). Research is limited on how small, innovative firms respond to IP risks when faced with unfavorable market conditions or shocks (Rai and Funkhouser, 2015). Answering these questions, along with rigorously evaluating the range of innovative approaches that are beginning to be implemented, can help scale up locally-developed climate innovations.

Implications of the US-China rivalry on LMIC finance. The climate investment landscape is rapidly shifting due to how the U.S., China, and their allies and affiliated institutions deploy overseas investment as a tool for development, partnership building, and foreign policy. With the bulk of energy- and climate-related finance directed to LMICs coming from either Chinese entities or US-aligned MDBs and DFIs, it will be important to understand what these shifting approaches to climate and infrastructure financing mean for LMICs.

The US and G7 announcement of the Partnership for Global Infrastructure and Investment in 2022—of which JETPs are an example—represents a new western model of overseas investment emphasizing flexibility, speed, scale, and comprehensiveness. This is occurring just four years after the creation of a new, re-tooled US$60 billion DFI entity in the US, - the US International Development Finance Corporation. These are direct responses to the rapid rise of Chinese overseas energy and infrastructure finance to LMICs over the past decade through the Belt and Road Initiative (BRI). The Chinese turnkey infrastructure development model – in which complex projects can be designed, financed, built, and operated under a single high-level, government-to-government agreement – has proven attractive for many LMICs. Many LMIC governments, with limited domestic capacity and frustrations with the demands imposed by western and multi-lateral finance institutions, have found China to be a viable alternative development partner. Consequently, the BRI deployed more infrastructure investment to developing countries than all MDBs and DFIs combined over the past decade.

More recently, Chinese infrastructure investment has declined and LMIC debt loads have skyrocketed as a result of the pandemic. Navigating LMIC debt relief and/or supporting new lending programs to governments may be fraught, as China now holds upwards of 40% of the debt of the world's poorest nations and restructuring sovereign debt will likely require bringing them to the table with western government lenders and private bond holders. At the same

time, China has announced it will no longer finance coal power systems and is promoting a "Global Development Initiative," which is expected to focus more on sustainable development. Researchers can help LMICs identify the most effective ways to navigate this rapidly shifting landscape.

Workforce capacity development: By definition, a transition will require new skills. Programs to build this human capacity must be evidence-based, accessible, well-marketed , and strategically integrated. They must build skills in growth sectors, rather than simply retraining workers no longer valued by society. For example, although women make up 32% of the workforce in renewable energy (as opposed to 20% in oil and gas), a lack of science, technology, engineering, and mathematics (STEM) education – among other structural challenges – limits the scope for women's participation in many green job sectors (IRENA, 2021). A workforce development program that targets investments in STEM for women can deliver shared value with gender-based objectives.

7.5 Opportunities for high-impact research on innovative climate finance

What mechanisms will be most efficient and inclusive for integrating low-carbon technology into private sector business models?
What changes in climate financing models need to occur, how can they be achieved, and what support is needed for marginalized communities to benefit? How can financing for a LCT be directed to small- and medium size enterprises (SMEs) and women-owned businesses?

How do innovative financing models for LCT perform? How well do they support the integration of low-carbon technology, improve resilience to climate change, and improve inclusion into private sector business models and plans?

What policies, financing, and training are needed to develop an inclusive workforce for low-carbon sectors? How can bottom-up investments be used to support capacity development? How are different populations with overlapping identities impacted by different climate financing models?

What decision support tools are needed to evaluate tradeoffs, clarify impacts, and identify financing pathways for low-carbon development? How can local researchers receive the support necessary to develop and apply such tools? How can financing models, including equity concerns, be integrated into NDCs before the NDCs are adopted?

How can ex ante and ex-post evaluations ensure that "impact investing" delivers the impacts it promises as opposed to greenwashing and inefficient capital allocation? How can common metrics be harmonized, based on rigorous methods and granular data, in order to facilitate these kinds of comparisons, including the scale and durability of impacts? How can international stakeholders engage with a focus on local benefits first and global co-benefits second?

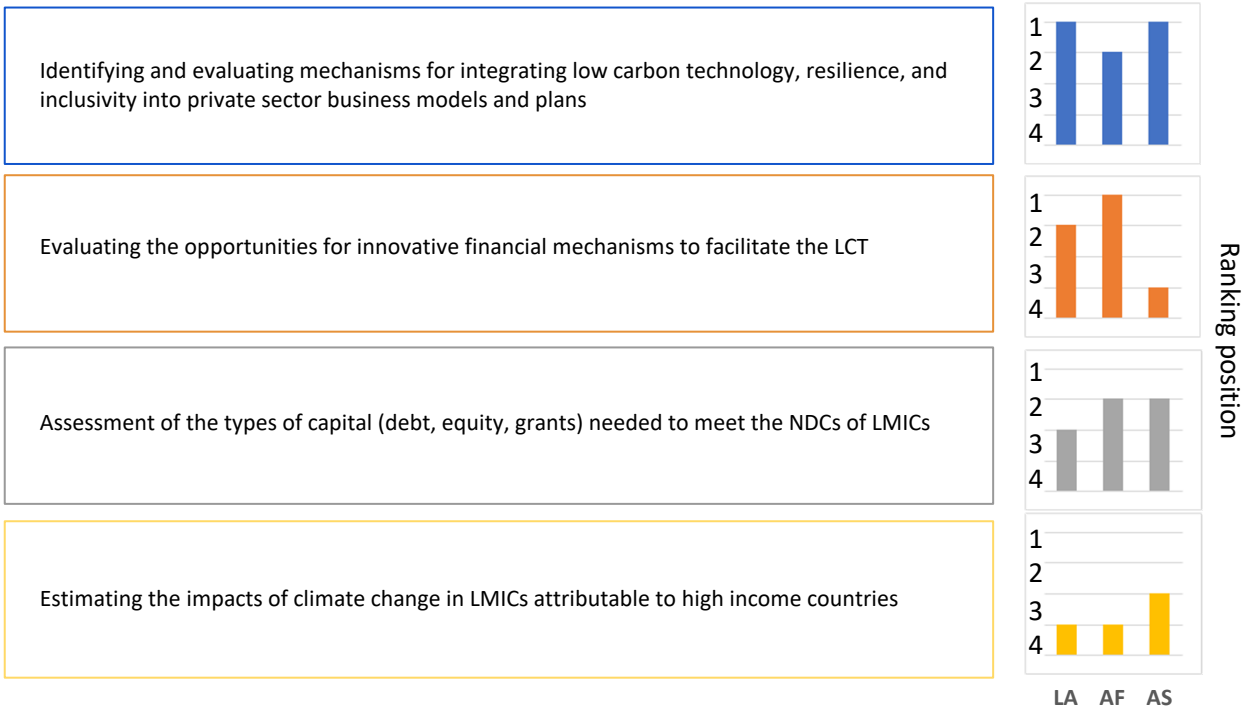
What kinds of business activities and investments are needed to maximize total returns on investment? What combination of public and private capital is needed to capture the inevitable mix of public and private benefits flowing from scaled approaches? What type of impact metrics can be used to help identify the financial instruments, sectors, and projects that are most impactful? How must those metrics be adapted for different contexts?

How can investments be channeled to key actors, including SMEs and women, as well as other marginalized groups that face high barriers to accessing finance? Which domestic or locally-oriented finance approaches (green banks, green bonds, intermediary funds, etc.) have been most effective at channeling finance to green SMEs, why they have been successful, and how can international public investment most efficiently capitalize the sector? What evidence can be gathered from participatory, context-specific, local studies?

7.6 Regional priorities on mobilizing new climate investments

When ranking selected research opportunities on climate finance, "Identifying and evaluating mechanisms for integrating low-carbon technology, resilience and inclusivity into private sector business models and plans" was consistently ranked as a high-priority opportunity across regions, while "Estimating the impacts of climate change in LMICs attributable to high-income countries" had a low ranking in all workshops. "Evaluating the opportunities for innovative financial mechanisms for the LCT" was bottom ranked in the Asia Workshop, even though it had high rankings in the other regions. The opportunities and results of the ranking exercise are presented on Figure 7.4.

Figure 7.4. Ranking of high-impact research opportunities on Climate Finance at validation workshops



8. Human and institutional capacity

8. Human and institutional capacity

8.1 Introduction

The foregoing sections have spelled out the high-level research agenda for various sectoral and cross-cutting themes. This section emphasizes the gaps that exist in getting the identified research done and used in driving LCTs. It presents a voice of practitioners on what is required for implementation to happen effectively on the ground. In addition to advocating for facilitating research, the section motivates for commensurate investment in human and institutional capacity in order to drive LCTc.

Achieving low-carbon transitions demands new human capital (knowledge regarding the challenges and the skills to design appropriate measures to deal with them) targeted at policymakers, regulators, and practitioners of today and tomorrow. Most importantly, a new generation of climate and development experts must be trained in every country.

Achieving low-carbon transitions also demands new institutions (i.e., new ways of implementing Agenda 2030 and the Paris Agreement/Glasgow Pact, and, in some cases, new organizational units to carry out and support new functions, roles and activities). The slow pace of achievement of the Sustainable Development Goals in some parts of the world presents another motivation for rethinking institutions.

Human and institutional capacity development has been called for repeatedly by the international community, such as the UNESCO Global Education 2030 Agenda, the United Nations Framework Convention on Climate Change and the Johannesburg Plan of Implementation of the World Summit on Sustainable Development.

8.2 Motivation

Global challenges demand not only global responses but also local capacity and action. That has never been more evident than during the COVID-19 pandemic, when the poorest and the most vulnerable have been the ones most at risk. Many foreign development actors working in the Global South repatriated back to their countries, leaving their former hosts to deal with the pandemic by themselves. Developing countries that capitalized on development aid to build local capacity are today better able to manage the aftermath of the pandemic and other challenges.

Emerging critical strands of literature (Glavovic et al., 2021) are highlighting the failure of advances in climate change science to translate to the commensurate action urgently required to avoid catastrophic climate change. This speaks to a disconnect between knowledge generation and its use in influencing policy. In some ways, this reflects two types of failures: (i) the scientific community's failure to bring research down to the specific contexts of policy-makers and practitioners, and (ii) policy-makers' and practitioners' failure to translate available research knowledge to policy reform/formulation, planning, implementation, monitoring and evaluation in their contexts.

The absence of enabling policy environments and action on LCT in the Global South is symptomatic of three key things:

(i) there is a lack of knowledge on what needs to be done for LCT when, where and how - a gap which could be addressed by locally anchored research;
(ii) there is a lack of capacity in the Global South for (a) doing relevant research and (b) using the evidence from that research to guide policies - a gap which could be addressed by appropriate capacity development programs; and
(iii) there is a lack of appropriate institutions and institutional frameworks to manage the whole LCT value chain (i.e., to use design thinking to identify problems, understand the problems, generate both proactive and reactive responses/solutions, and reform existing mechanisms/platforms or craft new mechanisms/platforms to manage the design thinking value chain) - a gap which could be addressed through institutional reforms and the development of new, better, more appropriate institutions.

Thus, the appropriate response to the slow pace of LCT in the Global South would be to develop the human and institutional capacity of the scientific community, policy-makers, and practitioners.

This section presents a capacity assessment focusing on low-carbon transitions and gender equity in the Global South. The scope of the capacity assessment covers individual, organizational and institutional capacities. The

capacity assessment will be useful for funders to identify and select capacity building priorities to fund, for capacity development practitioners to know what programs to design and offer, and for governments to assess the relevance of the capacity needs characterized.

The section layout is as follows: Sub-section 8.3 motivates the importance of capacity for a low-carbon transition; Sub-section 8.4 makes a case for the role of human and institutional capacity for research and policy-driven transitions; Sub-section 8.5 assesses human and institutional capacity gaps and priorities; and Sub-section 8.6 identifies opportunities for high-impact human and institutional capacity and institutional development for low-carbon transition.

8.3 The importance of human and institutional capacity

Extensive appraisals on inclusive low-carbon transitions in the Global South confirm human and institutional capacity gaps (e.g., the UNESCO Global Education 2030 Agenda, the United Nations Framework Convention on Climate Change and the Johannesburg Plan of Implementation). This points out a need to build human and institutional capacity to drive action on low-carbon transitions during this decade.

The conceptual framework for the importance of capacity for a low-carbon transition contemplates that: (i) there are specific actions required to drive low-carbon transitions; (ii) there are gaps in human and institutional capacity to deliver on the required actions; (iii) capacity development could fill the identified gaps; (iv) specific skills and competencies must be embedded in the design of the capacity development programs; and (v) graduates from such programs would perform the functions and roles responsible for the specific actions that drive low-carbon transitions.

8.4 The role of human and institutional capacity for research and policy-driven transitions

Closely linked to academic capacity is the generation of new knowledge. This is one of the primary roles of research. Despite the fact that a majority of people in extreme poverty are adversely affected by carbon-intensive economic systems, insufficient attention is given to generating knowledge on how their circumstances can be improved through low-carbon transitions. Thus, some research is left undone that could directly produce evidence that policy actors need to improve policies. Human capital (skills, knowledge, and expertise) is fundamental to a sustainable future.

The design of integrated social, environmental, and economic policies to drive low-carbon transitions is dependent on advanced domestic capacity; this is needed to understand the complex interaction between ecological/biophysical and economic systems marred by market and institutional failures. A fundamental challenge is to integrate relevant knowledge based on applied research into domestic and international policies and practice. Awareness of the opportunities for poverty reduction and gender equality from low-carbon transitions is the first step, but moving beyond awareness to real policy-making, based on evidence, is critical. Appropriate domestic human and institutional capacity is needed to design, implement, and evaluate policies in support of low-carbon transitions. In addition, cost-effective solutions depend on a thorough understanding of the functioning and limitations of local institutions.

The most fundamental gap is that there are not enough professionals with these specialized skills in developing countries, where the needs are the greatest. The first Global Sustainable Development Report highlights the unequal global distribution of scientific capacity. While OECD countries have about 3500 researchers per million inhabitants, in the least-developed countries, there are only about 66 researchers per million inhabitants. In addition, only about 29% of the world's researchers are women. Trained women and men in the Global South can best transform their own countries, particularly through a gender lens.

8.5 Human and institutional capacity and institutional gaps and priorities

8.5.1 Analytical framework

This capacity assessment drew on an analytical framework proposed by Hunter et al. (2021) and adapted it to identify the priority gaps and needs in technical skills, competencies, and education related to inclusive low-carbon transitions in the Global South, focusing on the needs of policy actors and the design and roll-out of capacity development programs by science-policy institutes. The analytical framework considers six dimensions of capacity development interventions.

Dimension 1: Priorities for inclusive green transitions for the Global South
This dimension acknowledges that there are a multitude of complex interlinked problems playing out across different timeframes and scales, with contested response options. A key question under Dimension 1 is thus: Is there a priority to focus on building capacity in a single sector or issue relating to inclusive low-carbon transitions in the Global South, or is it more strategic to focus broadly on a range of sectors or issues related to inclusive low-carbon transitions in the Global South?

Dimension 2: Priorities of science-policy institutes in the Global South
This dimension acknowledges that, while science-policy institutes in the Global South share common interests and goals, they may differ in terms of their mandate, scope, main activities, and capacity. A key question under Dimension 2 is thus: Are there differences in capacity development priorities and needs for inclusive low-carbon transitions amongst science-policy institutes in the Global South?

Dimension 3: Career paths in science-policy institutes
As climate change and sustainable development are multi-sectoral issues, there is no fixed career path for those working in these domains, and many practitioners move between sectors. A key question under Dimension 3 is thus: What are the trends in career paths for science-policy professionals working on inclusive low-carbon transitions in the Global South?

Dimension 4: Disciplinary focus, skills, and knowledge needs
Climate change is an inter- and trans-disciplinary field that spans the natural sciences, social sciences, engineering, law, and more, and includes the expertise of non-academics. A key question under Dimension 4 is thus: Is it better for capacity development interventions in inclusive low-carbon transitions to be broader (i.e., offer a range of modules, sectors, approaches) or go deeper (i.e., specialized, in-depth knowledge on key issues, sectors, approaches)?

Dimension 5: Teaching theories and practices for developing the capacity needed
Building the competencies required to work effectively on complex problems and contested solutions in collaborative ways may mean adopting teaching theories and practices that break away from traditional lecture-style modes of teaching. A key question for Dimension 5 is thus: Is there a need for interventions that employ different teaching and learning methods aside from the traditional modes of teaching?

Dimension 6: Feasibility, funding landscape, business model, and financial sustainability
Innovative teaching approaches require some degree of risk when approaches have not been tried before, which requires some degree of trust by participants, funders, and partners, and a willingness to explore and learn. On the other hand, to be truly effective, a capacity development intervention must ideally be financially sustainable to benefit from the longer-term insights gained from reflective iterations. Understanding the funding landscape, demand, feasibility, and potential business models that allow capacity development institutions to evolve and remain relevant and competitive in a shifting global landscape goes some way toward understanding sustainability.

The capacity needs assessment used three main data sources, namely literature review, key informant interviews, and stakeholder surveys. Two types of interviews were conducted: Type 1 and Type 2. Type 1 interviews focused on an organizational perspective of the capacity needs of the 13 selected countries and the Global South more broadly. Type 2 interviews targeted 10 key multilateral organizations and focused on organizational perspectives on capacity needs for an inclusive low-carbon transition amongst their beneficiary organizations. Two surveys were created using Google Forms and shared with stakeholders of science-policy institutes in 13 countries across the Global South. Survey Type 1 targeted the five most important local and national level partner organizations of the science-policy institutes. Survey Type 2 focused on individual stakeholder's perspectives of their own capacity. The analytical framework informed the analysis of the literature review, interviews, and survey data.

8.5.2 Human and institutional capacity gaps and priorities

Contextualizing capacity needs of the Global South:
A far-reaching low-carbon transition will be dependent

on differentiated sectoral transitions. Sector transitions are determined by the emissions profile and resource endowments of a country, as well as political, policy, and regulatory dimensions. The techno-economic case for a transition varies greatly between sectors, as does the state of the evidence base. The current knowledge base provides strong starting points for energy sector transitions, and evaluating this process will be useful in developing strategies for harder-to-abate sectors such as heavy industry. For some countries, it would therefore make sense to prioritize the energy transition in the short term and the transformation of heavy industrial sectors in the medium term. Ultimately, each country will need to determine how best to structure their sectoral transitions as the basis for achieving just transitions within their unique contexts. This point reinforces the need for research in the sectoral and cross-cutting themes, as identified by the preceding sections, at the country and regional levels.

Identifying capacity gaps: Capacity-building efforts will need to anticipate the types of capacity needed based on unfolding trends, and focus on starting to build those capacities now, while ensuring that they are capable of adapting to a rapidly shifting landscape. Already, current career paths have shifted or are currently shifting because of the emerging needs presented by the unfolding transition, and this shift in career paths is indicative of capacity demands and the future job market.

The job market in the science-policy-practice interface is also facing ***rapid change*** as a result of multiple drivers.

NDC cycles provide windows of opportunity for building capacity and driving change (i.e., in preparation for, within, and between submissions). Due to their role in the transition, globally, and in nearly every country in the world, NDCs are a priority area for capacity building. Some of the capacity areas associated with the NDCs include translating from paper to implementation in terms of accurate costings, establishing monitoring, reporting and verification (MRV) systems, translation into sector and investment plans, and working through partnerships to drive implementation.

More effort is needed to connect short-term actions and long-term goals through pathways, which ensure that they are aligned. An example of the current misalignment between short- and long-term action is the disconnect between the NDCs and Low Emissions Development Strategies (LEDS); aligning the next round of NDCs in 2025 with the LEDS is a concrete example of how countries could enhance the alignment between the short- and long-term priorities.

A positive outcome of capacity development for an inclusive low-carbon transition would result in a critical mass of skilled individuals equipped to communicate and effectively support policy-makers, finance experts, and other partner organizations working within and across sectoral

Table 8.1: Knowledge areas and technical, policy, and project management skills in demand

Knowledge areas	Technical skills	Policy skills	Cross-cutting skills
• Climate finance: developing bids and bankable projects; accessing finance for the transition (incl. utilizing innovative climate finance instruments such as green bonds); and skills to address limitations when the scale of projects are too small for financing opportunities (i.e., to develop aggregation mechanisms to bring together small projects) • Climate governance • Natural capital analysis • Adaptation • Environmental economics • Ecosystems-based management for climate resilience and human well-being • Climate-smart agriculture; Green economy for the Global South • Emissions trading and pricing • Low-carbon growth • Technology in teaching • 4IR	• CGE modelling • ICT skills • R language • Python • GIS • Agent-based modelling • Economic modelling • Machine learning • Monitoring, reporting, and verification (MRV) • Big data management, analysis, and visualization	• Climate policy formulation • Translating research and knowledge into policy recommendations • Science communication • Systems thinking • Engage with diverse perspectives • Planetary boundaries	• Research writing • Grant writing • Project management • Project reporting • Soft skills to make an impact at the science-policy interface: collaboration; communication; and facilitation skills • Capacity to interrogate dominant paradigms • Capacity to navigate the political economy of transitions

thematic areas and contexts. Science-policy institutes (SPIs) have key roles to play in this knowledge ecosystem.

Specific capacity needs, skills, knowledge areas, and roles: A diversity of thematic knowledge areas, and technical, policy, and project management skills were identified from the interviews and surveys, and are listed in Table 8.1 below.

A last key cross-cutting capacity need is intersectional capacity development. Actors, especially researchers, need to work with women, youth, local, and indigenous communities. Local and national governments need to bring in the voices of those who will be impacted by policy.

Generalists and specialists: Examples of specialists that are needed are climate scientists, finance specialists, economists, political economists, and gender and urban specialists. Generalists with transdisciplinary skillsets are also key to work with the diversity of knowledge areas. To further improve capacity at this level, policy should be incorporated in all academic training. Generalists and specialists need to work together. Generalists need to know enough about the area of expertise of the experts with whom they engage. Similarly, experts need to understand that their expertise is in the service of policy and broader societal needs and that this expertise needs to be translated as such. For example, if civil society organizations better understand the technical basis of a policy, they can tailor their policy advocacy and be more strategic in terms of their interventions. Similarly, experts can translate their research findings into key messages that are relevant for certain audiences or actor groups, so that these findings can be taken forward by others to build support for them and ultimately drive action.

Science-Policy Institutes: Organizations, including SPIs and their partners, require their own set of capacity needs. This includes project management and reporting, monitoring and evaluation, proposal writing, and fiduciary management, which all need to be strengthened to ensure that organizations from the Global South can play leading roles in project implementation and as principal investigators. Organizations also need to strengthen their ability to work internationally across diverse contexts of the Global South, with an increased capacity to integrate gender, equity, and justice into their work.

Policy actors: Governments in the Global South need to enhance their capabilities to create policy coherence across sectors to drive low-carbon transitions. This can be done by strengthening the know-how to align fiscal policy with climate goals. At present, climate is either seen as marginal by line ministries and central ministries, or they simply lack the skills to make this integration possible. This point speaks to inadequate institutions and institutional frameworks to support LCT. This problem can be solved using a suite of interventions such as training current ministry officials on climate change, getting new people with climate expertise into the ministry, changing the operational manuals within the ministry to mainstream climate change, setting up a department/unit on climate change in the ministry, and ensuring that ministries work collaboratively. Thus, the structure of line and central ministries and/or their modus operandi need to be updated.

Although Finance Ministries, in particular, are key agents for NDC implementation, they have limited knowledge about what the NDCs are or how to include them as part of the ministry's mandate. In addition, increasing capacity in Ministries of Environment would allow them to have more impact in a role of demystifying concepts such as resilience, decarbonization, and low-carbon transitions, and translating these issues into concrete actions to shift emphasis away from emissions to development. This means that Ministries of Environment need the tools unpack the costs and benefits of transitions, in order to identify trade-offs and opportunities for specific sectors. More fundamentally, there needs to be sufficient capacity among policy actors for research to have traction in their policies and programs. For research and impact evaluations to be integrated into decision-making processes, there needs to be sufficient understanding and appreciation of what these tools can provide.

Research actors: In terms of research, broadening the technical capacity to build a critical mass of researchers is a key part of establishing a robust and sustainable skills base, as there tend to be few – and typically overloaded – highly skilled, internationally recognized staff per organization. This means that, even where there are pockets of capacity, it is thin and easily lost due to staff turnover and retirements.

The way in which researchers are organized when conducting research also needs to be responsive to the

complexity of research problems. Climate change is a "glocal" problem and its understanding and resolution requires "glocal" approaches. Researchers working in their country contexts within a global team are likely to be more successful in addressing the LCT needs of their countries than those working in isolation. Research on the grand sustainability challenges ought to be conducted by consortia of researchers representing varied research problem contexts and methodologies. Teams of researchers in a long-lasting consortium are more likely than ad hoc consortia to sustainably work at the frontier of research problems. These considerations point to the need to use new institutional frameworks in supporting research and research training.

The research data needed to build the evidence base for low-carbon transitions still needs to be drastically improved in most countries in the Global South, including improvement in the quality and accessibility of data, data analysis, and data management capabilities. Most importantly, this includes a need for data on gender; future LCT research must make efforts to collect data that does not sit within the gender binary but include gender-diverse persons. Therefore, research is required to better untangle the relationships between gender and the low-carbon transition, as well as to test possible solutions and offer policy recommendations. These relationships will, of course, vary by region, country, and locality, as gender roles and relations vary by context. Addressing that variety will require research across contexts. In all cases, a major constraint to knowledge is a lack of capacity in gender analysis, and specifically in gender budgeting and gender auditing.

New data opportunities would need to be matched by appropriately rigorous methods of data analysis; not only should there be use of rigorous methodological approaches (such as quantitative causal analysis), there is also a need for multidisciplinary approaches.

Partnerships: Capacity should be developed for private-public partnerships, where the private sector can play a bigger role in assisting governments with implementing the low-carbon transition, other climate adaptation priorities, and climate finance instruments.

Lastly, entrepreneurship skills are needed to allow new business models, technologies, processes, and industries to enter the economy.

Approaches to building capacity: Delivery of capacity should be designed based on the type of capacity being provided (e.g., whether it is highly technical, bridging, or conceptually demanding), the accessibility of traditional and non-traditional training and education, and what is suitable for the local context. One way to think about the types of training is to differentiate according to on-the-job training and academic training.

Traditional training and education can include short courses, professional training, and university-based programs, such as Masters' or PhD programs. Capacity development that is urgently needed in the short term will require delivery through short courses and professional training, while capacity needed for the longer term can be provided through higher education institutions (HEIs). This could be relevant, for example, to develop the capacity of existing staff in the short term. HEIs may need more time and effort to update the curriculum to match the demands of the low-carbon transition and the future demands of industry. More time is also needed to build research skills and multi-disciplinary and transdisciplinary approaches at HEIs. Masters' programs have been shown to be effective at building the critical mass of graduates able to participate in low-carbon transitions, be it in research, government, the private sector, or civil society. PhD programs have been important for creating deep domain expertise, thereby establishing the cohort of specialists that can work with generalists and other policy actors.

Internships and other on-the-job training opportunities are practical approaches to train human resources in the workplace, especially at the junior level. Identifying and training future change agents within organizations to disseminate capacity into their organization is another possibility. Similarly, a train-the-trainers approach can be effective by focusing capacity-building resources on individuals who will go on to become trainers and will further share the skills and knowledge they have gained.

International networks of training centers, which may include science policy institutes and existing partnerships with relevant organizations in the region or farther afield, can be leveraged to deliver capacity. Such networks and related infrastructure are important to allow for cross-pollination of ideas and skills, and the movement of capacity-related resources to spread around the needed capacity.

An online training medium, such as the massive open

online courses (MOOC), can be advantageous because of their ability to reach a broad set of people and develop capacity through structured training. However, this type of offering is highly dependent on the availability and affordability of internet, and might not be appropriate, depending on the required level and type of training. Such considerations are critical for the Global South.

Resourcing capacity development: Another example is to focus resources on building a core set of open access teaching materials so that they are available whenever specific capacity-building is needed. Planning capacity development interventions over a long term (at least five years) is key to developing long-term relationships to achieve the intended outcomes.

Funding can be enhanced by both improving attractiveness for funding and increasing access to funding. Increasing access includes encouraging wider support from society, such as by encouraging the private sector to participate in capacity development. There may be opportunities to leverage government resources, such as linking a capacity program directly to a government departmental agenda.

It is also essential to prioritize how the available money is spent. It may be more important, for example, to prioritize spending on connecting and immersing students in a global capacity program rather than on travel and living costs.

Challenges or barriers that exist should be considered for designing capacity-building programs. One example is the challenge of accessing long-term funding, since funders generally want short-term results and short-term impacts, which limits the ability to plan for long-term sustainability of an intervention. Funding gaps also exist when funders' perceptions of what is needed are misaligned with actual capacity needs. Specific funding gaps are highlighted below:

- Carbon market, global finance, and private sector;
- Failure to train the end user of a technology (only the supply side for renewable energy is usually funded);
- Pressure to provide policy engagement services rather than research;
- Additional human resources, such as support staff (particularly research assistants); and
- Funding is usually for research, and the funding for course development is inadequate.

8.6 Opportunities for high-impact capacity and institutional development for low-carbon transitions

8.6.1 Characterizing the needs

Disaggregate and characterize specific capacity needs as the basis for developing targeted capacity-building solutions and support.

8.6.2 General recommendations

Identify and develop a core set of skills relevant to all actors working in sustainable LCT. There is a core set of skills needed to navigate complex challenges, to work collaboratively in diverse teams with diverse stakeholders, and to respond to context-specific challenges. A core set of skills should be developed through different approaches, depending on the actors and the contexts within which they operate. This capacity-building could be offered through the

Table 8.2: Public, private and cross-cutting target groups

For the public sector	For the private sector	Cross-cutting
• Accurately costing NDCs • Translating the NDCs into sector plans and into investment plans and fundable projects; • Revising and developing new NDCs; • Mainstreaming the budgeting, implementation, and tracking of NDCs: • Establishing MRV systems to track progress in project implementation, emissions, and the amount of climate finance attracted and spent; and • Developing long-term strategies and aligning NDCs with these long-term strategies.	• Developing bids and bankable projects, especially for adaptation; • Accessing finance for the transition, including utilizing innovative instruments such as green bonds and climate finance; • Developing aggregation mechanisms to bring together small projects to achieve scale (and access finance); and • Transformation of the finance sector (i.e., radically altered portfolios and products).	• Political and institutional elements of systems need transformation (i.e., not just a focus on technological solutions); • Soft skills are needed (e.g., collaboration and facilitation skills; translation of knowledge into useful policy inputs; the capacity to interrogate dominant paradigms; and the need to navigate the political economy of transitions).

development of course material that includes online videos and tutorials, as well as materials that can be integrated into formal teaching and training programs.

Capacity-building for a rapidly evolving landscape: Preparing for the future and recognizing that the future is here . Specific capacity-building programs need to target workers, at various skill levels, who will need to shift careers away from sectors that are not compatible with inclusive, low-carbon transitions. An initial step is to build on efforts to understand what needs to be undone. This should go beyond technical skills and consider paradigms and ways of thinking that are inconsistent with inclusive, low-carbon transitions. In some cases, this will also entail reforming existing institutions and establishing new ones, particularly regarding the structure and operation of government ministries.

Employment in key sectors – from the care economy to textile manufacturing – will also be shifted in the pursuit of a low-carbon economy, and this can have gendered repercussions. Evidence is already growing that shifts in agricultural technologies, for example, can inadvertently reduce women's employment opportunities. Anticipating those sectoral shifts is critical to implementing a just low-carbon transition, which will require training, re-training, and capacity building to support all genders in taking advantage of employment opportunities in the LCT.

As mentioned in the energy section, carbon-intensive sectors are often male-dominated, which means that an LCT could be good for women but negatively impact men's livelihoods. However, since future technology-based transitions will likely need more STEM knowledge, women would need targeted support to increase their participation in STEM education, where they are currently underrepresented. In general, much more attention, research, and interventions will be needed to ensure that a low-carbon transition will be equitable.

Determine the "critical mass" required to create breadth and depth of skills commensurate for the challenge at hand. There are pockets of excellence for the skills required for inclusive low-carbon transitions in countries of the Global South. In most of these countries, however, the real challenge is that they lack a critical mass of the skills that will be required to mainstream transitions at the scale and speed required, so that inclusive low-carbon transitions become the new business-as-usual. The concentration of skills also leads to an uneven distribution of skills, with capacity gaps most pronounced on the periphery. The uneven distribution of existing capacity applies to governments, local HEIs, and civil society organizations, and is further compounded by high staff turnover and precarious financial positions of these institutions.

Building this critical mass of skills will require large-scale funding and incentives. Those working in HEIs face limited incentives to reward activities at the science-policy interface. Therefore, resources should be provided to incentivize this type of work or dedicated science-policy interfaces funded. Shifting the focus of organizations to working at the science-policy interface will help transform their activities, by changing their structures and motivations.

Research is needed regarding the extent to which different skill sets are required in different contexts. Efficient allocation of capacity-building resources requires a better understanding of the extent of capacity needed to reach a critical mass. Although adequate capacity is required, too much capacity in a certain area would be inefficient and result in trade-offs at the expense of areas that might need more support.

The time for generalists. Generalists will be important in facilitating the multi-disciplinary and transdisciplinary approaches needed to tackle the challenges of transitioning to low-carbon. Generalists should be trained to have adequate expertise to work effectively with different specialist experts. In this regard, it is important to focus capacity-building around understanding what specialists can do and how they do what they do, so that generalists can influence the work of specialist and in turn effectively leverage their work. Specialists also need core skills to be able to work effectively with generalists.

Facilitate cost-effective access to capacity-building-related technologies and service providers. Effective capacity building needs to leverage modern technologies and service providers involved in the capacity-building value chain. This could include digital hardware, information technology solutions, and actual training programs, as well as indirect enablers such as telecommunications, secure and affordable energy, safe and supportive learning spaces, etc. Accessing such benefits is constrained by the lack of adequate knowledge of technologies and service providers, as well as funding constraints.

Build organizational capacity. Organizations that contribute to innovative research and advisory services

need a business model that ensures that these organizations crowd-in new skills and experience, foster innovation, and deliver value-added services.

Tackle incentives. Lobbying to change perverse incentives and to develop positive incentives should be regarded as a critical indirect mechanism to drive capacity development within the academic, public, and private spheres.

Alignment, integration, and coordination. There needs to be a focus on enabling collaboration across time and space.

Solutions and implementation focus. Building human and institutional capacity needs to focus on actions that solve the urgent problems of LCTs.

8.6.3 Recommendations for on-the-job training

Vocational training. Vocational training needs to a be key ingredient of capacity for inclusive low-carbon transitions. Most countries in the Global South have weak vocational training systems and the status of this training is low. However, these skillsets are crucial for a transition and should receive the resources and status deserved. Vocational training centers should be a key entry point for building capacity in the Global South.

Courses offering core skills. OOnline and other instruction methods that can be delivered on the job should be offered to equip actors in various spheres with relevant core skills (as described in Recommendation 1 under General Recommendations).

Motivate for time for training by tailoring to needs and realities. Work needs to be done to develop compelling business cases for training and to ensure that workplaces place value on training.

Online and short courses and refresher courses are more palatable to busy actors. Consideration should be given to programs such as the Continuous Professional Development (CPD) program in South Africa, which links capacity-building requirements to professional accreditations that the market requires.

Include innovative capacity-development programs. Providing core training to champions within an organization who can further train others within the organization. This can provide a lower cost and efficient way to disseminate training.

Introducing or expanding immersive training in the workplace, including internships, is an effective way to bridge recent graduates to professional careers.

8.6.4 Recommendations for academic programs

Focus on skills. Training should focus on developing skills rather than simply content knowledge. Content knowledge can be developed independently, while skills development typically requires more training and can then be applied widely.

Focus on sectors. Masters and PhD programs have key roles to play in developing the necessary skills and knowledge for sectoral transitions, as identified above.

Better understand the career paths of graduates and develop clearer career paths. Graduate career paths should be tracked to inspire current students, to monitor their outcomes, to use this monitoring process to refine programs, so that they better meet the needs of graduates in different paths. Efforts should be devoted to understanding future career paths based on evolving needs, and to respond accordingly.

Career paths in areas related to inclusive, low-carbon transitions have been ill-defined. The uncertainty associated with such paths is an inhibiting factor for young professionals, especially those more averse to uncertainty. Efforts should be undertaken to develop clearer career pathways, drawing on lessons from professions such as accounting, law, and engineering, which require periods of supervised, on-the-job learning and accreditation.

Additionally, MBA programs provide a useful model to leverage existing, real-world experienceduring a facilitated process of learning. This would make the learning process more tangible and build the networks and soft skills needed to work more effectively in multi- and trans-disciplinary ways.

8.6.5 Effective teaching and training

There are ingredients that are necessary for ensuring impactful training. These include teaching by passionate external experts and devoted mentors; active participation by students; post-training evaluations; shorter engagements; cross-country, global learning to cultivate more outward looking, international graduates; context-specific, embedded, and experiential learning; intentional online teaching for added reach; training entrepreneurs to participate in LCT transitions; learning in all directions, with policy-makers learning from researchers and researchers learning from policy-makers; and long-term learning and the application of learning.

8.6.6 Principles and considerations to inform the design of capacity-building programs

Do not throw the baby out with the bath water. There are many examples of appropriate and effective capacity-building initiatives that should be amplified and leveraged rather than disregarded.

Focus on scale and speed. More capacity is needed and quickly.

Be adaptive and build adaptive capacity. Programs need to be designed around consistent frameworks but must be able to respond to context-specific needs.

Build values not just skills. Alignment and coordination will be more easily achieved if actors start from a similar set of values.

Commit to long time periods. We need to secure funding, invest in technologies, and design programs for the long term.

Focus on intervention points. Certain processes and periods in time will facilitate greater impact.

8.6.7 Way forward

Human and institutional capacity development should address two types of failures: (i) the scientific community's failure to bring research down to the specific contexts of all policy-makers and practitioners, and (ii) policy-makers and practitioners' failure to translate available research knowledge to policy reform/formulation, planning, implementation, monitoring and evaluation in their contexts.

Results from the capacity needs assessment suggest that the requisite (human and institutional) capacity should be developed through an integrated, solution-focused, implementation-focused, long-term, collaborative and dynamic suite of programs, namely:

(1) On-the-job training providing tools for assessing, reforming, (re)formulating, implementing, and evaluating policies on inclusive low-carbon transitions;

(2) Masters' training providing hands-on training on analyzing inclusive low-carbon transitions challenges and addressing them through policy planning, policy-making, policy implementation, and policy evaluation;

(3) PhD training providing tools for conducting transformational research on inclusive low-carbon transitions and addressing challenges through new approaches to capacity development and policy engagement, and

(4) policy-engaged and gender-sensitive LCT research on sectoral and cross-cutting themes as proposed in this high-level research agenda to be conducted across countries and regions by long-lasting consortia.

Departing from previous models of capacity building, the model suggested here targets longer-term global (not continental) consortia with dedicated multi-disciplinary teams that are positioned in the interface between academia and policy. These consortia would simultaneously implement the high-level research agenda and run on-the-job and academic training programs.

9. Conclusion : toward implementing the HLRA

The goal of the HLRA is to develop a cutting-edge, actionable research agenda to support a low-carbon transition that promotes inclusion across intersecting dimensions, such as gender, poverty, and marginalized groups. The report has presented specific analyses that address knowledge gaps and research needs in the Global South, informed by regional reviews of national commitments and priorities. Gender and inclusion are at the core of the proposed research agenda. This core is then widened to sectoral issues (energy, infrastructural, land use) and conditioning factors such as human and institutional capacity, enabling policy environments, and mobilization of finance.

The review has shown that the limited research and the absence of enabling policy environments in the Global South are symptomatic of three key things: (i) a lack of knowledge on the most effective strategies for a gender-responsive LCT; (ii) the need to develop local capacity to carry out relevant research and to use the evidence from that research to guide policies; and (iii) a need for stronger institutions to implement and manage an inclusive LCT. Future research should also consider new ways of mobilizing climate finance in developing countries where adaptive capacity is low and climate finance is needed the most.

There are large knowledge gaps to realize inclusive LCTs in the Global South. These gaps limit the design of sensible policies and investments based on hard field evidence. Unfortunately, there is a persistent "know-do gap" – that is, a massive gap between what has been evaluated by scholars, on the one hand, and all the programs, projects, and policies actually implemented, on the other hand (Köhlin et al., 2015; Pattanayak et al., 2018). These know-do gaps take different forms—the policies and programs implemented are often not the ones studied, the intended impacts are not the impacts studied, and the geographical areas studied do not fully represent the areas of implementation.[18] The know-do gap signals that there is a systemic disconnect between the solutions world and the research world.

What causes this gap, and why is it a problem? There is simply too little policy research and impact evaluation on LCTs in the Global South that involves scholars from these very settings (Ambec et al., 2023). A great majority of existing climate research is carried out by researchers in the Global North (Overland et al, 2022). This lack of local ownership of the research agenda is particularly acute for African countries. Consequently, the existing literature is thin, weak, and scattered. Moreover, isolated case studies cannot provide general lessons. It is therefore difficult, if not impossible, to implement evidence-based policies since the evidence is simply lacking. Overcoming these knowledge-policy traps (as pervasive as poverty traps) requires shifting the locus of research toward academic institutions in the Global South and investing in a critical mass of scholars who can produce policy-relevant evidence in local, national, and regional contexts.[19]

Stand-alone research calls on specific issues need to be complemented by investment on long-term collaborations on core themes. The choice of implementation modalities will be important for successful implementation of the HLRA. Given the multiple challenges of ensuring the necessary and relevant research to guide a rapid and inclusive LCT in the Global South, the modalities for implementing this HLRA become very important. The tradition of stand-alone open research calls on specific issues might only provide part of the knowledge base needed. In order to evaluate the impact of nationwide policies, there is a need for more long-term and in-depth collaborations between academic institutions and agencies and ministries responsible for the design and

18 Know-do gaps emerge largely because impact evaluations are public goods (Köhlin et al, 2015). So, it rarely makes sense for an organization to conduct an expensive impact evaluation that will not directly benefit the project. Besides, there are large differences between evidentiary standards and the research needs of policymakers and researchers. Inevitably, there isn't enough local capacity to conduct serious evaluations.

19 Such a call for investments overlaps with concerns in natural, medical, and social sciences disciplines to decolonize the production of science (Blicharska et al., 2017; Chaudhuri et al., 2021; Nobles et al., 2022), including in economics (Kvangraven and Kesar, 2022). Unsurprisingly then, the patterns of knowledge monopolies also show up in the policy economics research on LCTs (Gubbay and Ghosh, 2021).

implementation of the policies. Thankfully, IDRC and other donors have already ample experience of a range of implementation modalities of research calls. It would therefore be very valuable to review those experiences in light of the striking need to create active, and long-standing, interactions between very strong inter-disciplinary research environments in local academic institutions and their policy counterparts in government agencies. In most cases, capacity will need to be built on both sides of this interface.

The review has shown that the limited research and the absence of enabling policy environments in the Global South are symptomatic of three key things: (i) a lack of knowledge on the most effective strategies for a gender-responsive LCT; (ii) the need to develop local capacity to carry out relevant research and to use the evidence from that research to guide policies; and (iii) a need for stronger institutions to implement and manage an inclusive LCT. Future research should also consider new ways of mobilizing climate finance in developing countries where adaptive capacity is low and climate finance is needed the most.

There is a need to invest in relevant data and data repositories. As economies in the Global South also adapt toward net-zero greenhouse gas emissions, researchers will need to analyze this process in real-time impact assessments, to make the transition as efficient as possible. However, the limitations in data availability present a clear challenge. This holds for most analyses but is particularly disconcerting when it comes to gender analysis, where the challenges are striking. Special data collection efforts or the development of easily accessible repositories of relevant data should be considered. A low-hanging opportunity could be to integrate investment on data and data repositories with big-ticket initiatives that are receiving traction. For example, there is currently momentum on locally-led restoration in Africa, which could result in significant investments. There is a need for an intentional effort to ensure this is accompanied by deep learning, which will in turn require investing in universities and research institutions in restoration hotspots, so that they can become the hubs of data and research.

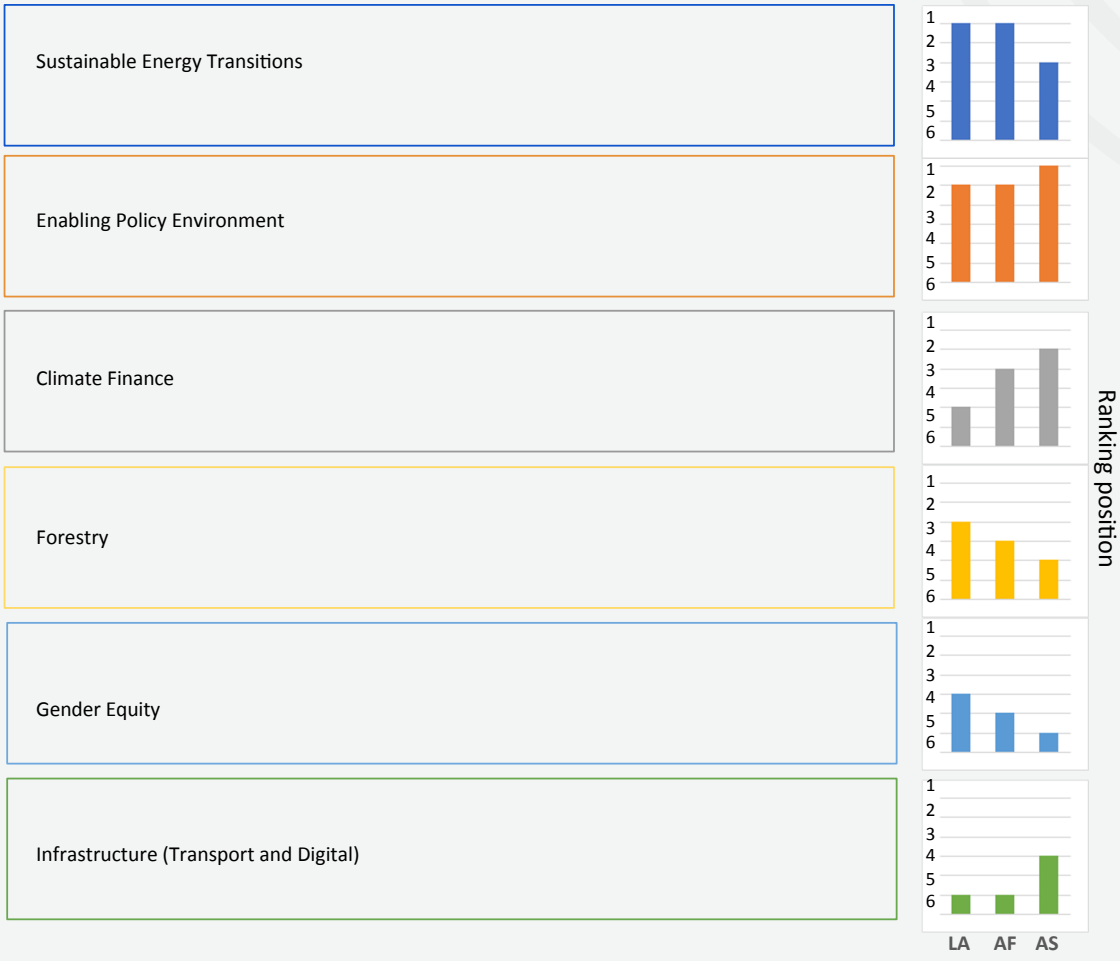
Research methodologies need to be conducive to analysis of inclusion, which could imply the need for multi-disciplinarity, and harmonization of qualitative and quantitative methods The methodologies will need to be chosen carefully in order to guide interventions and discern distributional effects. To increase the targeting and quality of future research calls, methodological considerations should be spelled out in the call and considered in the selection. This is, of course, particularly important when multidisciplinary research is required.

Traditional capacity building needs to be combined with innovative approaches targeted to a wider audience, given the need for a global transition that encompasses all professions and sectors. Future research should take a holistic and multidisciplinary approach because of the strong linkages between themes such as policy development and implementation, gender, and human and institutional capacity. This requires not only capacity building among experts in different fields and institutions, so that they are prepared to handle low-carbon transitions, but also deliberate linkages between sectors and collaboration among researchers. These linkages often need strengthening through the establishment of dedicated platforms for collaboration.

Finally, future research agendas should be developed in an inclusive way, with active participation of local institutions and target groups. As was the case for this HLRA, future knowledge gaps need to be validated and prioritized based on local conditions. Therefore, validation workshops and definition of key actors both in the academic and policy arena (governments, communities, NGOs, and other key stakeholders) arise as important venues to develop a prioritization of the needs to support the transition toward an inclusive, gender-equitable, low-carbon economy in the Global South. The validation workshops conducted for this report show that priorities can differ dramatically between regions. As part of these regional validation workshops[20] , the participants were also asked to rank the six areas for high-impact research. As can be seen in Figure 9.1, Sustainable Energy Transition and Enabling Policy Environments were highly ranked the highest, while Gender and Infrastructure had low rankings. Climate finance ranked low in Latin America compared to the other regions. This implies that future calls need to be targeted to particular regions for maximum relevance and impact.

20 The findings from this research agenda were validated by stakeholders from the public and private sector and civil society in regional workshops in Africa (South Africa), Asia (Vietnam) and Latin America (Colombia) in March 2023.

Figure 9.1. Regional validation workshops' ranking of high-impact research areas



References

Acheampong, A. O., Dzator, J., & Savage, D. A., 2021. Renewable energy, CO2 emissions and economic growth in sub-Saharan Africa: Does institutional quality matter? Journal of Policy Modeling, 43(5), 1070–1093. https://doi.org/10.1016/j.jpolmod.2021.03.011

Acumen, ICRW, 2017. Women and Social Enterprises: How Gender Integration Can Boost Entrepreneurial Solutions to Poverty. Washington D.C: International Centre for Research on Women

Adaptation Fund, 2019. Assessment report on the progress in the implementation of the Adaptation Fund's Gender Policy and Gender Action Plan. AFB/B 34.

Aera, 2022. Aera in nutshell The Largest Originator and Trader of African Carbon Credits. Paris: Aera. https://aera-group.fr/

Africa on the Rise, 2019. Developing Africa's Youth to Respond to the Challenges of Digitization (Blog post). Djembe Consultants. https://djembeconsultants.com/developing-africas-youth-respond-challenges-digitization/

African Development Bank, 2022. African Economic Outlook 2022 – Supporting Climate Resilience and a Just Energy Transition in Africa, Abidjan, AfDB.

African Development Bank, Asian Development Bank, European Bank for Reconstruction and Development, European Investment Bank, Inter-American Development Bank, International Monetary Fund, World Bank, 2015. From Billions to Trillions: Transforming development finance post-2015 financing for development: multilateral development finance.

African Development Bank, UNEP (United Nations Environment Programme), and UNECA (United Nations Economic Commission for Africa), 2019. Climate Change Impacts on Africa's Economic Growth 2019. Abidjan, Côte d'Ivoire: African Development Bank

Afridi, F., Bishnu, M., Mahajan, K., 2022. Gender and mechanization: Evidence from Indian agriculture. American J Agri Economics ajae.12315. https://doi.org/10.1111/ajae.12315

Agrawal, A., Chhatre, A., and Hardin, R., 2008. Changing Governance of the World's Forests. Science, 320, 1460–1462.

Aguilar, L., Araujo, A., Quesada-Aguilar, A., 2007. Reforestation, afforestation, deforestation, climate change and gender. Fact Sheet. Costa Rica: IUCN.

Aguilar, L., Granat, M., Owren, C., 2015. Roots for the future: The landscape and way forward on gender and climate change.Costa Rica: IUCN.

Aguilar-Farias, N., Cortinez-O'Ryan, A., Chandia-Poblete, D., Heesch, K.C., 2019. Prevalence and correlates of transport cycling in Chile: Results from 2014 to 2015 national surveys. Journal of Transport & Health 14, 100594.

Agutu, C., Egli, F., Williams, N.J., Schmidt, T.S., Steffen, B., 2022. Accounting for finance in electrification models for sub-Saharan Africa. Nat Energy 7, 631–641. https://doi.org/10.1038/s41560-022-01041-6

Ahmed, Akhter U., Malapit, Hazel J., Pereira, Audrey, Quisumbing, Agnes R., Rubin, Deborah, Ghostlaw, Julie, Haque, Md. Latiful, Hossain, Nusrat Zaitun, Tauseef, Salauddin, 2018. Tracking empowerment along the value chain: Testing a modified WEAI in the Feed the Future Zone of Influence in Bangladesh. Washington D.C: IFPRI.

Allan, S., Bahadur, A.V., Venkatramani, S., Soundarajan, V., 2019. The Role of Domestic Budgets in Financing Climate Change Adaptation. Oxford Policy Management.

Amasawa, E., Ihara, T., Hanaki, K., 2017. Role of e-reader adoption in life cycle greenhouse gas emissions of book reading activities. International Journal of Life Cycle Assess 23, 1874–1887

Ambec, S., Nauges, C., & Pattanayak, S.K., 2023. Introduction to the SETI special issue. Resource and Energy Economics 72, 101361. https://doi.org/10.1016/j.reseneeco.2023.101361

Andersen, O.W., Basile, I., Kemp, A. de, Gotz, G., Lundsgaarde, E., Orth, M., 2019. Blended Finance Evaluation: Governance and Methodological Challenges (OECD Development Co-operation Working Papers No. 51), OECD Development Co-operation Working Papers. https://doi.org/10.1787/4c1fc76e-en

Anderson, C. M., DeFries, R. S., Litterman, R., Matson, P. A., Nepstad, D. C., Pacala, S., & Field, C. B., 2019. Natural climate solutions are not enough. Science, 363(6430), 933-934.

Angelsen, A., Wang Gierløff, C., den Elzen, M., Mendoza Beltran, A., 2014. REDD Credits in a Global Carbon Market: Options and Impacts: Norden. Catching carbon. Nat. Geosci. 15, 341

Anser, M. K., Shabbir, M. S., Tabash, M. I., Shah, S. H. A., Ahmad, M., Peng, M. Y.-P., & Lopez, L. B., 2021. Do renewable energy sources improve clean environmental-economic growth? Empirical investigation from South Asian economies. Energy Exploration & Exploitation, 39(5), 1491–1514. https://doi.org/10.1177/01445987211002278

Arayssi, M., Dah, M., Jizi, M., 2016. Women on boards, sustainability reporting and firm performance. Sustainability Accounting, Management and Policy Journal.

Arze del Granado, F. J., Coady, D., & Gillingham, R., 2012. The Unequal Benefits of Fuel Subsidies: A Review of Evidence for Developing Countries. World Development, 40(11), 2234–2248. https://doi.org/10.1016/j.worlddev.2012.05.005

Ashraf, M.M., Hassan, N., Lewis, L., Hassan, M.R., Ray, P., 2017. A systematic literature review of the application of ICT for visually impaired people. International Journal of Disability Management, 11, E6. doi:10.1017/idm.2016.6

Attridge, S., Engen, L., 2019. Blended finance in the poorest countries: the need for a better approach. ODI. https://odi.org/en/publications/blended-finance-in-the-poorest-countries-the-need-for-a-better-approach/

Aziz, A., Azhar, S., 2019. Social exclusion and official recognition of Hijra in Bangladesh. Journal of Research on Women and Gender 9, 3–19.

Aziz, A., Islam, M.M., Zakaria, M., 2020. COVID-19 exposes digital divide, social stigma, and information crisis in Bangladesh. Media Asia 47, 144–151. https://doi.org/10.1080/01296612.2020.1843219

Azocar, M. J., and M. M. Ferree., 2016. Engendering the sociology of expertise. Sociology Compass 10(12): 1079–1089.

Banales, S., 2020. The enabling impact of digital technologies on distributed energy resources integration. Journal of Renewable Sustainable Energy, 12, 045301.

Barbieri, A.F., Carr, D.L., 2005. Gender-specific out-migration, deforestation and urbanization in the Ecuadorian Amazon. Global and Planetary Change 47, 99–110. https://doi.org/10.1016/j.gloplacha.2004.10.005

Bardasi, E., M. Gassier, M. Goldstein and A. Holla., 2021. The Profits of Wisdom: The Impact of a Business Support Program in Tanzania. The World Bank Economic Review 35(2): 328–347.

Barragán-Escandón, A., Jara-Nieves, D., Romero-Fajardo, I., Zalamea-Leon, E.F., Serrano-Guerrero, X., 2022. Barriers to renewable energy expansion: Ecuador as a case study. Energy Strategy Reviews 43, 100903. https://doi.org/10.1016/j.esr.2022.100903

Barron, M., Philip Clarke, R., B. Elam, A., A. Klege, R., Shankar, A., Visser, M., 2020. Gender and Entrepreneurship in the Renewable Energy Sector of Rwanda. IDS Bulletin 51. https://doi.org/10.19088/1968-2020.105

Bastin, J.F., Finegold, Y., Garcia, C., Mollicone, D., Rezende, M., Routh, D., Zohner, C.M., Crowther, T.W., 2019. The global tree restoration potential. Science 365, 76–79.

Baxter, C., DENNINGS, K., BAILLIE, S., 2022. Gender and the Climate Crisis: Equitable Solutions for Climate Plans. Center for Biological Diversity. https://www.biologicaldiversity.org/programs/population_and_sustainability/pdfs/gender_and_the_climate_crisis_equitable_solutions_for_climate_plans_2022.pdf

Bensch, G., Kluve, J., Peters, J., 2010. Rural Electrification in Rwanda – An Impact Assessment Using Matching Techniques. SSRN Journal. https://doi.org/10.2139/ssrn.1735399

Berkhout, F., & Hertin, J., (2001). De-materialising and re-materialising: Digital technologies and the environment. Futures. 36. 903–920. https://doi.org/10.1016/j.futures.2004.01.003

Bernhardt, A., E. Field, R. Pande and N. Rigol., 2019. Household matters: Revisiting the returns to capital among female microentrepreneurs. American Economic Review: Insights 1(2): 141–160.

Beuchelt, T.D., Badstue, L., 2013. Gender, nutrition- and climate-smart food production: Opportunities and trade-offs. Food Sec. 5, 709–721. https://doi.org/10.1007/s12571-013-0290-8

Bhatia, M., & Angelou, N., 2015. Beyond Connections: Energy Access Redefined [Working Paper]. World Bank. https://openknowledge.worldbank.org/handle/10986/24368

Bhattacharya, A., Stern, N., 2021. Policy note Beyond the $100 billion: financing a sustainable and resilient future. Grantham Research Institute on Climate Change and the Environment.

Bhattacharya, D., Khan, S. S., 2019. Is blended finance trending in the LDCs? Perspectives from the ground. Southern Voice. http://southernvoice.org/wp-content/uploads/2019/02/Ocassional-Paper-Series-N49.pdf

Bill & Melinda Gates Foundation, n.d. GENDER EQUALITY LEXICON [WWW Document]. URL https://www.gatesgenderequalitytoolbox.org/definitions-concepts/gender-equality-lexicon/

Binkley, C.S., Steward, F., and Power S., 2020. Pension-Fund Investment in Forestry. EFI Insight–Finance Rep., Washington, DC: World Bank, .

Blackman, A., 2020. Latin American and Caribbean Forests in the 2020s: Trends, Challenges, and Opportunities. Inter-American Development Bank. Recovered from: https://publications.iadb.org/publications/english/document/Latin-American-and-Caribbean-Forests-in-the-2020s-Trends-Challenges-and-Opportunities.pdf

Blackman, A., Corral, L., Lima, E., & Asner, G., 2017. Titling indigenous communities protects forests in the Peruvian Amazon. Proceedings of the National Academy of Sciences of the United States of America, 114, 4123–4128.

Blicharska, M., Smithers, R.J., Kuchler, M., Agrawal, G.K., Gutiérrez, J.M., Hassanali, A., Mikusinski, G., 2017. Steps to overcome the north-south divide in research relevant to climate change policy and practice. Nat. Clim. Change 7 (1), 21–27. https://doi.org/10.1038/nclimate3163

Blimpo, M., & Cosgrove-Davies, M., (2017). Electricity Access in Sub-Saharan Africa Uptake, Reliability, and Complementary Factors for Economic Impact. Washington D.C: World Bank Group

Bloomberg, 2017. China Gives Automakers More Time in World's Biggest EV Plan. Bloomberg.Com. https://www.bloomberg.com/news/articles/2017-09-28/china-to-start-new-energy-vehicle-production-quota-from-2019

Boulton, C.A., T.M. Lenton and N. Boers. 2022. Pronounced loss of Amazon rainforest resilience since the early 2000s. Nature Climate Change 12: 271–278

Braidotti, R., Charkiewicz, E., Hausler, S., Wieringa, S., 1994. Women, the environment and sustainable development: towards a theoretical synthesis. Zed books.

Brancalion, P.H.S., Campoe, O., Mendes, J.C.T., Noel, C., Moreira, G.G., Melis, J., Stape, J.L., Guillemot, J., 2019. Intensive silviculture enhances biomass accumulation and tree diversity recovery in tropical forest restoration. Ecol Appl 29.

Buolamwini, J., Gebru, T., 2018. Gender shades: Intersectional accuracy disparities in commercial gender classification, in: Conference on Fairness, Accountability and Transparency. PMLR, pp. 77–91.

Busch, J., Engelmann, J., Cook-Patton, S.C., Griscom, B.W., Kroeger, T., Possingham, H., Shyamsundar, P., 2019. Potential for low-cost carbon dioxide removal through tropical reforestation. Nat. Clim. Chang. 9, 463–466.

CABRI, 2021. The integration of climate change into budgeting and finance. CABRI Policy Brief. https://www.cabri-sbo.org/en/publications/policy-brief-2021-the-integration-of-climate-change-into-budgeting-and-finance

CAF, 2021. CAF Reaffirms Commitment to Becoming Latin America's Green Bank at COP26 [WWW Document]. https://www.caf.com/en/currently/news/2021/11/caf-reaffirms-commitment-to-becoming-latin-america-s-green-bank-at-cop26/

Calderón, C., Cantú, C., & Chuhan-Pole, P., (2018). Infrastructure development in Sub-Saharan Africa: A scorecard (Policy Research Working Paper 8425). Washington D.C: World Bank Group

Calvert, n.d. Gender equity is good for investment, good for business, and good for society. Calvert. https://calvertimpact.org/resources/category/gender-equity.

Cárdenas, M. et al., 2021. Climate Policies in Latin America and the Caribbean. Success Stories and Challenges in the Fight Against Climate Change. Inter-American Development Bank. https://publications.iadb.org/publications/english/document/Climate-policies-in-latin-america-and-the-caribbean.pdf

Cárdenas, M., Bonilla, J.P., Brusa, F., 2021. Climate Policies in Latin America and The Caribbean. Inter-American Development Bank. http://dx.doi.org/10.18235/0003239

CARE-WWF Alliance., 2019. The value of integrating conservation and development: Lessons from Mozambique, Tanzania and Nepal. Morges: WWF. www.worldwildlife.org/partnerships/care-wwf-alliance

Carl, J., & Fedor, D., 2016. Tracking global carbon revenues: A survey of carbon taxes versus cap-and-trade in the real world. Energy Policy, 96, 50–77. https://doi.org/10.1016/j.enpol.2016.05.023

CEPAL, N., 2019. Gender equality plans in Latin America and the Caribbean: Road maps for development. Santiago: United Nations Economic Commission for Latin America and the Caribbean. https://www.cepal.org/en/publications/41015-gender-equality-plans-latin-america-and-caribbean-road-maps-development

CGIAR, 2021. Recognizing the Agricultural Efforts of Women. CGIAR. URL https://www.cgiar.org/news-events/news/cgiar-celebrates-international-womens-day-2021/

Chape, S., Harrison, J., Spalding, M., & Lysenko, I., 2005. Measuring the extent and effectiveness of protected areas as an indicator for meeting global biodiversity targets. Philosophical Transactions of the Royal Society of London, 360(1454): 443–455.

Chasukwa, M., 2016. The Gender Machinery: Opportunities and Challenges for Women in Central Government, in: Women in Politics in Malawi. Bergen: Chr. Michelsen Institute (CMI Brief). https://www.cmi.no/publications/5880-the-gender-machinery-women-in-malawis-central

Chaudhuri, M.M., Mkumba, L., Raveendran, Y., Smith, R.D., 2021. Decolonising global health: beyond 'reformative' roadmaps and towards decolonial thought. BMJ Glob. Health 6 (7), e006371. https://doi.org/10.1136/bmjgh-2021-006371

Chhatre, A., and A. Agruwal., 2009. Trade-Offs and Synergies between Carbon Storage and Livelihood Benefits from Forest Commons. Proceedings of the National Academy of Sciences of the United States of America 106 (42): 17667–17670.

Cho, S., Crenshaw K.W., & McCall l., 2013. Toward a field of intersectionality studies: Theory, applications, and praxis. Signs: Journal of women in culture and society 38(4): 785–810.

Chomba, S., Kariuki, J., Lund, J. F., & Sinclair, F., (2016). Roots of inequity: How the implementation of

REDD+ reinforces past injustices. Land Use Policy, 50. 202-213.

Chowdhury, S., van Wee, B., 2020. Examining women's perception of safety during waiting times at public transport terminals. Transport Policy 94, 102–108. https://doi.org/10.1016/j.tranpol.2020.05.009

Clancy, J., Winther, T., Matinga, M., Oparaocha, S., 2012. Gender equity in access to and benefits from modern energy and improved energy technologies: world development report background paper. Gender and Energy WDR Background Paper 44.

Climate Action Tracker, 2022. Country Summaries.: https://climateactiontracker.org/

Climate Bonds Initiative, 2017. Bonds and Climate Change: The State of the Market /update 2017 India. https://www.climatebonds.net/resources/reports/bonds-and-climate-change-state-market-2017

Climate Bonds Initiative, 2022. China Green Finance Policy Analysis Report 2021. https://www.climatebonds.net/resources/reports/china-green-finance-policy-analysis-report-2021

Coady, D., Flamini, V., & Sears, L., 2015. The Unequal Benefits of Fuel Subsidies Revisited: Evidence for Developing Countries [IMF Working Paper]. https://www.imf.org/en/Publications/WP/Issues/2016/12/31/The-Unequal-Benefits-of-Fuel-Subsidies-Revisited-Evidence-for-Developing-Countries-43422

Coelho, S. T., A. Sanches-Pereira, L. G. Tudeschini and J. Goldemberg., 2018. The energy transition history of fuelwood replacement for liquefied petroleum gas in Brazilian households from 1920 to 2016. Energy Policy 123: 41–52.

Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S., (eds.) 2016. Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN. xiii + 97pp.

Cohn, A.S., Newton, P., Gil, J.D.B., Kuhl, L., Samberg, L., Ricciardi, V., Manly, J.R., Northrop, S., 2017. Smallholder Agriculture and Climate Change. Annual Review of Environment and Resources 42, 347–375.

Colenbrander, S., Dodman, D., Mitlin, D., 2018. Using climate finance to advance climate justice: the politics and practice of channelling resources to the local level. Climate Policy 18, 902–915. https://doi.org/10.1080/14693062.2017.1388212

Convergence, 2019. Case Study: Development Bank of South Africa's Climate Finance Facility. https://www.convergence.finance/resource/climate-finance-facility-case-study/view

Convergence, 2021. The State of Blended Finance 2021. https://www.convergence.finance/resource/the-state-of-blended-finance-2021/view

Cooke-St. Clair, P.C., G. Köhlin and W. F. Hyde. 2008.'Fuelwood, forests and community management – evidence from household studies', Environment and Development Economics, 13: 103–135.

Coria, J., & Sterner. T. (2010). Tradable Permits in Developing Countries: Evidence from Air Pollution in Chile. The Journal of Environment and Development, 19(2), 145–170. DOI: https://doi.org/10.1177%2F1070496509355775

CPI, 2021a. Global Landscape of Climate Finance 2021. Climate Policy Initiative. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/

CPI, 2021b. Global Landscape of Climate Finance 2021 – Methodology. Climate Policy Initiative. https://www.climatepolicyinitiative.org/publication/global-landscape-of-climate-finance-2021/

Crenshaw, K., 2018. Demarginalizing the intersection of race and sex: A Black feminist critique of antidiscrimination doctrine, feminist theory, and antiracist politics [1989], in: Feminist Legal Theory. Routledge, pp. 57–80.

Das, I., T. Klug, P. Krishnapriya, V. Plutshack, R. Saparapa, S. Scott and S. Pattanayak., 2020. A Virtuous Cycle? Reviewing the evidence on women's empowerment and energy access, frameworks, metrics and methods. White Paper.

Davies, R., & van Seventer, D., 2019. Using economy-wide modelling for South African policy analysis: An

introduction. SA-TIED Working Paper, 61, 25.

Dawson, C., Naughton, K., Coppola, G., 2019. Auto Workers Fear EVs Will be Job Killers [WWW Document]. Automotive News. https://www.autonews.com/manufacturing/auto-workers-fear-evs-will-be-job-killers

De Mel, S., D. McKenzie and C. Woodruff., 2009. Are women more credit constrained? Experimental evidence on gender and microenterprise returns. American Economic Journal: Applied Economics 1(3): 1-32.

Dembele, F., Schwarz, R., Horrocks, P., 2021. Scaling up Green, Social, Sustainability and Sustainability-linked Bond Issuances in Developing Countries. Paris: OECD

Dhali, H.H., 2008. Deforestation and its Impacts on Indigenous Women: A Case from the Chittagong Hill Tracts in Bangladesh. Gender, Technology and Development 12, 229–246. https://doi.org/10.1177/097185240801200204

Di Sacco, A., Hardwick, K.A., Blakesley, D., Brancalion, P.H., Breman, E., Cecilio Rebola, L., Chomba, S., Dixon, K., Elliott, S., Ruyonga, G. and Shaw, K., 2021. Ten golden rules for reforestation to optimize carbon sequestration, biodiversity recovery and livelihood benefits. Global Change Biology, 27(7), pp.1328–1348.

Ding, W., He, L., Zewudie, D., Zhang, H., Zafar, T.B., Liu, X., 2019. Gender and renewable energy study in Tibetan pastoral areas of China. Renewable Energy 133, 901–913. https://doi.org/10.1016/j.renene.2018.10.065

Dorband, I. I., Jakob, M., Kalkuhl, M., & Steckel, J. C., 2019. Poverty and distributional effects of carbon pricing in low- and middle-income countries – A global comparative analysis. World Development, 115, 246–257. https://doi.org/10.1016/j.worlddev.2018.11.015

Doss, C., 2013. Intrahousehold bargaining and resource allocation in developing countries. The World Bank Research Observer 28, 52–78.

Dubay, T., Egan, D., Hjerpe, E.E., Selig, W., Brewer, D., Coelho, D., Wurtzebach, Z., Schultz, C. and Waltz, A.E., 2013. Breaking barriers, building bridges: collaborative forest landscape restoration handbook. Ecological Restoration Institute.

Dutta, S., (2020). Promoting Women's Entrepreneurship in Distribution of Energy Technologies: Lessons from ENERGIA's WEE Programme. IDS Bulletin 51(1).

Dyarto, R., Setyawan, D., 2021. Understanding the political challenges of introducing a carbon tax in Indonesia. Int. J. Environ. Sci. Technol. 18, 1479–1488. https://doi.org/10.1007/s13762-020-02925-4

Echeverría, C., Smith-Ramírez, C., Aronson, J. and Barrera-Cataño, J.I., 2015. Good news from Latin America and the Caribbean: national and international restoration networks are moving ahead. Restor Ecol, 23: 1–3. https://doi.org/10.1111/rec.12174

ECOWAS, 2017. Policy on Gender Mainstreaming in Energy Access. Abidjan: African Development Bank. https://www.afdb.org/fileadmin/uploads/afdb/Documents/Generic-Documents/ECOWAS_Policy_for_Gender_Mainstreaming_in_Energy_Access.pdf

Edwards, D.P., Cerullo, G.R., Chomba, S., Worthington, T.A., Balmford, A.P., Chazdon, R.L. and Harrison, R.D., 2021. Upscaling tropical restoration to deliver environmental benefits and socially equitable outcomes. Current Biology, 31(19), pp. R1326-R1341.

Ekesa, B., Ariong, R.M., Kennedy, G., Baganizi, M., Dolan I., 2020. Relationships between land tenure insecurity, agrobiodiversity, and dietary diversity of women of reproductive age: Evidence from Acholi and Teso subregions of Uganda. Maternal & Child Nutrition 16 (Suppl 3).

Elias M., Ihalainen M., Monterroso I., Gallant B., Paez Valencia AM., 2021. Enhancing synergies between gender equality and biodiversity, climate, and land degradation neutrality goals: Lessons from gender-

responsive nature-based approaches. Bioversity International. Rome, Italy. 28 p.

ENERGIA, 2020. Gender and Energy Program. New York: United Nations https://www.un.org/esa/ffd/ffd3/commitments/commitment/energia-programme.html

ENERGIA, World Bank, 2018. Accelerating SDG 7 Achievement Policy Brief 12 Global Progress of SDG 7—Energy and Gender.

Erbaugh, J.T., Pradhan, N., Adams, J., Oldekop, J.A., Agrawal, A., Brockington, D., Pritchard, R., Chhatre, A., 2020. Global forest restoration and the importance of prioritizing local communities. Nat Ecol Evol 4, 1472–1476.

Errigo, F & Tesoriere, G., (2018) Urban Travel behavior determinants in Saudi Arabia. TeMA Journal of Land Use, Mobility and Environment, SP/01 (01/18). pp. 31–46. ISSN 1970-9870

Erthal Abdenur, A., 2020. Gender, Climate and Security in Latin America and the Caribbean: From Diagnostics to Solutions. Climate Diplomacy. https://climate-diplomacy.org/magazine/cooperation/gender-climate-and-security-latin-america-and-caribbean-diagnostics olutions#:~:text=It's%20not%20just%20the%20disasters,economic%20subsidies%20and%20other%20incentives

Escalante, D., Choi, J., Chin, N., Cui, Y., Larsen, M.L. (2020). Green Bonds in China: The State and Effectiveness of the Market. Climate Policy Initiative. https://www.climatepolicyinitiative.org/publication/green-bonds-in-china-the-state-and-effectiveness-of-the-market/

Espinoza Trujano, J., Lévesque, A.-M., 2022. Development finance institutions and the care economy: opportunities for building more resilient and gender-equitable economies. Journal of Sustainable Finance & Investment 12, 704–723. https://doi.org/10.1080/20430795.2022.2030662

Etongo, D., Epule, T. E., Djenontin, I. N. S., & Kanninen, M., 2018. Land management in rural Burkina Faso: the role of socio-cultural and institutional factors. In Natural Resources Forum (Vol. 42, No. 3, pp. (201-213). Oxford: Blackwell Publishing Ltd.

European Commission, 2020. Long-term low greenhouse gas emission development strategy of the EU and its Member States. Retrieved from Long-term low greenhouse gas emission development strategy of the EU and its Member States | UNFCCC

European Investment Bank., 2021. Finance in Africa: for green, smart and inclusive private sector development. Luxembourg: European Investment Bank. https://www.eib.org/attachments/publications/economic_report_finance_in_africa_2021_en.pdf

European Parliament, 2022. The impact of textile production and waste on the environment [WWW Document]. URL https://www.europarl.europa.eu/news/en/headlines/society/20201208STO93327/the-impact-of-textile-production-and-waste-on-the-environment-infographic

FAO, 2016. The state of food and agriculture: Climate change, agriculture and food security. Rome: FAO.

Favero, A., Daigneault, A., and Sohngen, B., 2020. Forests: carbon sequestration, biomass energy, or both? Science Advances 6, eaay6792

Feed the Future, n.d. TThe Women's Empowerment in Agriculture Index [WWW Document]. URL https://www.feedthefuture.gov/the-womens-empowerment-in-agriculture-index/

Fekete, H., Kuramochi, T., Roelfsema, M., Elzen, M. den, Forsell, N., Höhne, N., Luna, L., Hans, F., Sterl, S., Olivier, J., van Soest, H., Frank, S., & Gusti, M., 2021. A review of successful climate change mitigation policies in major emitting economies and the potential of global replication. Renewable and Sustainable Energy Reviews, 137, 110602. https://doi.org/10.1016/j.rser.2020.110602

Fernandez-Feijoo, B., Romero, S., Ruiz-Blanco, S., 2014. Women on Boards: Do They Affect Sustainability Reporting?: Women on Boards: Do They Affect Sustainability Reporting? Corp. Soc. Responsib. Environ. Mgmt. 21, 351–364. https://doi.org/10.1002/csr.1329

Fingleton-Smith, E., 2018. The lights are on but no (men) are home. The effect of traditional gender roles on perceptions of energy in Kenya. Energy research & social science 40, 211–219.

Fisher, S. and Mohun, R., 2015. Low-carbon resilient development and gender equality in the least developed countries. London: IIED

Folbre, N., 2018. Developing care Recent research on the care economy and economic development. Ottawa: IDRC. http://hdl.handle.net/10625/57142

Folbre, N., 2021. Developing Care: The care economy and economic development, in: Women's Economic Empowerment. Routledge, pp. 102–125.

Forest Trends' Ecosystem Marketplace, 2021. Ecosystem Marketplace Insights Report Markets in Motion State of the Voluntary Carbon Markets 2021 Installment. https://www.ecosystemmarketplace.com/publications/state-of-the-voluntary-carbon-markets-2021/

Fowlie, M. and R. Meeks., 2021. The economics of energy efficiency in developing countries. Review of Environmental Economics and Policy 15(2): 238–260.

Franks, M., Lessmann, K., Jakob, M., Steckel, J.C., Edenhofer, O., 2018. Mobilizing domestic resources for the Agenda 2030 via carbon pricing. Nature Sustainability 1, 350–357.

Friedlingstein, P., Jones, M., O'Sullivan, M., Andrew, R., Hauck, J., Peters, G., et al., (2019). Global carbon budget 2019. Earth Syst.Sci. Data 11, 1783–1838.

Fukuda-Parr, S., 2016. From the Millennium Development Goals to the Sustainable Development Goals: shifts in purpose, concept, and politics of global goal setting for development. Gender & Development 24(1): 43–52.

Galbreath, J., 2011. Are there gender-related influences on corporate sustainability? A study of women on boards of directors. Journal of management & organization 17, 17–38.

Galvin, R., 2015. The ICT/Electronics question: structural change and the rebound effect. Ecological Economics, 120, 23–31.

García JH, Sterner T., 2021 'Carbon Taxes.' Oxford Encyclopaedia of Environmental Economics, 65: 101232

García, A., 2022. Women as leaders of urban climate action in Latin America and the Caribbean. Inter-American Development Bank. https://blogs.iadb.org/ciudades-sostenibles/en/women-as-leaders-of-urban-climate-action-in-latin-america-and-the-caribbean/

García-Franco, J.F., Carvajal-Quintero, S.X., Arango-Aramburo, S., 2021. Rational and efficient energy use programs in Non-Interconnected Zones in Colombia: a system dynamics analysis. Energy Efficiency 14, 78. https://doi.org/10.1007/s12053-021-09989-2

Gazzola, P., Pavione, E., Pezzetti, R., Grechi, D., 2020. Trends in the Fashion Industry. The Perception of Sustainability and Circular Economy: A Gender/Generation Quantitative Approach. Sustainability 12, 2809. https://doi.org/10.3390/su12072809

GCF, 2017. Mainstreaming Gender in Green Climate Fund Projects. Incheon: Green Climate Fund. https://www.greenclimate.fund/document/mainstreaming-gender-green-climate-fund-projects

GFMA & BCG, 2021. Unlocking the Potential of Carbon Markets to Achieve Global Net Zero. https://www.gfma.org/correspondence/unlocking-the-potential-of-carbon-markets-to-achieve-global-net-zero/

Ghosh, J., 2021. Gender concerns in debt relief. London: IIED. https://www.iied.org/20691iied

Glass, C., Cook, A., Ingersoll, A.R., 2016. Do Women Leaders Promote Sustainability? Analyzing the Effect of Corporate Governance Composition on Environmental Performance: Women Leaders. Bus. Strat. Env. 25, 495–511. https://doi.org/10.1002/bse.1879

Glavovic, B. C., Smith, T. F., & White, I., 2021. The tragedy of climate change science. Climate and

Development. https://doi.org/10.1080/17565529.2021.2008855

Global Carbon Project, 2014. Carbon budget 2014: An Annual Update of the Carbon Budget and Trends. http://www.globalcarbonproject.org/carbonbudget

Global Center on Adaptation (GCA), 2020, "State and Trends in Adaptation Report 2020: Building Forward Better from Covid-19: Accelerating Action on Climate Adaptation". https://gca.org/wp-content/uploads/2021/03/GCA-State-and-Trends-Report-2020-Online-3.pdf

Godfrey, J., Bertini, R.L., 2019. Attracting and retaining women in the transportation industry. San Jose State University. https://scholarworks.sjsu.edu/mti_publications/259/

Goldthau, A., Eicke, L., Weko, S., 2020. The Global Energy Transition and the Global South, in: Hafner, M., Tagliapietra, S. (Eds.), The Geopolitics of the Global Energy Transition, Lecture Notes in Energy. Springer International Publishing, Cham, pp. 319–339. https://doi.org/10.1007/978-3-030-39066-2_14

Göras, A., & Mohajer, C., 2016. Impact assessment of solar energy projects in rural areas: A case study in Kenya. Chalmers Univeristy of Technology. https://publications.lib.chalmers.se/records/fulltext/241704/241704.pdf

Goulder, L.H., Hafstead, M.A.C., Kim, G., Long, X., 2019. Impacts of a carbon tax across US household income groups: What are the equity-efficiency trade-offs? Journal of Public Economics 175, 44–64. https://doi.org/10.1016/j.jpubeco.2019.04.002

Government of Canada, 2021. Feminist International Assistance Gender Equality Toolkit for Projects [WWW Document]. URL https://www.international.gc.ca/world-monde/funding-financement/gender_equality_toolkit-trousse_outils_egalite_genres.aspx?lang=eng#tool_4 (accessed 10.12.22).

Government of China., 2011. China's Policies and Actions for Addressing Climate Change. Information Office of the State Council The People's Republic of China. https://faolex.fao.org/docs/pdf/chn195978.pdf

Government of China., 2018. The People's Republic of China Second Biennial Update Report on Climate Change (p. 94) [UNFCCC Update Report]. Government of China. https://unfccc.int/sites/default/files/resource/China%202BUR_English.pdf

Government of India., 2015. India's Intended Nationally Determined Contribution: Working Towards Climate Justice, (National Determined Contributions (NDC)) [National Policy Document]. Government of India. https://www4.unfccc.int/sites/submissions/INDC/Published%20Documents/India/1/INDIA%20INDC%20TO%20UNFCCC.pdf

Government of Kenya, 2019. Gender Policy. http://psyg.go.ke/wp-content/uploads/2019/12/NATIONAL-POLICY-ON-GENDER-AND-DEVELOPMENT.pdf

Government of Uganda, 2007. The Uganda Gender Policy. https://www.fao.org/faolex/results/details/es/c/LEX-FAOC163564/

Gray, L., A. Boyle, E. Francks and V. Yu., 2019. The power of small-scale solar: gender, energy poverty, and entrepreneurship in Tanzania. Development in Practice 29(1): 26–39.

Griscom, B.W., Adams, J., Ellis, P.W., Houghton, R.A., Lomax, G., Miteva, D.A., Schlesinger, W.H., Shoch, D., Siikamäki, J.V., Smith, P., Woodbury, P., Zganjar, C., Blackman, A., Campari, J., Conant, R.T., Delgado, C., Elias, P., Gopalakrishna, T., Hamsik, M.R., Herrero, M., Kiesecker, J., Landis, E., Laestadius, L., Leavitt, S.M., Minnemeyer, S., Polasky, S., Potapov, P., Putz, F.E., Sanderman, J., Silvius, M., Wollenberg, E., Fargione, J., 2017. Natural climate solutions. Proc. Natl. Acad. Sci. U.S.A. 114, 11645–11650. https://doi.org/10.1073/pnas.1710465114

G-SEARCh, n.d. Gender Lens [WWW Document]. alphamundi. URL https://www.alphamundi.ch/copy-of-impact (accessed 9.18.22)

Gubbay, N., N. Ghosh , 2021. Geographical Distribution in Climate Economics Publications. Research Note. economists for future. https://econ4future.org/wp- content/uploads/2021/11/Geographi-Distribution-For-

Publishing.pdf.

Gupta, M., 2016. Willingness to pay for carbon tax: A study of Indian road passenger transport. Transport Policy, 45, 46–54. https://doi.org/10.1016/j.tranpol.2015.09.001

Gutiérrez R L, Hogarth NJ, Zhou W, Xie C, Zhang K, et al., 2016. China's conversion of cropland to forest program: a systematic review of the environmental and socioeconomic effects. Environ.Evid. 5:21

Hanto, J., Krawielicki, L., Krumm, A., Moskalenko, N., Löffler, K., Hauenstein, C., & Oei, P.-Y., 2021. Effects of decarbonization on the energy system and related employment effects in South Africa. Environmental Science & Policy, 124, 73–84. https://doi.org/10.1016/j.envsci.2021.06.001

Hasanbeigi, A., Price, L., 2015. A technical review of emerging technologies for energy and water efficiency and pollution reduction in the textile industry. Journal of Cleaner Production 95, 30–44. https://doi.org/10.1016/j.jclepro.2015.02.079

Hawash, Ronia, and Guenter Lang., 2020. Does the digital gap matter? Estimating the impact of ICT on productivity in developing countries. Eurasian Economic Review 10.2. 189–209.

Hayes, A., Gray, M., et al., 2008. Social Inclusion: Origins, concepts and key themes. Canberra: Australian Institute of Family Studies.

Hibbard, M., & Karle, K., 2002. Ecosystem Restoration as Community Economic Development? An Assessment of the Possibilities, Journal of the Community Development Society, 33:2, 39–60, https://doi.org/10.1080/15575330209490092

Hjerpe, E., Mottek Lucas, A., & Eichman, H., 2021. Modeling regional economic contributions of forest restoration: A case study of the Four Forest Restoration Initiative. Journal of Forestry, 119(5), 439–453.

Hjort, Jonas, and Jonas Poulsen., 2019. The arrival of fast internet and employment in Africa. American Economic Review 109.3. 1032-79.

Hogarth, N.J., B. Belcher, B. Campbell, N. Stacey. (2013). The role of forest-related income in household economies and rural livelihoods in the border-region of southern China World Dev., 43 (2013), pp.111–123.

Hoor-Ul-Ain, S., 2020. Public sexual harassment mayhem on public transport in megacities – Karachi and London: A comparative review. Aggression and Violent Behavior 52, 101420. https://doi.org/10.1016/j.avb.2020.101420

Houghton, R. A., and Nassikas, A. A., 2018. Negative emissions from stopping deforestation and forest degradation, globally. Glob. Change Biol. 24, 350–359. https://doi.org/10.1111/gcb.13876

Hub de Energía América Latina y el Caribe., n.d.. Gender in the Energy Transition Guidelines, Plans and Policies of Latin American and Caribbean Countries. https://hubenergia.org/index.php/en/indicators/gender-energy-transition-guidelines-plans-and-policies-latin-american-and-caribbean

IDRC, 2019. Transforming gender relations: insights form IDRC research. Ottawa: IDRC. https://idl-bnc-idrc.dspacedirect.org/handle/10625/57633

Idriss, Y., Patel, S., 2021. Delivering high-quality, predictable and accessible climate finance for least developed countries. IIED. https://www.iied.org/delivering-high-quality-predictable-accessible-climate-finance-for-least-developed-countries

IEA Hydropower, 2019. Flexible hydropower providing value to renewable energy integration. https://www.ieahydro.org/media/51145259/IEAHydroTCP_AnnexIX_White%20Paper_Oct2019.pdf

IEA, 2020. Renewables 2020 - Analysis and forecast to 2025. Paris: IEA. https://www.iea.org/reports/renewables-2020

IEA, 2021, Greenhouse Gas Emissions from Energy: Overview, Paris: IEA. https://www.iea.org/reports/

greenhouse-gas-emissions-from-energy-overview

IEA, 2022, SDG7: Data and Projections, Paris:IEA. https://www.iea.org/reports/sdg7-data-and-projections

IEA., 2019a. GB/T 50378-2014 Green Building Evaluation Standard – Policies. https://www.iea.org/policies/7915-gbt-50378-2014-green-building-evaluation-standard

IEA., 2019b. GB/T51141-2015 Evaluation Standard for Green Retrofit of Existing Buildings – Policies. Paris: IEA https://www.iea.org/policies/7913-gbt51141-2015-evaluation-standard-for-green-retrofit-of-existing-buildings

ILO, 2018a. Care Work and Care Jobs: For the Future of Decent Work. Geneva:ILO. https://www.ilo.org/global/publications/books/WCMS_633135/lang--en/index.htm

ILO, 2018b. Gender Equality in the Global Garment Industry. Geneva: ILO. https://betterwork.org/wp-content/uploads/2018/01/BW-GenderStrategy-Highlights-v4-Web.pdf

ILO, 2020. The future of work in the automotive industry: The need to invest in people's capabilities and decent and sustainable work, Issues paper for the Technical Meeting on the Future of Work in the Automotive Industry.

Ilskog, E., Kjellström, B., 2008. And then they lived sustainably ever after? —Assessment of rural electrification cases by means of indicators. Energy Policy 36, 2674–2684. https://doi.org/10.1016/j.enpol.2008.03.022

Overland, I., Sagbakken, H., Isataeva, A., Kolodzinskaia, G.,Simpson, N., Trisos, C., & Vakulchuk, R., (2022). Funding flows for climate change research on Africa: where do they come from and where do they go? Climate and Development. 14:8, 705-724, DOI: 10.1080/17565529.2021.1976609

Infante-Vargas, D., Boyer, K., 2022. Gender-based violence against women users of public transport in Saltillo, Coahuila, Mexico. Journal of Gender Studies 31, 216–230. https://doi.org/10.1080/09589236.2021.1915753

International Telecommunication Union (ITU), 2021. Measuring digital development: facts and figures 2021. https://www.itu.int/en/ITU-D/Statistics/Documents/facts/FactsFigures2021.pdf

IPCC, 2014. Climate change 2014: Synthesis report. Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva.

IPU, 2022. Global and regional averages of women in national parliaments [WWW Document]. URL https://data.ipu.org/women-averages?month=5&year=2022

IRENA, 2018. Power System Flexibility for the Energy Transition, Part 1. Abu Dhabi. International Renewable Energy Agency (IRENA). https://www.irena.org/publications/2018/Nov/Power-system-flexibility-for-the-energy-transition

IRENA, 2021. Renewable Energy and Jobs – Annual Review 2021. International Renewable Energy Agency. https://www.irena.org/publications/2021/Oct/Renewable-Energy-and-Jobs-Annual-Review-2021#:~:text=The%202021%20Annual%20Review%20is,energy%20transition%20scenarios%20to%202050.

Islam, Md. M., Irfan, M., Shahbaz, M., & Vo, X. V., 2022). Renewable and non-renewable energy consumption in Bangladesh: The relative influencing profiles of economic factors, urbanization, physical infrastructure and institutional quality. Renewable Energy, 184, 1130–1149. https://doi.org/10.1016/j.renene.2021.12.020

ITF, 2019. ITF/UITP Positive Employer Gender Policy. International Transport Federation. https://www.itfglobal.org/en/reports-publications/itfuitp-positive-employer-gender-policy

IUCN, 2012a. The Art of Implementation: Gender Strategies Transforming National and Regional Climate Change Decision-Making. Gland: International Union for Conservation of Nature. https://portals.iucn.org/library/efiles/documents/2012-086.pdf

IUCN, 2012b. Climate Change Gender Action Plan for the Government of Nepal. Gland: International Union for Conservation of Nature. https://genderandenvironment.org/nepal-ccgap/

IUCN, 2013. Bangladesh Climate Change Gender Action Plan. Gland: International Union for Conservation of Nature. https://genderandenvironment.org/zambia-climate-change-gender-action-plan-ccgap-report/ IUCN, 2018. Zambia Climate Change Gender Action Plan (ccGAP) Report.

IUCN, 2021. Gender and national climate planning: Gender integration in the revised Nationally Determined Contributions. Gland: International Union for Conservation of Nature. https://portals.iucn.org/library/node/49860

Jagger, P., Das, I., 2018. Implementation and scale-up of a biomass pellet and improved cookstove enterprise in Rwanda. Energy for Sustainable Development 46, 32–41. https://doi.org/10.1016/j.esd.2018.06.005

Jakob, M., & Steckel, J. C. (Eds.)., 2022. The Political Economy of Coal: Obstacles to Clean Energy Transitions. Routledge. https://doi.org/10.4324/9781003044543

Jakob, M., Flachsland, C., Christoph Steckel, J., & Urpelainen, J., 2020. Actors, objectives, context: A framework of the political economy of energy and climate policy applied to India, Indonesia, and Vietnam. Energy Research & Social Science, 70, 101775. https://doi.org/10.1016/j.erss.2020.101775

Jenkins, K., B. K. Sovacool and D. McCauley., 2018. Humanizing sociotechnical transitions through energy justice: An ethical framework for global transformative change. Energy Policy 117: 66–74.

Jensen, R., Oster, E., 2009. The Power of TV: Cable Television and Women's Status in India *. Quarterly Journal of Economics 124, 1057–1094. https://doi.org/10.1162/qjec.2009.124.3.1057

Jeuland, M., Fetter, T.R., Li, Y., Pattanayak, S.K., Usmani, F., Bluffstone, R.A., Chávez, C., Girardeau, H., Hassen, S., Jagger, P., 2021. Is energy the golden thread? A systematic review of the impacts of modern and traditional energy use in low-and middle-income countries. Renewable and Sustainable Energy Reviews 135, 110406.

Jeuland, M., Ohlendorf, N., Saparapa, R., & Steckel, J. C., 2020. Climate implications of electrification projects in the developing world: A systematic review. Environmental Research Letters, 15(10), 103010. https://doi.org/10.1088/1748-9326/abb0ed

Jeuland, M.A., Pattanayak, S.K., 2012. Benefits and Costs of Improved Cookstoves: Assessing the Implications of Variability in Health, Forest and Climate Impacts. PLoS ONE 7, e30338. https://doi.org/10.1371/journal.pone.0030338

Jiang, Z., Ouyang, X., & Huang, G., 2015. The distributional impacts of removing energy subsidies in China. China Economic Review, 33, 111–122. https://doi.org/10.1016/j.chieco.2015.01.012

Johnstone, K., & Perera, N., Can cooking solutions for refugees better serve gender dynamics? IIED Briefing Papers. https://www.iied.org/17762iied

Jones N., 2018. How to stop data centres from gobbling up the world's electricity. Nature, 561(7722): 163–167.

Jost, C., Kyazze, F., Naab, J., Neelormi, S., Kinyangi, J., Zougmore, R., Aggarwal, P., Bhatta, G., Chaudhury, M., Tapio-Bistrom, M.-L., Nelson, S., Kristjanson, P., 2016. Understanding gender dimensions of agriculture and climate change in smallholder farming communities. Climate and Development 8, 133–144. https://doi.org/10.1080/17565529.2015.1050978

Kabeer, N., 2002. The power to choose: Bangladeshi women and labor market decisions in London and Dhaka, Verso. https://www.versobooks.com/en-gb/products/1692-the-power-to-choose

Kazenergy., 2017. National Energy Report. KAZENERGY Association. https://www.kazenergy.com/upload/document/energy-report/National_Energy_Report-ENGLISH_03.09.pdf

Keja, R., Knodel, K., 2019. Mistrust and social hierarchies as blind spots of ICT4D projects: lessons from Togo and Rwanda. TATuP 28/2.

Klege, R.A., Visser, M., Barron A, M.F., Clarke, R.P., 2021. Competition and gender in the lab vs field: Experiments from off-grid renewable energy entrepreneurs in Rural Rwanda. Journal of Behavioral and Experimental Economics 91, 101662. https://doi.org/10.1016/j.socec.2021.101662

Koh, J., Johari, S., Shuib, A., Matthew, N. K., & Siow, M. L., 2021. Impacts of Carbon Pricing on Developing Economies. International Journal of Energy Economics and Policy, 11(4), 298–311

Köhlin, G., S.K. Pattanayak, E. Sills, E. Mattsson, M. Ostwald, A. Salas, D. Ternald, 2015. In search of double dividends from climate change interventions evidence from forest conservation and household energy transitions. EBA (Expertgruppen för Biståndsanalys) Report. Sweden.

Kriechel, B., & Ziesemer, T., 2006. Taxation and Technology Adoption: A Hotelling Approach, MERIT Working Papers 2006-009, United Nations University - Maastricht Economic and Social Research Institute on Innovation and Technology (MERIT).

Kristjanson, P., Bah, T., KURIAKOSE, A., Shakirova, M., SEGURA, G., Siegmann, K. and Granat, M., 2019. Taking action on gender gaps in forest landscapes. Program on Forests (PROFOR). Washington DC.

Kumleben, N., 2021. South Africa's Coal Deal Is a New Model for Climate Progress. Foreign Policy. https://foreignpolicy.com/2021/11/12/coal-climate-south-africa-cop26-agreement/

Kvangraven, I.H., S. Kesar, 2022. Standing in the way of rigor? Economics' meeting with the decolonization agenda. Review of International Political Economy: 1–26.

Kwet, Michael., 2019. Digital colonialism. US empire and the new imperialism in the Global South. Race & Class 60 (4), pp. 3–26.

Lamb, W. F., Antal, M., Bohnenberger, K., Brand-Correa, L. I., Müller-Hansen, F., Jakob, M., Minx, J. C., Raiser, K., Williams, L., & Sovacool, B. K., 2020. What are the social outcomes of climate policies? A systematic map and review of the ex-post literature. Environmental Research Letters, 15(11), 113006. https://doi.org/10.1088/1748-9326/abc11f

Larson, A.M., Mausch, K., Bourne, M., Luttrell, C., Schoneveld, G., Cronkleton, P., Locatelli, B., Catacutan, D., Cerutti, P., Chomba, S. and Djoudi, H., 2021. Hot topics in governance for forests and trees: Towards a (just) transformative research agenda. Forest Policy and Economics, 131, p.102567.

Latin American Energy Organization (OLADE)., 2018. Energy Access and Affordability Voluntary Action Plan for Latin America and the Caribbean. Inter-American Development Bank (IDB). https://www.olade.org/en/publicaciones/energy-access-and-affordability-voluntary-action-plan-for-latin-america-and-the-caribbean/

Leblond, J. P., & Pham, T. H., 2014. Recent forest expansion in Thailand: a methodological artifact? Journal of Land Use Science, 9(2). 211–241.

Lee, K., E. Miguel and C. Wolfram., 2020. Does household electrification supercharge economic development? Journal of Economic Perspectives 34(1): 122–144.

Lema, R., Bhamidipati, P. L., Gregersen, C., Hansen, U. E., & Kirchherr, J., 2021. China's investments in renewable energy in Africa: Creating co-benefits or just cashing-in? World Development, 141, 105365. https://doi.org/10.1016/j.worlddev.2020.105365

Levien, M., 2017. Gender and land dispossession: a comparative analysis. The Journal of Peasant Studies 44, 1111–1134. https://doi.org/10.1080/03066150.2017.1367291

Li, J., Zhao, F., Chen, S., Jiang, W., Liu, T., Shi, S., 2017. Gender Diversity on Boards and Firms' Environmental Policy: Gender Diversity on Boards. Bus. Strat. Env. 26, 306–315. https://doi.org/10.1002/

bse.1918

Lieu, J., Sorman, H., Johnson, O. W., Virla L. D., and Resurrección, BP., 2020. Three sides to every story: Gender perspectives in energy transition pathways in Canada, Kenya and Spain. Energy Research & Social Science 68: 101550.

Liu, C., Wang, S., Liu, H. and Zhu, W., 2017. Why did the 1980s' reform of collective forestland tenure in southern China fail? Forest policy and economics, 83, pp.131–141.

Lytle, M., Skarbek, R.W., Robinson, R., 2019. Shifting diversity into high gear: Helping to close the auto industry's talent gap [WWW Document]. Deloitte. URL https://www2.deloitte.com/us/en/insights/industry/automotive/women-in-automotive-sector-gender-diversity.html

MacGregor, S., Arora-Jonsson, S., Cohen, M., 2022. Caring in a changing climate: Centering care work in climate action, Oxfam Research Backgrounder.

Mahadevia, D., Advani, D., 2016. Gender differentials in travel pattern–the case of a mid-sized city, Rajkot, India. Transportation Research Part D: Transport and Environment 44, 292–302.

Mahendra, A., Venter, C., Lionjanga, N., (2021) Urban expansion and mobility on the periphery in the global South Urban Form and Accessibility.Elsevier, Pages 243-264,

Mahrenbach, L., 2018. The Promises and Challenges of Digitalization and Development in Major Emerging Markets. Global Policy, https://www.globalpolicyjournal.com/sites/default/files/FINAL_Mahrenbach2018_PromisesChallengesDigitalDevelopment_0.pdf

Martinez, D.F., Mitnik, O.A., Salgado, E., Scholl, L., Yañez-Pagans, P., 2020. Connecting to Economic Opportunity: the Role of Public Transport in Promoting Women's Employment in Lima. J Econ Race Policy 3, 1–23. https://doi.org/10.1007/s41996-019-00039-9

Matas, A., Raymond, J.-L., Roig, J.-L., 2010. Job accessibility and female employment probability: The cases of Barcelona and Madrid. Urban Studies 47, 769–787.

Mavisakalyan, A., Tarverdi, Y., 2019. Gender and climate change: Do female parliamentarians make difference? European Journal of Political Economy 56, 151–164. https://doi.org/10.1016/j.ejpoleco.2018.08.001

McKenzie, D. and C. Woodruff., 2014. What are we learning from business training and entrepreneurship evaluations around the developing world? The World Bank Research Observer 29(1): 48–82.

Medrano, M., Sievert, M., Sills, E.O., Toman, M., 2021. Is energy the golden thread? A systematic review of the impacts of modern and traditional energy use in low-and middle-income countries. Renew. Sustain. Energy Rev. 135, 110406

Meinzen-Dick, R., Quisumbing, A., Doss, C., & Theis, S., 2019. Women's land rights as a pathway to poverty reduction: Framework and review of available evidence. Agricultural Systems, 172, 72–82.

Men Engage Alliance, 2016. Men, Masculinities and Climate Change: A Discussion Paper. Washington, DC: Men Engage Global Alliance.

Meyiwa, T., Maseti, T., Ngubane, S., Letsekha, T., Rozani, C., 2014. Women in selected rural municipalities: Resilience and agency against vulnerabilities to climate change. Agenda 28, 102–114. https://doi.org/10.1080/10130950.2014.955686

Michaels, J., 2018. Tech Giants at the crossroads. A modest proposal. https://www.lawfareblog.com/tech-giants-crossroads-modest-proposal, last accessed 16. 05. 2019.

Miller, J., 2020. Germany's Shift to Electric Cars Puts 400,000 Jobs at Risk in Next Decade [WWW Document]. Financial Times. https://www.ft.com/content/c80707b2-361d-11ea-a6d3-9a26f8c3cba4

Ministry of Power., 2018. Energy conservation building code rules. Ministry of Power, Government of India.

https://powermin.gov.in/en/content/energy-efficiency?page=7

Moayed, T., Guggenheim, S., & Chamier., 2021. From Regressive Subsidies to Progressive Redistribution: The Role of Redistribution and Recognition in Energy Subsidy Reform. Path Finders, 32.

Montoya-Duque, L., Arango-Aramburo, S., Arias-Gaviria, J., 2022. 'Simulating the Effect of the Pay-as-You-Go Scheme for Solar Energy Diffusion in Colombian off-Grid Regions'. Energy 244 123197. https://doi.org/10.1016/j.energy.2022.123197

Montoya-Robledo, V., Escovar-Álvarez, G., 2020. Domestic workers' commutes in Bogotá: Transportation, gender and social exclusion. Transportation Research Part A: Policy and Practice 139, 400–411.

Moore, N., Glandon, D., Tripney, J., Kozakiewicz, T., Shisler, S., Eyres, J., Zalfou, R., Leon, D., Kurkjian, V., Snilstveit, B., & Perdana, A., 2020. Effects of Access to Electricity Interventions on Socioeconomic Outcomes in Low- and Middle- Income Countries [Independent Evaluation: SR-01]. Independent Evaluation Department (IED) and the International Initiative for Impact Evaluation (3ie).

Morrissey, J., 2017. The Energy Challenge in Sub-Saharan Africa: A Guide for Advocates and Policy-Makers. Addressing Energy Poverty. Available at: https://s3.amazonaws.com/oxfam-us/www/static/media/files/oxfam-RAEL-energySSA-pt2.pdf, Oxfam America.

Mundaca, L., Neij, L., Worrell, E., & McNeil, M., 2010. Evaluating Energy Efficiency Policies with Energy-Economy Models. Annual Review of Environment and Resources, 35(1), 305–344. https://doi.org/10.1146/annurev-environ-052810-164840

Munoz, J. Mark, and Al Naqvi., 2017. Artificial Intelligence and Urbanization: The Rise of the Elysium City. Journal of Economics and Political Economy 4.1 (2017): 1–13.

NAP Global Network, n.d. Trends in NAP Documents. Enabling Factors [WWW Document]. URL https://trends.napglobalnetwork.org/search-by-trend/enabling-factors (accessed 9.14.22).

Nature Geoscience, 2022. Catching Carbon. Nat. Geosci. 15, 341 (2022). https://doi.org/10.1038/s41561-022-00951-0

Nature, 2017. Nature-based solutions' is the latest green jargon that means more than you might think. Nature 541, 133–134.

Nelson, S., Kuriakose, A.T., 2017. Gender and Renewable Energy: Entry Points for Women's Livelihoods and Employment. Washington D.C: Climate Investment FundIF. https://www.cif.org/sites/cif_enc/files/gender_and_re_digital.pdf

Nguyen, T.T., Bauer, S. and Uibrig, H., 2010. Land privatization and afforestation incentive of rural farms in the Northern Uplands of Vietnam. Forest policy and economics, 12(7), pp.518–526.

Nobles, M., C. Womack, A. Wonkam, E. Wathuti, 2022. Ending racism is key to better science: a message from Nature's guest editors. Nature Vol 610, 419.

Noguchi, L.A., 2011. Women, Decision-Making and Sustainability: Exploring the Experience of the Badi Foundation in Rural China. Hastings Women's LJ 22, 295.

OECD, 2015, The Economic Consequences of Climate Change. Paris: OECD Publishing, Paris. https://www.oecd.org/env/the-economic-consequences-of-climate-change-9789264235410-en.htm

OECD, 2015. Activation policies for more inclusive labour markets, in: OECD Employment Outlook. pp. 105–166. Paris: OECD Publishing, Paris. https://www.oecd.org/els/emp/activation.htm

OECD, 2016. Handbook on the OECD-DAC gender equality policy marker. OECD Publishing. Paris: OECD Publishing. https://www.oecd.org/dac/gender-development/Handbook-OECD-DAC-Gender-Equality-Policy-Marker.pdf

OECD, 2018. OECD Toolkit for Mainstreaming and Implementing Gender Equality Implementing the 2015 OECD Recommendation on Gender Equality in Public Life. OECD Publishing, Paris.

OECD, 2022a. The effect of declining unemployment benefits on transitions to employment: Evidence from

Belgium (OECD Social, Employment and Migration Working Papers No. 272), OECD Social, Employment and Migration Working Papers. https://doi.org/10.1787/cba7af24-en

OECD, 2022b. Aggregate Trends of Climate Finance Provided and Mobilised by Developed Countries in 2013-2020. Paris: OECD Publishing. https://www.oecd.org/finance/aggregate-trends-of-climate-finance-provided-and-mobilised-by-developed-countries-in-2013-2020-d28f963c-en.htm

OECD, 2022c. Development Finance for Gender-Responsive Climate Action, OECD Development Co-operation Directorate. Paris: OECD Publishing, Paris. https://www.oecd.org/dac/development-finance-gender-climate-action.pdf

OECD, n.d. OECD-DAC Rio Markers for Climate Handbook. OECD Publishing, Paris.

Ohlendorf, N., Jakob, M., & Steckel, J. C., 2022. The political economy of coal phase-out: Exploring the actors, objectives, and contextual factors shaping policies in eight major coal countries. Energy Research & Social Science, 90, 102590. https://doi.org/10.1016/j.erss.2022.102590

Ohlendorf, N., Jakob, M., Minx, J. C., Schröder, C., & Steckel, J. C., 2021. Distributional Impacts of Carbon Pricing: A Meta-Analysis. Environmental and Resource Economics, 78(1), 1–42. https://doi.org/10.1007/s10640-020-00521-1

Oldekop, Johan A., et al., 2020. COVID-19 and the case for global development. World Development 105044.

Otzelberger, A., 2014. Tackling the double injustice of climate change and gender inequality. CARE International. https://careclimatechange.org/wp-content/uploads/2019/06/Double_Injustice.pdf

Overland, I., Sagbakken, H., Isataeva, A., Kolodzinskaia, G.,Simpson, N., Trisos, C., & Vakulchuk, R., (2022). Funding flows for climate change research on Africa: where do they come from and where do they go? Climate and Development. 14:8, 705-724, DOI: 10.1080/17565529.2021.1976609

Owen, R., Brennan, G., Lyon, F. 2018. Enabling investment for the transition to a low-carbon economy: Government policy to finance early stage green innovation. Current opinion in environmental sustainability 31, 137–145.

Oxfam, 2017. Beneath the dry land. Kenya Drought Gender Analysis. Oxfam International. https://policy-practice.oxfam.org/resources/beneath-the-dryland-kenya-drought-gender-analysis-620403/

Oxfam, 2019. Forced from Home: Climate-fuelled displacement. Oxfam International. https://www.oxfam.org/en/research/forced-home-climate-fuelled-displacement

Oxfam, 2020. Making care count. An overview of the women's economic empowerment and care initiative. Oxfam International. https://policy-practice.oxfam.org/resources/making-care-count-an-overview-of-the-womens-economic-empowerment-and-care-initi-621100/

Pachauri, S., and N. D. Rao., 2013. Gender impacts and determinants of energy poverty: are we asking the right questions? Current Opinion in Environmental Sustainability 5(2): 205–215.

Pan, Y., Birdsey, R.A., Fang, J., Houghton, R., Kauppi, P.E., Kurz, W.A., Phillips, O.L., Shvidenko, A., Lewis, S.L., Canadell, J.G., Ciais, P., Jackson, R.B., Pacala, S.W., McGuire, A.D., Piao, S., Rautiainen, A., Sitch, S., Hayes, D., 2011. A large and persistent carbon sink in the world's forests. Science 333 (6045), 988–993.

Pangotra, P., & Shukla, P. R., 2012. Infrastructure for low-carbon transport in India: a case study of the Delhi-Mumbai dedicated freight corridor. New York: United Nations. https://wedocs.unep.org/20.500.11822/8492

Panitchpakdi, S., 2008. Secretary-general of UNCTAD, statement to third global congress of women in politics and governance: Gender in climate change and disaster risk reduction. Makati, The Philippines Oct. 18. Available at: http://unctad.org/en/pages/SGStatementArchive.aspx?ReferenceItemId=16455

Paris, R., Chi, T.T.N., 2005. The impact of row seeder technology on women labor: A case study in the Mekong Delta, Vietnam. Gender, Technology and Development 9, 157–184.

Paris, T.R., Pingali, P.L., 1996. Do agricultural technologies help or hurt poor women? Competition and conflict in Asian agricultural resource management: issues, options, and analytical paradigms: IRRI discussion paper series No 11. International Rice Research Institute, Los Banos 237–245.

Parry, I., Black, S. y Vernon, N., 2021. Still Not Getting Energy Prices Right: A Global and Country Update of Fossil Fuel Subsidies. IMF Working Paper

Pathak, M., & Shukla, P. R., 2016. Co-benefits of low-carbon passenger transport actions in Indian cities: Case study of Ahmedabad. Transportation Research Part D: Transport and Environment, 44, 303–316.

Pattanayak, Usmani, S.K.F., Girardeau, H., 2018. Achieving universal energy access by closing the gap between what we know and what we do. Future Dev., Brook. Inst. May 1, 2018 https://brook.gs/2HG2MZR

Pattanayak, S. K., M. Jeuland, J. Lewis, F. Usmani, N. Brooks, V. Bhojvaid, A. Kar, L. Lipinski, L. Morrison and O. Patange., (2019). Experimental evidence on promotion of electric and improved biomass cookstoves. Proceedings of the national Academy of Sciences 116(27): 13282-13287.

Phillips, J., Plutshack, V., Fetter, T.R., Jeuland, M., Elisha, F., Vanover, A., Yoder, E., 2022. Catalyzing Climate Finance for Low-Carbon Agriculture Enterprises. . https://shellfoundation.org/learning/catalysing-climate-finance-for-low-carbon-agriculture-enterprises/

Porro, R., A. Lopez-Feldman, J.W. Vela-Alvarado. (2015). Forest use and agriculture in Ucayali, Peru: livelihood strategies, poverty and wealth in an Amazon frontier. Forest Policy Econ., 51 (2015), pp. 47–56.

Price, R., 2020. Lessons learned from carbon pricing in developing countries (K4D Helpdesk Report No. 799; p. 20). Institute of Development Studies.

Priya, P.R., Rekha, D., 2020. Sustainability modelling and green optimisation in micro grid powered distributed fogMicroData Centres in rural area. Wireless Networks. Wireless Netw 27, 5519–5532 (2021). https://doi.org/10.1007/s11276-019-02207-z

Promjiraprawat, K., & Limmeechokchai, B., 2012. Assessment of Thailand's Energy Policies and CO2 Emissions: Analyses of Energy Efficiency Measures and Renewable Power Generation. Energies, 5(8), 3074–3093. https://doi.org/10.3390/en5083074

Pross, C., Han, J.Y.-C., Kim, D., Vigil, S., 2020. Climate Change, Gender Equality and Human Rights in Asia. World Fish. https://digitalarchive.worldfishcenter.org/handle/20.500.12348/5286y

Quang, N.N., Wildemeersch, D. and Masschelein, J., 2015. The five million hectare reforestation programme in Vietnam–lessons and policy implications. International Journal of Environment and Sustainable Development, 14(1), pp. 40–55.

Quinones, L.M., 2020. Sexual harassment in public transport in Bogotá. Transportation Research Part A: Policy and Practice 139, 54–69. https://doi.org/10.1016/j.tra.2020.06.018

Quintero, J., 2006. Ghana: women's energy enterprise-developing a model for mainstreaming gender into modern energy service delivery. World Bank, Washington, DC

Rai, V., Funkhouser, E., 2015. Emerging insights on the dynamic drivers of international low-carbon technology transfer. Renewable and Sustainable Energy Reviews 49, 350–364.

Ramirez, A. D., Boero, A., Rivela, B., Melendres, A. M., Espinoza, S., & Salas, D. A., 2020. Life cycle methods to analyze the environmental sustainability of electricity generation in Ecuador: Is decarbonization the right path? Renewable and Sustainable Energy Reviews, 134, 110373. https://doi.org/10.1016/j.rser.2020.110373

Rao, N., Singh, C., Solomon, D., Camfield, L., Sidiki, R., Angula, M., Poonacha, P., Sidibé, A., Lawson,

E.T., 2020. Managing risk, changing aspirations and household dynamics: Implications for well-being and adaptation in semi-arid Africa and India. World Development 125, 104667. https://doi.org/10.1016/j.worlddev.2019.104667

RECAI., 2020. Renewable Energy Country Attractiveness Index. E&Y. https://assets.ey.com/content/dam/ey-sites/ey-com/en_gl/topics/power-and-utilities/ey-recai-56-country-index.pdf

Reeson, A.F., Measham, T.G., Hosking, K., 2012. Mining activity, income inequality and gender in regional Australia*: Mining activity, income inequality and gender. Australian Journal of Agricultural and Resource Economics 56, 302–313. https://doi.org/10.1111/j.1467-8489.2012.00578.x

REN21., 2018. Renewables 2018 Global Status Report. Renewable Energy Policy Network. https://www.ren21.net/gsr-2018

Renner, S., 2018. Poverty and distributional effects of a carbon tax in Mexico. Energy Policy, 112, 98–110. https://doi.org/10.1016/j.enpol.2017.10.011

Republic of Ghana, 2015. National Gender Policy: Mainstreaming Gender Equality and Women's Empowerment into Ghana's Development Efforts. https://www.mogcsp.gov.gh/?mdocs-file=654

Resurrección, B.P., Bee, B.A., Dankelman, I., Park, C.M.Y., Halder, M., McMullen, C.P., 2019. Gender-transformative climate change adaptation: Advancing social equity. Background paper to the 2019 report of the Global Commission on Adaptation. Rotterdam and Washington, DC.

Ribot, J., Agrawal, A., & Larson, A. (2006). Recentralizing while decentralizing: How national governments reappropriate forest resources. World Development, 34 (11), 1864–1886.

Richards, J.A., Bradshaw, S., 2017. Uprooted by climate change. Oxfam, Nairobi. https://oxfamilibrary.openrepository.com/handle/10546/620357

Rights and Resources Initiative (RRI), 2020. Tenure tracking tool. RRI, Washington, DC. https://rightsandresources.org/tenure-tracking/

Rights and Resources Initiative, 2018. Power and Potential: A comparative analysis of national laws and regulations concerning women's rights to community forests. RRI, Washington, DC https://rightsandresources. org/wp-content/uploads/2017/07/Power-and-Potential-A-Comparative-Analysis-of-Nation-al-Laws-and-Regulations-Concerning-Womens-Rights-to-Community-Forests_May-2017_RRI-1. pdf

Roller, Lars-Hendrik, and Leonard Waverman., 2001. Telecommunications infrastructure and economic development: A simultaneous approach. American Economic Review 91.4. 909–923.

Root Capital, 2021. Root Capital Announces New Initiative to Strengthen Gender Lens Investing in Agriculture [WWW Document]. Root Capital. URL https://rootcapital.org/root-capital-announces-new-initiative-to-strengthen-gender-lens-investing-in-agriculture/ (accessed 9.18.22).

Roriz, P. A. C., Yanai, A. M., & Fearnside, P. M., 2017. Deforestation and carbon loss in Southwest Amazonia: impact of Brazil's revised forest code. Environmental management, 60(3), 367-382.

Rudee, A., 2020. Want to Help the US Economy? Rethink the Trillion Trees Act. Washington: World Resource Institute (WRI). https://www.wri.org/insights/want-help-us-economy-rethink-trillion-trees-act

Samberg, L.H., Gerber, J.S., Ramankutty, N., Herrero, M., West, P.C., 2016. Subnational distribution of average farm size and smallholder contributions to global food production. Environ. Res. Lett. 11, 124010.

Sarkar, D., & Sheth, A., 2021. Public private partnership model for sustainable bus rapid transit system in Ahmedabad, India. International Journal of Construction Management, 1–11.

Satterthwaite, D., (2008). Cities' contribution to global warming: notes on the allocation of greenhouse gas emissions. Environment and Urbanization, 20(2), 539–549. https://doi.org/10.1177/0956247808096127

Sausen, H., 2020. What is digitalisation? Opportunities and challenges in East Africa. The Friedrich-Ebert-

Stiftung, Rwanda.

Schachter, E.N., Zuskin, E., Moshier, E.L., Godbold, J., Mustajbegovic, J., Pucarin-Cvetkovic, J., Chiarelli, A., 2009. Gender and respiratory findings in workers occupationally exposed to organic aerosols: A meta analysis of 12 cross-sectional studies. Environ Health 8, 1. https://doi.org/10.1186/1476-069X-8-1

Schaffitzel, F., Jakob, M., Soria, R., Vogt-Schilb, A., Ward, H., 2020. Can government transfers make energy subsidy reform socially acceptable? A case study on Ecuador. Energy Policy 137, 111120. https://doi.org/10.1016/j.enpol.2019.111120

Schalatek, L., 2020. Gender and Climate Finance. Heinrich Böll Stiftung.

Schia, N.N., 2018. The cyber frontier and digital pitfalls in the Global South. Third World Quarterly, 39(5), 821–837.

Schiff, H., Fries, R., Chambers, T., 2013. Beyond the Threshold: Investing in Women-led Small & Growing Businesses. Value for Women. https://andeglobal.org/publication/beyond-the-threshold-investing-in-women-led-small-growing-businesses/

Schiller, Andrew & de Sherbinin, Alex & Hsieh, Wen-Hua & Pulsipher, Alex., 2007. The Vulnerability of Global Cities to Climate Hazards. Environment and Urbanization. 19. 10.1177/0956247807076725.

Schnitzer, H., Brunner, C., Gwehenberger, G., 2007. Minimizing greenhouse gas emissions through the application of solar thermal energy in industrial processes. Journal of Cleaner Production 15, 1271–1286. https://doi.org/10.1016/j.jclepro.2006.07.023

Sègla, A. D., 2019. Mobile apps for the illiterate: Knowledge production and self-learning among the Yoruba peoples in the Republic of Benin. Journal for Technology Assessment in Theory and Practice. Vol. 28 No. 2: Digitalization in the Global South

Semmler, W., Braga, J., Lichtenberger, A., Toure, M., Ha, Erin., 2021. Fiscal Policies for a Low-Carbon Economy. Washington, DC: World Bank

Sergi, B., M. Babcock, N. J. Williams, J. Thornburg, A. Loew and R. E. Ciez. 2018. Institutional influence on power sector investments: A case study of on-and off-grid energy in Kenya and Tanzania. Energy research & social science 41: 59–70.

Shabib, D., Khan, S., 2014. Gender-sensitive adaptation policy-making in Bangladesh: status and ways forward for improved mainstreaming. Climate and Development 6, 329–335. https://doi.org/10.1080/17565529.2014.951017

Shahinzadeh, A., et al., 2019. Internet of energy in smart power systems. 5th conference on knowledge-based engineering and innovation, Iran University of Science and Technology, Iran

Shammin, M. R., and A. Enamel Haque., 2022. Small-scale solar solutions for energy resilience in Bangladesh. Climate Change and Community Resilience, Springer, Singapore: 205–224.

Shankar, A. V., M. Onyura and J. Alderman., 2015. Agency-based empowerment training enhances sales capacity of female energy entrepreneurs in Kenya. Journal of health communication 20(sup1): 67–75.

Shen, G., W. Lin, Y. Chen, D. Yue, Z. Liu and C. Yang., (2015). Factors influencing the adoption and sustainable use of clean fuels and cookstoves in China-a Chinese literature review. Renewable and Sustainable Energy Reviews 51: 741–750.

Sherbinin, A., L.K. VanWey, K. McSweeney, R. Aggarwal, A. Barbieri, S. Henry, R. Walker., 2018. Rural household demographics, livelihoods, and the environment. Glob Environ Change., 18(1): 38–53. https://doi.org/10.1016/j.gloenvcha.2007.05.005

Shirley, R., Lee, C.-J., Njoroge, H.N., Odera, S., Mwanzia, P.K., Malo, I., Dipo-Salami, Y., 2019. Powering jobs: The employment footprint of decentralized renewable energy technologies in sub-Saharan Africa. Journal of Sustainability Research 2.

Sirker, K., 2021. Strengthening disaster recovery in the Caribbean using a gender lens. World Bank Blogs. Recovered from: https://blogs.worldbank.org/latinamerica/strengthening-disaster-recovery-caribbean-using-gender-lens

Slavchevska, V., Kaaria, S., Taivalmaa, S.-L., 2016. Feminization of agriculture in the context of rural transformations: What is the evidence? Washington, , D.C: World Bank.

Söderström, E., 2015. Men, masculinities, and climate change A study of climate change impacts in cases from Greenland, Australia Peru and South Africa. Linneuniversitetet. https://www.diva-portal.org/smash/get/diva2:823110/FULLTEXT01.pdf

Somanathan, E., Prabhakar, R., & Mehta, B., 2009. Decentralization for cost effective conservation. Proceedings of the National Academy of Sciences, 106(11), 4143–4147.

Stadelmann-Steffen, I., Dermont, C., 2021. 'Acceptance through Inclusion? Political and Economic Participation and the Acceptance of Local Renewable Energy Projects in Switzerland'. Energy Research & Social Science 71: 101818. https://doi.org/10.1016/j.erss.2020.101818

Standal, K. and T. Winther., 2016. Empowerment through energy? Impact of electricity on care work practices and gender relations. Forum for Development Studies, Taylor & Francis.

Standal, K., M. Talevi and H. Westskog., 2020. Engaging men and women in energy production in Norway and the United Kingdom: The significance of social practices and gender relations. Energy research & Social science 60: 101338.

Statista, 2020, Distribution of carbon dioxide emissions produced by the transportation sector worldwide in 2020, by subsector. Hamburg: Statista. https://www.statista.com/statistics/1107970/carbon-dioxide-emissions-passenger-transport/

Steckel, J. C., Renner, S., & Missbach, L., 2021. Distributional Impacts of Carbon Pricing in Low- and Middle-Income Countries. CESifo Forum, 22(5), 7.

Steckel, J. C., Schwerhoff, G., & Edenhofer, O., 2017. Enabling Low-Carbon Development in Poor Countries. In R. Stark, G. Seliger, & J. Bonvoisin (Eds.), Sustainable Manufacturing: Challenges, Solutions and Implementation Perspectives (pp. 33–44). Springer International Publishing. https://doi.org/10.1007/978-3-319-48514-0_3

Steffen, Will & Rockström, Johan & Richardson, Katherine & Lenton, Timothy & Folke, Carl & Liverman, Diana & Summerhayes, C. & Barnosky, Anthony & Cornell, Sarah & Crucifix, Michel & Donges, Jonathan & Fetzer, Ingo & Lade, Steven & Scheffer, Marten & Winkelmann, Ricarda & Schellnhuber, Hans., 2018). Trajectories of the Earth System in the Anthropocene. Proceedings of the National Academy of Sciences. 115. 201810141. https://doi.org/10.1073/pnas.1810141115

Sterner, T. (Ed.). (2012). Fuel Taxes and the Poor: The distributional consequences of gasoline taxation and their implications for climate policy. RFF Press.

Sterner, T., & Coria, J. (2012) Policy Instruments for Environmental and Natural Resource Management (2nd Ed.). RFF Press, Routledge. ISBN 978-1-61726-097-1

Stevens, D., 2021. Institutions and Agency in the Making of Carbon Pricing Policies: Evidence from Mexico and Directions for Comparative Analyses in Latin America. Journal of Comparative Policy Analysis: Research and Practice 23, 485–504. https://doi.org/10.1080/13876988.2020.1794754

Strassburg, B.B.N., Iribarrem, A., Beyer, H.L., Cordeiro, C.L., Crouzeilles, R., Jakovac, C.C., Braga Junqueira, A., Lacerda, E., Latawiec, A.E., Balmford, A., Brooks, T.M., Butchart, S.H.M., Chazdon, R.L., Erb, K.-H., Brancalion, P., Buchanan, G., Cooper, D., Díaz, S., Donald, P.F., Kapos, V., Leclère, D., Miles, L., Obersteiner, M., Plutzar, C., de M. Scaramuzza, C.A., Scarano, F.R., Visconti, P., 2020. Global priority areas for ecosystem restoration. Nature 586, 724–729.

Sunderlin, W.D., B. Belcher, L. Santoso, A. Angelsen, P. Burgers, R. Nasi, S. Wunder. Livelihoods, forests, and conservation in developing countries: an overview. World Dev., 33 (9 SPEC. ISS) (2005), pp. 1383–1402.

The Web Foundation., 2015. Women's rights online. Washington D.C: World Wide Web Foundation. http:// webfoundation.org/ docs/2015/10/womens-rightsonline_Report.pdf

The Web Foundation., 2016. Women's rights online digital gender gap audit. Washington D.C: World Wide Web Foundation http://webfoundation.org/about/ research/digital-gender-gapaudit/

Timilsina, G. R., 2022. Carbon Tax Design Architectures for Developing Countries. Washington D.C: World Bank. https://thedocs.worldbank.org/en/doc/1eb53e73b8dca5f7f7d16f8430a38a87-0360012022/original/Carbon-

Torres, B., Günter, S., Acevedo-Cabra, R. and Knoke, T., 2018. Livelihood strategies, ethnicity and rural income: The case of migrant settlers and indigenous populations in the Ecuadorian Amazon. Forest Policy and Economics, 86, pp.22–34.

Trung Thanh, Truong Lam Do, Dorothee Bueler, U.G. Rebecca Hartje., 2015. Rural livelihoods and environmental resource dependence in Cambodia. Ecol. Econ., 120 (2015), pp. 282–295.

Tseng, T. W. J., Robinson, B. E., Bellemare, M. F., BenYishay, A., Blackman, A., Boucher, T., et al., 2021. Influence of land tenure interventions on human well-being and environmental outcomes. Nature Sustainability, 4. 242–251.

UN Women, 2013. Bangladesh's Climate Change Gender Action Plan (ccGAP). Bangladesh: UN Women. https://www.empowerforclimate.org/en/resources/r/e/v/review-of-implementation-bangladeshs-climate-change-gender-action-plan-ccgap

UN Women, 2022. Women's representation in local government: A global analysis. Bangladesh: UN Women. https://www.unwomen.org/en/digital-library/publications/2022/01/womens-representation-in-local-government

UN, 2019. "Race against time" to help women who bore brunt of Cyclone Idai: UN reproductive health agency. UN News. https://news.un.org/en/story/2019/03/1035581 New York: United Nations Organisation

UNDP, 2011. Asegurando la equidad de género en la financiación para hacer frente al cambio climático. New York: United Nations Development Programme https://www.undp.org/sites/g/files/zskgke326/files/publications/Ensuring-gender-equity-CC_SP.pdf

UNDP, 2017. Gender Equality in National Climate Action: Planning for Gender-Responsive Nationally Determined Contributions. New York: United Nations Development Programme

UNDP, GGCA, 2016. Gender and Climate Finance. New York: United Nations Development Programme. https://www.undp.org/publications/gender-and-climate-change

UNEP, 2014. Using models for Green Economy Planning (PAGE: Green Economy Toolkit for Policymakers). Nairobi: United Nations Environment Programme. https://www.un-page.org/static/a81965da358b284283832f22384d3fd6/using-models-for-green-economy-policymaking.pdf

UNFCCC, 2021. The United States of America Nationally Determined Contribution Reducing Greenhouse Gases in the United States: A 2030 Emissions Target. New York: United Nations Framework Convention on Climate Change

UNFPA, 2015. Shelter from the storm. New York: United Nations Population Fund. https://www.unfpa.org/sites/default/files/sowp/downloads/State_of_World_Population_2015_EN.pdf

UNHCR, 2019. Analytical study on gender-responsive climate action for the full and effective enjoyment of the rights of women: report of the Office of the United Nations High Commissioner for Human Rights. https://www.ohchr.org/en/documents/reports/analytical-study-gender-responsive-climate-action-full-and-

effective-enjoyment

Ûrge-Vorsatz, D., Harvey, D., Mirasgedis, S., & Levine M., 2007. Mitigating CO2 emissions from energy use in the world's buildings, Building Research & Information, 35:4, 379–398, https://doi.org/10.1080/09613210701325883

USAID, 2020. Feed the Future: Women's empowerment in agriculture index [WWW Document]. URL https://www.usaid.gov/developer/WEAI

Uzsoki, D., 2021. Integrating a Gender Lens in Sustainable Investing. International Institute for Sustainable Development (IISD). https://www.msfi.com.my/wp-content/uploads/2021/01/2-ASEAN-LCEP-MY-1-Integrating-a-Gender-Lens-in-Sustainable-Investing-Malaysia.pdf

Valencia, A., Hallack, M., 2022 'How Open to Private-Sector Involvement Is the Electric Power Industry in Latin America and the Caribbean?' Energía Para El Futuro – IADB (blog). https://blogs.iadb.org/energia/en/how-open-to-private-sector-involvement-is-the-electric-power-industry-in-latin-america-and-the-caribbean/

Vallejos, P.Q., Veit, P., Tipula, P. and Reytar, K., 2020. Undermining rights: Indigenous lands and mining in the Amazon. Washington D.C. : World Resource Institute. https://www.wri.org/research/undermining-rights-indigenous-lands-and-mining-amazon

Vega-Araújo, J., Heffron, R., 2022. 'Assessing Elements of Energy Justice in Colombia: A Case Study on Transmission Infrastructure in La Guajira'. Energy Research & Social Science 91, September): 102688. https://doi.org/10.1016/j.erss.2022.102688

Venter, C., Jennings, G., Hidalgo, D., & Valderrama Pineda, A. F., 2018. The equity impacts of bus rapid transit: A review of the evidence and implications for sustainable transport. International Journal of Sustainable Transportation, 12(2), 140–152. https://doi.org/10.1080/15568318.2017.1340528

Verde, S. F., & Tol, R. S. J., 2009. The distributional impact of a carbon tax in Ireland. Economic & Social Review, 40(3), 317–338.

Verra., n.d. The Sustainable Development Verified Impact Standard (SD VISta) Program [WWW Document]. URL https://verra.org/project/sd-vista/ (accessed 9.12.22).

Vincent, J. R., Curran, S. R., & Ashton, M. S., 2021. Forest Restoration in Low-and Middle-Income Countries. Annual Review of Environment and Resources, 46. 289–317.

Vivid Economics. 2020. Transformative Climate Finance. London: Vivid Economics. https://openknowledge.worldbank.org/server/api/core/bitstreams/a8a18a69-118b-5fa6-bc72-3b0ed0a77f12/content

Wagle, R., Pillay, S., and Wright, W., 2017. Examining Nepalese Forestry Governance from Gender Perspectives. International Journal of Public Administration, 40(3). 205–225.

Wakunuma, K. (2019). Power as an ethical concern in the Global South's digital transformation. Journal for Technology Assessment in Theory and Practice 28/2. https://doi.org/10.14512/tatup.28.2.s29

Wang, P., Liu, L., Tan, X., Liu, Z., 2019. Key challenges for China's carbon emissions trading program. WIREs Clim Change 10. https://doi.org/10.1002/wcc.599

Wang, Q., Hubacek, K., Feng, K., Wei, Y.-M., & Liang, Q.-M., 2016. Distributional effects of carbon taxation. Applied Energy, 184, 1123–1131. https://doi.org/10.1016/j.apenergy.2016.06.083

WEDO, 2020. Spotlight On Gender in NDCS. . New York: Women's Environment and Development Organization (WEDO). https://wedo.org/wp-content/uploads/2020/10/Spotlight-Gender-in-NDCS.pdf

WEF, 2022. Global Gender Gap Report 2022: Insight Report. Geneva: World Economic Forum. https://www.weforum.org/reports/global-gender-gap-report-2022/

Westholm, L., Arora-Jonsson, S., 2015. Defining solutions, finding problems: Deforestation, gender, and REDD+ in Burkina Faso. Conservation and Society 13, 189–199.

WHO, 2022. WHO updates its widely-used gender mainstreaming manual. Geneva: Switzerland. https://www.who.int/news/item/06-07-2022-who-updates-widely-used-gender-mainstreaming-manual

Wickramasinghe, A., 2011. Energy access and transition to cleaner cooking fuels and technologies in Sri Lanka: Issues and policy limitations. Energy policy 39(12): 7567-7574.

Winther, T., K. Ulsrud, M. Matinga, M. Govindan, B. Gill, A. Saini, D. Brahmachari, D. Palit and R. Murali., 2020. In the light of what we cannot see: Exploring the interconnections between gender and electricity access. Energy Research & Social Science 60: 101334.

Woetzel, J., Madgavkar, A., Ellingrud, K., Labaye, E., Devillard, S., Kutcher, E., Manyika, J., Dobbs, R., Krishnan, M., 2015. How advancing women's equality can add $12 trillion to global growth. McKinsey Global Institute.

Women Gender Constituency, 2021. What should I know about gender equality in new and updated NDCs? New York: United Nations Framework Convention on Climate Change. https://womengenderclimate.org/wp-content/uploads/2021/04/FINAL_Gender-NDCs-WGC-Brief-1.pdf

Wong, S., 2016. Can climate finance contribute to gender equity in developing countries? Journal of International Development. 28(3), pp.428–444.

World Bank, 2012. Gender differences in employment and why they matter. Washington, D.C: World Bank Group. https://elibrary.worldbank.org/doi/10.1596/9780821388105_ch5

World Bank, 2016a. CO2 emissions (kt) [Dataset]. Washington, D.C: World Bank Group. https://data.worldbank.org/indicator/EN.ATM.CO2E.PC

World Bank, 2016b. Forests Generate Jobs and Incomes. Washington, D.C: World Bank Group

World Bank, 2021. Gender and Carbon Pricing. Washington, D.C: World Bank Group. https://www.thepmr.org/system/files/documents/Gender%20and%20carbon%20pricing%20discussion%20paper.pdf

World Bank, 2022. State and Trends of Carbon Pricing 2022 (English). Washington, D.C.: World Bank Group. https://openknowledge.worldbank.org/entities/publication/a1abead2-de91-5992-bb7a-73d8aaaf767f

World Development Report, 2019. Ideas for social inclusion, Chapter 7. Washington, D.C: World Bank Group. https://openknowledge.worldbank.org/handle/10986/37455

World Energy Council, 2018. The role of ICT in energy efficiency management: Household sector. https://www.worldenergy.org/assets/downloads/20180420_TF_paper_final.pdf

WRI, (2022). Sustainable Urban Mobility in the NDCs: The Essential Role of Public Transport. World Resource Institute Working Papers. Washington, D.C: World Resource Institute

WWF, 2015. INDC analysis: An overview of the forest sector. Washington, DC: World Wildlife Fund (WWF). https://wwf.panda.org/wwf_news/?257883/INDC-Analysis-An-Overview-of-the-Forest-Sector

Yemiru, T., A. Roos, B. Campbell, F. Bohlin., 2010. Livelihoods strategies and the role of forest incomes and poverty alleviation under participatory forest management in the Bale Highlands, Southern Ethiopia. Int. For. Rev., 12 (1), pp. 66–77

Yi, Y., Köhlin, G. and Xu, J., 2014. Property rights, tenure security and forest investment incentives: evidence from China's Collective Forest Tenure Reform. Environment and Development Economics, 19(1), pp.48–73.

Zenteno, M., P.A. Zuidema, W. de Jong, R.G. Boot. (2013)., Livelihood strategies and forest dependence: new insights from Bolivian forest communities. Forest Policy Econ. 26, pp. 12–21.

Zhao, Y., Tang, K. K., & Wang, L., 2013. Do renewable electricity policies promote (renewable electricity generation? Evidence from panel data. Energy Policy, 62, 887–897. https://doi.org/10.1016/j.enpol.2013.07.072

Zuleta, G., Rovere, A.E., Pérez, D., Campanello, P.I., Guida Johnson, B., Escartín, C., Dalmasso, A., Renison, D., Ciano, N. and Aronson, J., 2015. Establishing the ecological restoration network in Argentina: from Rio1992 to SIACRE2015.

Restoration Ecology, 23(2), pp.95–103.

Zusman, E., Lee, S.-Y., Rojas, A., Adams, L., 2016. Mainstreaming Gender into Climate Mitigation Activities Asian Development Bank Guidelines for Policy-Makers and Proposal Developers. Mandaluyong: Asian Development Bank

The project partners