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07/2021



EVIDENCE GAP MAP AND INTERVENTION HEAT MAP OF CLIMATE CHANGE MITIGATION INTERVENTIONS IN THE PRIVATE SECTOR IN DEVELOPING COUNTRIES

Nathalie Doswald, Isabel Puche Marín, Jerónimo José Rocio Pérez, Martin Prowse, Emma De Roy, Luis Sanchez Torrente, Guido Fernández De Velasco



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First Print Edition

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Citation

The detailed citation for this paper is:

Doswald, Nathalie, Isabel Puche Marín, Jerónimo José Rocio Pérez, Martin Prowse, Emma De Roy, Luis Sanchez Torrente, and Guido Fernández De Velasco (2021). Evidence Gap Map and Intervention Heat Map of Climate Change Mitigation Interventions in the Private Sector in Developing Countries. IEU learning paper (July). Songdo, South Korea: Independent Evaluation Unit, Green Climate Fund.

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Cover photo: Smoke from a power plant causes air pollution, ©Voyagerix/Shutterstock

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About this IEU Learning Paper

This paper presents an evidence gap map and intervention heat map for climate change mitigation interventions in the private sector in developing countries. It describes topics for which high-quality evidence exists and highlights gaps in the available evidence.

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ACKNOWLEDGEMENTS

The authors are grateful for the substantial comments received from the engagement committee for this evidence review: Carolina Aguirre Echeverri (UNFCCC); Sergio Pombo (previously of the Private Sector Facility, Green Climate Fund (GCF)); Thomas Fuhr (Private Sector Facility, GCF). Any errors or inconsistencies are entirely our responsibility.

ABSTRACT

This paper presents an evidence gap map and an intervention heat map on climate change mitigation interventions implemented by the private sector in developing countries. According to a strict set of inclusion and exclusion criteria, the evidence gap map (EGM) is derived by systematically and exhaustively reviewing high-quality evidence from evaluation, research, peer-reviewed and grey literature. Specifically, the EGM:

- Provides a robust typology of eight sectors,¹ 11 intervention types² and three outcome groups³ that serves as a conceptual tool for defining the objectives of further studies and for locating interventions more accurately
- Provides an accessible overview of evidence from systematic reviews, impact evaluations and rigorous quantitative studies
- Highlights available evidence and their characteristics, such as confidence ratings of systematic reviews
- Allows users to explore the evidence base and findings of relevant studies
- Structures relevant intervention actions and outcomes within a framework
- Populates areas with available studies and reviews while highlighting “absolute gaps” related to impact evaluations and systematic reviews

The EGM identifies 32 papers that are mapped onto a conceptual framework that includes the type of intervention, the sector of activity and types of outcomes measured. Most studies use quasi-experimental designs and multivariate analyses. The results show that a large share of the available evidence is in the energy and industrial sectors, and within them, on the effectiveness of fossil fuel substitution and energy efficiency measures. The main gaps include a scarcity or absence of evidence regarding building and urban planning, reforestation/afforestation, and anti-desertification measures. Soil and fertilizer management is also absent from the evidence gathered for the agricultural sector. There is also a scarcity of studies that examine employment co-benefits and intermediary outcomes such as behavioural change.

We also compare the available evidence with the GCF’s project/investment portfolio in the form of an intervention heat map, which indicates whether the portfolio operates in evidence-rich or evidence-scarce fields. This shows that much of the portfolio covers energy-related interventions where the EGM has highlighted several relevant studies (albeit spread out over a range of mitigation, intermediate and co-impact outcome areas). Investments in industry, transport, agriculture, and forestry and land management are in sectors where the EGM has highlighted a limited number of studies (especially transport, with only one single piece of evidence). Investments in buildings are in a sector where the EGM found no studies.

¹ Sectors: energy, industry, transport, waste management, building, urban planning, agriculture & livestock, forestry & land management

² Intervention types: fossil fuel substitution, energy efficiency, sequestration, capture and storage, recycling and re-use of materials, recycling and composting, soil and fertilizer management, improved husbandry, forest protection and sustainable management, reforestation/afforestation, avoided desertification/sustainable management, agroforestry and other sustainable practices

³ Outcome groups: GHG emissions; intermediate outcomes; co-impacts

ABBREVIATIONS

CCM	climate change mitigation
CEE	Collaboration for Environmental Evidence
EGM	evidence gap map
GCF	Green Climate Fund
GDP	gross domestic product
GHG	global greenhouse gas
IE	Impact evaluation
IEU	Independent Evaluation Unit
IFC	International Finance Corporation
IHM	intervention heat map
IOB	Policy and Operations Evaluation Department, Ministry of Foreign Affairs of the Netherlands
IPCC	Intergovernmental Panel on Climate Change
LCA	life-cycle assessment
OECD	Organisation for Economic Co-operation and Development
PICO	Population Intervention Comparator Outcome
REDD+	reducing emissions from deforestation and forest degradation
SME	Small- and medium-sized enterprise
ToC	Theory of Change
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar

INTRODUCTION

Scientists agree that global warming of more than 1.5°C above pre-industrial levels is likely to have far-reaching ramifications. To deter catastrophic effects on society and the natural environment, governments adopted the Paris Agreement in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC). This landmark agreement urges nations to pursue ambitious mitigation and adaptation interventions while promoting sustainable development and environmental integrity (UNFCCC, 2015). Predicated on Nationally Determined Contributions, many governments have pursued ambitious plans to decrease carbon emissions through low-emission technologies, energy savings and nature-based solutions. However, according to the Intergovernmental Panel on Climate Change (IPCC):

Estimates of the global emissions outcome of current nationally stated mitigation ambitions as submitted under the Paris Agreement would lead to global greenhouse gas (GHG) emissions in 2030 of 52–58 GtCO₂eq yr⁻¹ (medium confidence). Pathways reflecting these ambitions would not limit global warming to 1.5°C, even if supplemented by very challenging increases in the scale and ambition of emissions reductions after 2030 (IPCC, 2018, p. 18).

The IPCC (2018) underscores the need to increase global investment in mitigation interventions beyond national ambitions. An estimated USD 1.5-3.8 trillion investments are required to maintain global temperature increases to 1.5°C (IPCC, 2018). However, current public and private investments in mitigation are failing to meet this threshold (Gupta et al., 2014). Climate finance needs in developing countries are particularly urgent. Indeed, developing countries will disproportionately carry the burden of climate change impacts. Pauw et al. (2021) highlight how adaptation costs are expected to rise to USD 140-300 billion per annum by 2030 in developing countries and continue to increase after this time. Binet et al.'s (2021) recent study of financial flows highlights how around USD 350 billion per year flow to non-OECD⁴ countries, with around 14 per cent of these flows coming from non-OECD sources. Just 7 per cent of these annual flows target adaptation with the vast bulk funding mitigation interventions. These investments will, to some extent, limit the increases in GHG emissions as these countries industrialize (International Finance Corporation (IFC), 2016). Continued investments in low-carbon technology and nature-based solutions in these countries will be vital in the coming years. Public finance, however, will be insufficient to meet these needs. The private sector could significantly contribute to this goal because, while it manages more than USD 200 trillion in assets, it currently directs less than 5 per cent of investments into climate opportunities.

1. PRIVATE SECTOR AND CLIMATE CHANGE MITIGATION

Climate change will severely impact biodiversity and ecosystems, influencing businesses worldwide (IPCC, 2018). Indeed, hydro-meteorological disasters destroy critical infrastructure that is often owned by the private sector and disrupt employment and production. Ultimately, this impacts the economy of which businesses are the foundation (Tierney, 2007). Cognisant of the detrimental impacts of climate change on business, the private sector urged governments to reach an agreement in Paris (IFC, 2016). Over 600 global companies and investors have made voluntary commitments to reduce their carbon footprints through targets to reduce their GHG emissions and/or energy consumption (IFC, 2016). Despite ambitions to mitigate climate change, there is ample scope for the private sector to increase its investments in climate change mitigation (CCM). At least USD 23 trillion of investment opportunities exist for climate smart investments in emerging markets,

⁴ OECD stands for Organisation for Economic Co-operation and Development.

especially in green buildings and sustainable transport (IFC, 2016). While certain climate investment markets such as renewables and energy efficiency have matured, plenty of investment opportunities remain in energy distribution, storage and battery technologies. Investment challenges are greater in cement, steel, aviation, manufacturing, agriculture and land-use because solutions are less well understood and greater innovation is required.

2. CLIMATE CHANGE MITIGATION INVESTMENT

Many institutional and corporate investors need a first-loss layer to move into new mitigation investments and financial instruments can play a crucial role in promoting investment in low-carbon climate-resilient interventions. Green bonds or climate policy performance bonds can help raise funds for CCM, while capital instruments and risk management instruments can help CCM projects (World Wide Fund for Nature (WWF), 2018). Governments, development banks or other private or public institutions can help deploy these instruments.

In the wake of the COVID-19 pandemic, there is considerable momentum to steer towards a green and resilient economy. Indeed, there is a substantial potential for CCM investments to be part of the economic and social recovery from COVID-19. Countries such as South Korea, the United Kingdom, Germany, the United States and France are at the forefront of these efforts. However, thus far, only a small proportion of the finance committed for economic and social recovery has been climate smart. Increasing this proportion can help stimulate the economy and contribute to employment while reducing GHG emissions. For example, Hourcade et al. (2021) highlight how financial decision makers have a fiduciary responsibility to not only safeguard asset holdings and economic activity but to steer the investment climate towards sustainable and low carbon alternatives at the same time as meeting current challenges in terms of global public goods and development. Hourcade et al. (2021) suggest this can be achieved through utilising blended finance to integrate COVID-19 recovery with climate and development concerns, manage debt burdens through debt-for-climate swaps and similar modalities, leverage multi-country guarantee funds and increase developing country access to the green bond market.

3. EVIDENCE REVIEWS

Evidence gap maps (EGMs) are thematic collections of evidence focusing on a particular issue, mapping completed and ongoing systematic reviews and impact evaluations (IEs). The underlying conceptual framework of an EGM is key because the evidence is consolidated in an organized matrix. EGMs show in what sectors, interventions and outcome areas evidence are available and where gaps exist. This EGM will contribute to an evidence base where relevant stakeholders can explore the findings and quality of existing evidence on CCM interventions. It will ideally support evidence-based policy making by informing the design and implementation of mitigation interventions.

It is important to highlight at this early stage that EGMs present evidence neutrally and provide no explanatory power on the effect size of the interventions. EGMs do not indicate whether the evidence supports the relationship between an intervention and an outcome (i.e. has a positive effect overall), if the evidence has a negative relationship or if there's no relationship at all (i.e. there is no significant effect). For this, further meta-analyses or reviews of mapped articles are necessary.⁵

We also introduce one other review tool in this paper. In all public policy making, but especially in international cooperation with scarce resources for addressing complex global problems, interventions are ideally evidence-based and effective. For donors and agencies, comparing their

⁵ A synthetic review of specific studies included in this EGM is presented in a companion paper.

portfolio with the available evidence can offer an overview of how evidence-based their portfolio is. This enables planners and decision makers to see where more evidence needs to be generated and where interventions are backed by evidence. This type of comparison can be provided by an intervention heat map (IHM): a systematic overlay of an intervention portfolio with the evidence base. Such systematic comparisons are rare in international cooperation, especially among climate funds. This study aims to start filling this void by providing intervention heat maps for the portfolio of the GCF which is earmarked as a private intervention.

The report's structure is as follows: In Part I, we develop, present and discuss the global EGM of CCM in developing countries. In Part II of the report, we present two intervention heat maps. The report concludes with implications from the EGM and IHMs and provides an outlook.

PART I. EVIDENCE GAP MAP OF CLIMATE CHANGE MITIGATION INTERVENTIONS IN THE PRIVATE SECTOR

A. INTRODUCTION

Understanding the CCM measures that the private sector can undertake requires technical knowledge about the multiple sources and complex processes that lead to the accumulation of GHG, the options for their abatement and a picture of private sector engagement within the CCM sphere. A Theory of Change (ToC) is a helpful tool to depict these complex processes and relationships (Bours et al., 2014), which we have used to develop our EGM. Current frameworks and ToC for CCM are commonly applied in two types of analytical scenarios. A ToC can be applied to specific projects and interventions (van den Berg, 2017) or may portray the main driving forces of CCM globally, including transformational changes or joint adaptation-mitigation dimensions (Carbon, 2017).

In this section, we first outline the main question for our EGM and provide key concepts and definitions that will help build our ToC and subsequently our EGM framework. We then outline the systematic process of evidence collection and analysis before outlining the results. Finally, we discuss the implications of the evidence collected on private sector investment in CCM.

1. OBJECTIVES OF THE EGM

This report draws on the conceptual approach and methods paper for this specific evidence review (Bertschy et al., 2020). It addresses the primary question: What evidence exists concerning the effectiveness and efficiency of CCM interventions in the private sector in developing countries? (see Table 1)

Table 1. *Main elements of the EGM on private mitigation to climate change (the PICO⁶ framework)*

POPULATION	INTERVENTION	COMPARATOR	OUTCOME
Private sector agents (households, private enterprises and companies) in developing countries who hold ownership rights over a physical asset used in a CCM intervention ⁷	CCM interventions aimed at reducing energy consumption, decreasing GHG in the atmosphere or from being released in the atmosphere	No mitigation intervention; different levels of intervention; or comparison of different interventions	Effectiveness and efficiency of mitigation, including the following aspects: <ul style="list-style-type: none"> • Reduction of GHG (including measurement relative to resource use) • Changes in energy consumption and generation patterns • Behavioural change towards lower emissions • Co-impacts (environmental, health, financial returns, social, etc.)

The overall outcome in Table 1 is broad. It leaves room for accommodating different elements of CCM, such as the reduction of GHG emissions or changes in energy consumption and generation

⁶ PICO stands for Population Intervention Comparator Outcome.

⁷ We use the low-to-middle-income country classification as defined by the World Bank (2020) as a proxy for developing countries.

patterns. PART IIA will discuss the interventions that have been included, while PART IIB will go into more detail on the outcomes.

To understand the extent of evidence related to CCM, including what sort of evidence exists and relevant gaps, we

- (a) developed a clear framework of interventions and outcomes from the state of evidence regarding the ability of private mitigation interventions to help developing countries contribute to GHG abatement (see Bertsky et al., 2020)
- (b) developed a search protocol for systematic reviews and primary studies (see Bertsky et al., 2020)
- (c) mapped available systematic reviews and primary studies using this framework and protocol

These are now discussed in the following sections.⁸

2. DEFINITIONS AND CONCEPTS

Climate change can be defined as alterations to global and regional climates caused by an anthropogenic increase in GHGs compared to a baseline climate (Bindoff & Stott et al., 2013).⁹ Numerous organizations have defined CCM in the context of climate change policy (Table 2). These organizations conceptualize CCM in relation to the actions needed to limit GHG concentrations in the atmosphere, either by reducing emissions, enhancing sinks or both. The capacity to implement CCM interventions depends on socioeconomic and environmental factors and on the availability of reliable information and technology. Numerous policies and instruments are available to governments to create incentives in those areas for the private sector to undertake CCM interventions.

Table 2. *Common policy definitions of CCM*

ORGANIZATION/ AUTHOR	DEFINITION
IPCC ¹⁰	CCM involves actions that reduce the rate of climate change. CCM is achieved by limiting or preventing GHG emissions and by enhancing activities that remove these gases from the atmosphere.
UNFCCC ¹¹	In climate change, a human intervention to reduce the sources or enhance the sinks of GHG. Examples include using fossil fuels more efficiently for industrial processes or electricity generation, switching to solar energy or wind power, improving the insulation of buildings and expanding forests and other “sinks” to remove greater amounts of CO ₂ from the atmosphere.
UNEP ¹²	CCM refers to efforts to reduce or prevent GHG emissions. Mitigation can mean using new technologies and renewable energies, making older equipment more energy-efficient or changing management practices or consumer behaviour.

The private sector constitutes the segment of an economy owned and managed by individuals or organizations that are not directly under government control or any public agency. The private sector includes households and individuals, for-profit enterprises, sole traders, partnerships and

⁸ This section draws largely from Bertsky et al. (2020).

⁹ The reference baseline period of 1961 to 1990 has usually been favoured (IPCC, 2013; World Meteorological Organization, 2017).

¹⁰ IPCC Working Group III, available at <https://www.ipcc.ch/working-group/wg3/>

¹¹ Glossary of climate change acronyms and terms <https://unfccc.int/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms>

¹² UNEP stands for United Nations Environment Programme, available at <https://www.unenvironment.org/explore-topics/climate-change/what-we-do/mitigation>

corporations. Such entities are usually free from most forms of state control. Additionally, mixed public-private organizations can also deliver goods or services to society.

There are two common ways to measure the **effectiveness** of CCM strategies. One is through calculating the temperature increase that an intervention would prevent (McCarthy, 2012). Another is through calculating the annual percentage reduction in GHG emissions (McCarthy, 2012). Only the latter method is readily conducive to an evaluation framework. Hence, we define effectiveness as atmospheric GHG emissions reductions. This can include direct emission reductions, GHG emissions reductions through removal processes or intermediate outcomes that unequivocally lead to emissions reduction. In the context of intermediate outcomes, we will measure their effectiveness as the degree to which a CCM intervention successfully produces behaviour patterns that directly lead to GHG reductions, even when these are not explicitly measured.¹³ Other desirable results not directly related to CCM will not be considered in our definition of effectiveness.

We define efficiency in terms of the qualitative and quantitative outcomes associated with a particular intervention concerning the inputs or resources committed towards the desired outputs. It implies that the intervention achieves the desired results with minimal waste and effort. This requires comparing alternative approaches to see whether the most efficient process has been adopted (OECD, 2010). In the context of our framework, efficiency captures the degree of GHG reductions (or the relevant intermediate outcomes) that are attributable to a particular intervention, relative to the resources utilized in its implementation (e.g. land surface, financial resources invested, time units, natural resources, etc.).

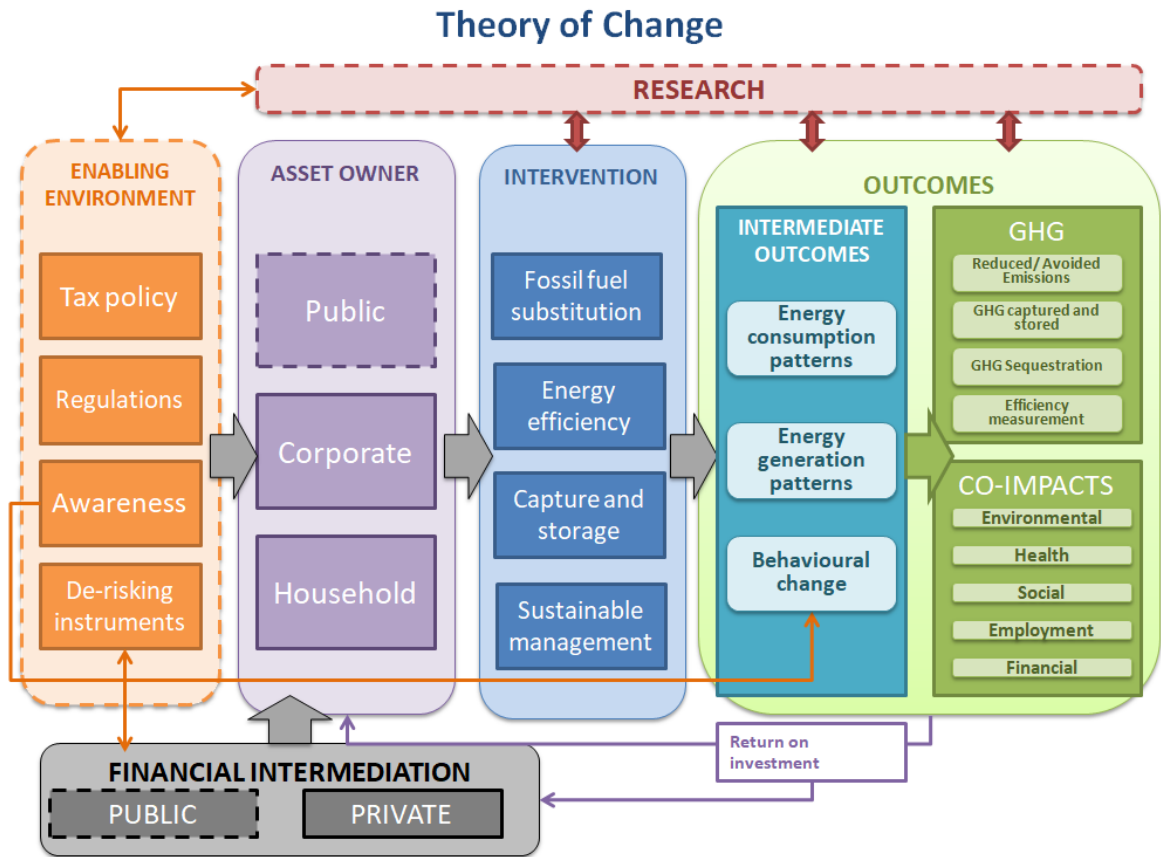
B. THE EGM FRAMEWORK

1. THEORY OF CHANGE

Developing a framework for the EGM required identifying a relevant set of interventions and outcomes for CCM. We developed our EGM framework using a ToC. Our evaluation question places our ToC in an intermediate position to those commonly used (van den Berg, 2017; Carbon, 2017). In this respect, our ToC narrative must be comprehensive enough to include all possible sectors and relevant interventions while portraying only the relevant players and processes. We have limited the scope of our ToC in several respects. Firstly, we have constrained our definition of the private sector (see above). Secondly, we have included only interventions that consist of physical assets owned or invested in that reduce GHG emissions. Our ToC identifies the relevant sectors, interventions and outcomes for our EGM framework in a causal chain, as shown in Figure 1.

¹³ See sections IIA and IIIB for further insight on the definition of relevant outcomes.

Figure 1. Theory of Change¹⁴



Our approach starts with defining an **enabling environment** that facilitates the adoption of relevant CCM interventions (Figure 1). This includes system-level changes in institutional systems, which set the pre-conditions for relevant agents to engage in CCM interventions. Appropriate tax incentives, regulations, awareness campaigns and financial instruments are vital to creating and enhancing an enabling environment. These conditions attempt to lower the risk of investment decisions by firms, which can come in the form of insurance policies, equity contracts and guarantees.

The key player in our narrative is the **owner of a CCM asset** (e.g. technology, infrastructure, devices, vehicles, buildings, businesses, land). This defines the population element of our PICO protocol. Private sector participation can also come in the form of **financial intermediation** services, which play a crucial role in the provision of resources (and de-risking instruments) for the implementation of CCM interventions. Financial intermediaries are also relevant players, both in the role of beneficiaries of the expected outcomes and as recipients of financial returns of the implemented CCM assets.

CCM interventions implemented by key actors can be summarized in four types of mitigation strategies in the ToC: 1) the phase-out or substitution of fossil fuels; 2) energy efficiency; 3) sustainable management, and; 4) carbon sequestration (see PART II for more information on interventions).

The most important causal link of the ToC is the expected **outcome** directly attributable to the interventions. Our EGM framework includes outcomes capturing the direct measurement of GHG reductions, either through avoided emissions (e.g. substitution of fuel engines by electric motors),

¹⁴ Discontinued lines represent elements outside the scope of the EGM.

captured and stored GHG (e.g. carbon geo-injection) or sequestered GHG (e.g. forest carbon sinks). In many cases, **intermediate outcomes** are present, which may lead to the reduction of GHG emissions. These include outcomes capturing cuts or savings in energy consumption rates, changes in the balance of energy generation structures (renewable versus non-renewable) or behavioural changes leading to lower demand for energy services. While all CCM interventions attempt to reduce emissions, a portion also produce economic, social or environmental impacts. Our framework includes these in the form of **co-impacts** where we consider five categories: social, environmental, health, employment and financial.

The outcomes defined in our ToC also have a further implication for the actors involved in the process. Indeed, this is the primary motivation for the private actors: the **return on investment**, which both asset owners and financial intermediaries accrue. Financial gains from CCM intervention assets will vary depending on the financial structure and the particular actors involved. These may range from savings at the domestic level (e.g. from home solar systems or energy efficient appliances) to profit shares obtained from a project financed by an infrastructure fund.

The relevant evidence to be mapped in our exercise provides an empirical linkage between the interventions and outcomes of the ToC. Although important in understanding the overall narrative, aspects related to the enabling environment are outside the scope of the EGM.

2. MITIGATION SECTORS AND INTERVENTIONS

a. Sectors

Several sectors are directly associated with GHG emission reductions, and different organisations have different sector classifications (Table 3).

Table 3. *Multilateral organizations and sectors considered for mitigation*

ORGANIZATION	SECTOR
IPCC (AR5)	Energy; transport; buildings; industry; waste; agriculture, forestry and other land-use
UNFCCC ¹⁵	Energy supply; transportation; buildings; industry; agriculture; forestry; waste
OECD, 2015	Energy (non-transport); energy (transport); agriculture; industrial processes; waste
GCF ¹⁶	Energy access and power generation; transport; buildings, cities, industries and appliances; land-use and forestry

In this EGM – which aims to investigate the evidence base regarding the ability of CCM interventions to reduce GHG from the atmosphere – we group interventions into eight sectoral categories:

- 1) Energy
- 2) Industry
- 3) Transport
- 4) Waste management
- 5) Building
- 6) Urban planning
- 7) Agriculture & livestock

¹⁵ Heaps and Kollmuss (2008)

¹⁶ Green Climate Fund (2014)

8) Forestry & land management

This classification attempts to capture all aspects reflected in the approaches used by leading climate organizations (Table 3). Contrary to other organizations, we disaggregate the agriculture, forestry and other land-use category into three different sectors (sectors 6-8) to capture more detailed evidence. For example, we would classify a study addressing the effectiveness of a multifaceted intervention in several districts across major cities (including brownfield conversion into green areas, low-carbon transport and renewable energies) in sector number 6. In contrast, we would classify an intervention addressing the introduction of agroforestry in depleted soils under sector 8.

b. Interventions

There are different ways to classify mitigation interventions. One of these approaches consists of organizing interventions relative to various anthropogenic sources of GHG concentration. These result from a broad set of human activities, most notably those associated with energy supply and consumption and with the use of land for food production and other purposes (IPCC, 2014). Intervention categories under these approaches would be highly sector-specific, resulting in a long catalogue of possible technologies, techniques and measures to be applied in each of these human activities. In order to overcome this issue and to provide a practical approach for the EGM, we will instead focus on cross-cutting mitigation processes that occur in almost all sectors. For example, the IPCC's AR5 (2014) provides a cross-cutting analysis of different key mitigation strategies and their presence in different human activities. Building on this analysis, we have defined three categories that capture all relevant interventions:

- **Fossil fuel substitution.** This category covers the phase-out of fossil fuels across different sectors, including the introduction of renewable energies, or its substitution by lower GHG intensity options. This category derives from the IPCC's "GHG intensity reduction" category.
- **Energy efficiency.** This category covers any process aiming at using less energy to perform the same function without significant losses in the quality of the service or process. This includes most of the interventions captured under both "technical efficiency" and "resource efficiency" categories of the IPCC's approach. However, this category will exclude the substitution of fossil fuel options (e.g. use of electric motors in substitution of fuel engines in industrial processes).
- **Sequestration, capture and storage.**¹⁷ GHG - in particular CO₂ - can be captured directly from the air or industrial sources using recently developed technologies, including absorption, chemical looping absorption or membrane gas separation. This category will also include non-naturally occurring sequestration processes (e.g. geo-sequestration) and *capture and utilization* technologies.¹⁸ Within this category, we will also include carbon sequestration from improved soil management techniques and the creation, preservation and extension of forest carbon sinks. In the energy and industrial sectors, this category also includes end-of-the-pipe solutions that aim at reducing or capturing emissions through the treatment of residual gases at the final stage of the productive process.

The above three categories are used in our EGM framework to classify interventions across all sectors, reflecting the main cross-cutting processes in CCM approaches. Additionally, we also incorporate sector-specific mitigation interventions (Table 4). For example, we include treatment and recycling in a separate category in the waste management and industry sectors. In the agricultural sector, we have also included a category for interventions aimed at reducing GHG

¹⁷This aspect was not originally captured in the categories' definition in the approach paper (Bertsy et al., 2020) and has been added during the coding process.

¹⁸ Capture and utilisation technologies do not result in geological storage of carbon dioxide and aim to use it for the production of other substances (e.g. plastics, concrete, biofuel).

emissions through soil and management. In this respect, our framework distinguishes between agricultural interventions aimed at soil carbon sequestration from those aimed at reducing potential emissions from agricultural processes (e.g. reducing or avoiding N₂O emissions from soils and drainage or reducing CH₄ and N₂O emissions from the storage, processing and application of manure - Richards et al., 2019). The forestry and land management sector, whose main potential contribution to CCM comes in the form of carbon sinks, has been depicted in the framework through more specific categories, following from the specific mitigation strategies described by the IPCC's AR5 (Working Group III, Chapter 11).

Table 4. General mitigation intervention types and examples of related mitigation activities

INSTRUMENT TYPE	EXAMPLES OF RELATED MITIGATION ACTIVITIES
General (cross-sectoral)	
Fossil fuel substitution	Deployment of renewable and low carbon energy sources; fuel switching within the group of fossil fuels; specific biofuels in various modes; substitution of fuelled engines by electric motors; decarbonization of heat
Energy efficiency	Energy recovery and cogeneration in manufacturing; building insulation; efficient device design (appliance, lighting, stoves, etc.); use of light materials; voltage optimization; smart grids; efficient energy transportation and storage solutions; district heating
Sequestration, capture and storage ¹⁹	Improved soil sequestration in agricultural fields through agroforestry; electrolysis; carbon capturing materials (asphalts, etc.); geochemical storage of CO ₂ ; enhanced oil recovery; chemical looping absorption; membrane gas separation or gas hydrate technologies
Specific interventions in the waste sector	
Recycling and composting ²⁰	Gas collection in landfills; material recovery; mechanical biological treatment; composting; anaerobic digestion
Specific interventions in the industry sector	
Recycling and re-use of materials	Re-use of structural steel; crushed concrete and asphalt used as structural fill or in pavement; recycled coal ash in the manufacturing of ceiling tiles and cement
Specific interventions in the agriculture and livestock sector²¹	
Soil and fertilizer management	Use of compost, manure or synthetic nitrogen fertilizers; minimum tillage; improved collection, storage or treatment of manure; reduced irrigation of paddy rice
Improved husbandry	Pasture improvement using rotational or controlled grazing; improved diets for livestock; improved animal feeding management; breed diversification
Agroforestry and other sustainable practices ²²	Combination of crops and trees (e.g. alley cropping or home gardens) combination of forestry and grazing of domesticated animals on pastures, rangelands or on-farm
Specific interventions in the forestry and land management sector	
Forest protection and sustainable management	Conservation of existing carbon pools in forest vegetation and soil by controlling deforestation; control of fires and pest outbreaks; reducing slash and burn agriculture; management of forests for sustainable timber production (e.g. extending rotation cycles, reducing damage to remaining trees, reducing

¹⁹ For further insight on capture and storage see for instance Cuellar-Franca and Azapagic (2015).

²⁰ For further insight on the role of waste management in CCM see European Commission (2001) and Albanna (2012).

²¹ For further insight on mitigation options in the agriculture and livestock sector see for instance Henderson et al. (2019) and Sejian and Naqvi (2012).

²² This category was added as a modification of the original approach paper as described in Bertsy et al. (2020).

	logging waste, implementing soil conservation practices, fertilization and using wood in a more efficient way)
Reforestation/afforestation	Improved biomass stocks by planting trees on non-forested agricultural lands, including monocultures or mixed species plantings
Avoided desertification/sustainable management	Re-vegetation (establishment of vegetation that does not meet the definitions of afforestation and reforestation); improved fire and grazing management; control of erosion; integrated crop, soil and water management

3. MITIGATION OUTCOMES

Our main outcomes are partitioned into GHG emissions, intermediary outcomes and co-impacts. These can be further divided into sub-elements (Table 5).

Table 5. *CCM outcomes and sub-elements*

OUTCOMES	SUB-ELEMENTS
GHG emissions	Reduced or avoided GHG
	Captured and stored GHG
	GHG sequestration
	Efficiency measurement
Intermediary outcomes	Energy consumption patterns
	Energy generation patterns
	Behavioural change
	Other intermediary outcomes
Co-impacts	Social
	Employment
	Environmental
	Health
	Financial

CCM outcomes may vary depending on the sector and the intervention employed (Table 6); therefore, the EGM is not expected to show a fully symmetrical distribution of the evidence across different outcomes. Specific outcome indicators are expected to vary widely in their formulation, depending on the nature of the mitigation process addressed by the corresponding intervention, the measurement units and the type of outcome.

Table 6. *Example CCM interventions and outcomes by sector*

SECTORS	EXAMPLE CCM INTERVENTIONS	EXAMPLE CCM OUTCOMES
Energy	Installation of home solar power systems in selected city suburbs, supported through microcredit by a proven social investor	<ul style="list-style-type: none"> • Changes in yearly energy consumption and expenditure • Improvement in respiratory disease due to indoor pollution
Industry	Substitution of fuelled engines by electric motors powered by energy recovery systems in manufacturing plants	<ul style="list-style-type: none"> • Avoided GHG emissions per year

Transport	Construction of urban biking tracks in selected districts across cities through a public-private partnership	<ul style="list-style-type: none"> • Increase in total kms of bicycle riding • Decrease in total kms of private car circulation
Waste management	Installation of wastewater treatment equipment for capture and reutilization of CO ₂	<ul style="list-style-type: none"> • Total amount of CO₂ and re/utilized • Total GHG avoided under a life cycle assessment (LCA)
Building	Renovation in private office buildings to enhance thermal insulation, efficient heating systems and renewable energy generation systems	<ul style="list-style-type: none"> • Reduction in average building energy consumption rates (KWh/m²)
Urban planning	Comprehensive intervention in selected districts across different cities for the development of sustainable residential areas, including nature-based solutions, sustainable transport, building insulation and land-use regulations	<ul style="list-style-type: none"> • Average household energy consumption rates • Average building energy consumption rates • Sequestered CO₂ • Avoided GHG emissions from vehicle circulation • Total green cover
Agriculture and livestock	Investment in agroforestry practices in smallholding farms	<ul style="list-style-type: none"> • Yearly increase in green cover and equivalent sequestered GHG
Forestry and land management	Credit support to promote private investments in green value chains and sustainable forestry activities in local small- and medium-sized enterprises (SMEs)	<ul style="list-style-type: none"> • Revenues obtained by forestry SME • Changes in forest cover area and in equivalent yearly CO₂ sequestration rates

4. FRAMEWORK

Our framework has a 3-D structure with sectors, interventions and outcomes (see Table 7).

Table 7. Evidence gap map framework for CCM interventions in the private sector

CCM		GHG EMISSIONS				INTERMEDIATE OUTCOMES				CO-IMPACTS				
SECTOR	OUTCOMES	Reduced/ avoided GHG	Captured and stored GHG	GHG Sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
	INTERVENTIONS	Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/ Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
Energy	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, C&S													
Industry	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, C&S													
	Recycling and re-use of materials													
Transport	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, C&S													
Waste management	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, C&S													
	Recycling and composting													
Building	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, C&S													

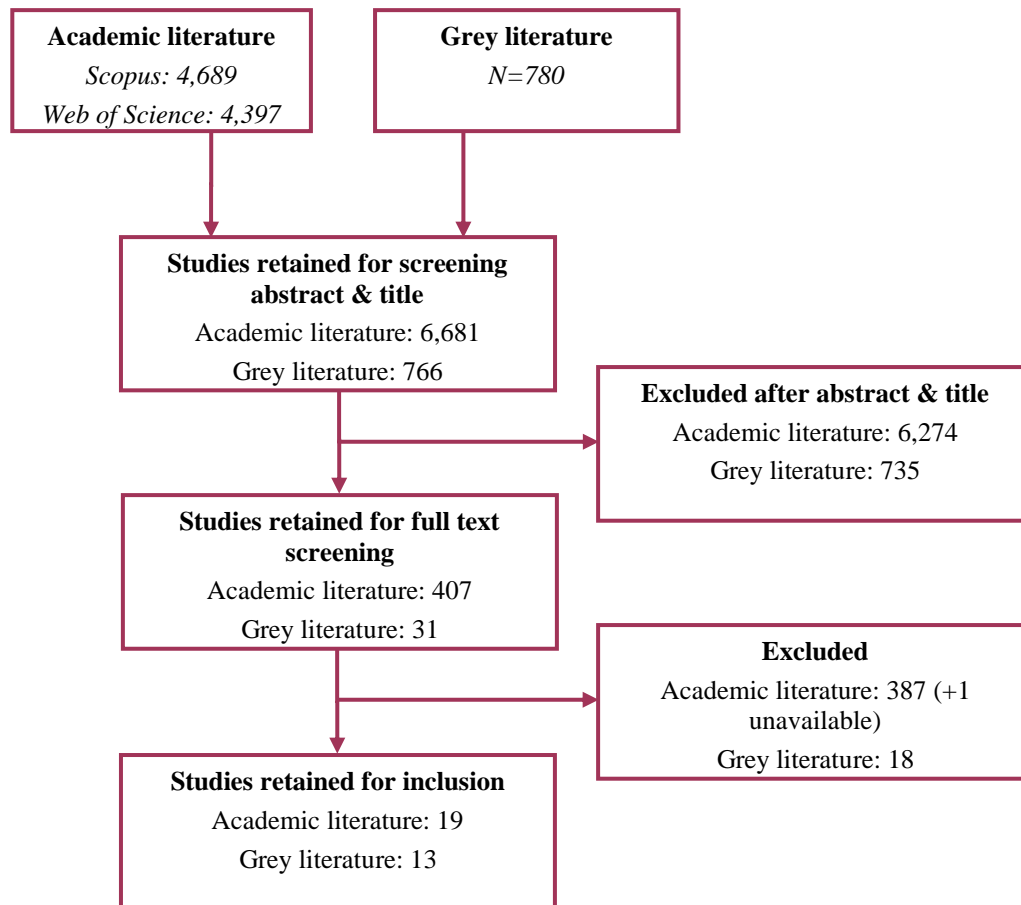
- Evidence Gap Map and Intervention Heat Map of Climate Change Mitigation Interventions in the Private Sector in Developing Countries -

CCM	SECTOR	OUTCOMES INTERVENTIONS	GHG EMISSIONS				INTERMEDIATE OUTCOMES				CO-IMPACTS				
			Reduced/ avoided GHG	Captured and stored GHG	GHG Sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
		Illustrative outcome indicators	Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/ Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
Urban planning		Fossil fuel substitution													
		Energy efficiency													
		Sequestration, C&S													
Agriculture & livestock		Fossil fuel substitution													
		Energy efficiency													
		Soil and fertilizer management													
		Improved husbandry													
		Agroforestry and other sustainable practices													
Forestry & land management		Forest protection and sustainable management													
		Reforestation/ afforestation													
		Avoided desertification/ sustainable management													

C. REVIEW

A systematic map protocol was used, which followed guidelines set out by the Centre for Evidence-Based Conservation (CEE, 2018). Several databases (Web of Science, Scopus and Ideas/RePEc) and grey literature from several organizational websites were systematically searched using this search protocol (see Appendix 1 and Bertsky et al., 2020). Searches were performed in English and identified all literature that had an English abstract. Some articles, however, were in different languages and were included if they were in Spanish, French or German; otherwise they were excluded. The inclusion/exclusion criteria are summarized in Table 8. The search found a total of 7,447 papers. Once duplicates had been removed and after screening according to exclusion criteria, 32 were included (see Figure 2 for a PRISMA²³ diagram).

Figure 2. *Inclusion exclusion diagram*



²³ PRISMA stands for Preferred Reporting Items for Systematic Reviews and Meta-Analyses.

Table 8. Summary of inclusion and exclusion criteria and illustrative examples

INCLUSION CRITERIA	ILLUSTRATIVE EXAMPLES OF INCLUDED ITEMS	EXCLUSION CRITERIA
1. POPULATION		
<p>Private sector (households, private enterprises and companies) in developing countries who:</p> <ul style="list-style-type: none"> • Hold full ownership of the main intervention assets, or • Hold ownership of the main intervention assets in the context of Public-Private arrangements, or • Provide financial intermediation in the form of equity²⁴ 	<ul style="list-style-type: none"> • SME installing solar roofing in their facilities • Private office buildings installing insulation measures • Households investing in home solar generation equipment • Private and public banks taking part in an Infrastructure Equity Fund for the financing of a large wind energy project 	<ul style="list-style-type: none"> • No private sector involved in the ownership of the intervention assets • Assets entirely owned by the public sector, even with the participation of private financial intermediation • Anecdotal participation of the private sector in mixed ownership structures • No description of the financial structure is provided • Developed countries²⁵
2. INTERVENTION		
<ul style="list-style-type: none"> • CCM interventions: <ul style="list-style-type: none"> – Aiming at reducing energy consumption, decreasing GHG in the atmosphere or from being released in the atmosphere, and – Implemented through the purchase, replication or improvement of assets or items with the expectation that they will generate income or appreciate • Multifaceted interventions in which physical assets and regulatory components are combined • Pilot studies of innovations performed in real life context and/or market conditions • Interventions with both adaptation and mitigation outcomes 	<ul style="list-style-type: none"> • Sustainable agriculture programme, for the improvement of soil management techniques for better adaptation and GHG soil capture • Pilot programme by a private social investor consisting in the provision of credit lines for SME for the acquisition of energy recovery equipment in small-scale industrial processes • Institutional Public-Private Forest Fund to promote private investments in forest conservation in the context of reducing emissions from deforestation and forest degradation (REDD+) 	<ul style="list-style-type: none"> • Non-mitigation interventions. No mention of mitigation, energy saving or emissions reduction or other mitigation or intervention search terms. • Mitigation measure not implemented through an asset (e.g. consumption goods, grants, donations, subsidies). • Experimental settings in which the intervention assets are not distributed under usual market conditions. • Financial instruments aimed at de-risking investments in CCM interventions (guarantees, insurance, etc.) • Investments into nuclear energy generation projects.

²⁴ We use low-to-middle-income country classification as defined by the World Bank (2020) as a proxy for developing countries.

²⁵ We use high-income countries as defined by the World Bank (2020) as a proxy for developed countries.

3. COMPARATOR		
<ul style="list-style-type: none"> • Comparisons with a non-mitigation intervention scenario • Different levels of intervention and comparisons between interventions • Time observation studies 	<ul style="list-style-type: none"> • Comparison of insulated buildings and non-insulated ones • Comparison of land plot GHG capture by the level of tillage • Time series analysis of city GHG inventory 	<ul style="list-style-type: none"> • No measure of success of the mitigation intervention is presented and compared with no mitigation intervention or different levels of intervention
4. OUTCOME		
<ul style="list-style-type: none"> • Direct measurement of GHG reduction (avoided emissions, capture and storage, sequestration) • Outcomes that can potentially have a translation into GHG savings including: <ul style="list-style-type: none"> – Changes in energy consumption and generation patterns – Behavioural change (transportation, appliance use, consumption, etc.) • Outcomes that capture positive and negative co-impacts (environmental, social, health and financial) 	<ul style="list-style-type: none"> • Tons of yearly CO₂ emissions avoided through energy recovery equipment installed in manufacturing facilities • Increase in the number of yearly kms run by bicycle because of the construction of biking tracks in cities • Changes in respiratory disease prevalence ratios because of the implementation of clean production technologies in industrial districts 	<ul style="list-style-type: none"> • No measure of effectiveness or efficiency of the mitigation intervention is presented • Studies addressing co-impacts exclusively • Cost-effectiveness studies
5. STUDY		
<p>Quantitative or mixed-methods studies published as peer-review articles or as grey literature (documents published by organizations), including the following methodological approaches:</p> <ul style="list-style-type: none"> • IE approach, which assesses the impact of an intervention using counterfactual analysis (experimental and quasi-experimental approaches) • Correlation analyses (e.g. using cross-sectional data, panel data or time series) • Systematic reviews of quantitative evidence studies 	<ul style="list-style-type: none"> • Study combining a differences-in-differences approach and qualitative research to assess energy savings effects • Binary regression to assess the probability of behavioural change in the use of sustainable transport • Systematic review of the empirical evidence of GHG emission reduction in building renovation programmes 	<ul style="list-style-type: none"> • Process-based evaluation reports (i.e. evaluation reports based on milestone indicators, stakeholder-based evidence and qualitative information) • Prospective and predictive analysis based on modelling • Cost-benefit and cost-effectiveness analysis • Books or book sections

6. LANGUAGE

- Language of article with English abstract: English, French, Spanish and German

- Languages outside those in the inclusion criteria

7. PUBLICATION DATE: 1 January 2005- 1 September 2020

Fleiss's Kappa analysis was undertaken to test reviewer rating agreement at the abstract filtering stage. Kappa values range from +1 to -1, with anything less than 0 indicating no agreement (Landis and Koch, 1977), with values 0.60–1.00 rated as indicating sufficient agreement between the reviewers. The Kappa score obtained between the three reviewers in this study was 0.60.

D. DATA CODING AND ANALYSES

Included papers were given an identifier number and all bibliographic information was recorded in a spreadsheet. Each paper was analysed to identify all the interventions/outcomes tested in the studies, generating a second database in the form of a coding sheet which included several fields relevant to the gap map analysis: (1) region; (2) country; (3) population subgroup; (4) sector; (5) intervention type; (6) intervention; (7) outcome; (8) outcome subgroup; (9) outcome indicator; (10) study design; and (11) methods. Fields 1, 3, 4, 5, 7, 8 and 10 were coded numerically to allow descriptive statistics, while fields 2, 6, 9 and 11 were coded using text (see Appendix 2). The EGM was populated with the number of coded articles in each intervention/outcome cell. One single article can be found coded into several cells in the EGM if they contain different interventions and/or outcomes.

E. RESULTS

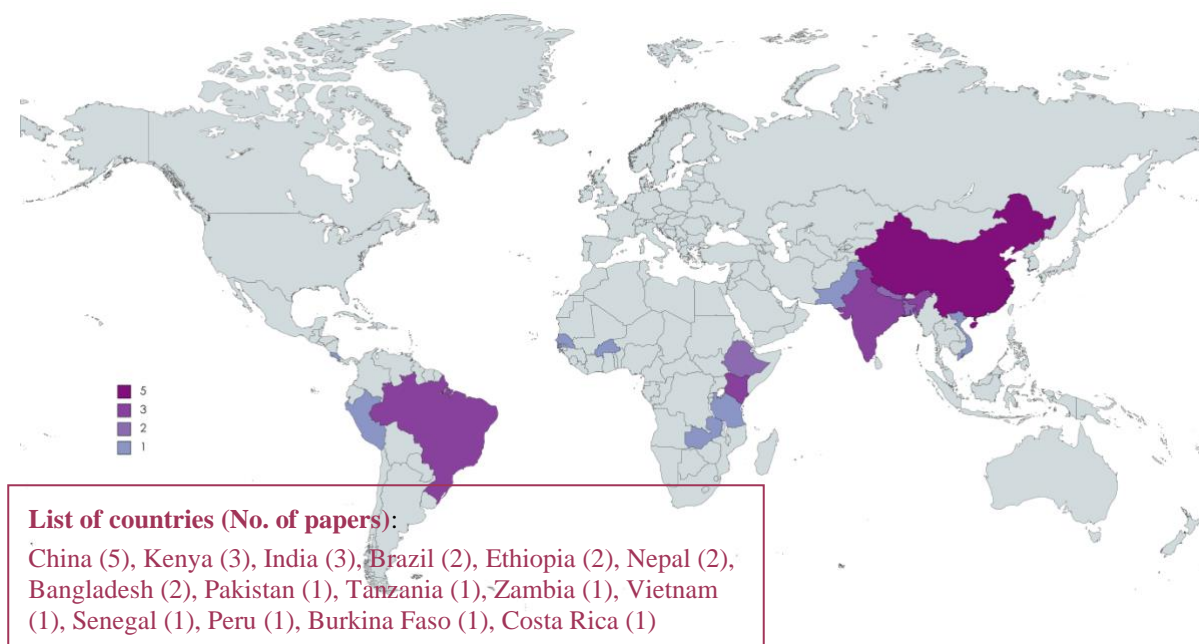
1. GEOGRAPHIC DISTRIBUTION

Out of the 32 included papers, 28.1 per cent pertained to interventions in sub-Saharan Africa, followed by South Asia and East Asia and the Pacific with around 25 and 18.8 per cent, respectively (see Table 9). Latin American countries were the area of study in 12.5 per cent of the cases, whereas the literature did not cover Central Asia, the Middle East and North Africa. A further five papers (15.6 per cent of the total) provided evidence of CCM interventions at the global or multi-regional level. It is interesting to note that out of the 27 single-country papers identified, 40.7 per cent of these were located in just three countries, meaning empirical evidence on private interventions of CCM is highly concentrated around a limited number of countries (Figure 3).

Table 9. *World Bank regions focused on by included papers*

WORLD BANK REGION	NUMBER OF PAPERS	PERCENTAGE
Sub-Saharan Africa	9	28.1%
South Asia	8	25.0%
East Asia & Pacific	6	18.8%
Multiple countries/global	5	15.6%
Latin America and Caribbean	4	12.5%
Europe & Central Asia	0	0.0%
Middle East & North Africa	0	0.0%
Total	32	100.0%

Figure 3. Geographic distribution of single-country papers, with top 10 countries



2. SECTORS, INTERVENTIONS AND OUTCOMES

Table 10 below shows the distribution of evidence within the EGM. Each cell contains the number of articles that test for a relationship between the intervention/outcome described by that cell. We add a third level of classification where we group each intervention type by sector, and outcomes are grouped by broader categories as discussed above. An intensity colour scale depicts the density of available evidence in the selected literature in each cell: the darker the colour, the higher the number of articles collected for that particular sector, intervention and outcome. Blue coloured cells refer to peer-reviewed academic articles and red ones to grey literature.

Table 10. Evidence gap map – number of intervention/outcomes for each intervention type and outcome, by sector

Sectors	CCM	GHG Emissions								Intermediate outcomes								Co-impacts										
	Outcomes	Reduced/ avoided GHG		Captured and stored GHG		GHG Sequestration		Efficiency measurement		Energy consumption patterns		Energy generation patterns		Behavioural change		Other intermediary outcomes		Social		Employment		Environmental		Health		Financial		
	Illustrative outcome indicators	Amount of GHG reduced or avoided		Amount of GHG captured		Amount of GHG sequestered		GHG/surface GHG/ investment		Household/ Industrial energy consumption reduction		Proportion of renewable energy generation		Use of bicycles, use of appliances, consumption patterns		Reforested surface, recycled waste		Educational outcomes, time savings		Job creation, working conditions		Air pollution, biodiversity, soil fertility		Respiratory diseases		Return on investment, household savings		
	Interventions	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	C	NC	
Energy	Fossil fuel substitution	0	3	0	0	0	0	0	1	3	3	0	1	0	0	0	1	2	0	0	0	0	0	1	1	1	3	
	Energy efficiency	1	0	0	0	0	0	0	1	2	1	0	1	0	0	0	0	1	0	0	0	0	0	0	1	0	1	
	Sequestration, capture, and storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	
Industry	Fossil fuel substitution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	2	0	0	0	0	0	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	2	0	
	Sequestration, capture, and storage	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Recycling and re-use of materials	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Transport	Fossil fuel substitution	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Sequestration, capture, and storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Waste Management	Fossil fuel substitution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Sequestration, capture, and storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Recycling and composting	0	3	0	0	0	0	0	0	1	2	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1	0	
Building	Fossil fuel substitution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Sequestration, capture, and storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Urban planning	Fossil fuel substitution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Sequestration, capture, and storage	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
Agriculture & Livestock	Fossil fuel substitution	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Energy efficiency	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Soil and fertilizer management	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Improved husbandry	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Agroforestry and other sustainable practices	0	2	0	0	0	2	0	2	0	1	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	
Forestry & Land Management	Forest protection and sustainable management	0	0	0	1	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	0	0	1	0	0	0	0	
	Reforestation/afforestation	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
	Avoided desertification/ sustainable management	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	

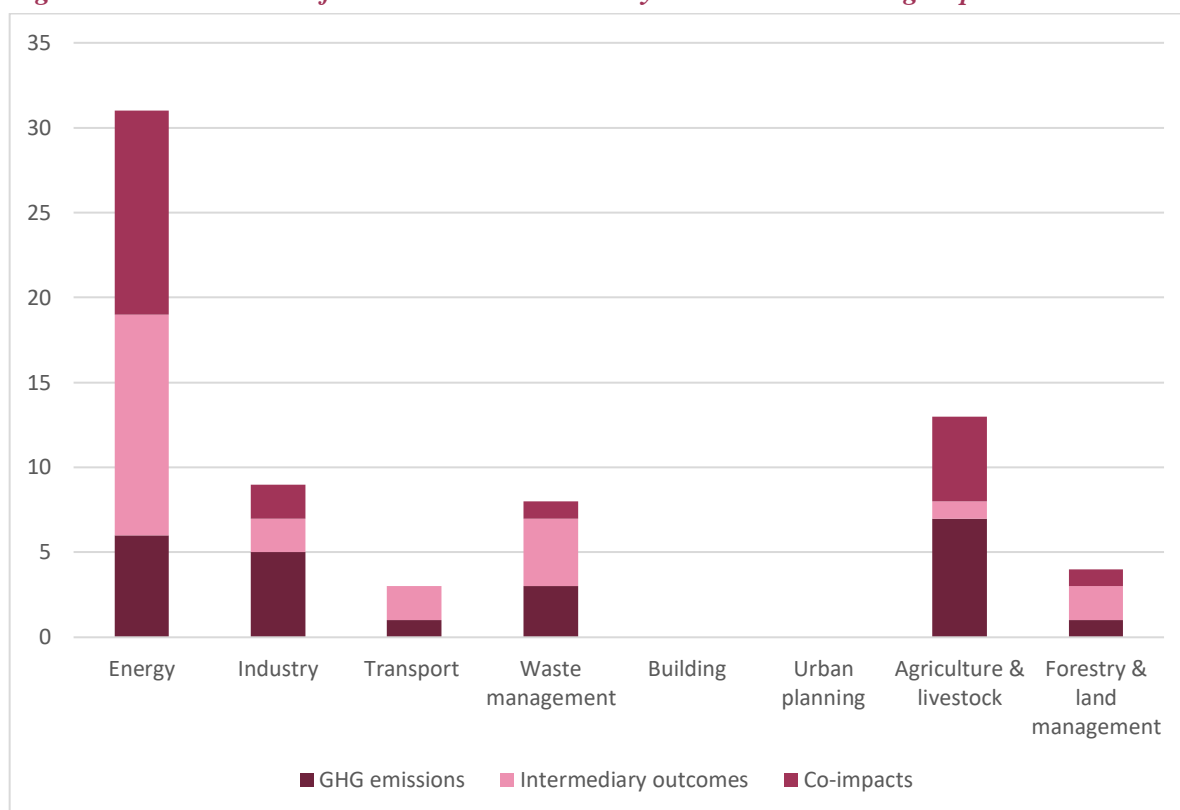
Note: Academic literature Grey literature

Out of the 32 research papers that met all of the inclusion criteria, 68 interventions/outcomes were coded and mapped according to the EGM framework’s categories. Since, commonly, one single paper addresses the effectiveness of multiple interventions (and often in connection to several outcomes), the number of papers in each cell adds up to a substantially larger figure than the total number of papers, with an average of 2.1 interventions/outcomes per paper. Out of the 68 interventions/outcomes, 26 correspond to causal analyses (in other words, experimental or quasi-experimental studies), whereas 42 were obtained through correlational analyses and other non-causal approaches.

a. Results by sector

The area with the most concentration in the EGM is the energy sector (Figure 4), which is the subject of 12 papers and 31 interventions/outcomes. Furthermore, the majority of articles relate to fossil fuel substitution interventions.

Figure 4. *Number of interventions/outcomes by sector and outcome group*

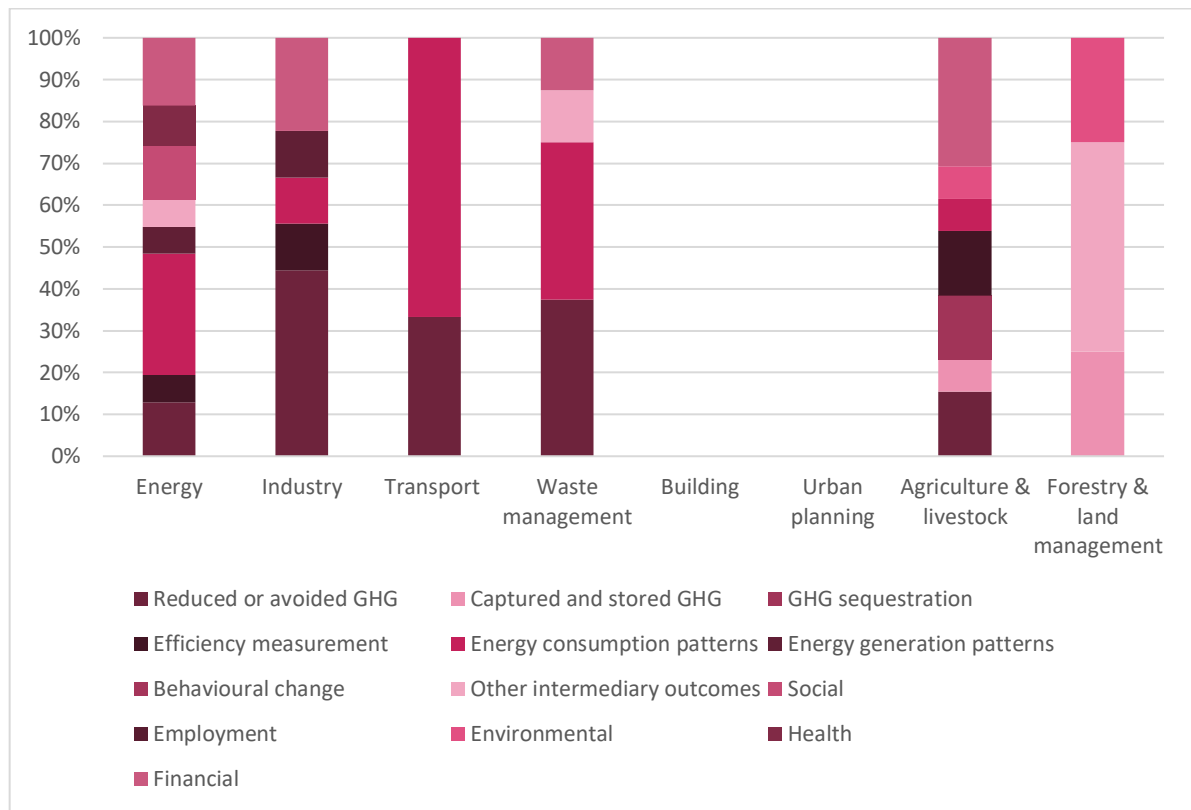


The second most populated sector of the EGM is agriculture and livestock, with 13 interventions/outcomes and 21.8 per cent of the collected evidence, followed by industry, with nine intervention/outcomes and 19.9 per cent of the evidence. Studies in agriculture and livestock mainly address agroforestry and other sustainable agricultural practices, such as alternative cropping systems, and only one paper addresses improved land husbandry. For the most part, studies in industry relate to energy efficiency measures and, to a lesser extent, to carbon capture and storage interventions. The building and urban planning sectors, which are considered highly important in the framework of CCM policies, have not been the subject of quantitative evaluation studies within the selected literature. Papers addressing interventions in the waste management, forestry and transport sectors have gathered eight, four and three interventions/outcomes, respectively.

b. Results by outcome

Figure 5 shows the distribution of outcomes per sector. It can be seen that the most diversified sector in terms of outcomes is the energy sector, where different co-impacts and intermediary outcomes are more frequent than in the rest of the EGM framework. Energy consumption patterns are the most common outcome addressed in the energy-related articles, followed by financial and social co-impacts. The second most diversified sector is agriculture and livestock, where financial co-benefits, GHG sequestration and efficiency measurements take greater weight in the distribution of outcomes compared to other sectors. Although each sector may be by definition more inclined towards certain type of outcomes (e.g. agricultural and forestry activities are more suitable for outcomes related to carbon sequestration than emission reductions), some outcome categories are consistently present across different sectors. This is the case for the reduction and avoidance of GHG or energy consumption patterns, with the exception, perhaps, of forestry and land management.

Figure 5. *Distribution of evidence by outcome category in each intervention sector²⁶*



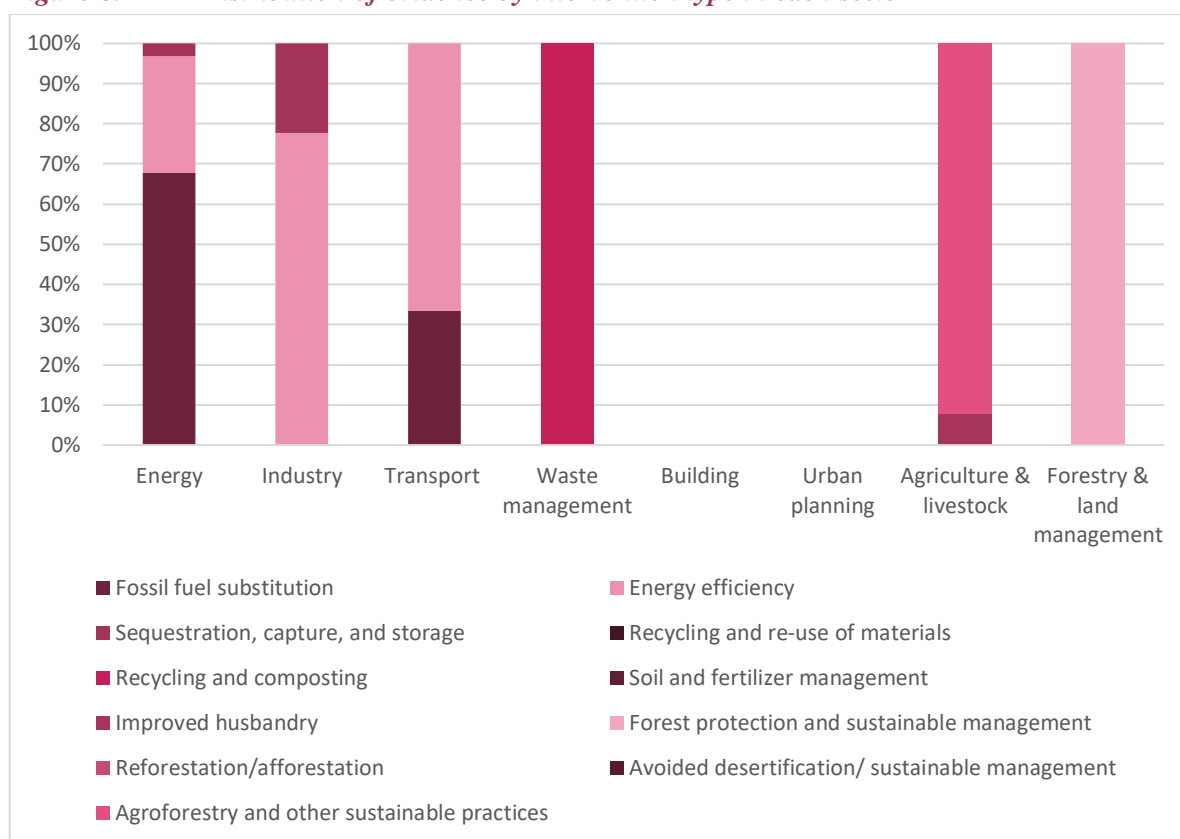
Another relevant result worth noting is that most studies addressing GHG sequestration, carbon and storage are found only in two sectors (agriculture and livestock, and forestry and land management), with no presence in some other relevant sectors industry. Regarding the distribution of co-impacts, it should be noted that the literature most frequently addresses the financial effects of the interventions and are most frequently expressed in terms of economic gains, domestic savings/expenditure, productivity or agricultural yield. Environmental co-impacts, however, are only present in the agriculture and forestry sectors, whereas health co-impacts are only addressed in energy-related articles. No employment co-benefits have been addressed in the selected literature. Within the group of intermediary outcomes, the most important gap is found concerning behavioural change outcomes. No study within the selected literature has examined such an approach. In contrast, energy consumption in the energy sector has been most studied.

²⁶ The purple scale refers to co-impacts, grey scale to intermediate outcomes and red scale to GHG emission outcomes.

c. Results by intervention type

Figure 6 shows the distribution of the types of interventions studied within each sector. Given that each sector shows a different set of interventions, some of them being exclusive to a particular sector and some other being cross-cutting categories, direct comparison between sectors is not a useful exercise in this case. As a result, the distribution of interventions across different sectors is quite uneven, depending on the particularities of the assessed activities. Thus, in the energy sector, we see that the most common intervention type is the substitution of fossil fuels, followed by energy efficiency measures. In contrast, carbon capture and storage and end-of-the-pipe solutions account for a small fraction of the evidence. The most frequent intervention category in the industry and transport sector is energy efficiency measures. The waste management sector concentrates on recycling and composting types of measures. By comparison, the agriculture and livestock sector gathers evidence exclusively on agroforestry, sustainable agricultural practices and, to a lesser extent, improved husbandry interventions. The main interventions noted for the forestry sector refer to forest protection and sustainable land management interventions.

Figure 6. *Distribution of evidence by intervention type in each sector*

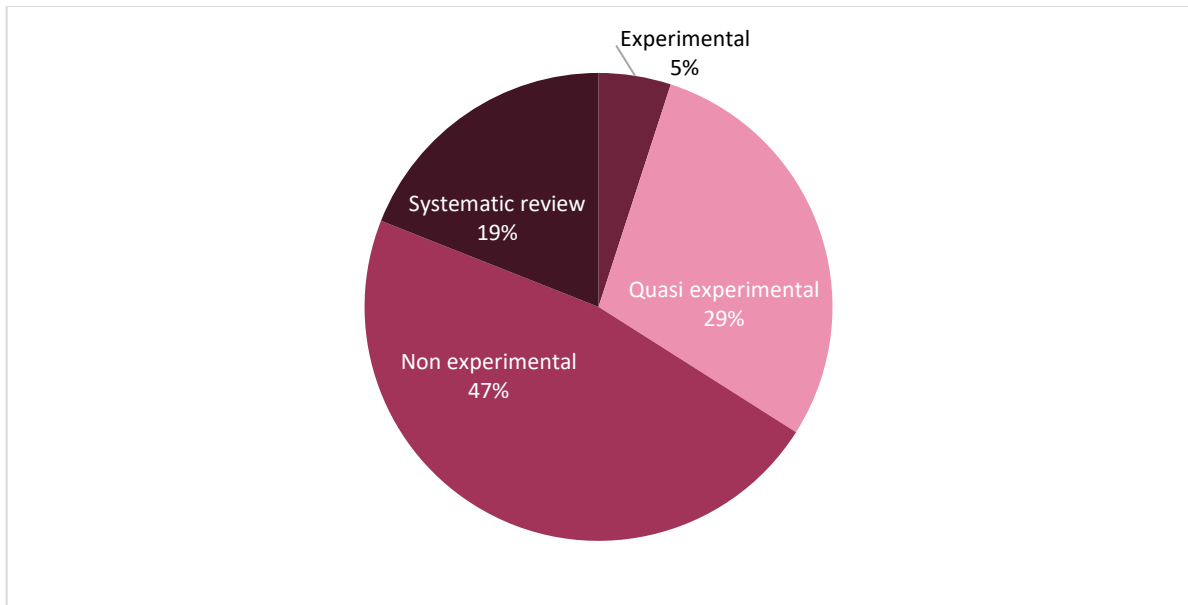


The total absence of reforestation/afforestation measures and interventions aimed at avoiding desertification are among the most notable gaps in terms of interventions. Soil and fertilizer management are also absent from the evidence gathered for the agricultural sector. However, this gap should be taken cautiously, as some interventions coded as “agroforestry and other sustainable practices” may include interventions relevant to that category. Recycling and re-use of materials are also absent from studies in the industrial sectors. Finally, the absence of energy efficiency intervention from sectors other than industry, energy and transport is also worth noting.

3. STUDY DESIGN TYPES IN THE EGM

This report classified all individual articles into four potential categories: experimental (e.g. field experiments, randomized control trials), quasi-experimental (studies comparing non-random treatment versus non-treatment), non-experimental (studies employing correlation methods such as multivariate regression and other approaches such as life-cycle analysis) and systematic reviews (which also include meta-analysis). Figure 7 shows the distribution of study designs within the set of collected evidence. As it can be seen, nearly half the papers are non-experimental.

Figure 7. Percentage share of study design types within the collected evidence

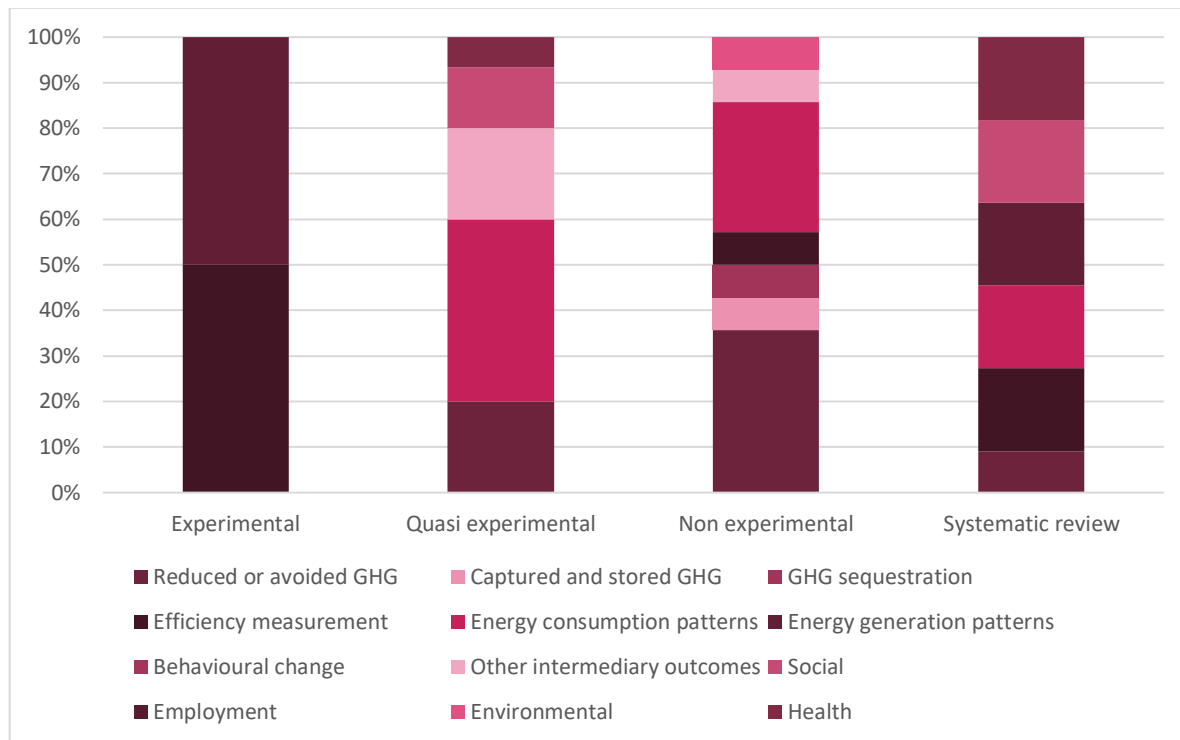


These mostly include correlation studies in the form of multivariate analysis and binomial regressions that investigate the causal relationship between certain intervention measurements (independent variables) and CCM outcome indicators (dependent variables), usually controlling for other factors to isolate the effects.

The second most frequent study design consists of quasi-experimental approaches (29 per cent), are mostly matching techniques and, to a lesser extent, instrumental variable approaches and difference-in-difference models. These study types perform comparisons between two or more groups of subjects (e.g. farmers, households, individuals, territorial units, etc.). These groups are differentiated by the type of intervention received or not received, but whose inclusion in one or another group has not followed a randomized design (i.e. experimental).

The use of experimental designs amounts only to 5 per cent of the collected evidence, which corresponds to three interventions/outcomes gathered in one paper that tests the effect of energy efficiency services in an experimental setting. Hence, the proportion of experimental designs – such as randomized control trials for private sector investments in mitigation – is very limited (on this topic, see Prowse and Snielsveit, 2009). Finally, systematic reviews amount to 19 per cent of the overall collected evidence. These studies aggregate and assess a previous set of relevant studies, whether they are empirical, quasi-empirical or non-empirical. An aspect worth noting is that most of the evidence under the systematic review category corresponds to a single paper covering several IEs of renewable energy interventions (Policy and Operations Evaluation Department (IOB), 2013), hence generating several interventions/outcomes in the EGM.

Figure 8. Distribution of evidence by outcome in each study design type



Across sectors, the percentage of studies in each design is uneven. The energy sector contains no experimental studies, 32.3 per cent (10) quasi-experimental studies, 29.0 per cent (9) non-experimental studies and 38.7 per cent (12) systematic reviews. The industry sector contains an equal share of study types distributed across experimental, quasi-experimental and non-experimental designs (3 of each category). The transport sector contains evidence from only three interventions/outcomes obtained from non-experimental studies. The waste management sector contains 62.5 per cent (5) of quasi-experimental studies, 25 per cent (2) of non-experimental studies and 12.5 per cent (1) of systematic review studies. The agriculture and livestock sector contains 7.7 per cent (1) of quasi-experimental studies and 92.3 per cent (12) of non-experimental studies; and the forestry and land management sector contains 25 per cent (1) of quasi-experimental studies and 75 per cent (3) of non-experimental studies. The landscape of studies by intervention/outcome cell is shown in Table 11.

Table 11. Evidence gap map with evidence colour-coded by study design

Sectors	CCM	GHG emissions				Intermediate outcomes				Co-impacts				
	Outcomes	Reduced/avoided GHG	Captured and stored GHG	GHG sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
	Illustrative outcome indicators	Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
Interventions	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	E Q N S	
Energy	Fossil fuel substitution	1 2				1	3 2		1				1 1	2 1 1
	Energy efficiency	1				1	2		1				1	1
	Sequestration, capture, and storage								1					
Industry	Fossil fuel substitution													
	Energy efficiency	1 1			1		1	1						1 1
	Sequestration, capture, and storage	2												
	Recycling and re-use of materials													
Transport	Fossil fuel substitution	1												
	Energy efficiency					2								
	Sequestration, capture, and storage													
Waste management	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture, and storage													
	Recycling and composting	1 1 1					2 1		1					1
Building	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture, and storage													
Urban planning	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture, and storage													
Agriculture & livestock	Fossil fuel substitution													
	Energy efficiency													
	Soil and fertilizer management													
	Improved husbandry		1											
	Agroforestry and other sustainable practices	2		2	2	1						1		1 3
Forestry & land management	Forest protection and sustainable management		1						1 1			1		
	Reforestation/afforestation													
	Avoided desertification/ sustainable management													

Note: E = experimental; Q = quasi-experimental; N = non-experimental; S = systematic review

F. DISCUSSION

1. OVERALL VOLUME OF EVIDENCE

After reviewing more than 7,000 references, the EGM and the corresponding search protocol have resulted in a **limited number of articles that passed the inclusion/exclusion criteria**, with only 32 articles selected. This shows that there are large evidence gaps in this topic area. Furthermore, given that the maximum number of individual interventions/outcomes mapped in a single cell only amounts to four (six when counting both causal and non-causal evidence), the possibility of performing a conclusive meta-analysis of the evidence for a particular topic is limited.

Several explanations beyond a lack of evidence could be behind the low number of selected references, some of them already pointed out in previous similar exercises. As carefully explained by White (2007) as well as Doswald et al. (2020), interventions with an important infrastructure component are less prone to being the subject of IEs, as they are favoured by other types of research such as cost-benefit analysis, predictive modelling and ex-ante impact assessments. Indeed, implementing large projects such as energy generation or transport infrastructure is expensive and disruptive, and ex-ante studies are therefore commissioned prior to their undertaking (Griskeviciene et al., 2012). Furthermore, for many sectoral projects, it is more important to establish the evaluation of potential effects, such as whether a large solar farm will save GHG in net terms. Hence, sectors that are more reliant on these types of approaches seem to have received less attention from IE literature.

Our scope of private sector (or mixed) interventions is another important element that could explain the limited volume of evidence. It is important to note that, until recently, rigorous IEs had been rare in the area of finance and private sector development. A possible reason lies in the perception that many private projects in this area lend themselves less to formal evaluations (McKenzie, 2010). Furthermore, as a powerful accountability tool, IEs have been traditionally driven by the need to assess the effectiveness of interventions in the framework of public policies, hence responding to the increasing scrutiny of donors and taxpayers. The lack of private sector involvement in CCM projects could be the leading factor in explaining the low-level of evidence in some specific sectors. For example, in the forestry sector it is clear that mechanisms to involve private participation in mitigation initiatives are yet to be further explored (Lujan and Silva-Chavez, 2019). This is particularly the case for REDD+, where the need for further involvement of the private sector has been long discussed and remains as one of the areas for improvement in the future.

2. GEOGRAPHIC DISTRIBUTION

A high proportion of the papers were undertaken in sub-Saharan Africa and South Asia, which could be explained by the ongoing development of an energy model based on renewable sources and the spread of sustainable and off-grid solutions for vulnerable communities, particularly in the rural sector. The high interest in adaptation to climate shocks and food security issues that have plagued these regions could also be behind the presence of mitigation studies in the agricultural domain, where a mix of adaptation and mitigation outcomes are commonly addressed. Both East Asia and Latin America are well represented in the gap map, although a large share of the evidence is concentrated around two large economies (China and Brazil). As noted above, a very limited number of countries have produced a large share of the total compiled evidence, with China (3), Kenya (3) and India (3) already covering 40.7 per cent of the literature on a global scale.

The low representation of Europe & Central Asia and the Middle East & North Africa regions might be due to a number of reasons. A plausible hypothetical explanation is due to the fact that

middle income countries are predominant in these regions. Middle income countries have particular characteristics in key sectors for CCM that could make them less prone to private sector investments. For instance, in many of these countries the rate of expansion of sustainable and off-grid energy solutions have been significantly lower than in low-income countries.²⁷ The lesser weight of the agricultural sector in the gross domestic product (GDP) of middle income countries could be also a possible factor behind the lack of evidence. In this sense, research on sustainable agricultural options seems to have traditionally focused on regions where rural livelihoods are particularly vulnerable and imply an important share of the overall economy. In connection to activities related to carbon sinks and sequestration, it should be noted that the prevalence of these initiatives and interventions seems to be more concentrated around tropical regions than in arid, or semi-arid ones, as it is the case of Central Asia, the Middle East and North Africa.

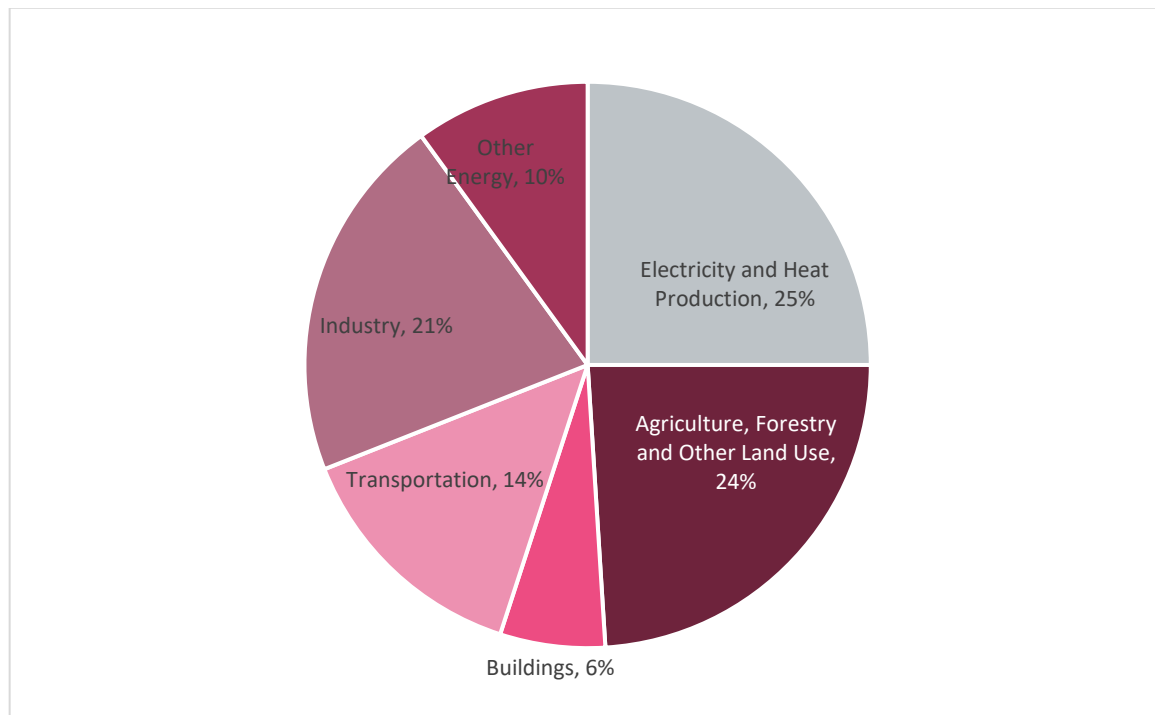
The Latin America region might be misrepresented in the EGM. This is unlikely to be a real gap and might have been partially affected by the search strategy applied during the process. In particular, it is reasonable to think that an important share of the relevant evidence in the field might have been published in Spanish-language journals that our search protocol was not able to capture. This is because all the search terms applied in the protocol were worded in English, for academic and grey literature. Although a priori, it was expected that this strategy would be able to capture publications in Spanish that included at least abstracts and keywords in English, the low output of relevant papers in the region may suggest that literature in Spanish would require a specific search protocol in that language. The representativeness of evidence from sub-Saharan Africa and the Maghreb could be also affected by the same issue, since the presence of French-speaking countries in the selected literature is very low (only nine articles for sub-Saharan Africa).

3. SECTORS, INTERVENTIONS AND OUTCOMES

The sectoral differences in terms of evidence reflect several issues. The first may be how much each sector provides ease of **identification**, that is, whether the sector is clearly a potential contributor to CCM. For example, the potential CCM contribution is a priori more significant in sectors such as energy, industry and transport, where much of the GHG emissions are generated (see Figure 9). This relative importance in sectoral GHG contributions seems to be reflected in the EGM. The high concentration of evidence around the energy sector seems to be consistent with the global distribution of GHG sources. It is similarly consistent with developing countries increasingly adopting alternative energy generation models based on renewable sources. In 2017 developing countries accounted for 63 per cent of global investment in renewable energy (Arndt et al., 2019). The agriculture and forestry sectors are also well represented in the EGM.

²⁷See data on electricity production from renewable sources, excluding hydroelectric (kWh), by the World Bank (<https://data.worldbank.org>)

Figure 9. Global emissions by economic sector



Source: IPCC (2014)

The greatest gaps in terms of sectors are found in connection to buildings and urban planning, where no evidence could be identified for our analytical framework, despite the fact that 6 per cent of global GHG emissions stem from this source. This might not be due to the lack of evidence but to the fact that sustainable building and urban planning is a sector yet to be further scaled in developing countries. Thus, the building construction sector in developing countries is still mainly engaged in conventional practices mostly associated with brick/block, mortar and concrete as major materials for buildings (Chukwu et al., 2019).²⁸ Sustainable practices in the construction sector aimed at energy saving, land saving, material conservation or pollution reduction are yet to be deployed in developing countries to a significant scale; therefore, the evidence from such interventions is expected to be low.

Table 12. Relative weight of the agriculture, forestry and fishing sectors in GDP, by country income level

COUNTRY INCOME CLASSIFICATION	AGRICULTURE, FORESTRY AND FISHING, VALUE ADDED (% OF GDP)
High income	1.3
Upper middle income	6.4
Middle income	8.4
Lower middle income	15.1
Low-income	25.1

Source: World Bank Open Data²⁹

²⁸ On the other hand, the GCF is supporting the Development Bank of Southern Africa with a Climate Finance Facility that is investing in, *inter alia*, low-emission materials and construction for low-cost housing.

²⁹ Available at <https://data.worldbank.org/>

The uneven distribution of outcomes across sectors cannot solely be attributed to research preferences, but also to the specific needs and challenges of each sector. For instance, outcomes related to carbon sequestration are expected to be more densely concentrated around interventions in the agricultural and forestry sectors, particularly through forest protection and sustainable agricultural practices. In this sense, the EGM seems to be distributed in line with expectations. However, some of the already identified gaps may respond to other possible causes. Thus, the absence of behavioural outcomes could be a consequence of purely methodological issues, as behavioural study designs are generally less frequent than other designs. On the other hand, the lack of evidence on employment co-impacts could be highlighted as a clear research gap. Given the potential of the green economy to generate jobs and the emphasis in the international agenda on this topic, further evidence would be desirable.³⁰

The distribution of the evidence in terms of interventions is highly concentrated within each sector. The emphasis in fossil fuel substitution within the energy sector, for instance, is consistent with much of what has been already said about the recent development of renewable options for the energy sector. In the case of energy efficiency, the second most populated intervention type in the EGM, two different cases are worth distinguishing. Interventions at the household level are generally less frequent, possibly due to the fact that the problem of energy access is perhaps still a priority over energy efficiency in the most vulnerable contexts. In the case of industries, however, energy efficiency interventions are more frequent than fossil fuel substitution. One reason for this is that fossil fuel substitution may be more suited for industrial companies whose production process includes their own energy generation activities or that are highly dependent on fuelled motors. On a separate note, the general absence of sequestration, capture and storage types of interventions is consistent with the early stage of development of such technologies. In particular, the high cost of carbon capture technology poses a challenge in developing countries towards the advancement in their implementation in developing countries (Wilberforce et al., 2018).

4. STUDY DESIGN TYPES IN THE EGM

The number of papers would have been reduced by 60 per cent if correlation studies (quantitative evidence without an experimental or quasi-experimental design) had been excluded. Experimental designs are not always common when studying social and environmental systems (Baldasari et al., 2017), which was one of the reasons for including this type of data. Only one experimental design is present in the EGM. Experimental settings that can be performed in real life scenarios under market conditions (as required by the inclusion criteria) are very difficult to design. In most randomized control trials, a service or good is freely distributed among participants. Given our private sector focus, such a research design would be precluded. The only exception is found in Ryan (2017) where the free provision of energy consulting services is tested in an experimental setting and assessed in terms of the consequent investments in energy efficiency measures, which are performed under market conditions.

Quasi-experimental designs have been used in 29 per cent of the evidence, in most cases in the form of matching methodological approaches. The energy sector concentrates the highest number of interventions/outcomes under these study designs, although causal evidence has been gathered for almost all the sectors where evidence exists (except for waste management). Quasi-experimental studies require in most cases a comparison between two groups that are differentiated by the

³⁰ Articles exclusively addressing co-impacts (with no CCM issues being directly addressed) are excluded from the scope of the EGM. Therefore, papers exclusively addressing employment benefits of CCM interventions might be present in the literature. Readers are actively encouraged to check the IEU evidence review on transformational change which highlights one cell on employment co-benefits and conducts a meta-analysis including a forest plot and fixed effects regression to ascertain the overall effect size from this critical mass of studies.

adoption of a certain intervention, and whose characteristics can be controlled and compared without systematic biases. This scenario seems particularly suitable for sustainable energy options in rural environments (off-grid solar systems, biodigesters, etc.), where adopters and non-adopters can be compared under quasi-experimental conditions.

Non-experimental designs provide non-causal evidence, mostly in the form of correlational studies, but also, in CCM in the form of life-cycle analysis. With regard to the latter, it should be noted that these are predominantly modelling and/or predictive approaches. However, under certain circumstances LCA can be considered as an ex-post form of evidence. Indeed, when the data that feeds the LCA model has a high explanatory power and has a clear empirical nature (e.g. from household surveys), then the evidence can be considered to meet our inclusion criteria. In the framework of the EGM, non-experimental designs take a variety of forms and approaches and are also evenly distributed across different sectors.³¹

G. LIMITATIONS

There are a few limitations to this study. One was the potential underrepresentation of studies in which English is not the primary academic language, and which might have been better captured using non-English search terms. Another limitation is the very broad range of classifications for interventions and outcomes, which allows for a wide overview and comparability between sectors but perhaps obscures some of the detail that could have been captured by a more specific sectoral mitigation gap map. This is particularly true for the sectors in which demand-side and supply-side interventions can be distinguished (which potentially includes a wide variety of interventions grouped together). As highlighted above, the EGM can reveal gaps and concentrations of evidence but cannot indicate the causes behind them.

As also highlighted above, it is important to reiterate that the EGM does not indicate whether the evidence shows that the interventions are successful or not (i.e. it does not show the direction or magnitude of impact). The EGM only considers quantitative evidence obtained mostly through correlational studies or in experimental settings. As mentioned earlier, some interventions are not entirely suitable for this kind of evaluation. Engineering projects, newly built or renewed infrastructure, as well as many governance related actions (e.g. passed laws or institutional capacity-building), for instance, are interventions where it can be extremely challenging to define a counterfactual or, in some cases, assign a single outcome variable for quantitative measurement.

H. RECOMMENDATIONS

The presented evidence relates to a limited number of interventions privately undertaken by a variety of agents and organizations. Policymakers and implementers can make use of the EGM by linking the findings with their portfolio and partner preferences to prioritize research needs, particularly in relation to the promotion of the private sector's participation in CCM. The gaps identified in the evidence base point to interventions and instruments that are lacking due to limited research and evaluation initiatives and the result of low investment levels in CCM and policy instruments in the context of developing countries. Given the aim of evidence-based policy making in development cooperation, greater evidence to fill the gaps mentioned above could improve the effectiveness and impact of private sector involvement in CCM.

The current evidence on CCM suggests that efforts should be directed towards improving the evidence base in private interventions across all economic sectors, with a particular focus on those

³¹ The quality of all the evidence within the EGM would need to be assessed if more in-depth analyses such as systematic reviews or meta-analyses were subsequently undertaken.

that show greater potential and suitability for ex-post evidence. This is the case for the agricultural sector, for which combined adaptation/mitigation outcomes could be regarded as an efficient way to optimize resources in the implementation of research initiatives. The energy sector has also proved to be a suitable domain for rigorous evaluations, particularly for community and household-level investment initiatives. For some other sectors, it is reasonable to conclude that prior to the promotion of further research, interventions and investments with the participation of the private sector need to be further supported. For example, sectors where no evidence could be gathered (such as building and urban planning). Finally, ex-post evidence should be supported in research areas traditionally governed by modelling and predictive approaches, such as the transport industry and large projects within the energy sector.

PART II. INTERVENTION HEAT MAP

A. INTRODUCTION

In PART I of this report, we have presented the EGM on CCM interventions in the private sector in developing countries. In PART II, we present IHM findings, which provides a systematic comparison of intervention portfolios undertaken by the GCF with the available evidence in the EGM. It can provide substantial insights for portfolio development and thus, should have a high priority. This allows readers, planners and decision makers to see whether the GCF portfolio is focused on areas with no or limited evidence or whether the portfolio has interventions predominantly in areas where ample evidence is available. IHMs help us take traditional EGMs further because we are able to understand the extent to which resources and evidence are aligned in an organization. We illustrated the overlap between the spread of evidence contained in the EGM and the allocation to interventions by the GCF and examined both the number of projects and the funds allocated to private sector mitigation interventions committed by the GCF. We provide these results in a series of heat maps.

B. METHODS

We examined the number of project/investment interventions (see Table 4 in PART I) and amount of commitments for private sector investments in mitigation by the GCF (until November 2020). The comparison of the project/investment portfolio undertaken by the GCF is based on data from a sample of 32 interventions from the Private Sector Facility that were classified either as CCM (23) or cross-cutting projects (9).³² We coded the available data for these project/investments – for those which yielded sufficient information – and mapped them with the intervention types and outcomes of the project, categorized into the EGM sectors/intervention types and outcomes. Most projects/investments were coded as multiple intervention types, yielding a total number of 98 project/investment interventions categorized according to our intervention types. Appendix 3 provides details on the data used and the methods for developing the intervention heat maps.

C. RESULTS

All 98 project/investment interventions were included in the IHM, and no exclusions were necessary due to ambiguous or insufficient descriptions about their activities. All of them were considered as relevant interventions to the applicable inclusion/exclusion criteria (Table 13).

Table 13. *Number of interventions coded, by theme (GCF)*

THEME	COUNT
Mitigation, private sector	23
Cross-cutting, private sector	9
Total	32

³² For simplicity, the IEU team used Private Sector Facility projects as a proxy for all private sector related investments in this paper. There are, however, other GCF-funded projects with private sector elements in the overall GCF portfolio. For example, the approach paper for the IEU's evaluation of the Green Climate Fund's approach to the private sector highlights how, in addition to Private Sector Facility projects, private sector engagement can also be seen to encompass: (a) the portfolio undertaken by private sector Accredited Entities; (b) engagement of the private sector through Readiness and Preparatory Support Programme grants; (c) use of non-grant instruments; (d) co-finance mobilized by GCF projects (see IEU, 2021).

Table 14 shows the distribution of funded interventions across different regions classified by the World Bank. Sub-Saharan Africa has received the largest number of initiatives together with global/multi-region initiatives, whereas in the opposite side of the ranking, Europe & Central Asia, the Middle East & North Africa and South Asia stand as the regions with the least number of intervention actions.

Table 14. *Number of projects and interventions by World Bank region*

WORLD BANK REGION	PROJECTS	INTERVENTIONS
East Asia & Pacific	6	14
Europe & Central Asia	1	3
Latin America & Caribbean	5	12
Middle East & North Africa	1	4
South Asia	1	2
Sub-Saharan Africa	11	30
Global/multi-region	7	33
Total	32	98

We assessed the activities of the GCF in terms of budgets and number of project/investment interventions. Table 15 shows the IHM for the total number of coded project/investment interventions funded by the GCF. There was a total of 98 project/investment intervention actions as some interventions in countries contained several intervention types (see Appendix 3). Consistent with the results of the EGM, the majority of project/investment interventions are found in the energy sector, with 64 project/investment interventions (65.3 per cent). However, the rest of the distribution by sector does not seem to be in line with the distribution of the evidence. Thus, the second sector with the greatest number of project/investment interventions is buildings (11.2 per cent) followed by forestry and land management (9.1 per cent), which show significantly lower percentages in the EGM. On the other hand, the third most populated sector in terms of evidence, namely industry, received only 4 per cent of the GCF interventions.

Disaggregated by intervention types (Figure 10), the most frequent categories are fossil fuel substitution (67 per cent) and energy efficiency (15 per cent), very much in line with the distribution of the evidence in the EGM. The rest of the distribution is also consistent with the EGM, with lower percentages for the rest of the remaining categories, but with a slightly more prominent role for forest protection and agroforestry and other sustainable practices.

Figure 10. *Distribution by intervention type in the Intervention Heat Map*

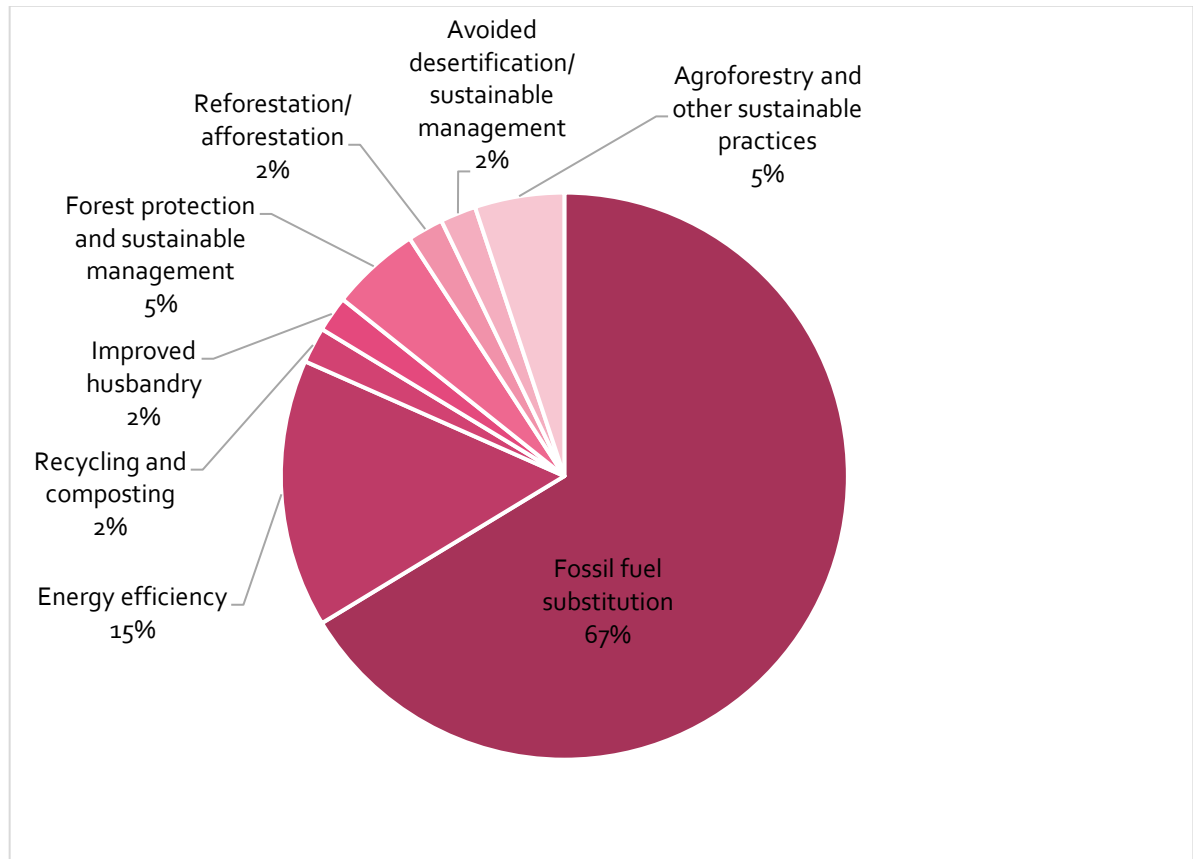
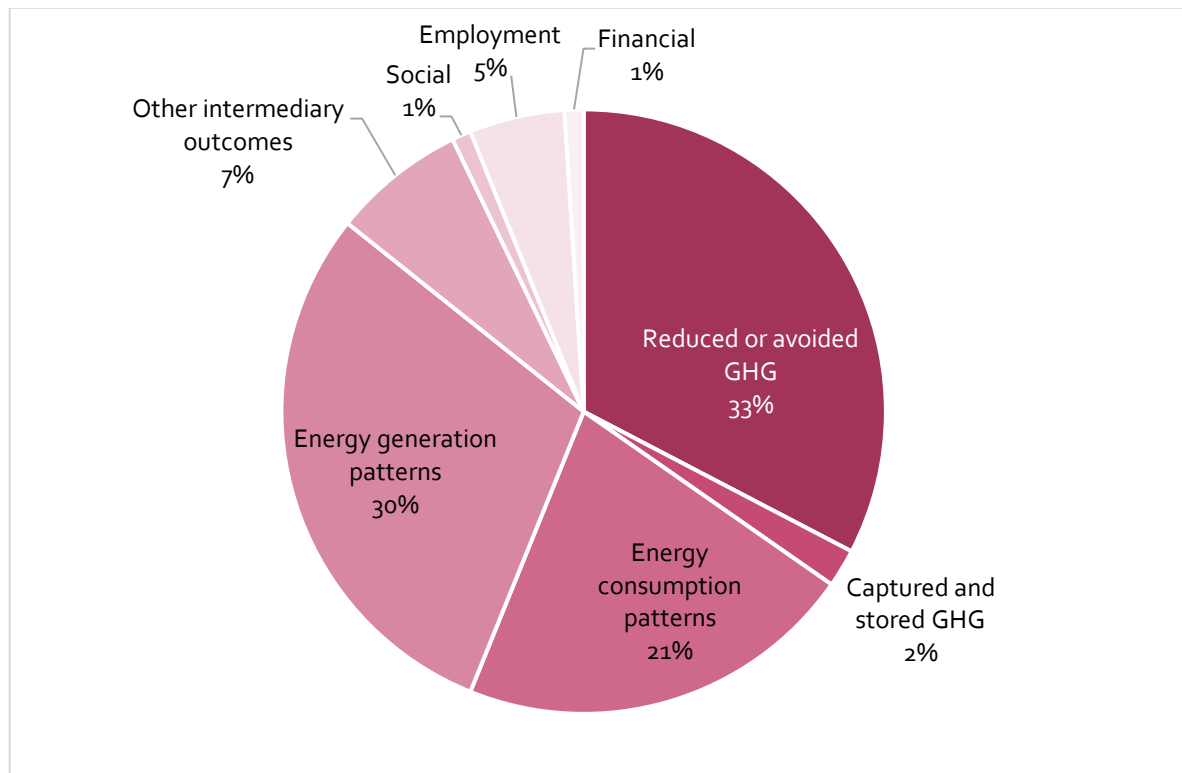


Table 15 shows a substantially different pattern in the distribution of projects by outcome groups, when compared to the distribution of the evidence. There is a significantly higher presence of intermediate outcomes, such as energy generation and consumption patterns, than of co-impacts. This is due to the fact that projects, at least in the terms in which their objectives are defined in the reviewed documentation, seem to focus on more immediate outcomes, measurable in terms of energy savings or efficiency, rather than setting specific goals on GHG reductions. Nevertheless, outcomes directly related to GHG reduction or avoidance are the most numerous within the GCF's portfolio, making up 33% of all project/investment interventions (see Figure 11). In contrast to the EGM, employment is a co-impact outcome for GCF projects, whereas environmental outcomes are not.

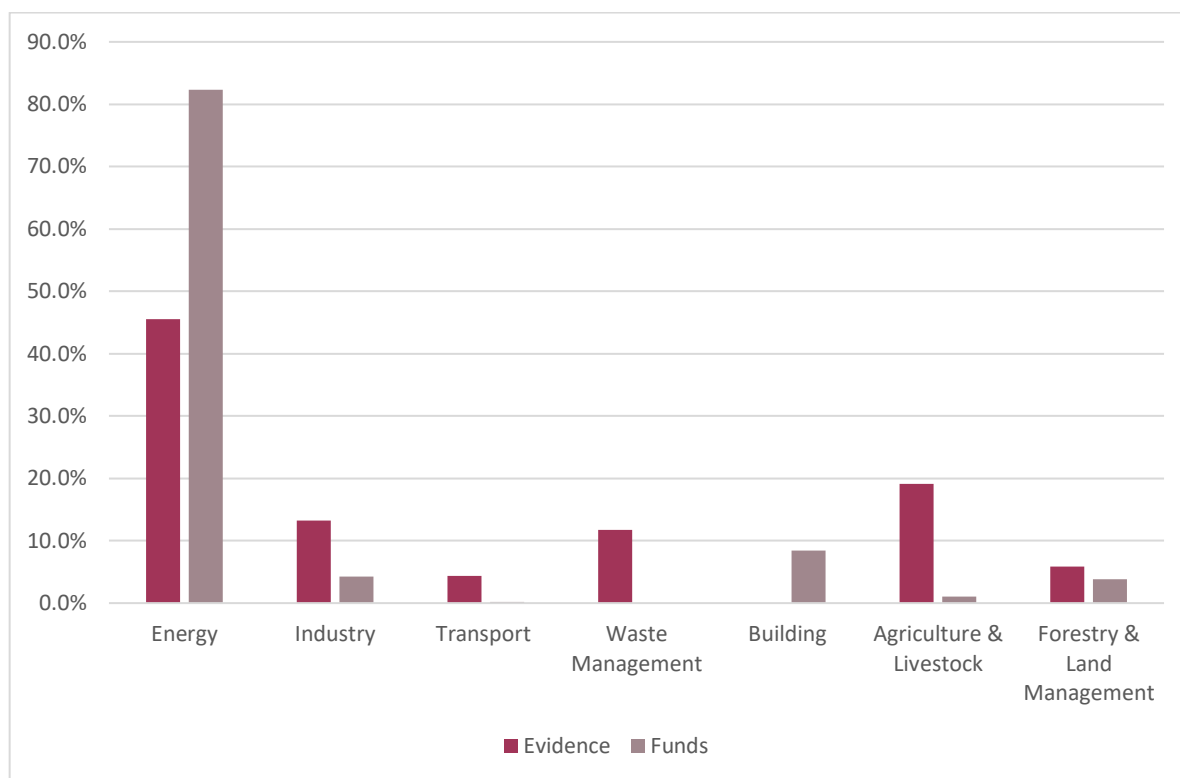
Figure 11. Distribution of outcomes in the Intervention Heat Map



Another aspect worth noting is the fact that outcomes related to sequestration, capture and storage of GHG are absent from the objectives of the projects. The EGM found that the evidence base in these fields is also very limited.

Table 16 shows the IHM for the budget committed to the project/investment interventions. This shows a very similar pattern to the number of project/investment interventions, with just a few exceptions worth noting. First, the agricultural and forestry sectors are less represented in terms of funds than in terms of the number of project/investment interventions. This implies that the average budgeting for this type of intervention is lower than in other sectors. Second, and as highlighted above, it can be observed that the funds are all allocated towards intermediate outcomes, with no funds allocated for GHG emissions and co-impact outcome groups. This makes sense because funds spent on reducing energy consumption (the first outcome in the ToC) would be the same as those spent on the subsequent GHG reductions. In order to avoid double counting, all funds were allocated to the most immediate outcome category, as defined in the corresponding project documentation.

Figure 12. *Distribution of funds and evidence for private mitigation in each sector of the EGM*



For the purpose of identifying possible gaps between research evidence and the actual allocation of funds in the mitigation field, Table 17 overlays the IHM with the EGM. As can be seen, there is some consistency with regard to the energy and forestry sectors: the former is the most represented sector, both in terms of evidence and funding (particularly the latter), whereas forestry and land management have a relatively low weight in both cases (see also Figure 13). For the remaining sectors, however, there are some considerable gaps. Thus, industry, agriculture and livestock, transport and waste management show a greater share of the evidence compared to the share of allocated funds. The opposite can be observed with the building sector. Nevertheless, these gaps should be interpreted with caution given the overall low number of articles identified in the EGM. In terms of intervention types, the majority of funds were spent on fossil fuel substitution and energy efficiency measures, in line with the distribution of evidence (Figure 13). However, in the case of fossil fuel substitution, the funding percentage is considerably higher than evidence percentage. With the exception of reforestation and afforestation, the remaining interventions show a smaller share of funding than the share of evidence.

Figure 13. *Percentage distribution of funds for private mitigation intervention types compared with the percentage distribution of research evidence*

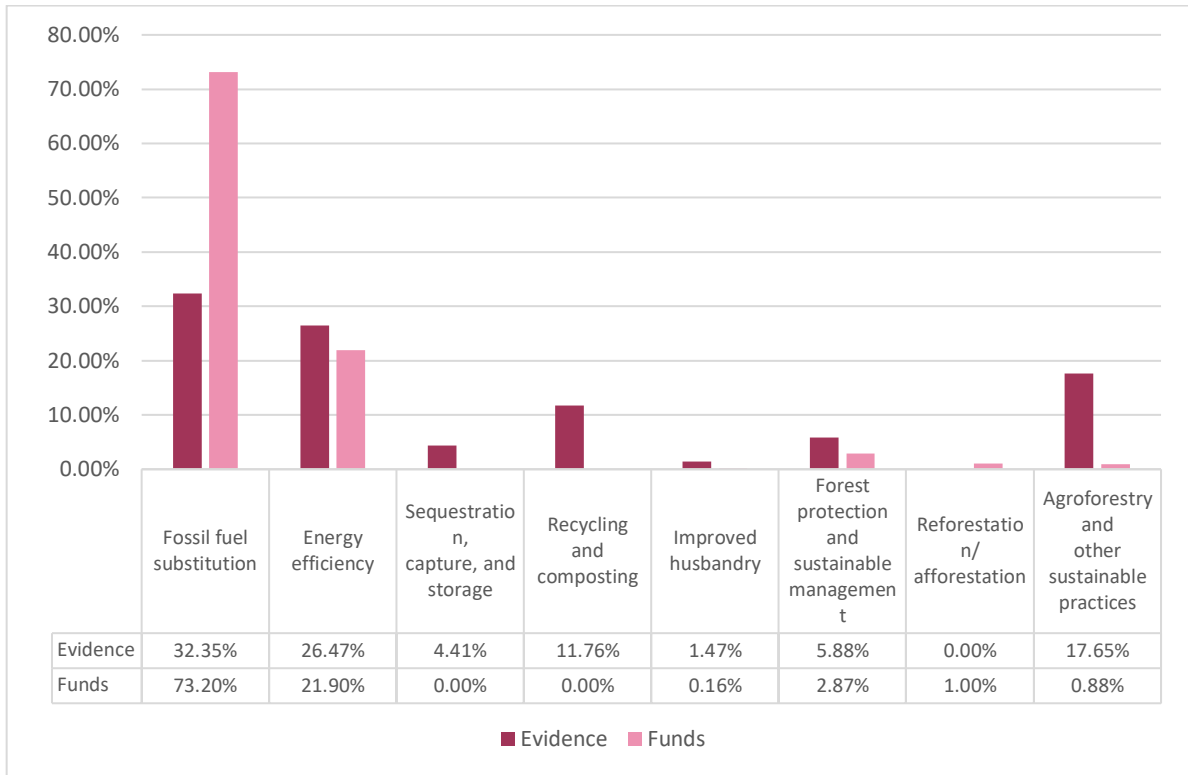


Table 15. Intervention Heat Map of the GCF, number of private mitigation projects

Sectors	Outcomes	Reduced/ avoided GHG	Captured and stored GHG	GHG Sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
	Illustrative outcome indicators	Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/ Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
	Interventions													
Energy	Fossil fuel substitution	25				6	26			1	2			
	Energy efficiency					2	2							
	Sequestration, capture, and storage													
Industry	Fossil fuel substitution					2								
	Energy efficiency					2								
	Sequestration, capture, and storage													
	Recycling and re-use of materials													
Transport	Fossil fuel substitution													
	Energy efficiency						1							
	Sequestration, capture, and storage													
Waste Management	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture, and storage													
	Recycling and composting	1							1					
Building	Fossil fuel substitution	1				2								
	Energy efficiency	2				6								
	Sequestration, capture, and storage													
Urban planning	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture, and storage													
Agriculture & Livestock	Fossil fuel substitution													
	Energy efficiency													
	Soil and fertilizer management	2							2					1
	Improved husbandry													
	Agroforestry and other sustainable practices	1				1								
Forestry & Land Management	Forest protection and sustainable management		1						3		1			
	Reforestation/afforestation								1		1			
	Avoided desertification/ sustainable management		1								1			

Table 16. Intervention Heat Map of the budget in USD

CCM		GHG Emissions				Intermediate outcomes				Co-impacts				
Sectors	Outcomes	Reduced/ avoided GHG	Captured and stored GHG	GHG Sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
	Illustrative outcome indicators	Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/ Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
	Interventions													
Energy	Fossil fuel substitution	GCF				256.480.000	1.515.103.229							
		Co-financing				84.020.000	5.796.290.135							
	Energy efficiency	GCF				232.527.000	63.803.000							
		Co-financing				683.319.000	94.962.000							
	Sequestration, capture, and storage	GCF												
		Co-financing												
Industry	Fossil fuel substitution	GCF				33.700.000								
		Co-financing				121.900.000								
	Energy efficiency	GCF				72.588.400								
		Co-financing				189.724.350								
	Sequestration, capture, and storage	GCF												
		Co-financing												
Recycling and re-use of materials	GCF													
	Co-financing													
Transport	Fossil fuel substitution	GCF												
		Co-financing												
	Energy efficiency	GCF						3.892.700						
		Co-financing						8.045.800						
	Sequestration, capture, and storage	GCF												
		Co-financing												
Waste Management	Fossil fuel substitution	GCF												
		Co-financing												
	Energy efficiency	GCF												
		Co-financing												
	Sequestration, capture, and storage	GCF												
		Co-financing												
Recycling and composting	GCF													
	Co-financing													
Building	Fossil fuel substitution	GCF				33.700.000								
		Co-financing				121.900.000								
	Energy efficiency	GCF					177.346.733							
		Co-financing					344.941.630							
	Sequestration, capture, and storage	GCF												
		Co-financing												

- Evidence Gap Map and Intervention Heat Map of Climate Change Mitigation Interventions in the Private Sector in Developing Countries -

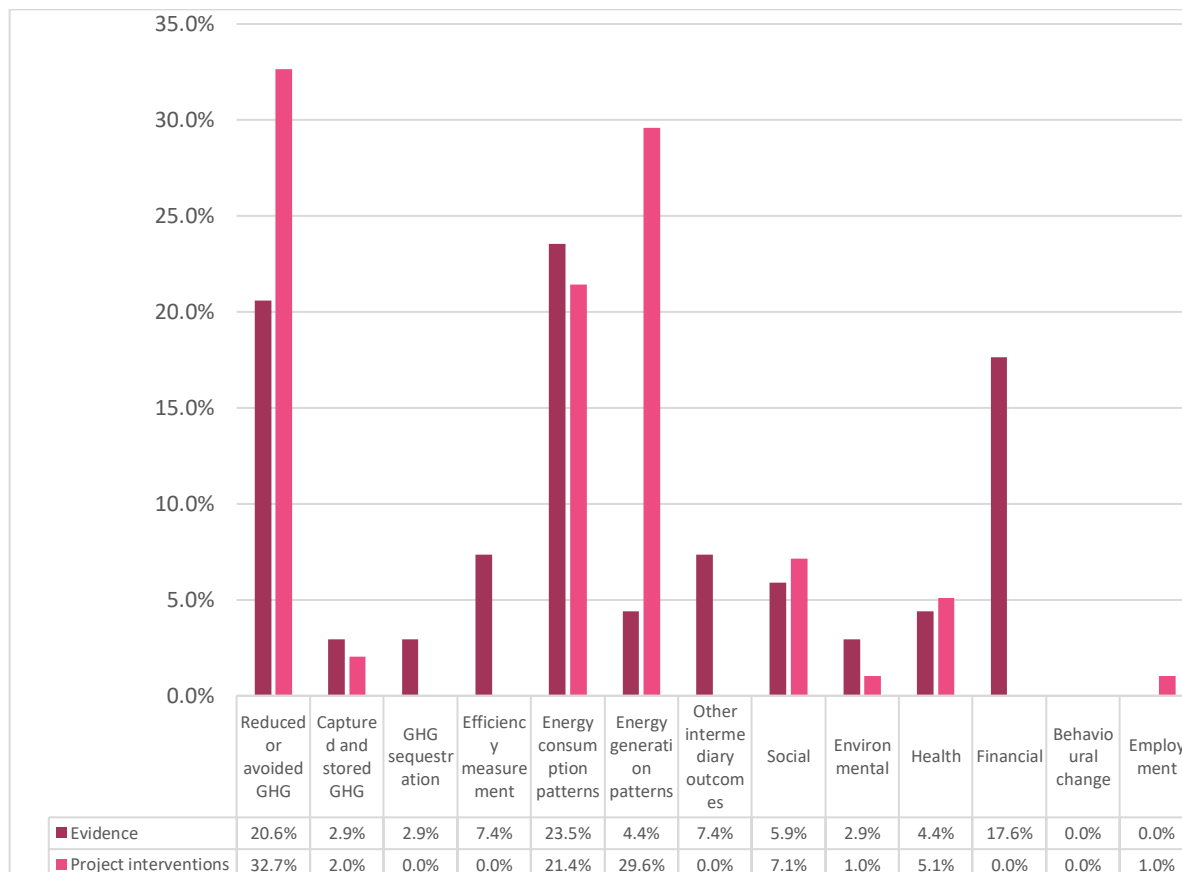
CCM		GHG Emissions				Intermediate outcomes				Co-impacts					
Sectors	Outcomes		Reduced/ avoided GHG	Captured and stored GHG	GHG Sequestration	Efficiency measurement	Energy consumption patterns	Energy generation patterns	Behavioural change	Other intermediary outcomes	Social	Employment	Environmental	Health	Financial
	Illustrative outcome indicators		Amount of GHG reduced or avoided	Amount of GHG captured	Amount of GHG sequestered	GHG/surface GHG/ investment	Household/ Industrial energy consumption reduction	Proportion of renewable energy generation	Use of bicycles, use of appliances, consumption patterns	Reforested surface, recycled waste	Educational outcomes, time savings	Job creation, working conditions	Air pollution, biodiversity, soil fertility	Respiratory diseases	Return on investment, household savings
	Interventions														
Urban planning	Fossil fuel substitution	GCF													
		Co-financing													
	Energy efficiency	GCF													
		Co-financing													
	Sequestration, capture, and storage	GCF													
		Co-financing													
Agriculture & Livestock	Fossil fuel substitution	GCF													
		Co-financing													
	Energy efficiency	GCF													
		Co-financing													
	Soil and fertilizer management	GCF								22.101.058					
		Co-financing								79.465.570					
	Improved husbandry	GCF													
		Co-financing													
	Agroforestry and other sustainable practices	GCF					4.000.000								
		Co-financing					1.120.000								
Forestry & Land Management	Forest protection and sustainable management	GCF								72.125.000					
		Co-financing								167.435.000					
	Reforestation/afforestation	GCF								25.000.000					
		Co-financing								175.000.000					
	Avoided desertification/ sustainable management	GCF													
		Co-financing													

Table 17. Intervention Heat Map overlaid with the Evidence Gap Map, the darker the cell colour the more evidence for that intervention type/outcome

Sectors	CCM		GHG Emissions						Intermediate outcomes						Co-impacts													
	Outcomes		Reduced/ avoided GHG		Captured and stored GHG		GHG Sequestration		Efficiency measurement		Energy consumption patterns		Energy generation patterns		Behavioural change		Other intermediary outcomes		Social		Employment		Environmental		Health		Financial	
	Illustrative outcome indicators		Amount of GHG reduced or avoided		Amount of GHG captured		Amount of GHG sequestered		GHG/surface GHG/ investment		Household/ Industrial energy consumption reduction		Proportion of renewable energy generation		Use of bicycles, use of appliances, consumption patterns		Reforested surface, recycled waste		Educational outcomes, time savings		Job creation, working conditions		Air pollution, biodiversity, soil fertility		Respiratory diseases		Return on investment, household savings	
	Interventions		Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds	Evidence	Funds
Energy	Fossil fuel substitution	3						1		6	256480000	1	1515103229			1		3						2		4		
	Energy efficiency	1						1		3	232527000	1	63803000					1					1		1			
	Sequestration, capture, and storage															1												
Industry	Fossil fuel substitution										33700000																	
	Energy efficiency	2						1		1	72588400	1														2		
	Sequestration, capture, and storage	2																										
Transport	Fossil fuel substitution	1																										
	Energy efficiency									2			3892700															
	Sequestration, capture, and storage																											
Waste Management	Fossil fuel substitution																											
	Energy efficiency																											
	Sequestration, capture, and storage																											
Building	Fossil fuel substitution																										1	
	Energy efficiency										33700000																	
	Sequestration, capture, and storage										177346733.3																	
Urban planning	Fossil fuel substitution																											
	Energy efficiency																											
	Sequestration, capture, and storage																											
Agriculture & Livestock	Fossil fuel substitution																											
	Energy efficiency																											
	Soil and fertilizer management																22101057.58											
Forestry & Land Management	Improved husbandry			1																								
	Agroforestry and other sustainable practices	2				2		2		1	4000000											1				4		
	Forest protection and sustainable management			1												2	72125000					1						
Forestry & Land Management	Reforestation/afforestation																25000000											
	Avoided desertification/ sustainable management																											

When analysing the results by outcome categories, we observe that projects aiming at energy generation and energy consumption patterns, both of them intermediate type of outcomes, accumulate most of the funding. However, as stated above, this should not be interpreted as a gap in the funding of other relevant outcomes, particularly in the GHG emission and co-impact groups. In this case, the analysis in terms of the number of GCF actions, as detailed above, provides a more accurate perspective of possible gaps (Figure 14).

Figure 14. *Percentage distribution of GCF interventions for mitigation outcomes compared with the evidence*



D. DISCUSSION AND IMPLICATIONS

The IHM offers a visual representation of how projects and funds for GCF CCM interventions by the private sector are distributed between different sectors, intervention types and outcomes defined in the EGM framework. Overlapping the results of both the IHM and EGM offers a visual representation of how well mitigation efforts are aligned with existing evidence. However, some specificities of the interventions and the evidence need to be taken into account to evaluate these results.

As the EGM only considers rigorous quantitative data, this may explain some observed imbalances between the flow of funds and the availability of research and evaluations. Thus, as stated in Part I, some interventions are not entirely suitable for the kind of impact assessments that were within the scope of the inclusion criteria of the EGM. Furthermore, private sector interventions have proved to be the subject of rigorous evaluations to a lesser extent than public policies and interventions, probably due to a longer tradition of accountability and scrutiny of publicly managed funds.

Generally, it may also be difficult to attribute funds to certain categories of outcomes that form part of the chain of effects in the ToC, particularly those related to GHG emissions and co-impacts. In

this sense, funds are mostly attributed to the most immediate outcomes, generally related to energy generation and consumption patterns, or the protection of green areas in the case of carbon sink initiatives. This explains the weight of financial flows in the intermediate outcome group category.

When considering the funds allocated to each cell in the EGM framework, it must be noted that the budget differs drastically between intervention types. For instance, new energy generation infrastructure construction will typically require more funding than a project providing extension services through a local farmers' association. Thus, it is to be expected that interventions with a predominant built infrastructure component have a higher share when the allocation of funds is considered. Therefore, an analysis between funds and evidence does not carry a linear relationship.

CONCLUSIONS AND OUTLOOK

The EGM on CCM interventions in the private sector takes stock of the high-quality evidence related to relevant interventions and outcomes in developing countries. It provides a valuable resource for policymakers and researchers by identifying gaps where further impact assessments need to be prioritised and by highlighting areas where there is sufficient evidence to enable evidence-based decision-making in the design and implementation of future mitigation investments. In-depth reviews of the sources used for the evidence base can be carried out to answer specific questions.

Specifically, the EGM on CCM interventions in the private sector:

- Provides a robust typology of eight sectors,³³ 11 intervention types³⁴ and three outcome groups³⁵ that serves as a conceptual tool for defining the objectives of further studies and for better locating interventions
- Provides an accessible overview of evidence from systematic reviews, IEs and rigorous quantitative studies
- Highlights available evidence and their characteristics, such as confidence ratings of systematic reviews
- Allows users to explore the evidence base and findings of relevant studies
- Reflects relevant intervention actions and outcomes associated with a particular area and are structured around a framework
- Populates areas with available studies and reviews, while highlighting “absolute gaps” related to IEs and systematic reviews

The EGM reports a relatively low level of evidence on mitigation interventions in the private sector. Results from the 32 included studies in the EGM indicate large variations in private CCM evidence by region, sector, intervention type and outcome. However, the distribution of the evidence seems to be consistent with the sectoral contributions of GHG emissions at the global level, with a leading role for the energy and industrial sectors. The most relevant gaps in the evidence are found with respect to the following areas:

- By sectors: Building and urban planning, possibly due to an early stage of development of private sector mitigation solutions in developing countries.
- By interventions: Reforestation/afforestation measures as well as interventions aimed at avoiding desertification. Soil and fertilizer management are also absent from the evidence gathered for the agricultural sector.
- By outcomes: No employment co-benefits have been addressed in the selected literature, whereas in the group of intermediary outcomes, the most important gap was found with respect to behavioural change type of studies.

In this sense, it is highly recommended that the ex-post evaluation culture is reinforced and promoted for mitigation interventions traditionally relying on predictive and modelling evidence.

³³ Sectors: energy, industry, transport, waste management, building, urban planning, agriculture & livestock, forestry & land management

³⁴ Intervention types: fossil fuel substitution, energy efficiency, sequestration, capture and storage, recycling and re-use of materials, recycling and composting, soil and fertiliser management, improved husbandry, forest protection and sustainable management, reforestation/afforestation, avoided desertification/ sustainable management, agroforestry and other sustainable practices

³⁵ Outcome groups: GHG emissions; Intermediate outcomes; co-impacts

This is also particularly relevant in the context of private investment interventions, where ex-post IEs and causal analysis seem to be less widespread.

Part II of the report described the IHM which:

- Is a systematic comparison of intervention portfolios with the available evidence
- Offers insights for portfolio development
- Enables readers, planners and decision makers to see whether the portfolio has interventions predominantly in sectors with intervention types where evidence is available
- Shows the extent to which resources and evidence are correlated in an organization

The IHM shows that the GCF portfolio of private investments in CCM is generally in line with the global distribution of GHG emissions. Nevertheless, there is an observed trend towards a greater relative importance of the energy sector (mostly concentrated around fossil fuel substitution).

Notable gaps are the following:

- Outcomes: project/investment interventions targeting sequestration, capture and storage of GHG, behavioural change, as well as environmental co-benefits
- Sectors: interventions in transport, waste management and agriculture and livestock
- Intervention types: interventions relating to sequestration, carbon and storage, improved husbandry and recycling & composting

Therefore, compared to the evidence from the EGM, it is observed that the energy sector seems to capture most of the private mitigation initiatives within the GCF portfolio. This leaves sectors such as transport, waste management, agriculture and livestock possibly under-represented in terms of approved funding, at least in terms of their share of the corresponding evidence.

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APPENDICES

Appendix 1. SEARCH

Publication database searches

- Web of Science (WoS)
- Scopus

The field codes “Topic (TS)” and “Abstract (ABS)” were used for WoS and Scopus respectively. A title exclusion (TI) was also included for biological terms rather than making exclusions based on journal or category, since we discovered that we missed potentially useful evidence from trialling.

Specialist searches

A selection of “grey” literature was identified by going directly to relevant organization websites, informed by the list of relevant sources determined by expert input. These included:

- 3ie impact evaluations: <https://www.3ieimpact.org/evidence-hub/impact-evaluation-repository>
- IDEAS-Repec: <https://ideas.repec.org/>
- EconLit: <https://www.aeaweb.org/econlit/>
- Environmental Evidence Library: <http://www.environmentalevidence.org/completed-reviews>
- CEEDER <https://environmentalevidence.shinyapps.io/CEEDER/>
- DFID research output: <https://www.gov.uk/dfid-research-outputs>
- SIDA <https://www.sida.se/English/publications/publicationsearch/>
- USAID Evaluations Clearinghouse: <http://dec.usaid.gov/>
- J-PAL <https://www.povertyactionlab.org/evaluations>
- World Economic Forum: <https://www.weforum.org/>
- OECD: <http://www.oecd.org/>
- UN Department of Economic and Social Affairs: <https://www.un.org/esa/ffd/index.html> (Financing for Development, FFD)
- UN Environment Programme (REDD+): <https://www.unenvironment.org/explore-topics/climate-change/what-we-do/mitigation>
- UN Framework Convention on Climate Change: <https://unfccc.int/>
- Green Finance Platform: <https://www.greenfinanceplatform.org/>
- Global Environment Facility: <https://www.thegef.org/topics/climate-change-mitigation> (also: <https://sgp.undp.org/areas-of-work-151/climate-change/climate-change-mitigation-176.html>)
- European Commission: https://ec.europa.eu/europeaid/policies/financing-development/eip_en
- European Environment Agency: <https://www.eea.europa.eu/>
- Development Finance Institutions:
 - Islamic Development Bank: <https://www.isdb.org/publications>
 - Eurasian Development Bank: <https://eabr.org/en/analytics/>
 - Council of Europe Development Bank: <https://coebank.org/en/>
 - Inter-American Development Bank: <https://www.iadb.org/en/topics-effectiveness-improving-lives/impact-evaluations-repository>
 - African Development Bank: <https://www.afdb.org/en/all-documents>
 - Asian Development Bank: <https://www.adb.org/publications>
 - World Bank- Open Knowledge Repository: <https://openknowledge.worldbank.org/>

- World Bank (DIME): <https://www.worldbank.org/en/research/dime>
- International Finance Corporation (IFC): <https://www.ifc.org/>
- European Bank for Reconstruction and Development: <https://www.ebrd.com/home>
- European Investment Bank: <https://www.eib.org/en/index.htm>
- U.S. International Development Finance Corporation: <https://www.dfc.gov/media/reports/archived>
- European Development Finance Institutions: <https://www.edfi.eu/>
- Individual pages of European Development Finance Institutions (EDFI) members:
 - Belgium: <http://www.bio-invest.be>
 - Belgium: <http://www.bmi-sbi.be>
 - UK: <http://www.cdcgroup.com>
 - Spain: <http://www.cofides.es>
 - Germany: see also in below list www.deginvest.de
 - Finland: <http://www.finnfund.fi>
 - Netherlands: <http://www.fmo.nl>
 - Denmark: <http://www.ifu.dk>
 - Norway: <http://www.norfund.no>
 - Austria: <http://www.oe-eb.at>
 - France: <http://www.proparco.fr>
 - Switzerland: <http://www.sifem.ch>
 - Italy: <http://www.simest.it>
 - Portugal: <http://www.sofid.pt>
 - Sweden: <http://www.swedfund.se>
- German websites for grey literature search:
 - Bundesministerium fuer wirtschaftliche Zusammenarbeit und Entwicklung (BMZ): <http://www.bmz.de/de/index.html>
 - Deutsches Institut fuer Entwicklungspolitik: <https://www.die-gdi.de/>
 - Kreditanstalt fuer Wiederaufbau (KfW): <https://www.kfw.de/>
 - KfW DEG: <https://www.deginvest.de/>
 - Deutsche Bank: <https://www.cib.db.com>
 - Hub for sustainable finance Germany: <https://www.h4sf.de/>
 - Oesterreichische Forschungsstiftung fuer Internationale Entwicklung: <https://www.oefse.at/>
 - Schweizer EDA Entwicklung und Zusammenarbeit: <https://www.eda.admin.ch/deza/de/home.html>
- Spanish websites for grey literature search:
 - AECID: <http://www.aecid.es/ES>
 - Asociación Latinoamericana de Instituciones Financieras para el Desarrollo: <http://www.alide.org.pe/publicaciones-2/publicaciones-alide/>
 - Banco Centroamericano de Integración Económica: <https://www.bcie.org/>

- Banco de Desarrollo de América Latina: <https://www.caf.com/>
- Banco Interamericano de Desarrollo: https://publications.iadb.org/en/?field=type_view&locale-attribute=es
- Caribbean Development Bank (English): <https://www.caribank.org/our-work/evaluation>
- CEPAL: <https://www.cepal.org/es/publications/list>
- COFIDES: <https://www.cofides.es/>
- Corporación Andina de Fomento: <https://www.caf.com/>
- Fondo Internacional de Desarrollo Agrícola: <https://www.ifad.org/es/web/knowledge/publications>
- French websites for grey literature search:
 - Fondation pour les études et recherche sur le développement internationale: <https://ferdi.fr/publications>
 - Agence Française de Développement: <https://www.afd.fr/fr/ressources-accueil>
 - Comité Français pour la solidarité internationale: <https://www.cfsi.asso.fr/ressources-et-presse>

Search strategy

Grey literature: Different search terms used depending on the characteristics and search of options of the corresponding database. List of specific search terms for each source are available upon request.

Web of Science and Scopus search:

1. Climate Change Mitigation

TS=("climate change mitigation" OR "mitigation of climat" OR "GHG emission*" OR "GHG abatement" OR "emission* reduc*" OR "reduc* emission*" OR "emission* abatement" OR "CO2 abatement" OR "CO2 emission*" OR "carbon emission*" OR "carbon abatement" OR "climate neutral" OR "carbon footprint" OR "greenhouse gas*" OR "energy saving*" OR "energy expenditure" OR "energy access")*

2. Interventions

AND TS=("fossil fuel" OR "energy efficienc*" OR "energy generation" OR "energy consumption" OR "electrificat*" OR "renewable energ*" OR "clean energy" OR "solar" OR "clean technolog*" OR "clean product*" OR "recycle*" OR "circular econom*" OR "sustainable material*" OR "appliance*" OR "sustainable construct*" OR "sustainable infrastructure" OR "clean development mechanism" OR "carbon sink*" OR "forest protection" OR "reforestation" OR "afforestation" OR "avoided desertification" OR "sequest*" OR "carbon offset*" OR "thermal energ*" OR "geothermal energ*" OR "wind energ*" OR "hydropower" OR "low emission transport" OR "sustainable transport" OR "liquefied natural gas" OR "energy conservation" OR "fuel conversion" OR "carbon-neutral" OR "biofuel*" OR "biogas*" OR "biodiesel" OR "bioethanol" OR "carbon capture" OR "CO2 capture" OR "building insulation" OR "forest conservat*" OR "reforest*" OR "compost*" OR "husbandr*" OR "soil manage*" OR "fertilizer manage*" OR "agroforestr*" OR "soil conserv*" OR "carbon intens*" OR "decarboniz*" OR "de-carboniz*" OR "carbon capture" OR "low-carbon" OR "lighting")*

3. Private sector

AND TS=("invest" OR "private" OR "compan*" OR "business*" OR "SME" OR "climate finance" OR "household*" OR "industr*" OR "purchas*" OR "loan*" OR "credit*" OR "bank*" OR "financial")*

4. Sector

AND TS=("transport" OR "energy*" OR "industr*" OR "agricultur*" OR "waste" OR "building*" OR "construct*" OR "urban" OR "forest*" OR "land use" OR "land manag*" OR "livestock" OR "farm")*

5. Method

AND TS= ("empirical evidence" OR empiric OR "impact evaluation" OR "systematic review" OR "statistical analysis" OR counterfactual OR experiment* OR "quasi-experiment*" OR "quasi experiment" OR "discontinu* design" OR "fixed effect*" OR regression OR "difference* in difference*" OR "double differenc*" OR "instrumental variable*" OR "propensity score" OR "matching" OR "propensity weight*" OR "time-series" OR "panel data" OR "double robust" OR "random* control*" OR randomization OR "random* trial*" OR "control group" OR "pipeline approach" OR "pipeline method" OR "pipeline comparison" OR "impact assessment" OR "econometric analys*" OR "cross-sectional data" OR "difference-in-difference" OR "random* control* trial*" OR "difference-in-difference*" OR "diff in diff" OR "diff-in-diff" OR "fixed effect*" OR "rapid evidence assessment*" OR "systematic literature review*" OR "systematic* review*" OR "control* treatment" OR "instrumental variable*" OR "heckman*" OR "counterfactual" OR "counter factual" OR "counter-factual" OR "control* evaluation" OR "randomized field" OR "household survey")*

6. Exclusion

NOT TI=(US OR USA OR "United states" OR "North America" OR Alabama OR Alaska OR Arizona OR Arkansas OR California OR Colorado OR Connecticut OR Delaware OR Florida OR Hawaii OR Idaho OR Illinois OR Indiana OR Iowa OR Kansas OR Kentucky OR Louisiana OR Maine OR Maryland OR Massachusetts OR Michigan OR Minnesota OR Mississippi OR Missouri OR Montana OR Nebraska OR Nevada OR "New Hampshire" OR "New Jersey" OR "New Mexico" OR "New York" OR "North Carolina" OR "North Dakota" OR Ohio OR Oklahoma OR Oregon OR Pennsylvania OR "Rhode Island" OR "South Carolina" OR "South Dakota" OR Tennessee OR Texas OR Utah OR Vermont OR Virginia OR Washington OR "West Virginia" OR Wisconsin OR Wyoming OR Canad* OR UK OR England OR Scotland OR Wales OR Ireland OR Irish OR Spain OR France OR Greece OR Ital* OR Portug* OR German* OR Switzerland OR Swiss OR "New Zeal*" OR Australia* OR Israel* OR Belgi* OR Netherland* OR "Dutch" OR Luxemb* OR Denmark OR Norway OR Sweden OR Finland OR Iceland* OR Poland OR Austria* OR Malta OR Hungar* OR Czech OR Slovak* OR Latvia OR Lithuania OR Estonia OR Russia* OR Romania* OR Bulgaria* OR Serbia OR Croatia OR Japan* OR Korea* OR "Hong Kong" OR Singapore OR "Saudi Arabia" OR Qatar OR Emirates) NOT TI=("Tax" OR "fiscal" OR "kuznets" OR "potential" OR "predict*" OR "mathematical" OR "modelling" OR "modeling" OR "simulat*" OR "politic*" OR "law" OR "growth" OR "FDI" OR "GDP" OR "population" OR "foreign direct investment")*

IDEAS/Re-PeEc search:

<p>Search options</p> <p>Whole record</p> <p>Papers</p> <p>From 2005 to 2020</p>

use + for AND, | for | and ~ for NOT

("climate change mitigation" | "mitigation of climate" | "GHG emissions" | "GHG abatement" | "emissions reduction" | "reduced emissions" | "emissions abatement" | "CO2 abatement" | "CO2 emissions" | "carbon emissions" | "carbon abatement" | "climate neutral" | "carbon footprint" | "greenhouse gases" | "energy savings" | "energy expenditure" | "energy access") + ("investment" | "private" | "company" | "business" | "SME" | "climate finance" | "households" | "industry" | "purchase" | "loan" | "credit" | "bank" | "financial") + ("transport" | "energy" | "industry" | "agriculture" | "waste" | "building" | "construction" | "urban" | "forestry" | "land use" | "land management" | "livestock" | "farm") + ("empirical evidence" | empirical | "impact evaluation" | "systematic review" | "statistical analysis" | counterfactual | experimental | "quasi-experimental" | "quasi experiment" | "discontinuity design" | "fixed effects" | regression | "difference in differences" | "double difference" | "instrumental variable" | "propensity score" | "matching" | "propensity weight" | "time-series" | "panel data" | "double robust" | "random control" | randomization | "random trial" | "control group" | "pipeline approach" | "pipeline method" | "pipeline comparison" | "impact assessment" | "econometric analysis" | "cross-sectional data" | "difference-in-difference" | "random control trial*" | "difference-in-differences" | "diff in diff" | "diff-in-diff" | "fixed effects" | "rapid evidence assessment" | "systematic literature review*" | "systematic* review*" | "control* treatment" | "instrumental variable*" | "heckman" | "counterfactual" | "counter factual" | "counter-factual" | "control evaluation" | "randomized field" | "household survey")*

Appendix 2. CODING

DATA FIELD	CODE
World Bank region	
East Asia & Pacific	1
Europe & Central Asia	2
Latin America & Caribbean	3
Middle East & North Africa	4
South Asia	5
Sub-Saharan Africa	6
North America	7
Global/multi-region	0
Population	
Households	1
Private enterprises	2
Factory/industrial plant/productive unit	3
Land plots/farms	4
Buildings	5
Districts/neighbourhood	6
Village/city/municipality	7
Regions	8
Countries	9
Study design	
Experimental	1
Quasi-experimental	2
Non-experimental	3
Systematic review	4
Causal/non-causal	
Causal	1
Non causal	2

DATA FIELD	CODE
Outcome group	
GHG emissions	1
Intermediary outcomes	2
Co-impacts	3
Outcome	
Reduced or avoided GHG	1
Captured and stored GHG	2

DATA FIELD	CODE
GHG sequestration	3
Efficiency measurement	4
Energy consumption patterns	5
Energy generation patterns	6
Behavioural change	7
Other intermediary outcomes	8
Social	9
Employment	10
Environmental	11
Health	12
Financial	13

DATA FIELD	CODE
Sector	
Water	1
Built environment/land-use	2
Forestry, agriculture, fishing	3
Health, economy, society	4
Intervention type	
Nature-based options	1
Built infrastructure/structural	2
Technological options	3
Informational/educational	4
Institutional/planning/policy/laws/regulations	5
Financial/market mechanisms	6
Social/behavioural	7

Appendix 3. DATA AND METHODS FOR INTERVENTION HEAT MAPS

A. DATA SOURCES

Our IHMs use the same framework as the EGM but plot the amount of resources/funds going towards different intervention types and outcomes. In this study, we examine the number of interventions and amount of funds committed on adaptation using data from the GCF.

As of November 2020 the GCF portfolio included 32 private mitigation projects, of which nine were cross-cutting while the remaining 23 projects were focused on mitigation.

There are three main sources for this work:

- An Excel database of the GCF's financial flows to relevant result areas, distributed among adaptation, mitigation and cross-cutting projects. Of these, we selected mitigation and cross-cutting projects that were labelled as "Private" (32 in total). In the cross-cutting projects, only the mitigation financial flows were considered.
- Website profile for each project, available at www.greenclimate.fund/project/.
- Financing proposal document. These were available at the GCF's website for 26 of the 32 projects. For the latest six projects, approved in November 2020, only a brief description was available on their websites.

B. DATA CODING

Each intervention from the database was analysed to identify the intervention actions and outcomes of the project, categorised into the EGM sectors/intervention types and outcomes (see Part I). In most cases, the brief description provided as a project summary served as the main sources of information to identify all relevant elements.

Attribution of interventions and sectors

Many projects focused on one intervention (i.e. "wind energy development"), and the connection between intervention and outcome was straightforward. When a single project had several interventions (i.e. "energy efficiency in buildings" and "rooftop solar panels"), the funds were allocated following the distribution described in the Excel database. Through these columns, the funds were distributed in four results areas:

- 1) Energy access and power generation
- 2) Low-emission transport
- 3) Building, cities and industries and appliances
- 4) Forestry and land-use

In some cases, interventions relative to this third area, "buildings, cities and industries and appliances" could be assigned to any three of our sectors: "Energy," "Buildings" or "Industry." In these cases, the funding proposal was examined to look for specific information on the contents of such interventions. When there was no clear hint about the actual content of the intervention that was being funded (for instance, whether investment was being financed in EE appliances or in EE buildings), the budget was distributed evenly among sectors.

Attribution of outcomes

For the 26 projects and programmes where the funding proposal was available, we followed a logic framework which makes a distinction between inputs, outputs and results of the projects. In this sense, the financing provided by the GCF and co-financing parties were considered "inputs." They produce "outputs," which are the project/programme direct material results (i.e. "MW of low-

emission energy capacity installed”). These outcomes contribute to the “outcome” of the project, that is, to its expected result (usually, “reduced GHG emissions”). When the documents described further results related to the mitigation intervention, they were coded as co-impacts in our framework, if they proposed an indicator to measure it (i.e. “number of people employed in the construction and operation of a power plant”). When the co-benefits were merely described or assumed (i.e. health benefits, economic development, etc.), they were not coded.

In our framework, outcomes are divided into three groups: “GHG emissions,” “intermediary outcomes” and “co-impacts.” We provide two IHM, one counting the interventions and their outcomes, and the other showing the allocation of the funds, both from the GCF and from the co-financers. Following the logic framework, all funds were allocated to “intermediary outcomes.” Most of the interventions of these projects and programmes finance the production or installation of assets (i.e. “energy efficient buildings,” “wind power plant,” etc.) with the objective of reducing, avoiding, storing or sequestering GHG, improving energy efficiency, etc. Therefore, the funds are immediately linked to the assets themselves (intermediary outcome), while the effects on GHG emissions and other areas (co-impacts) come afterwards.

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