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CLIMATE CHANGE MITIGATION INTERVENTIONS IN THE PRIVATE SECTOR IN DEVELOPING COUNTRIES

Approach paper for an evidence gap map

Climate change mitigation interventions in the private sector in developing countries

Approach paper for an evidence gap map

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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 (Private Sector Facility, Green Climate Fund); and Thomas Fuhr (Private Sector Facility, Green Climate Fund). Any errors or inconsistencies are entirely our responsibility.

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ABBREVIATIONS

CCA	Climate Change Adaptation
CH₄	Methane
CO₂	Carbon Dioxide
DRM	Disaster Risk Management
ROI	Return of Investment
EGM	Evidence Gap Map
GCF	Green Climate Fund
GHG	Greenhouse Gas
GtCO₂	Gigatonnes of Carbon Dioxide
HFC	Hydrofluorocarbons
IE	Impact Evaluation
IPCC	Intergovernmental Panel on Climate Change
LMIC	Low and Middle-Income Countries
N₂O	Nitrous Oxide
OECD	Organisation for Economic Co-Operation and Development
PICO	Population Intervention Comparator Outcome
PSF	Private Sector Facility
SME	Small- to Medium-Size Enterprises
PPP	Public-Private Partnerships
ToC	Theory of Change
UNFCCC	United Nations Framework Convention on Climate Change
WoS	Web of Science
WMO	World Meteorological Organization

A. 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, governments adopted the Paris Agreement in 2015 under the United Nations Framework Convention on Climate Change (UNFCCC). This landmark agreement urged 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).

This report underscores the need to increase global investment in mitigation interventions beyond national ambitions. An estimated USD 1.6-3.8 trillion investments yr⁻¹ 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). Increasing investment in climate change mitigation is paramount to bridge this gap. Climate finance needs in developing countries are particularly urgent, as is the need for private sector engagement. Developing countries will disproportionately carry the burden of climate change. Furthermore, GHG emissions are expected to inflate as these countries industrialize (International Finance Corporation [IFC], 2016). To limit these projected GHG emissions, 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 can make a significant contribution to this goal (IFC, 2011).

Private sector and CCM

Climate change will severely impact biodiversity and ecosystems, influencing businesses worldwide (IPCC, 2018). Indeed, disasters not only destroy critical infrastructure that is often owned by the private sector, they also disrupt employment and production. Ultimately, this impacts the economy worldwide, 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 CCM. At least USD 23 trillion of investment opportunities exist for climate smart investments in emerging markets, 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.

Climate change mitigation investment

Many institutional and corporate investors need a first-loss layer to move into new mitigation spaces. 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 (Puri et al., 2020), while capital instruments and risk management instruments help CCM projects (WWF, 2018). Governments, development banks or other private or public institutions can deploy these instruments.

The Green Climate Fund (GCF) is a climate finance organization set up by the UNFCCC. It finances CCM and climate change adaptation interventions in developing countries and small island developing states. The GCF can play a catalytic role in co-opting private sector investment. The GCF provides assurance and lowers the risk for investors by offering a mixture of grants or concessional loans, subordinated debt, junior equity holdings and guarantees. These instruments have the potential to crowd-in private sector investments and calm the nerves of institutional investors.

The private sector plays a vital role in the GCF, which created a Private Sector Facility (PSF) to leverage private sector engagement and mobilize forms of blended climate finance. The facility supports direct and indirect private sector activities at the national, regional and international levels and is advised by the Private Sector Advisor Group. Notably, the GCF has the strongest private sector focus of any multilateral climate fund. The GCF's PSF is readily involved in CCM projects, which comprise most of its portfolio (IEU, 2019). To support the private sector effectively in CCM, the GCF must know which private sector mitigation investments have been most effective and efficient, and which provide the best social and private rates of return.

In the wake of the COVID-19 pandemic, it has become even more crucial to unlock investments in 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 and France are at the forefront of these efforts. But, thus far, only a small proportion of the finance committed to an economic and social recovery has been climate smart. Increasing this proportion can help stimulate the economy and contribute to employment while contributing to the future resilience of the planet.

Evidence reviews

Research-based evidence is a prerequisite to equip governments and institutions with the necessary information to make informed decisions about policies, programmes and projects. As shown by Davies (2004), evidence can come in different forms:

- Impact evidence (showing the effectiveness of the intervention)
- Implementation evidence (showing the effectiveness of implementation and delivery)
- Descriptive analytical evidence (through measuring the nature, size and dynamics of the subject)
- Public attitudes and understanding (undertaken via methods such as opinion polls or focus groups)
- Statistical modelling (predictive evidence through linear and logarithmic regression methods)
- Economic evidence (cost-benefit/cost-effectiveness studies)
- Ethical evidence (social justice studies)

Informed decision-making rests on a structured review of a chosen evidence base (e.g. impact evidence). There are several types of evidence reviews, which include evidence gap maps (EGMs), systematic reviews and meta-analyses. EGMs collect, quality assure, and visually depict the evidence on a given topic and provide a foundation for more focused synthesis (Saran & White,

2018). Both systematic reviews and meta-analyses focus on evidence related to a specific intervention. Meta-analyses also provide a statistical analysis that combines the results of multiple scientific studies to assess the overall effect of an intervention. Meta-analyses thus can only be done when a critical mass of statistical studies exist within a broadly similar intervention/outcome area which can be aggregated (such that the increase in sample size improves the precision of estimates of effect sizes at the same time as narrowing confidence intervals).

This study is the first to assess the evidence base of CCM interventions undertaken by the private sector. Specifically, we will use an EGM to understand where high-quality evidence exists and where there is a dearth of evidence of private sector engagement with CCM. Importantly, this EGM will permit funders of private sector CCM interventions to make evidence-based decisions.

The main objective of this paper is to provide the scope and framework for an EGM on CCM interventions in the private sector. The EGM aims to address the following question:

What evidence exists with respect to the effectiveness and efficiency of CCM interventions in the private sector in developing countries?

For our purposes, *effectiveness* refers to reducing GHG in the atmosphere that is attributable to a particular intervention. *Efficiency* refers to the degree of GHG reductions that is attributable to a specific intervention relative to the resources utilized in its implementation (see section 0 below).

Specifically, this approach paper will answer the following questions:

- a) How can CCM in the private sector be defined and conceptualized?
- b) What are suitable sectors, interventions and outcomes for this EGM?
- c) What are the main elements for the systematic process for this EGM, including relevant search terms and languages to be used for the EGM?

The EGM will provide a springboard for subsequent investigation. Firstly, we will use the EGM to contrast the available evidence with current GCF funding flows. Secondly, we will conduct a meta-analysis using areas of the EGM in which evidence is concentrated. Lastly, the EGM can stimulate future research in areas that have scarce evidence.

Definitions and concepts

Climate change refers to the change in global and regional climate trends caused by an anthropogenic increase in GHG (Bindoff et al., 2013) compared to a baseline climate trend. Here, we use the reference period from 1961 to 1990 (IPCC, 2013; WMO, 2017). Concentrations of GHG (CO₂, NO, CH₄, HFCs) contribute to increasing global temperatures, changing precipitation patterns, sea level rise and an increasing frequency of climate-related hazards.

Numerous organizations have defined **CCM** in the context of climate change policy (Table 1). Across organizations, definitions commonly highlight key words such as “reduce”, “limit”, “enhance”, and “prevent”. 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 institutional capacity, 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 1. Common policy definitions of CCM

ORGANIZATION/ AUTHOR	DEFINITION OF CCM
IPCC ¹	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 ²	In the context of 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
United Nations Environment Programme ³	CCM refers to efforts to reduce or prevent emission of GHG. 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 the control of the government or any public agency. The private sector includes entities such as households and individuals, for-profit enterprises, sole traders, partnerships and corporations. Private sector entities are often exempt from many forms of state control. Additionally, mixed and co-participation formulas of public-private partnerships (PPP) can also deliver a service or business venture to society.

There are two common ways to measure the **effectiveness** of CCM strategies. Researchers can calculate the temperature increase that an intervention would prevent (McCarthy, 2012). Alternatively, they can calculate 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 is successful in producing behaviour patterns that have a direct translation in GHG reductions, even when these are not explicitly measured.⁴ 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 in relation to 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 (Organisation for Economic Co-operation and Development [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.). This approach paper consists of three further sections. Section B develops the EGM framework, which consists of interventions in rows and outcomes in columns. Section C describes the methods

¹ IPCC Working Group III <https://www.ipcc.ch/working-group/wg3/>

² Glossary of climate change acronyms and terms <https://unfccc.int/process-and-meetings/the-convention/glossary-of-climate-change-acronyms-and-terms>

³ <https://www.unenvironment.org/explore-topics/climate-change/what-we-do/mitigation>

⁴ See sections IIA and IIIB for further insight on the definition of relevant outcomes

used for the literature search as well as the inclusion/exclusion criteria. It also outlines the strategy for data extraction, presentation and analysis. Section D offers a discussion and conclusion.

B. DEVELOPING THE EGM FRAMEWORK

1. THEORY OF CHANGE

A theory of change (ToC) provides a vision and a road map for achieving goals. We developed our EGM framework using a ToC, as they can provide a more comprehensive picture relative to logic models (Bours et al., 2014). 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). Our evaluation question places our ToC intermediate to these aforementioned scenarios. An EGM requires that our narrative is comprehensive enough to include all possible sectors and relevant interventions while portraying only the relevant players and processes. We will limit the scope of our ToC in several respects. Firstly, we will constrain our definition of the private sector. Secondly, we will include only interventions that consist of physical assets owned or invested that reduce GHG emissions.

Our approach starts with the assumption of 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. CCM initiatives and interventions under this umbrella sit outside the scope of our research question, as they would be largely promoted by public sector agents and having a policy/regulatory nature (except for de-risking instruments provided by private financial intermediaries). Research activities that allow for continuous innovation in mitigation options and strategies from a technical and financial point of view will also be part of our conceptualization of the enabling environment and are excluded from these analyses.

The key player in our narrative is the **owner of a CCM asset** (e.g. technology, infrastructure, devices, vehicles, buildings, businesses, land, etc.). This defines the population element of our Population Intervention Comparator Outcome (PICO) protocol. While asset owners can have a public, corporate (including mixed PPP) or household nature, we focus solely on private actors (as described above). Private sector participation can also come in the form of **financial intermediation** services, which play a crucial role in the provision of resources (as well as 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 interventions. Analogous to asset owners, financial intermediaries can have a public, private or mixed nature. For the purpose of our EGM, financial intermediation will play a key role in determining the relevance of a study, when private financial institutions take part in the intervention assets being evaluated.

Next, we discuss the implementation of the **CCM interventions**. These can be summarized in four types of mitigation strategies: 1) the phase-out or substitution of fossil fuels; 2) energy efficiency; 3) sustainable management and; 4) carbon sequestration (see Section B for more information on interventions).

The last and perhaps most important link in the ToC are the expected **outcomes** directly attributable to the interventions. CCM interventions aim to reduce GHG emissions. Our EGM framework will

include outcomes capturing the direct measurement of GHG reductions, either through avoided emissions (e.g. substitution of fuel engines by electric motors), captured and stored GHGs (e.g. carbon geo-injection), or sequestered GHGs (e.g. forest carbon sinks). However, there are important challenges in conducting evaluations of CCM interventions using counterfactual approaches, since it is often difficult to establish an emissions scenario against which post-project emissions levels can be compared (McCarthy et al., 2012; Prowse et al., 2010). Despite methodological difficulties, rigorous quantitative evaluations in CCM addressing GHG reduction outcomes are now available (e.g. Spada et al., 2019).

In many cases **intermediate outcomes** are available that may indicate a possible impact on 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. These categories should be regarded as cross-cutting outcomes that may occur in most of the sectors covered by the EGM. In connection to energy savings and behavioural change, it is important to stress that the EGM will not be focusing on a purely demand side type of outcome. Rather, we will be addressing interventions implemented through physical or financial assets that are expected to yield future income or savings. Under this scope, campaigns aimed at lowering energy consumption or promoting more sustainable transport habits from the demand side sit outside of the scope of our analysis. Nevertheless, we will consider behavioural change outcomes when a direct causal link can be established between the implementation of a certain physical asset and behaviour change (e.g. does the construction of urban bicycle tracks decrease the use of private cars?). Regarding energy savings outcomes, we will focus on the causal link between the use, implementation or installation of a physical asset and lower energy consumption rates. These effects are the consequence of the energy efficiency characteristics of the asset or an induced behavioural change.

While all CCM interventions attempt to reduce emissions, a portion also produce economic, social or environmental impacts. We will include outcomes of this nature when they are jointly addressed with pure mitigation outcomes (e.g. emissions reductions or energy consumption/generation patterns) and under relevant methodologies.⁵ Our framework will include these in the form of **co-impacts** where we will consider five categories: social, environmental, health, employment and financial.⁶

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 (ROI)**, which is accrued by both asset owners and financial intermediaries. Financial gains from CCM intervention assets will vary depending on the financial structure and the particular actors involved, ranging 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. ROI, when specifically addressed as an outcome in the context of a relevant study (i.e. establishing an empirical causal link between the intervention and the financial gains) will be mapped as a financial co-benefit.

The relevant evidence that will be mapped will focus on empirical linkages between the interventions and outcomes of the ToC. Aspects related to the enabling environment – although important in understanding the overall narrative – will be outside the scope of the EGM.

⁵ See section on inclusion/exclusion criteria

⁶ See section on inclusion/exclusion criteria for a detailed definition of co-impact categories and some illustrative examples

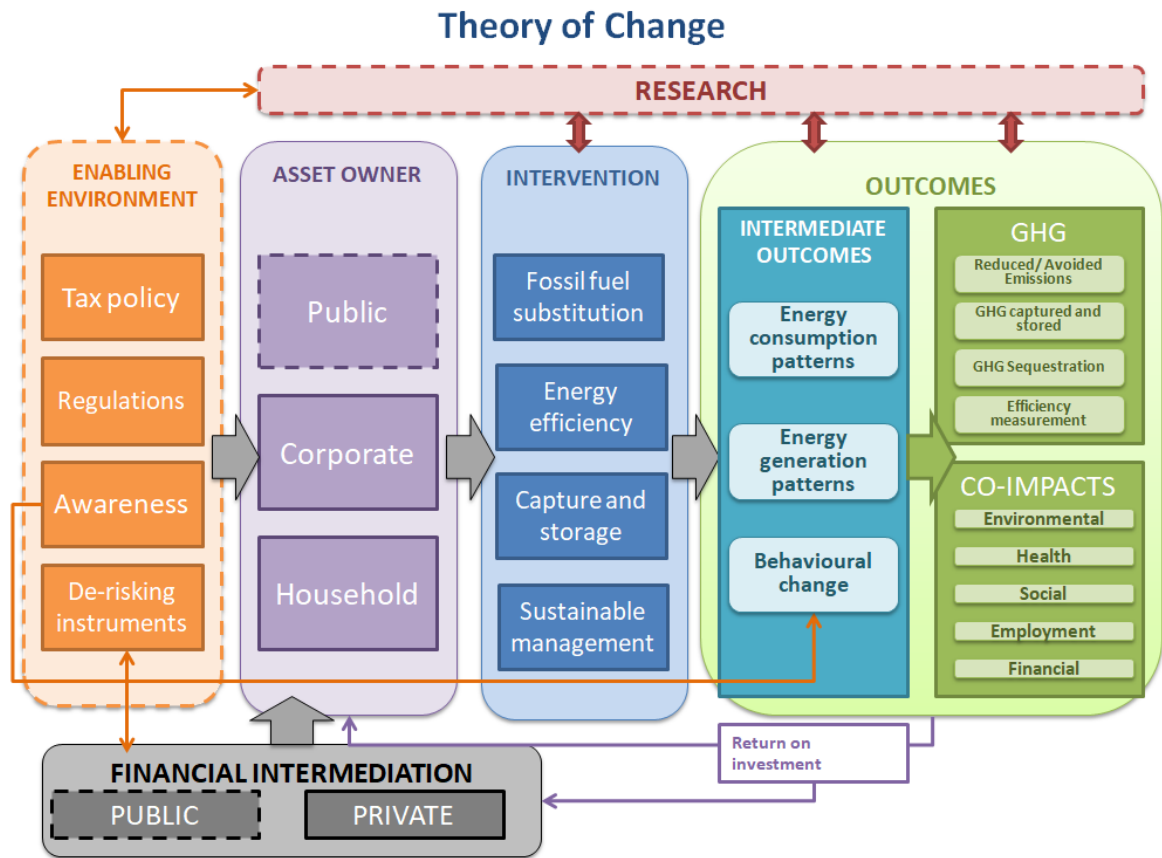


Figure 1. Theory of Change^{7,8}

2. MITIGATION SECTORS AND INTERVENTIONS

Sectors

Several sectors are directly associated with a potential for impact on GHG emissions (Table 2).

Table 2. Sectors that have potential for mitigating GHGs, by organization

ORGANIZATION	SECTOR
IPCC Fifth Assessment Report	Energy; transport; buildings; industry; waste; AFOLU (agriculture, forestry and other land use)
UNFCCC ⁹	Energy supply; transportation; buildings; industry; agriculture; forestry; waste
OECD	Energy (non-transport); energy (transport); agriculture; industrial processes; waste
GCF ¹⁰	Energy access and power generation; transport; buildings, cities, industries and appliances; land use and forestry

⁷ Discontinued lines represent elements outside the scope of the EGM

⁸ All outcomes in the Theory of Change represent the potential for CCM impacts and we qualify them as such

⁹ Heaps et al. (2008)

¹⁰ Green Climate Fund (2014)

In this EGM – which aims to investigate the evidence base regarding the ability of CCM interventions to impact GHGs from the atmosphere – we will group interventions into eight sectors:

- 1) Energy
- 2) Industry
- 3) Transport
- 4) Waste management
- 5) Building
- 6) Urban planning and cities
- 7) Agriculture and livestock
- 8) Forestry and land management

This classification attempts to capture all aspects reflected in the approaches used by leading climate organizations (Table 2). Contrary to other organizations, we disaggregate the AFOLU 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.

Interventions

There are different approaches to classifying mitigation interventions. One of these approaches consists of organizing interventions according to various anthropogenic sources of GHGs. These would reflect a broad set of human activities, most notably those associated with energy supply and consumption, and the use of land for food production and other purposes (IPCC, 2014). Intervention categories under these approaches are 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 Fifth Assessment Report (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 will cover 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. GHGs – 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* technologies¹¹. Within this category, we will also include carbon sequestration from improved soil management techniques and the creation, preservation and extension of forest carbon sinks.

¹¹ Capture and utilization 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)

The above three categories will be used in our EGM framework to classify interventions across all sectors, reflecting the main cross-cutting processes in CCM approaches. Additionally, we will also incorporate sector-specific mitigation interventions (Table 4). For example, we will 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 through soil and fertilizer management. In this respect, our framework will distinguish 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 come in the form of carbon sinks, has been depicted in the framework through more specific categories, following on the specific mitigation strategies described by the IPCC's Fifth Assessment Report (Working Group III, Chapter 11).

Table 3. 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 ¹²	Improved soil sequestration in agricultural fields through agroforestry; electrolysis; carbon capturing materials (asphalts, etc.); geochemical storage of CO ₂ ; enhanced oil recovery; chemical looping adsorption; membrane gas separation or gas hydrate technologies
Specific interventions in the waste sector	
Recycling and composting ¹³	Gas collection in landfills; material recovery; mechanical biological treatment; composting; anaerobic digestion
Specific interventions in 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 sector¹⁴	
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
Specific interventions in the forestry and land management sector	

¹² For further insight on capture and storage see for instance Cuellar et al. (2015)

¹³ For further insight on the role of waste management in CCM see European Commission (2001) and Albanna (2012)

¹⁴ For further insight on mitigation options in the agriculture and livestock sector see for instance Henderson et al. (2019) and Sejian et al. (2012)

INSTRUMENT TYPE	EXAMPLES OF RELATED MITIGATION ACTIVITIES
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 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 4. CCM outcomes and sub-elements

OUTCOMES	SUB-ELEMENTS
GHG emissions	Potential for reduced or avoided GHG
	Potential for captured and stored GHG
	Potential for GHG sequestration
	Efficiency measurement
Intermediate 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 5); therefore, the EGM is not expected to show a fully symmetrical distribution of the evidence across different outcomes. Specific outcome indicators are expected to widely vary 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 5. 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 several manufacturing plants	<ul style="list-style-type: none"> • Impact on GHG emissions per year
Transport	Construction of urban biking tracks in selected district across several cities through PPP	<ul style="list-style-type: none"> • Change in total kms of bicycle riding • Change 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 approach
Building	Renovation in private office buildings to enhance thermal insulation, efficient heating systems and renewable energy generation systems	<ul style="list-style-type: none"> • Impact on average building energy consumption rates (KWh/m²)
Urban planning & cities	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/ change in CO₂ • Avoided/ change in GHG emissions from vehicle circulation • Total green cover
Agriculture & Livestock	Investment in agroforestry practices in smallholding farms	<ul style="list-style-type: none"> • Yearly change in green cover and equivalent sequestered GHG
Forestry & Land Management	Credit support to promote private investments in green value chains and sustainable forestry activities in local forestry small to medium enterprise (SME) businesses	<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

An EGM provides a snapshot of the evidence base. Table 6 displays the EGM analytical framework, portraying all relevant sectors, interventions and outcomes.

Table 6. Evidence Gap Map Framework for CCM interventions in the private sector

CCM		GHG EMISSIONS				INTERMEDIATE OUTCOMES				CO-IMPACTS				
Sectors	Outcomes	Reduced or 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	Potential for reduced or avoided GHG	Potential for captured or stored GHG	Potential for GHG sequestration	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
	Illustrative outcome indicators													
Energy	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													
Industry	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													
	Recycling and re-use of materials													

TRANSPORT	FOSSIL FUEL SUBSTITUTION													
	Energy efficiency													
	Sequestration, capture and storage													
Waste Management	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													
	Recycling and composting													
Building	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													
Urban planning & Cities	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													
Agriculture & Livestock	Fossil fuel substitution													
	Energy efficiency													
	Sequestration, capture and storage													

Climate change mitigation interventions in the private sector in developing countries

	Soil and fertilizer management													
	Improved husbandry													
Forestry & Land Management	Forest protection and sustainable management													
	Reforestation/afforestation													
	Avoided desertification/sustainable management													

C. METHODS

1. SEARCH STRATEGY

We will limit our search to articles published after 2005. The Kyoto Protocol was adopted on 11 December 1997 to operationalize the UNFCCC by committing industrialized countries and economies in transition to limit GHG emissions in accordance with agreed individual targets. In 2005, the Kyoto Protocol came into force and established legally binding commitments for Annex I Parties to reduce GHG emissions. It also allowed non-Annex I to participate through the Clean Development Mechanism. The IPCC's Third Assessment Report (IPCC, 2007) addressed private sector's participation in CCM strategies shortly thereafter, in 2007.

We will restrict our search to articles found in the primary publication databases that are written in English, Spanish, German and French.

Search terms

Our search terms will provide broad but manageable coverage related to the EGM objective. We will use four sets of search terms with individual terms (and wild card symbols (*) where appropriate) separated by Boolean "OR" operators and sets combined using "AND". A fifth set will be used and combined with "AND NOT" (for exclusions). Appendix 1 contains an initial set of search terms, subject to refinement in subsequent search trials.

We will test the robustness of our search using a compilation of benchmark papers. These are papers that we know ought to be in the search results. A list of benchmark publications is presented separately in the References section.

Snowballing searches

The snowball method uses the bibliography of key document on the relevant subject to find other relevant titles. We will apply this technique for relevant systematic reviews identified through the above presented search terms. Two additional benchmarking publications that examine IE studies in the transport and energy sectors will be also examined under this methodology (Raitzer et al., 2019a and 2019b).

Publication database searches

We will utilize two peer-review databases, Web of Science (WoS) and Scopus. The field code 'Topic' and 'Abstract (ABS)' will be used for WoS and Scopus, respectively. We will combine the results from the Scopus search with the WoS search in Endnote, removing duplicates.

Specialist searches

A further limited selection of 'grey' literature will be identified by going directly to relevant organization's websites. It will not be possible to use the same search terms across peer-reviewed and grey literature databases. Rather, this search will be conducted manually using the expertise within the team according to the inclusion and exclusion criteria. To ensure replicability, a simple set of search terms will be used and recorded (see Appendix 2 for a list of grey literature sources), as well as the date of the search, and number of articles downloaded.

Estimating the comprehensiveness of the search

We estimate that the review will be comprehensive after combining both the peer-reviewed and grey literature. However, given that the search terms will only be in English, some studies without a title or abstract in English may be missed.

2. STUDY INCLUSION/EXCLUSION CRITERIA

We will combine search outputs from WoS, Scopus, and the grey literature (removing duplicates) and will undertake a stepwise inclusion/exclusion process (see below). We will apply a range of criteria to: a) the article title; b) the abstract, and; c) the full text of each article. Exclusion will be conservative during phase a) and b) if there is any doubt that the criteria for inclusion or exclusion are being met. We will test for reviewer bias at the start of the selection process of step b) with a Kappa analysis (CEE, 2013). Two extractors will review a common, random 10 per cent sample of abstracts. We will calculate the level of agreement between the number of articles rejected or accepted by the reviewers using the Kappa statistic. Values can range from +1 (perfect agreement) to -1 (strong disagreement). During step c), we will take reasonable efforts to secure the relevant articles, contacting authors if necessary. However, it may not be feasible within the time and budget constraints to secure all articles (a list of these will be made available when the results are published).

Inclusion criteria

We will include all papers that adhere to the **PICO** framework (Population, Intervention, Comparator, and Outcome), the study type, languages and publication dates.

Table 7. Main elements of the EGM on mitigation to climate change in the private sector

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 ¹⁵	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 exclusion and inclusion criteria for relevant and irrelevant subjects, interventions, comparators, outcomes and studies are described in Table 8.

¹⁵ In this evidence review we proxy the category of developing countries by using the low- to middle-income country (LMIC) classification as defined by the World Bank in 2020. In addition, the evidence review will provide a list of relevant studies in non-Annex I countries which not classified as LMIC in 2020.

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 entities (households, private enterprises, and companies) in developing countries, who:¹⁶</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 PPPs, or • Provide financial intermediation in the form of equity 	<ul style="list-style-type: none"> • SMEs 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 • High Income Countries
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 in value • 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 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.)

¹⁶ In this evidence review we proxy the category of developing countries by using LMIC classification as defined by the World Bank in 2020. In addition, the evidence review will provide a list of relevant studies in non-Annex I countries which not classified as LMIC in 2020.

INCLUSION CRITERIA	ILLUSTRATIVE EXAMPLES OF INCLUDED ITEMS	EXCLUSION CRITERIA
		<ul style="list-style-type: none"> Investments in nuclear energy generation projects
3. COMPARATOR		
<ul style="list-style-type: none"> Comparisons with a no-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 a 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"> Tonnes of yearly CO₂ emissions avoided through energy recovery equipment installed in manufacturing facilities Increase in the number of yearly kilometres 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"> Impact evaluation 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) 	<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

INCLUSION CRITERIA	ILLUSTRATIVE EXAMPLES OF INCLUDED ITEMS	EXCLUSION CRITERIA
<ul style="list-style-type: none"> Systematic reviews of quantitative evidence studies 		
6. LANGUAGE		
Language of article with English abstract: English, French, Spanish and German		<ul style="list-style-type: none"> Languages outside those in the inclusion criteria.
7. PUBLICATION DATE: 1 January 2005- 1 September 2020		

3. DATA EXTRACTION STRATEGY

Included studies will be given an identifier number and will be coded according to the relevant intervention and outcome categories included in the framework. Additionally, we will record:

- Full title of the paper
- Authors
- Year
- Publication type (journal name or acronym, or working paper series name)
- Mitigation sector
- Interventions
- Outcome indicators
- Abstract

4. DATA PRESENTATION AND ANALYSIS

The EGM framework will be filled with studies marked by their identifier. A report accompanying the EGM will include an annotated bibliography and an analysis of the data and main findings of the EGM. This report will also include recommendations for future studies.

D. DISCUSSION AND NEXT STEPS

This study will produce the first evidence review – in the form of an EGM – on private sector CCM interventions in developing countries. The EGM will graphically depict evidence on CCM interventions in the private sector in developing countries in terms of studied interventions and outcomes. However, EGMs present evidence neutrally and do not provide the reasons for the direction and effect size of interventions. For this, further meta-analyses or reviews of mapped articles will be necessary. To this end, we will examine the completed EGM for interventions and associated outcomes which contain sufficient evidence to warrant further investigation. The quality and comparability of data will dictate the feasibility of a subsequent meta-analysis or review. A meta-analysis requires comparable quantitative data where effect sizes can be compared. A review, whether systematic or not, allows for a broader analysis regardless of the data type.

To effectively allocate limited resources, the GCF must use evidence-based decision-making. This EGM will provide an overview of the current available evidence, against which we can compare the GCF's investment portfolio. To this end, we will overlay the completed EGM with a heat map of GCF funds disbursed towards CCM intervention projects (intervention heat map – IHM) and their relevant outcomes. This will provide an indication of the degree to which the portfolio is evidence-based (allowing for the caveat of certain CCM interventions not having IEs).

The EGM can also be used by other climate finance institutions to assess their investment portfolio on private sector CCM interventions in developing countries. The EGM will also inform the private sector and their investors on the evidence of the effectiveness and efficiency of CCM and enable evidence-based decision-making. Finally, it will identify research gaps within CCM and stimulate subsequent studies in this field.

REFERENCES

- Albanna, M. (2012). Solid Waste Management Options and their Impacts on Climate Change and Human Health. In: Malik A., Grohmann E. (eds) Environmental Protection Strategies for Sustainable Development. Strategies for Sustainability. Springer
- Bindoff, N.L., Stott, P.A., AchutaRao, K.M., Allen, M.R., Gillett, N., Gutzler, D., Hansingo, K., Hegerl, G., Hu, Y., Jain, S., Mokhov, I.I., Overland, J., Perlwitz, J., Sebbari, R., & Zhang, X. (2013). Detection and Attribution of Climate Change: from Global to Regional. In: Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V. and Midgley, P.M. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp. 867–952, doi:10.1017/CBO9781107415324.022
- Bours, D., McGinn, C., & Pringle, P. (2014). Guidance note 3: Theory of change approach to climate change adaptation programming. Guidance for M&E of climate change adaptation interventions. SEA Change and UKCIP. <https://www.ukcip.org.uk/wp-content/PDFs/MandE-Guidance-Note3.pdf>
- Carbon, M. (2017). An Analytical Framework for Evaluating a Diverse Climate Change Portfolio. In: Uitto J., Puri J., & van den Berg R. (eds) Evaluating Climate Change Action for Sustainable Development. Springer, Cham. https://doi.org/10.1007/978-3-319-43702-6_6
- Carney, M. (2015). Breaking the tragedy of the horizon – climate change and financial stability, speech given at Lloyd’s of London, 29 September
- CEE (Collaboration for Environmental Evidence). (2013). Guidelines for Systematic Review and Evidence Synthesis in Environmental Management. Version 4.2. Environmental Evidence: www.environmentalevidence.org/Documents/Guidelines/Guidelines4.2.pdf
- Conservation International. (2013). Constructing theories of change models for Ecosystem-based Adaptation projects: a guidance document. Conservation International. Arlington, VA
- Cuellar Franca, R., & Azapagic, A. (2015). Carbon capture, storage and utilisation of technologies: A critical analysis and comparison of their life cycle environmental impacts. Journal of CO₂ Utilization, 9, 82-102. <https://doi.org/10.1016/j.jcou.2014.12.001>
- Davies, P.T. (2004), ‘Is Evidence-Based Government Possible?’, Jerry Lee Lecture to the 4th Annual Campbell Collaboration Colloquium, Washington D.C., 19 February
- Doswald, N., Munroe, R., Roe, D., Guiliani, A., Castelli, I., Stephens, J., Moller, I, Spencer, T., Vira, B., & Reid, H. (2014). Effectiveness of ecosystem-based approaches for adaptation: review of the evidence-base. Climate and Development, 6, 185-201
- Egenhofer, C., Roth, S., & Stoefs, W. (2013). Carbon Leakage: An overview. CEPS Special Report No. 79/December 2013
- European Commission. (2001). Waste management options and climate change. Office for official publications of the European Communities Luxembourg ISBN 92-894-1733-1 http://ec.europa.eu/environment/waste/studies/pdf/climate_change.pdf
- Global Commission on the Economy and Climate (2016). The Sustainable Infrastructure Imperative: Financing for Better Growth and Development, access at http://newclimateeconomy.report/2016/wp-content/uploads/sites/4/2014/08/NCE_2016Report.pdf
- Green Climate Fund. (2014). Mitigation and adaptation performance measurement frameworks. Annex VIII to decision B.08/07, paragraph(a)
- Gupta S., J. Harnisch, D.C. Barua, L. Chingambo, P. Frankel, R.J. Garrido Vázquez, L. Gómez-Echeverri, E. Haites, Y. Huang, R. Kopp, B. Lefèvre, H. Machado-Filho, and E. Massetti, 2014: Cross-cutting Investment and Finance Issues. In: Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Edenhofer, O., R. Pichs-Madruga, Y. Sokona, E. Farahani, S. Kadner, K. Seyboth, A. Adler, I. Baum, S. Brunner, P. Eickemeier, B. Kriemann,

- J. Savolainen, S. Schlömer, C. von Stechow, T. Zwickel and J.C. Minx (eds.)). Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
- Heaps, C., & Kollmuss, A. (2008). UNFCCC Resource Guide for Preparing the National Communications of non-Annex I Parties. Module 4: Measures to Mitigate Climate Change. UNFCCC
- Henderson, B., Lankoski, J., & Giner, C. (2019). Enhancing Climate Change Mitigation through Agriculture. 10.1787/e9a79226-en. Herminia, A. F., et al (2011). Determinants Of Household Decisions On Adaptation To Extreme Climate Events in Southeast Asia, Economy and Environment Program for Southeast Asia (EEPSEA)
- Independent Evaluation Unit (IEU). (2019). Forward-Looking Performance Review of The Green Climate Fund (FPR). Evaluation Report No. 3 (2nd ed.), June 2019. Green Climate Fund, Songdo, South Korea
- IFC. (2011). Climate finance: Engaging the private sector. A background paper for “Mobilizing Climate Finance”, a report prepared at the request of G20 finance ministers. Washington, D.C. IFC
- IFC (2016) Climate investment opportunities in emerging markets. An IFC analysis. International Finance Corporation, Washington
- IPCC. (2013). Climate Change 2013: The Physical Science Basis. Contribution of Working Group I to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change [Stocker, T.F., Qin, D., Plattner, G.-K., Tignor, M., Allen, S.K., Boschung, J., Nauels, A., Xia, Y., Bex, V., & Midgley, P.M. (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 1535 pp
- IPCC. (2014). Climate Change 2014: Mitigation of Climate Change. Contribution of Working Group III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA
- IPCC. (2018). Summary for Policymakers. In: Global Warming of 1.5°C. An IPCC Special Report on the impacts of global warming of 1.5°C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty [Masson-Delmotte, V., Zhai, P., Pörtner, H.-O., Roberts, D., Skea, J., Shukla, P.R., Pirani A., Moufouma-Okia, W., Péan, C., Pidcock, R., Connors, S., Matthews, J.B.R., Chen, Y., Zhou, X., Gomis, M.I., Lonnoy, E., Maycock, T., Tignor, M., and Waterfield, T. (eds.)]. World Meteorological Organization, Geneva, Switzerland, 32 pp
- Jaworska, S. (2018). Change but no climate change: discourses of climate change in corporate social responsibility reporting in the oil industry. *International Journal of Business Communication*, 55 (2). pp. 194219
- Kameyama, Y., & Kawamoto, A. (2016). Four intermediate goals: a methodology for evaluation of climate mitigation policy packages, *Climate Policy*
- McCarthy N., Winters P., Linares A.M., & Essam T. (2012) Indicators to Assess the Effectiveness of Climate Change Projects. Inter-American Development Bank. Impact-Evaluation Guidelines: Technical. Notes, No. IDB-TN-398:1-37
- McCartney, M. (2009). Living with dams: managing the environmental impacts. *Water Policy* 11 Supplement 1 (2009) 121–139
- OECD. (2010). Glossary of Key Terms in Evaluation and Results Based Management. Available at <http://www.oecd.org/dac/evaluation/2754804.pdf>
- OECD. (2015). Climate Change Mitigation: Policies and Progress, OECD Publishing, Paris, <https://doi.org/10.1787/9789264238787-en>
- OECD. (2018). Private sector engagement to address climate change and promote green growth. Retrieved from <https://www.oecd.org/dac/peer-reviews/Policy-Brief-4-Private-Sector-Engagement-to-Address-Climate-Change-and-Promote-Green-Growth.pdf>
- Oliveira, W., Silva, J.S.L., Porto, R.G., Cruz-Neto, O., Tabarelli, M., Viana, B.F., Peres, C.A., Lopes, A.V. 62 signatories (2020) Plant and Pollination Blindness: Risky Business for Human

Food Security, *BioScience*, Volume 70, Issue 2, Pages 109–110,
<https://doi.org/10.1093/biosci/biz139>

- Prowse, M., & Snielsveit, B. (2010). Impact evaluation and interventions to address climate change: a scoping study. *Journal of Development Effectiveness*, 2(2), 228-262.
<https://doi.org/10.1080/19439341003786729>
- Puri, J., Khan, A., & Asfaw, S. (2020). Climate and Money: Dealing with Impact Washing and a case for climate impact bonds in *The Global Handbook of Impact Investing: Solving Global Problems Via Smarter Capital Markets Towards A More Sustainable Society*, Elsa de Morais Sarmiento and Paul Herman (eds). Wiley.
- Richards, M., Arsalan, A., Cavatassi R., & Rosenstock, T. (2019). Climate Change Mitigation Potential of Agricultural Practices Supported by IFAD Investments An Ex Ante Analysis. IFAD Research Series 35. Available at SSRN: <https://ssrn.com/abstract=3349032>
- Saran, A. & White, H. (2018) Evidence and gap maps: a comparison of different approaches. *Campbell Systematic Reviews*, 14, 1-38
- Sejian, V., & Naqvi, S. (2012). Livestock and Climate Change: Mitigation Strategies to Reduce Methane Production. 10.5772/32014
- Snilstveit, B., Vojtkova, M.A., & Gaarder, M. (2013). Evidence Gap Maps: a tool for promoting evidence-informed policy and prioritizing future research. Policy Research Working Paper 6725, Independent Evaluation Group, The World Bank
- Spada, A., Fiore, M., Monarca, U., & Faccilongo, N. (2019). R&D Expenditure for New Technology in Livestock Farming: Impact on GHG Reduction in Developing Countries. *Sustainability* 2019, 11, 7129
- UNFCCC. (2015). Paris Agreement
- UN Global Compact, UNCTAD, UNEPFI, & PRI (2015). Private sector investment and sustainable development: the role of institutional investors, banks and foundations in sustainable development. UN Global Compact, UNCTAD, UNEPFI, PRI
- Van den Berg, R.D. (2017). Mainstreaming Impact Evidence in Climate Change and Sustainable Development. In: Uitto J., Puri J., van den Berg R. (eds) *Evaluating Climate Change Action for Sustainable Development*. Springer, Cham. https://doi.org/10.1007/978-3-319-43702-6_3
- Vogt, R., Derreza-Greeven C., Giegrich, J., Dehoust, G., Möck, A., & Merz, C. (2015). The climate change mitigation potential of the waste sector. Report by order from the Federal Environment Agency of Germany
- Woerlen, C. (2011). Meta-Evaluation of Climate Mitigation Evaluations;. Available online: <https://www.climate-eval.org/sites/default/files/studies/Meta-Evaluation%20-%20Poland%20Case%20Study.pdf>
- WWF (2018) Financial instruments used by governments for climate change mitigation. WWF policy brief
https://dtmac4dfluyw8.cloudfront.net/downloads/wwf_2018_financial_instruments_used_by_governments_for_climate_change_mitigation.pdf
- Yu, C., & Hein, W. N. (2006). The thermal benefits of parks. *Energy and Buildings*, 38, 105–120
- Zhang, D.D., Lee, H.F., Lang, C., Li, B., Pei, Q., Zhang, J., & An, Y. (2011). The causality analysis of climate change and large-scale human crisis. *PNAS Early Edition*, 1-6
<https://doi.org/10.1073/pnas.1104268108>

Benchmark publications

- Aklin, M., Bayer, P., Harish, S.P., & Urpelainen, J. (2017). Does Basic Energy Access Generate Socioeconomic Benefits? A Field Experiment with Off-Grid Solar Power in India. *Science Advances*. 3 (5). E1602153
- Akram, R., Chen, F., Khalid, F., Ye, Z., & Majeed, M. T. (2020). Heterogeneous effects of energy efficiency and renewable energy on carbon emissions: Evidence from developing countries. *Journal of Cleaner Production* 247: 119122

- Chen, A. Z., Fischer J., Fraker A., Buddy N. S., Shirrell, S., & Stein, D.(2017). Welfare Impacts of an Entry-Level Solar Home System in Uganda.” *Journal of Development Effectiveness* 9 (2): 277–94. <https://doi.org/10.1080/19439342.2017.1307248>
- Chun, N., & Jiang, Y. (2013). How Households in Pakistan Take On Energy Efficient Lighting Technology. *Energy Economics*. 40. pp. 277–284
- Raitzer, D.A., Blöndal, N., & Sibal, J. (2019a). Impact evaluation of transport interventions: A review of the evidence. Manila: Asian Development Bank
- Raitzer, D. A., Blöndal, N., & Sibal, J. (2019b). Impact evaluation of energy interventions: A review of the evidence. Manila: Asian Development Bank
- Tierney K.J. (2007) Businesses and Disasters: Vulnerability, Impacts, and Recovery. In: *Handbook of Disaster Research. Handbooks of Sociology and Social Research*. Springer, New York, NY. https://doi.org/10.1007/978-0-387-32353-4_16
- Wang, L., Bandyopadhyay, S., Cosgrove-Davies, M., & Samad, H. (2011). Quantifying Carbon and Distributional Benefits of Solar Home System Programs in Bangladesh. *World Bank Policy Research Working Paper*. 5545

Appendix 1. SEARCH STRATEGY

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")

Appendix 2. SOURCES OF GREY LITERATURE

Websites for grey literature search

- 3ie impact evaluations: <https://www.3ieimpact.org/evidence-hub/impact-evaluation-repository>
- IDEAS-Repec: <https://ideas.repec.org/>
- Environmental Evidence Library: <http://www.environmentalevidence.org/completed-reviews>
- 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 Europa 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: <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>
 - European Development Finance Institutions: <https://www.edfi.eu/>
- Individual pages of European Development Finance Institutions' members:
 - UK: <http://www.cdccgroup.com>
 - 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>
- 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: <https://www.kfw.de/>
- Deutsche Bank: <https://www.cib.db.com>
- 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

- Asociación Latinoamericana de Instituciones Financieras para el Desarrollo:
<http://www.alide.org.pe/publicaciones-2/publicaciones-alide/>
- 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>
- 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>

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