IEc

Evaluation of the Development Impacts from CIF's Investments

Final Report

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Prepared for:

Climate Investment Funds

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Acronyms and Abbreviations

ABC	Sector Plan for the Mitigation and Adaptation of Climate Change for a Low Carbon Emissions Agriculture in Brazil
ACT	Accelerating Coal Transition
AEPC	Nepal's Energy Promotion Center
AIP	Annual Investment Plan
BC	Black Carbon
BenMap	Environmental Benefits Mapping and Analysis Program
BWD	Bangladesh Water Department
CAPCR	Community Action Project for Climate Resilience in Nigeria
CEIP	Coastal Embankment Improvement Project in Bangladesh
CGE Modeling	Computable General Equilibrium Modeling
CIF	Climate Investment Fund
CNG	Compressed Natural Gas
CO_2	Carbon Dioxide
CO_2e	Carbon Dioxide Equivalent
CONAB	Companhia Nacional de Abastecimento
CTF	Clean Technology Fund
DGM	Dedicated Grant Management Project in Brazil
DI	Developmental Impact
DISCOM	Electricity Distribution Company
EPA	United States Environmental Protection Agency
EPC	Engineering, Permitting, and Construction
EPPA	Environmental Prediction and Policy Analysis Model
FAO	United Nations Food and Agriculture Program
FIP	Forest Investment Program
FMU	Forestry Management Units
FTE	Full Time Equivalent
GCAM	Global Economic Modeling Platform
GCEIP	Geothermal Clean Energy Investment Project in Indonesia
GDP	Gross Domestic Product
GEUDP	Geothermal Energy Upstream Development Project in Indonesia
GHG	Greenhouse Gas
GPGP	Geothermal Power Generation Program in Indonesia
GREM	Geothermal Resource Risk Mitigation Project in Indonesia
GRPV	Grid-Connected, Rooftop Photovoltaic Solar
GTAP	Global Trade Analysis Project
GWh	Gigawatt Hours
IBRD	World Bank International Bank for Reconstruction and Development
ILM	Integrated Land Management Project in Brazil
INOCAS	Innovative Oil and Carbon Solutions
InVEST	Integrated Valuation of Ecosystem Services and Tradeoffs
I-O Model	Input-Output Model
JIM	Joint Impact Model
KEMP	Kenya Electricity Modernization Project
Kg/Hectare	Kilogram per Hectare
LEAP-IBC	Long-Range Energy Alternatives Planning – Integrated Benefits Calculator

LDP	Local Development Plan
LPG	Liquefied Petroleum Gas
MASEN	Moroccan Agency for Sustainable Energy
MDB	Multilateral Development Banks
MIT	Massachusetts Institute of Technology
MoEP	Kenyan Ministry of Energy and Petroleum
MSME	Micro, Small, and Medium Enterprises
MT	Megaton
MW	Megawatts
NDA	Nondisclosure Agreement
NGO	Non-Governmental Organization
NOx	Nitrogen Oxides
NPC	Nature, People, and Climate
O&M	Operations and Maintenance
OC	Organic Carbon
ONEE	Moroccan National Office of Electricity and Potable Water
PDO	Project Development Outcome
PGE	Pertamina Geothermal Energy
PLN	Indonesia State-Utility Perusahaan Listrik Negara
$PM_{2.5}$	Particulate Matter 2.5
PPCR	Pilot Program for Climate Resilience
PPA	Power Purchase Agreement
PPP	Public-Private Partnership
PV	Photovoltaic
RE	Renewable Energy
REI	Renewable Energy Integration
RES	Renewable Energy Systems
RESCO	Renewable Energy Service Company
RMG	Ready-Made Garments
SDG	Sustainable Development Goals
SEDICI	Social and Economic Development Impacts of Climate Investments
SEI	Stockholm Environment Institute
SFM	Sustainable Forestry Management
SLWM	Sustainable Land and Water Management
SMEs	Small and Medium Enterprises
SO_2	Sulfur Dioxide
SOx	Sulfur Oxides
SREP	Scaling-Up Renewable Energy Program
TCLP	Transformational Change Learning Partnership
TOE	Tons of Oil Equivalent
ToU	Time-of-Use
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollars
VSL	Value of Statistical Life
WEAP Tool	Water Evaluation and Planning Tool
WMO/WMA	Water Management Organizations/Associations

Executive Summary

Purpose and Objectives

This evaluation assesses the development impacts (DIs) linked to climate finance provided by the Climate Investment Funds (CIF). It combines quantitative and qualitative methods and three levels of evaluative activities: (1) a secondary information review to establish a library of evidence-based links between climate finance and DIs; (2) CIF portfolio analysis and cataloguing of modeling tools, to test the application and relevance of advanced modeling approaches to estimate DIs; and (3) CIF country program and project-level case studies to test how the application of different measurement and modeling approaches can yield new insights on DIs linked to climate finance.

Examining DIs in the aggregate is challenging, as the impacts are diverse and require a range of methods to analyze them. The use of case studies reflects that challenge, as the key lessons are grounded in the nuances of each case study's context and of the methods used. Still, by combining case studies, modeling/portfolio analysis, and secondary information, this evaluation has generated insights that are relevant to CIF and other climate funders.

Overall Insights

Climate finance investments can play an important role in achieving DIs.

Climate action and development are inextricably linked, and CIF's programs are designed accordingly, aiming to help countries achieve low-carbon, climate-resilient, and inclusive growth through targeted climate investments. Even though development impacts are understood to be a core benefit of climate finance—and this evaluation finds compelling evidence of them in CIF's portfolio—DIs are not always discussed in the planning of climate projects or included in monitoring and evaluation. Through intentional planning and tracking of DIs, there may be opportunities to achieve even greater impacts.

The secondary information review identified over 60 social, economic, environmental, and market development impacts that can be realized through interventions supported by climate finance. This evaluation organizes these DIs into a new Climate Finance DI Taxonomy and identifies potential DI pathways showing how climate finance interventions can contribute to DIs. The evaluation identifies and describes many of these DIs and their impact pathways in detail, through analysis of the CIF portfolio and 13 original case studies.

Measuring and modeling targeted, intervention-specific DIs can support more informed investment decisions and strengthen the case for climate finance.

The results of the DI analysis are compelling and informative. This evaluation shows how measurement and modeling can be used to assess high-priority DIs, which can then support more informed investment decisions. It can also enable investors to better capture and report on the wide range of benefits from climate investments.

For example, at the CIF portfolio level, economic modeling shows that CIF investments have contributed substantially to employment and added tens of billions of dollars in economic value to local economies.

At the program/project level, the case studies showcase the impressive breadth and diversity of DIs achieved by CIF investments. The evaluation demonstrates that DIs from climate finance can be measured, modeled, and estimated. Investors can use robust information about climate finance DIs to make better investment decisions and project plans.

To achieve and enhance DIs from climate finance, it is crucial to translate intentions into tangible project design elements, delivery, and estimation or measurement.

Converting *potential* DIs to *realized* DIs requires intentional project design and implementation, starting in the early stages. For example, ensuring economic and social inclusion, with meaningful participation by local communities, is critical to achieving social DIs and cross-cutting impacts, including benefits for the most vulnerable populations. Capacity building to facilitate local communities' participation is a key driver of well-distributed impacts, which should be built into project design and followed through during project implementation. Carefully designing projects with a programmatic approach in mind can also help ensure that local projects contribute to higher-level change.

This evaluation provides lessons and tools to help investors consciously plan for DIs when designing programs/projects. For example, the impact pathways identified and substantiated through this evaluation can be used to identify the drivers needed to achieve DIs—particularly those that have been identified as local priorities. This will help orient climate investments to consciously contribute to achieving those priorities. A "back-casting" approach can enable CIF to plan for more relevant DIs and shape how projects are designed, implemented, monitored, and evaluated accordingly. If climate investors design a climate intervention and then add DI objectives, they may not achieve the most important DIs in a particular place. They can achieve better results if they identify the most important DIs through diagnostic work and investment planning. Then they can progressively work back to what energy source/adaptation response would meet those development needs, and perhaps consider other factors, such as alternative ownership, the distribution of benefits, and empowerment of communities.

The effect of DIs is greater than the sum of the parts and should be analyzed synergistically. Certain DIs (such as market development, built capacity, social/gender inclusion, and local workforce development) are catalytic ("Super DIs") and influence the achievement of other DIs, necessitating even more careful attention in project planning and implementation.

DIs can be mutually reinforcing and act synergistically, producing greater benefits together than they could individually. For example, in the Indonesia geothermal projects, workforce development facilitated the expansion of the geothermal market, resulting in more employment opportunities, energy sector resilience, and gender equity. Similarly, boosting the incomes of disadvantaged groups, including women, can unlock greater economic and social benefits, such as access to education and broader empowerment. In other case studies, the demonstration effect of CIF-funded projects led to market development, replication/scale-up, and additional DIs. In Thailand, market development through the de-risking of utility-scale wind power drove private investment in wind projects that resulted in significantly more health benefits from reduced air pollutants. In Brazil, community engagement drove the spread of Macaúba cultivation from neighbor to neighbor, spreading sustainable agriculture practices and supporting DIs, including economic gains.

The case studies identified several "Super DIs" that are catalysts to unlocking other DIs. They include industrial competitiveness and market development, social inclusion, capacity building, and local workforce development. These Super DIs are particularly crucial to plan for in the project design.

Prioritizing vulnerable and marginalized groups, including women, can enhance DIs, distribute the benefits more equitably, and amplify uptake and effectiveness.

Many CIF projects explicitly include DI goals focused on women. The case studies highlight the benefits of prioritizing women and vulnerable groups in stakeholder consultations, and fully including them in interventions as employees, business owners, decision-makers, community leaders/members, and in other important roles. In addition to gender and social inclusion benefits, this can enhance DIs more broadly. For example, in the case study on low-carbon agriculture in Brazil's Cerrado biome, a program evaluation indicated that participating farms in which women were involved in decision-making were quicker to adopt the techniques, enhancing the delivery of the project's broader DIs. Other case studies show that project strategies to improve the participation and empowerment of women and vulnerable populations lead to DIs such as increased earnings and improved quality of life.

Prioritizing vulnerable populations and/or underdeveloped geographic areas can also enhance economic DIs. For example, modeling results for the Indonesia deep-dive case study suggest that the economic impacts are mainly driven by increased electrification in unelectrified or under-electrified areas, complemented by productivity benefits from improved education and health benefits from avoided local air pollutants. Similarly, local capacity building, including workforce development, can help ensure that local communities can benefit from job opportunities and participate in supply chain development. Modeling results also show that investments in small-scale distributed solutions that employ the local workforce create direct jobs and have "multiplier" effects; for example, in India, two solar rooftop programs are estimated to have created 8,545 direct jobs (in construction and maintenance) and 900 indirect jobs (in solar equipment manufacturing).

Comparative assessment and testing in this evaluation identified several promising modeling approaches that could be used by CIF and other climate actors to estimate hard-to-observe DIs, which should be further tested and applied.

For the portfolio-level analysis conducted as part of this evaluation, the IEc team reviewed modeling approaches/tools and provided recommendations to estimate three high-priority DIs identified with CIF. The DI categories selected for this review represent DIs that are difficult to directly observe or measure. They are: (1) improved air quality and resulting health benefits from reduced (or avoided) fossil fuel combustion; (2) increased climate resilience in agriculture, including increased abilities to cope with shocks, reduced losses from climate events, and increased agricultural productivity; and (3) increased energy-enabled economic output, including direct, indirect, and induced employment and income. We also explored approaches for estimating changes in pollinator abundance and agricultural yields resulting from biodiversity conservation. While all models have advantages and disadvantages, all were found to be fit for their intended purpose. Part 4 of this report provides an overview of the models tested, the results, and the key data requirements to run the models. Further testing and expanding these models would be beneficial for capturing DI results and making a compelling case for the development impacts of climate finance.

CIF, within its mandate as a learning lab for the wider climate finance community, has an important role to play in generating and disseminating lessons on the transformational impacts of climate finance on development that other climate funders can apply.

Through its programs and its robust learning initiative, including this evaluation, CIF can pilot and/or catalyze DI-centered climate finance strategies/investments, evaluate the results, and share this knowledge with other climate funders and broader audiences. This evaluation recommends paying attention to DIs at all stages of climate finance: from program design to project design and approval, project monitoring and reporting, and project close and ex-post evaluation. However, the different actors involved have different goals and capacity levels. CIF can focus on disseminating lessons on DIs and best practices, tailoring them to diverse stakeholders while raising the general level of capacity. In addition, CIF can provide a platform to engage stakeholders and promote increased collaboration to learn together and maximize DIs. The multilateral development banks (MDBs) and other climate funders, in turn, can apply these lessons and best practices to strengthen their development impacts and further expand the evidence base on the DIs of climate finance. Notably, CIF can also play an important role in addressing measurement gaps through additional research; specific focus areas are suggested in Part 4 of this report.

Recommendations for CIF and the Climate Finance Community

Based on the results of the evaluation, this report provides recommendations that MDBs can consider in designing and implementing CIF--funded and other projects, and that CIF can advance as part of its programmatic approach. As CIF is currently developing toolkits to implement Integrated Results Frameworks for the new CIF programs, it can include relevant DIs (e.g., Super DIs) and suggested indicators in the toolkits. There may also be opportunities to prioritize DIs in CIF's Transformational Change Learning Partnership (TCLP) and other thematic workshops, and help participants who are developing new climate programs to integrate DIs more explicitly into their planning process. Finally, we recommend ways for CIF to advance knowledge on designing for, tracking, and evaluating DIs through its mandate as a learning lab. We encourage other members of the climate finance community to use the DI taxonomy and impact pathways for program planning and to track the DI results. More detailed recommendations are provided in Part 4 of the full report.

Design and implement creative community engagement strategies to ensure that projects address local priorities, incorporate local expertise, and deliver benefits to local people.

The cases identified a variety of tactics such as intentional site selection, meaningful community participation, capacity building/training, employment, and direct payments or compensation where required. Beyond consultations, successful projects used community-based visioning, sustained engagement, formal project steering committees with local community members, and responsive monitoring and evaluation to ensure strong engagement and localization of DI benefits. For projects with supply chain aspects, including local content or employment requirements is also a way to localize DI benefits.

Mainstream gender and social inclusion as part of all climate finance investment lifecycles.

Even when projects do not have empowerment as a primary objective, applying a gender and social inclusion lens is still recommended. This analysis can help to identify underserved groups or underlying constraints—such as discriminatory gender norms, legal barriers, or lack of agency—that could impact performance both on climate objectives and DIs. It can also highlight any potential risks or unintended negative impacts for vulnerable groups.

To increase adoption of clean technologies or sustainable practices that underpin several types of DIs, focus on innovative financing structures, outreach, and capacity building.

For example, projects that introduced solar power projects financing or credit guarantee mechanisms to de-risk the rooftop solar market not only increased electricity access, but also made electricity more affordable. Pairing innovative finance with capacity building (e.g., for financial institutions offering innovative financial products for the first time) and outreach/awareness activities (e.g., for potential borrowers/early adopters) is crucial for expanding market adoption and the realization of DIs.

Blended finance approaches are well-suited to first-mover projects that aim to demonstrate a business case for new or riskier technologies or approaches.

Overcoming the first-mover risk is a critical role for funders such as CIF, as was noted in the Thai wind case and the Brazil Macaúba value chain case and a finding that is consistent with other evaluations. Demonstration of a viable business case helped to encourage early adopters and replication by other businesses and is intended to lead to mass commercialization of new technologies and value chains, which leads to multiplication of DI benefits even beyond the original investment.

Model and measure priority DIs.

Both at a planning stage and monitoring or evaluation stage, there are a variety of tools that are suitable for the needs of climate finance investors to better estimate secondary DIs, assess trade-offs between different investment options, or engage with stakeholders. Diverse DIs such as air quality, health impacts, agricultural productivity, biodiversity, and economic outputs from increased electrification and education can be modeled using existing data and tools. Further testing and collaboration with other climate investors on promising models could help to strengthen the case for climate finance. Recommendations for data collection are provided in the main body of the report.

Development Impacts Evaluation Management Response

Introduction

The Climate Investment Funds (CIF) was established in 2008 to provide scaled-up climate finance to developing countries to initiate transformational change towards low carbon, climate resilient development. The CIF encompass two funds: the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). The CTF includes two dedicated thematic funding windows – the Accelerating Coal Transition (ACT) Investment Program and the Global Energy Storage Program (GESP), in addition to multiple phases of the Dedicated Private Sector Program (DPSP). The SCF includes seven targeted programs – the Forest Investment Program (FIP), Industry Decarbonization Program, the Pilot Program for Climate Resilience (PPCR), the Renewable Energy Integration (REI) Program, the Scaling-Up Renewable Energy Program in Low Income Countries (SREP), Nature, People, and Climate (NPC) Program, and Smart Cities Program. Since CIF's inception in 2008, CIF has mobilized over $11 billion in climate finance from 15 donor countries. Through $7.5 billion in approved financing, CIF is supporting almost 400 projects in 72 low and middle-income countries on the frontlines of the climate crisis and has mobilized an additional $62 billion from governments, the private sector, and MDBs.

In 2021, the CIF's Evaluation and Learning (E&L) Initiative commissioned an independent mixed-methods evaluation on the Social and Economic Development Impacts of Climate Finance. The purpose of the evaluation was to 1) expand and improve the knowledge and evidence base on development impacts of climate finance (for CIF and the larger climate finance architecture in which it operates) across key economic sectors, including energy, infrastructure, and productive landscapes, as well as related social and environmental themes or issues; 2) strengthen the case for increasing the ambition of climate action, especially by countries, donors, multilateral development banks (MDBs), and others; and 3) enable key decision-makers to take better informed, and thus more impactful, climate investment decisions taking into account broader development impacts.

The evaluation included a secondary information review of broader climate finance programs, a modeling and portfolio analysis on the application and relevance of advanced modeling approaches to estimate development impacts, and 13 case studies that provide insights on how CIF projects contributed to development impacts.

The sections below outline a response by CIF and its MDB focal points to key insights and recommendations from the evaluation report by IEc. We are committed to taking these findings and recommendations forward in future programming strategy and decision-making processes in support of continued transformational change towards low carbon, climate resilient development.

Management Response to Overall Insights

Management welcomes and is very grateful for the opportunity to learn from an independent evaluation of the Development Impacts of Climate Finance from the Climate Investment Funds. This evaluation comes at an opportune time as CIF consolidates the outputs of existing programs and initiates new programs. These new programs will benefit from the insights generated through this evaluation. This work is thus closely aligned to CIF's mandate to enhance learning from a wide range of pioneering climate investments.

Management appreciates the wide range of methods used in this evaluation, including an extensive secondary information review, analysis of modeling approaches for high priority development impacts, and 5 deep dive and 8 light touch case studies that employed quantitative and qualitative methods.

Overall, the evaluation finds that climate investments can play an important role in achieving development impacts. Management appreciates the development of the Climate Finance Development Impact Taxonomy and Development Impact Pathways, tools that CIF and other stakeholders can use to better identify and realize potential development impacts of climate investments.

Management appreciates the insight that measuring and modeling targeted, intervention-specific development impacts can help investors make more informed investment decisions and better capture and report on a wide range of benefits from climate investments beyond direct climate mitigation or adaptation outcomes. It acknowledges the challenges in measuring some development impacts, including requirements for localized data collection and substantial resource requirements for measurement or modeling.

Management also acknowledges that achieving and amplifying development impacts from climate finance requires intentional project design, delivery, and estimation or measurement beginning from an early stage of the intervention. It will take steps to address barriers and pursue drivers that influence progress along development impact pathways.

Management appreciates the recognition that CIF has an important role to play in generating and providing lessons on the transformational impacts of climate finance for development impacts. It will reflect on how best to disseminate climate development impact best practices and learnings, maximize climate finance development impact learnings through stakeholder engagement, and try to address measurement gaps.

Management also appreciates the insight that some development impacts are catalytic and influence the achievement of other development impacts. Management notes that development impacts such as market development, capacity building, social and gender inclusion, and local workforce development can unlock greater social and economic benefits, such as access to education, more employment opportunities, and greater gender equity and empowerment. It further notes that investments that prioritize women and vulnerable populations are particularly effective at unlocking these catalytic development impacts. Management will seek to maximize development impacts by engaging women and vulnerable groups not just as beneficiaries, but also as employees, business owners, community leaders, and decisionmakers.

Management notes the promising new approaches identified by this evaluation for estimating hard-to-observe development impacts using modeling. It will consider these approaches for further testing and expanded use in the CIF.

Management appreciates the insights offered by this evaluation to support learning and improvement across CIF programs and projects and innovative climate finance more broadly.

Management Response to Recommendations

Local communities

Management agrees that CIF AU, MDBs, and other climate funders, should seek to achieve enhanced development impacts among local communities through meaningful engagement, capacity building, gender-responsive leadership, and tangible actions to localize economic benefits.

Management acknowledges that this requires collaboration and community outreach focused on local stakeholders and when relevant incorporating targets for local workers and local content in the supply chain. Management acknowledges that MDBs have existing local stakeholder requirements which includes incorporating a wide range of local community stakeholders through socially inclusive processes. To help further this process, the CIF is launching a Just Transition Toolbox that will provide resources and examples on mobilizing stakeholders into socially inclusive processes, including methods for establishing coordination mechanisms and identifying and engaging relevant stakeholders. Moreover, new CIF programs such as ACT include a focus on localizing economic benefits by supporting economic opportunities for communities most affected by coal transitions and enhancing local community participation in policy making related to the coal-to-clean energy transition.

Gender and social inclusion

Management notes the recommendation for the development of inclusive, gender-responsive project designs and robust monitoring of gender and social impacts. Management agrees with the recommendation that analysis of the gender and social context and preexisting barriers should be conducted during early stages of project scoping and design. It also agrees that Gender Action Plans are important to addressing barriers and monitoring results. It notes that CIF's Gender Action Plan, now in its third phase, supports gender-transformative change by improving women's assets, livelihoods, and voice through three pillars: 1) efforts across CIF-wide governance, 2) activities on Local and National Institutions, and 3) work across key Green Growth and Sustainable Livelihoods sectors that affect gender outcomes.

Management acknowledges the need to work together to broaden and deepen gender-inclusive project designs and monitoring. CIF AU and MDBs, working with country focal points, will also seek to operationalize the gender requirements in the investment criteria and Integrated Results Frameworks for the new CIF programs and present guidance through workshops. Interventions such as CIF's Women Led Coal Transition (WOLCOT) Grant Mechanism under the ACT program will take forward the recommendation for gender-inclusive designs by fostering women leadership and participation in design and implementation of coal-to-clean energy transition strategies and plans.

Innovative financing structures

Management acknowledges the recommendation supporting innovative financing structures paired with outreach and capacity building. It also acknowledges how this can lead to widespread uptake of these new technologies or practices, which can increase local job creation, improve access to essential services, among other benefits.

Management will seek opportunities to incorporate innovative financial arrangements and products, along with the appropriate capacity building and training, into CIF's new programs. This finding is consistent with previous evaluations that found that CIF's approach of piloting innovative instruments and blended finance structures helped MDB partners test new products and learn lessons that were later replicated with their own resources.

First-mover projects

Management acknowledges the importance of first-mover projects that aim to demonstrate the business case for new or risky technologies and lead to additional development impacts. Management welcomes the recommendation for continued support for first-mover projects across energy, agriculture, and other sectors. This is also in line with findings from previous CIF evaluations that found that the demonstration effect can play a key role in scaling and amplifying the transformational impact of climate finance.

Modeling and measuring priority development impacts

Management acknowledges the need to collect additional data and apply robust methodologies to model and measure priority development impacts. This evaluation builds on previous modeling work that CIF conducted to estimate development impacts of the CTF and SREP portfolios. To determine CIF's next phase of modeling work, CIF will, in discussion with partner MDBs, explore using the models recommended in the evaluation's modeling memo to estimate priority development impacts. Further development impact modeling could prove useful to CIF, MDBs, and other partners by informing Investment Plan and project design processes, enhancing knowledge on development impact pathways, increasing understanding of trade-offs between investment opportunities, and providing ex-ante and -post evaluation of development impacts.

Conclusion

In summary, management appreciates the efforts of the IEc team in conducting a thorough evaluation of the development impacts of climate finance. The evaluation team has produced a well-structured report in which the findings are well substantiated with evidence from a rich and diverse pool of data and case studies. Management also recognizes that this evaluation has come at a critical point in CIF's history where existing programs are being implemented and finalized alongside the emergence of new CIF programs, which provides opportunities to incorporate recommendations into new CIF programs. Management remains committed to CIF acting as a learning laboratory for innovative and transformational climate finance and associated climate action.

Introduction: Purpose, Objectives, and Study Approach

Industrial Economics, Incorporated (IEc), and its subcontractors Trinomics B.V., Ross Strategic, Dr. Johanna Polvi, and Dr. Sergei Paltsev (the IEc team), conducted an independent evaluation commissioned by the Evaluation and Learning Initiative of the Climate Investment Funds (CIF) to examine CIF's contribution to development impacts (DIs) through its climate investments.

Established in 2008, CIF provides scaled-up climate financing to developing countries to support transformational change towards low-carbon, climate-resilient development. CIF started with two funds: the Clean Technology Fund (CTF) and the Strategic Climate Fund (SCF). The latter includes three targeted programs: the Scaling-Up for Renewable Energy Program (SREP), the Pilot Program for Climate Resilience (PPCR), and the Forest Investment Program (FIP). In the summer of 2021, CIF announced the establishment of three new programs: Accelerating Coal Transition (ACT), Renewable Energy Integration (REI), and Nature, People, and Climate (NPC).

When considering the impacts of CIF investments, CIF stakeholders have articulated a desire to document the contributions that programs make above and beyond their core climate change objectives—that is, advancing broader national social, economic, environmental, and market development objectives, which may also be linked to the UN Sustainable Development Goals (SDGs). These additional DIs—sometimes called "co-benefits"—include, among others, job creation, economic growth, improved health outcomes, market development, social inclusion, and greater gender equality. They can be difficult to assess and measure, but there is consensus that being able to deliver co-benefits through climate investments can significantly strengthen the business case for increased and more ambitious climate finance. At the same time, a more robust and nuanced understanding of these DIs can enable climate financiers and development practitioners to maximize co-benefits.

In recognition of the importance and value of these development co-benefits, CIF launched a new workstream in 2019 focusing on the Social and Economic Development Impacts of Climate Investments (SEDICI). This DI program evaluation is part of that workstream.

Objectives and Questions

The evaluation has three main objectives:

- To expand and improve the knowledge and evidence base on development impacts linked to climate finance (for CIF and the larger climate finance architecture in which it operates) across key economic sectors, including energy, infrastructure, and productive landscapes, as well as related social and environmental themes or issues;
- To strengthen the case for increasing the ambition of climate action, especially by recipient countries, donors, multilateral development banks (MDBs), and others; and
- To enable key decision-makers to make better-informed, and thus more impactful, climate investment decisions that take broader development impacts into account.

Lessons from this evaluation can also help to inform new CIF investment plans, programs, and projects.

In service of these objectives, the evaluation addresses four questions:

1. What are the **primary development impacts** that CIF programs and investments, both current and future, are or could be contributing to, and how? What are the main impact pathways and modalities for contributing to these impacts?
2. What are the **key results and achievements** to date in terms of CIF contributions to DIs? What have been the main challenges or unintended impacts?
3. What are the **drivers and constraints** (programmatic, investment-level, institutional, context-specific, methodological, etc.) influencing the extent to which DIs are realized in CIF programs and investments?
4. How can programs and investments **strengthen their contributions** to DIs, both in the existing CIF portfolio and in new programs and future investments? What tools and approaches can help to better achieve and document these impacts?

Approach

This evaluation assesses DIs linked to CIF-provided climate finance, using a combination of quantitative and qualitative methods, and three levels of evaluative activities:

1. **Secondary information review of global climate finance programs to establish a library of evidence-based links between climate finance interventions and DIs:** The IEc team reviewed and synthesized existing evidence and lessons on DIs in the literature, for both CIF programs and external climate finance programs. The team coded and analyzed 35 CIF-related reports and 24 external reports to identify common patterns of interventions and impacts across different types of programs (e.g., utility-scale renewable energy projects, distributed energy resources projects, forest protection projects), including barriers identified and addressed. The results provide a common framework for analysis for a more comprehensive understanding of the range of potential DIs resulting from CIF investments or from other climate finance portfolios. As further explained in Part 1, the common analysis framework includes a taxonomy of DIs and DI impact pathway illustrations that show different levels of development impacts in the sequence in which they often occur. In addition to providing a framework for the current evaluation, these tools can be applied to inform future programming and measurement of DIs.
2. **CIF modeling and portfolio analysis to test the application and relevance of advanced modeling approaches to estimate DIs that are difficult to directly observe or measure.** This level of the evaluation focused on two key areas: first, a review of earlier testing of portfolio-level economic modeling approaches, which included the employment factors approach, I-JEDI, and the Joint Impact Model (JIM), to identify areas for further improvement and refinement of economic modeling tools; and second, an in-depth review of another 20 modeling approaches that CIF (and other climate funders) could potentially use to assess other types of DIs that do not lend themselves well to direct observation, such as health outcomes or productivity improvements. This analysis provides a high-level assessment of the suitability of 14 priority DIs for estimation using advanced modeling approaches and, for a subset of DIs, recommendations

on which modeling tools could be suitable for climate investors such as CIF. As part of this work, IEc reviewed CIF's use of the JIM tool and recommended ways to improve CIF's use of the tool in the near term and to further refine and/or enhance the tool in the longer term.

3. **CIF country program and project-level analysis (via 13 case studies), to test how different measurement and modeling approaches can yield new insights on DIs for climate finance.** The evaluation uses case study methods to generate new evidence and learning on the DIs—whether measured, modeled, or potential—of climate projects. The 13 case studies employ the detailed impact pathways from the secondary information review and, in some cases, the modeling approaches of the modeling analysis. They use both qualitative and quantitative methods, such as stakeholder interviews, analysis of project documents, and secondary data sources. Two types of case studies are included: 1) eight "light-touch" studies based on secondary data sources and targeted interviews, and 2) five "deep-dive" case studies that collected new primary data and applied innovative assessment methods, including modeling, and thus help to expand the evidence base for priority DI areas. The IEc team worked closely with CIF to select the cases, aiming for a representative and balanced mix (by geography, technology, sector, CIF program, and MDB). All represented significant CIF investments determined to have the potential to have significant DIs; there were also practical considerations, such as data availability. Several case studies include projects with both public and private sector participation. Table 1 summarizes basic information on each case study.

Table 2 presents the methods used to analyze specific DIs featured in the deep-dive case studies. Modeling methods included input/output modeling (JIM) and computable general equilibrium (CGE) modeling for economic benefits, use of LEAP-IBC for air quality and health benefits, and the InVEST model for ecosystem services benefits. Other quantified DIs were analyzed or reported using information from project reports and the literature, without modeling. Notably, several case studies identified potential economic value-added and employment effects that could not be quantified as part of this project.

Table 1. Overview of Case Studies

COUNTRY	PROGRAM	TYPE OF CASE STUDY	SECTOR/ SUBSECTOR	FUNDING MODALITY	SCOPE OF CASE STUDY
Bangladesh	SREP	Light-touch	Solar (rooftop)	Loan, grant	DIs resulting from scale-up of rooftop solar in the ready-made garment sector
Bangladesh	PPCR	Deep-dive	Agriculture	Loan, grant	DIs resulting from coastal embankment improvements to protect agricultural livelihoods
Brazil	FIP	Deep-dive	Agriculture	Grant	DIs resulting from improved land management and low-carbon agricultural practices in the Cerrado biome
Brazil	FIP	Light-touch	Forestry	Equity share	DIs resulting from a sustainable Macaúba value chain replacing traditional palm oil production
India	CTF	Light-touch	Solar (parks, rooftop), transmission	Loan, grant	DIs resulting from large-scale solar parks and rooftop solar
Indonesia	CTF	Deep-dive	Geothermal	Loan, grant	DIs resulting from upstream and downstream support for geothermal expansion
Indonesia	FIP	Light-touch	Forestry	Grants	DIs resulting from the expansion of sustainable forest management practices
Kenya	SREP	Light-touch	Off-grid electrification	Grant, loan	DIs resulting from mini-grids to expand electricity access in rural areas
Morocco	CTF	Light-touch	Solar (utility-scale)	Loan	DIs resulting from the construction of a concentrated solar power plant
Nepal	SREP	Deep-dive	Biogas	Grants	DIs resulting from the expansion of biogas-powered off-grid generation
Niger	PPCR	Light-touch	Agriculture	Loan, grant	DIs resulting from mainstreaming climate resilience coordination and scaling up interventions
Thailand	CTF	Deep-dive	Wind (utility-scale)	Grant, loan	Reduced air pollutants, health benefits, and other DIs resulting from the introduction of utility-scale wind power
Türkiye	CTF	Light-touch	Renewable energy	Loan, grant	DIs resulting from private investment in renewable energy sources

Table 2. Methods for Assessing Quantitative Benefits in Deep-Dive Case Studies

DEEP-DIVE CASE STUDY AND PROGRAM	DI CATEGORY	PROJECT-SPECIFIC DI	KEY METHODS FOR QUANTIFYING DIS
Bangladesh PPCR	Soil and crop productivity	Cropping intensity	Crop model
	Earnings (from construction and permanent jobs)	Increased farmer income	JIM model
	Employment (of any type)	(same as DI category)	JIM model
	Economic value-added (GDP)	(same as DI category)	JIM model
Brazil FIP	Ecosystem and Biodiversity	Protection of pollinator habitats	InVEST model
	Employment (of any type)	(same as DI category)	Project impact evaluation
	Soil and crop productivity	(same as DI category)	Project reports
	Sustainable land use	Adoption of low-carbon agricultural technologies	Project reports
	Sustainable land use	Establishment of legal reserves and permanent protected areas	Program evaluation
	Gender Benefits	(same as DI category)	Project reports
	Reduced Air Pollutants	Increased carbon sequestration	Project evaluation
Indonesia CTF	Expansion of electricity to new households and businesses	(same as DI category)	CGE modeling
	Economic value-added (GDP)	(same as DI category)	CGE modeling
	Health and safety	Health benefits of reduced air pollution	CGE modeling
	Employment (of any type)	(same as DI category)	CGE modeling
Nepal CTF	Competitiveness and industrial development	Increased financing for biogas	Project reports
	Energy sector security and resilience	Reduced fuel imports	Project reports
	Employment (of any type)	(same as DI category)	Project reports; external literature
	Access to essential services	(same as DI category)	External literature
	Access to essential services	(same as DI category)	External literature
Thailand CTF	Reduced air pollution	(same as DI category)	LEAP-IBC modeling
	Health and safety	Health benefits of reduced air pollution	LEAP-IBC modeling
	Employment (of any kind)	(same as DI category)	Project reports

In addition to developing these individual case studies, this final report synthesizes key lessons on DIs, conclusions, and thematic insights across the cases. A key limitation of this evaluation is that it is challenging to examine DIs in the aggregate, given the diversity of impacts and the range of methods needed. The use of case studies reflects these limitations, as the key lessons are grounded in the nuances of each case study's context and can best be interpreted within that context. Nonetheless, the combination of the case studies, modeling analysis, and secondary information review generated insights about climate finance and DIs that are broadly relevant to CIF and other climate funders.

Overview of the Report

The main body of this report is organized by the four evaluation questions:

- Part 1 establishes the taxonomy of DIs and impact pathways of climate finance, using existing evidence from CIF and the broader climate finance community.
- Part 2 evaluates and estimates the DIs achieved through the CIF portfolio, using the different methods described above (modeling/portfolio analysis and case studies).
- Part 3 describes the drivers and constraints that influence DI results in the CIF portfolio, with examples from the case studies.
- Part 4 provides recommendations for strengthening DIs in the context of climate finance programs and projects.
- Part 5 draws some conclusions based on a synthesis of the results of the four evaluation questions.

Appendix A provides supporting tables for the analysis. Appendix B provides an overview of the JIM modeling tool. Appendix C describes the case study selection criteria. Appendix D provides one-page summaries of the 13 case studies. The Secondary Information Review, the Modeling Memo, and the full case studies are available as separate documents.

Part 1. Taxonomy of DIs and Impact Pathways of Climate Finance

Key Messages

- The secondary information review identified over 60 social, economic, environmental, and market development impacts that can be realized through interventions supported by climate finance. This evaluation organizes these DIs into a new Climate Finance DI Taxonomy and identifies potential DI pathways showing how climate finance interventions can result in DIs.
- The most frequently identified DIs within CIF's clean energy development portfolio (CTF and SREP), based on review of CIF project documents,[1] include employment opportunities, access to essential services, competitiveness and industrial development, and energy sector security and resilience.
- The most frequently identified DIs within CIF's forestry and resilience portfolio (FIP and PPCR) include improved livelihoods, wealth, and quality of life; soils and crop productivity; women's economic empowerment and greater gender equality; and benefits to local stakeholders.
- The most frequently identified DIs in the CIF portfolio broadly align with the most commonly identified DIs in the secondary information review.
- Each climate investor may prioritize a different set of impacts, but the taxonomy and impact pathways tools are broadly applicable, since climate finance sectors are broadly similar.
- The DIs featured in the case studies reflect both the most frequently identified DIs in the CIF portfolio and the specific cases selected. In the 13 case studies, employment gains and market development were found to be the DIs that were likeliest to be assessed and quantified.
- Climate finance, by contributing to DIs, also contributes to the SDGs.

Climate action and development are inextricably linked. Even though development impacts are understood to be a core benefit of climate finance, they are not always discussed in the planning of climate projects or included in monitoring and evaluation. This evaluation focuses on the social, economic, environmental, and market development changes attributable to climate finance investments. As noted in the introduction, this section summarizes the findings of a review of the evidence on DIs from climate finance and the pathways to achieving them. It then presents two tools—the Climate Finance DI Taxonomy and DI Pathways illustrations—and applies them to the CIF portfolio and the case studies. Lastly, we discuss the DIs tracked by MDBs, make recommendations for future tracking, and map the DIs to the Sustainable Development Goals (SDGs), showing how climate finance can support the achievement of the SDGs.

1.1 Secondary Information Review: Climate Finance DI Taxonomy and Impact Pathways

As part of CIF's ongoing workstream on the development impacts of climate finance, the IEc team conducted an in-depth review of CIF program documents and other external program reports to develop a comprehensive climate finance DI taxonomy and graphics to illustrate the pathways through which activities supported by climate finance can lead to DIs.

[1] The review focused primarily on three relevant sections of MDB project documentation: "Project Development Outcome (PDO)," "Development Impact Narrative," and "Development Impact Targets or Estimates."

Table 3 presents the taxonomy, which has three levels of increasing specificity: 1) four broad categories: **social, economic, environmental, and market development** (blue headers); 2) narrower **subcategories** (gray headers); and 3) **specific, measurable impacts** (row text). For example, within social (Level 1), and livelihoods, wealth, and quality of life (Level 2), specific impacts include increased/diversified income, wealth generation, increased ability to cope with shocks, and many other specific DIs. It is important to note that equity and social inclusion are key considerations in assessing DIs, which is why several items listed focus on impacts on women/girls, other marginalized and vulnerable populations, and local stakeholders. Capacity development is also relevant across DI categories and is thus a recurring theme as well.

Table 3. Climate Finance DI Taxonomy

SOCIAL	
LIVELIHOODS, WEALTH, AND QUALITY OF LIFE[2]	
Increased or diversified income	Increased access to markets
Wealth generation	Improvements specific to women
Increased ability to cope with shocks	Improvements specific to vulnerable populations
Increased food security	Capacity building of local institutions
Reduced illegal activity[3]	Acquisition of transferable job skills
Recognition of tenure rights	Community engagement/social inclusion
Reduced losses from extreme climate events	Improved working conditions
HEALTH AND SAFETY	
Avoided health impacts from reduced fossil fuel combustion	
ACCESS TO ESSENTIAL SERVICES	
Expansion of electricity to new households/businesses	Increased access to education for women/girls
Increased electricity reliability/decreased outages	Increased access to education for vulnerable populations
Reduced energy costs	Access to healthcare/medicine
Increased access to public transportation	Reduced energy costs to essential sectors
Decreased transportation cost	Infrastructure
Increased access to reliable water supply	Increased access to education
ECONOMIC	
EMPLOYMENT OPPORTUNITIES	
Direct permanent employment	Construction earnings
Construction employment	Increase in employment opportunities for women
Induced/indirect employment	Increase in employment opportunities for vulnerable groups
Direct permanent earnings	Employment in power sector
ECONOMIC VALUE ADDED (GDP)	
Economic output	

[2] The Livelihoods, Wealth, and Quality of Life category contains microeconomic DIs; the Economic category contains macroeconomic DIs.

[3] Reduced illegal activity includes reduced illegal fishing, logging, and other resource extraction.

ENVIRONMENTAL	
AIR	
Reduced air pollutants	
WATER	
Access to clean water	
Improved water quality	
Improved legal/regulatory framework	
ECOSYSTEM AND BIODIVERSITY	
Improved legal/regulatory framework	Forest management planning
Enhanced forest stocks	Sustainable land use
SOILS AND CROP PRODUCTIVITY	
MARKET DEVELOPMENT	
ENERGY SECTOR SECURITY AND RESILIENCE	
Increased entrants into energy markets	Local energy generation
Diversification of energy sources	Reduced cost of power generation
Financial stability of energy sector	Reduced fuel imports
Increased governance capacity to regulate the energy sector	Reduced transmission/distribution line losses
Planning for shocks and stresses to system	
Energy system integration	
COMPETITIVENESS & INDUSTRIAL DEVELOPMENT	
Increased affordability of low-carbon technologies	Maturation of market structures
Expanded access to capital	Integration/connectivity of systems
Increased SMEs in market	Reduced trade imbalance
Technology adoption	Project/products met international standards
Supply chain development	Energy cost savings
Increased product offerings	
INCLUSIVENESS AND ENERGY JUSTICE	
Inclusiveness and energy justice	Business models targeting women
Better regulation to serve the needs of vulnerable groups	

Note: Many DIs can be examined through the lens of impacts to women and impacts to vulnerable populations. In addition, capacity development is relevant across the DI categories. As such, capacity, gender-related impacts, and impacts specific to vulnerable populations and local stakeholders are cross-cutting impact areas that appear multiple places within Levels 2 and 3 of the taxonomy.

The impact pathways, shown in Figures 1 and 2, organize DIs in terms of causal chains, in two broad areas of intervention: clean energy (mitigation, corresponding to the CTF and SREP programs), and forestry and resilience (mitigation and adaptation,[4] corresponding to PPCR and FIP). It is important to

[4] Since climate adaptation is highly context-specific and deeply related to social, economic, and environmental DIs, it should form an integral part of the larger development process (and therefore is embedded in a wide range of DIs that are themselves part of the adaptation process). It is also important to consider that adaptation and mitigation may not both have the same relationship to DIs.

note that while this framework clusters CTF/SREP and PPCR/FIP projects together because of their significant synergies and overlaps, each program has different objectives, scope, and areas of intervention, and the diagrams should be considered illustrative. For the case studies, we adapted the generic impact pathways to the specific context (see Appendix A), showing how this approach could be adapted for a range of future climate finance programs and projects.

The impact pathway graphics show how common types of investments in these programs lead to first-order outcomes, and the DIs that can result from those outcomes. For example, investments in utility-scale renewable projects lead to market development, and market development can create DIs such as employment opportunities, local and regional economic benefits, and potentially increased industrial competitiveness. That was the DI pathway identified in renewable energy case studies in Indonesia (geothermal) and India (utility scale solar). Similarly, investments in climate resilience, such as in the Bangladesh coastal infrastructure case study, can protect crops and boost crop productivity, and thus result in local and regional economic benefits. While the impact pathways were developed for CIF programs, they could be broadly applied to other climate finance portfolios that focus on similar interventions in energy, forestry, and resilience (gray boxes in the impact pathways). It should be noted that the impact pathways do not address distributional impacts (e.g., within impacted groups, which subpopulations stand to benefit the most or are at highest risk) or the net impacts of climate finance work (i.e., benefits minus costs).

Figure 1. Clean Energy Development Impact Pathways (CTF and SREP)

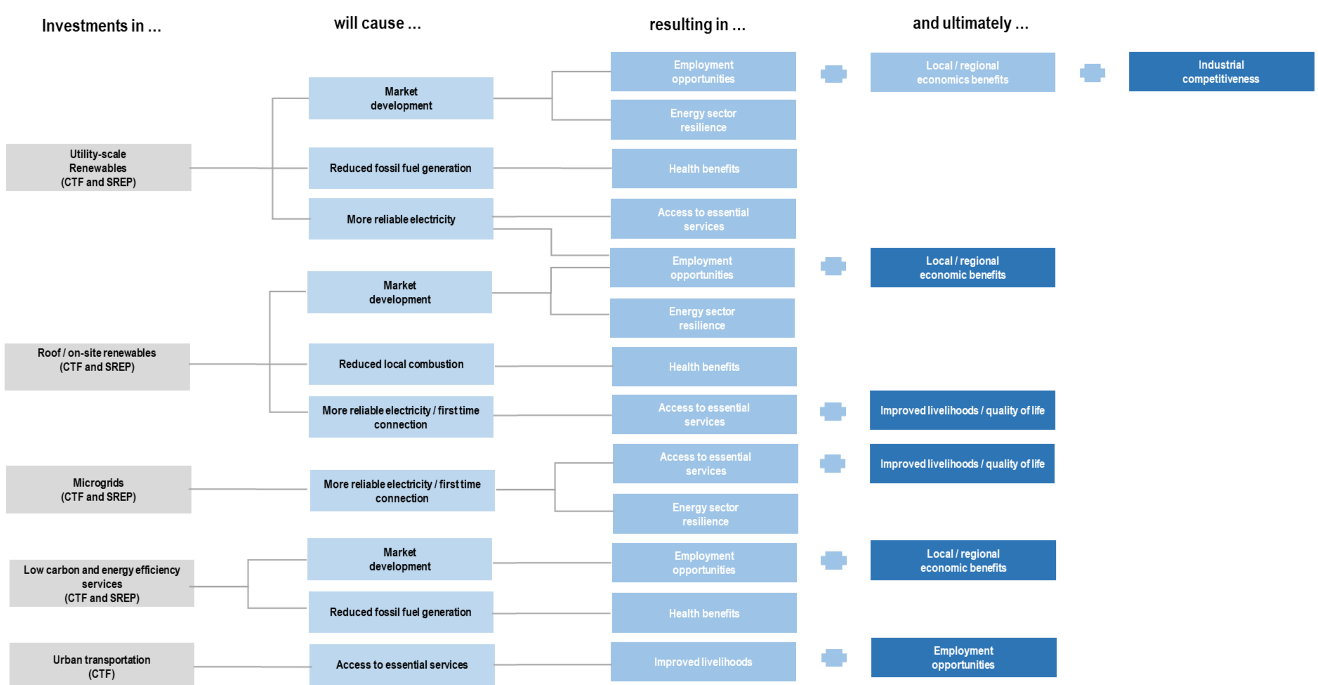
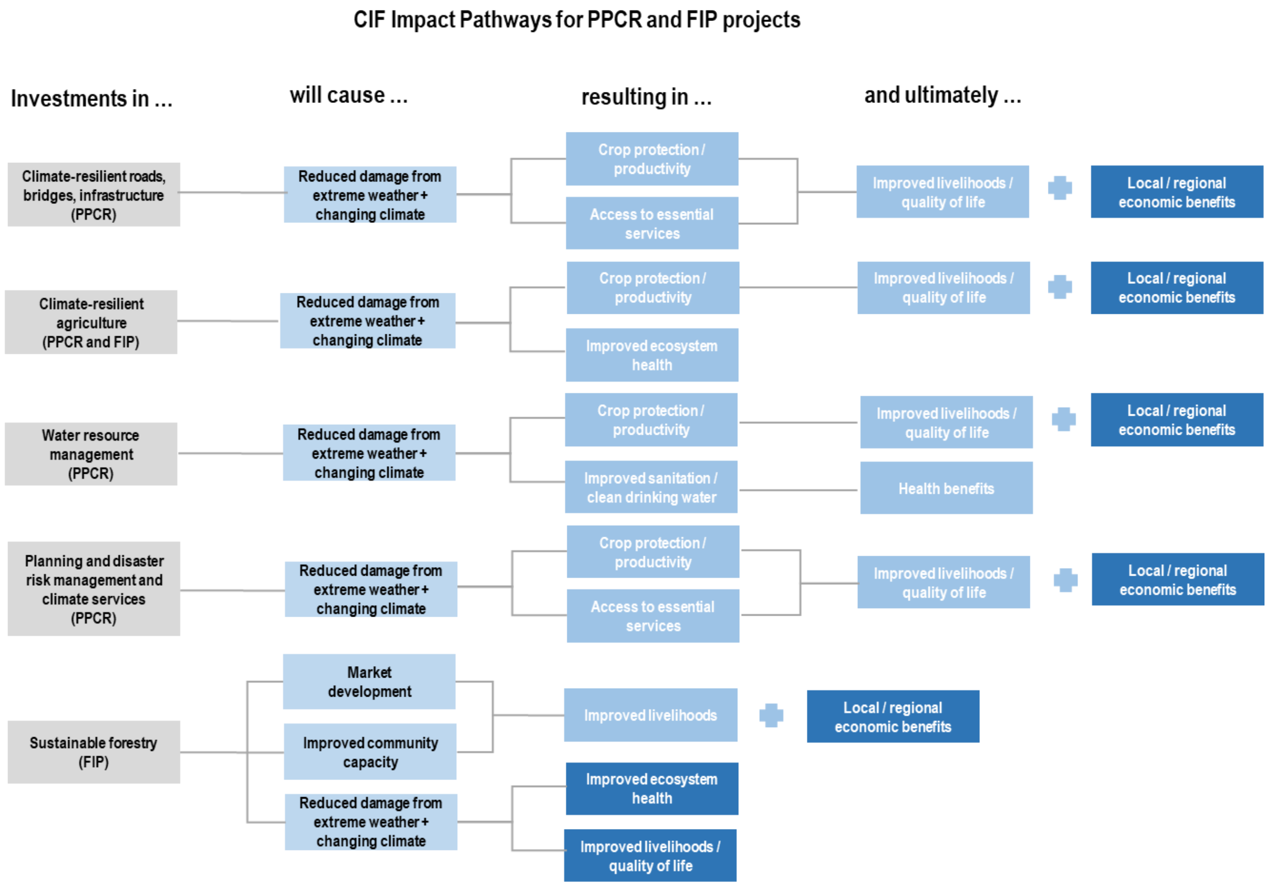


Figure 2. Forestry and Resilience Development Impact Pathways (PPCR and FIP)



1.2 Frequency of DIs Identified in the Secondary Information Review

The IEc team conducted an initial screen of reports provided by CIF for potential inclusion in the literature review, as well as external literature on climate finance development impacts from a variety of sources. CIF-related reports include CIF-developed reports and third-party reviews and evaluations of CIF programs. We also searched the external literature to collect additional information on development impacts in geographic areas that appeared to be underrepresented in our initial search. Ultimately, the IEc team screened 178 reports and articles, and selected 78 for inclusion in the literature review.

Table 4 summarizes the DI categories most frequently reported in the literature, showing how many times each impact area was examined. Social impacts predominate, by design, as we prioritized literature that addressed a wide array of social impacts. It is important to note that some reports present results on several impacts, so there are more impacts than reports.

- Within *social—livelihoods, wealth, and quality of life*, the most common specific impacts identified in the secondary information review are improvements specific to women, community engagement/social inclusion, and increased or diversified income.

- Within *social—access to essential services,* the most common specific impacts identified are increased access to reliable water supply, increased electricity reliability/decreased outages, and increased access to education.
- Within *economic—employment opportunities*, the most common specific impacts identified in the secondary information review are direct permanent employment, increase in employment opportunities for women, and construction/temporary employment.
- Within *market development—energy sector security and resilience,* the most common specific impacts identified are reduced cost of power generation, increased entrants into energy markets, and increased governance capacity to regulate the energy sector.
- Within *market development—competitiveness and industrial development*, the most common specific impacts identified are expanded access to capital, increased small and medium enterprises (SMEs) in the market, and technology adoption.

Table 4. Frequency of DIs Identified in the Secondary Information Review (Level 2)

IMPACT AREA	COUNT
Social—Livelihoods, wealth, and quality of life	104
Social—Access to essential services	45
Economic—Employment opportunities	41
Market development—Energy sector security and resilience	37
Market development—Competitiveness & industrial development	27
Environmental—Ecosystem and biodiversity	16
Environmental—Soils and crop productivity	10
Social—Health and safety	7
Market development—Inclusiveness and energy justice	6
Economic—Economic value added (GDP)	5
Environmental—Water	3
N/A	1
Total	**302**

1.3 Frequency of DIs Identified in the CIF Portfolio

The IEc team reviewed 249 CIF projects across the CTF, SREP, PPCR, and FIP portfolios to identify references to specific types of DIs. The review focused primarily on three relevant sections of MDB project documentation: “Project Development Outcome (PDO),” “Development Impact Narrative,” and “Development Impact Targets or Estimates” (both with and without climate targets), and coded each identified DI using the same framework used in the secondary review. We also reviewed CIF’s DI coding to ensure alignment. The most frequently identified DIs within the CIF portfolio were generally similar to the most common DIs identified in the secondary information review. Table 5 summarizes the frequency of DIs identified in the CIF portfolio.

Table 5. Frequency of DIs Identified in the CIF Portfolio (based on review of project documents)

IMPACT AREA	CTF (N=93)	SREP (N=40)	FIP (N=43)	PPCR (N=73)
Social—Health and safety	17%	35%	0%	41%
Social—Livelihoods, wealth, and quality of life	49%	18%	65%	40%
Social—Access to essential services	51%	88%	5%	36%
Economic—Employment opportunities	62%	60%	26%	8%
Economic—Economic value added (GDP)	43%	30%	65%	14%
Environmental—Water	3%	3%	0%	22%
Environmental—Ecosystem and biodiversity	16%	5%	30%	10%
Environmental—Soils and crop productivity	1%	3%	56%	41%
Market development—Energy sector security and resilience	59%	80%	7%	8%
Market development—Competitiveness and industrial development	66%	88%	9%	14%
Market development—Inclusiveness and energy justice	35%	65%	42%	18%
Gender dimension	25%	73%	44%	70%
Local stakeholders' dimension	-	-	56%	60%
Note: Gray highlighting identifies development impacts that appear in documentation for >50% of projects.				

- Within *social—health and safety*, the most frequently identified DI was avoided health impacts from reduced fossil fuel combustion.
- Within *social—livelihoods, wealth, and quality of life*, the most frequently identified DIs in the CIF portfolio were increased or diversified income, wealth generation, increased ability to cope with shocks, improvements specific to women, improvements specific to vulnerable populations, and acquisition of transferable job skills.
- Within *social—access to essential services*, the most frequently identified DIs were expansion of electricity to new households/businesses, increased electricity reliability/decreased outages, reduced energy costs, and increased access to education (overall, and specifically for women/girls and vulnerable populations).
- Within *economic—employment opportunities*, the most frequently identified DIs were direct permanent employment, induced/indirect employment, direct earnings, induced/indirect earnings, increase in employment opportunities for women, and increase in employment opportunities for vulnerable groups.
- Within *market development—energy sector security and resilience*, the most frequently identified DIs were increased entrants into energy markets, energy system integration, and reduced fuel imports.
- Within *market development—competitiveness and industrial development*, the most frequently identified DIs were expanded access to capital, increased SMEs in the market, supply chain development, and reduced trade imbalance.
- Within *market development—inclusiveness and energy justice*, the most frequently identified DIs were business models targeting vulnerable groups and business models targeting women.

- Within *environmental—ecosystem and biodiversity*, the most frequently identified DIs were enhanced forest stocks and forest management planning.

1.4 Frequency of DIs Featured in Case Studies

DIs commonly identified in the case studies are summarized in Table 6. These DIs are a mix of DIs from both Level 2 and Level 3 of the taxonomy above. In characterizing DIs from case studies, the IEc team consolidated the findings into a one-page visual of DI coverage. For example, we provide one column for *access to essential services*, which includes access to safe drinking water, sanitization, health care, and/or education, as noted at the bottom of the table. This consolidation is also informed by how DIs are typically identified by stakeholders consulted for the case studies, as well as the methods and metrics available for assessing the DIs.

Table 6 uses the following color coding:

- The dark blue boxes indicate the DIs quantitatively assessed in the case studies.
- The light blue boxes indicate the DIs qualitatively assessed in the case studies.
- The gray boxes indicate DIs that could be realized through this investment impact pathway, but were not assessed for one or more reasons, such as expected timeframe of impact, scale of the project, or additional research and analysis requirements.

The DIs featured in the case studies reflect both the frequency of DIs identified in the CIF portfolio (from which the 13 case studies were drawn) and the specific cases selected. As shown in Table 6, employment gains and market development are the DIs most frequently assessed within the 13 case studies. For employment gains, 10 case studies quantify the DI, and another two assess it qualitatively. For market development, nine case studies quantify the DI, and another assesses it qualitatively. These DIs were found to be the most commonly identified across renewable energy projects as well as agricultural and forestry projects. The prominence of these DIs is consistent with their prevalence in the CIF portfolio, as discussed above. Accordingly, seven case studies assess reduced air pollutants, five of them quantitatively. Four case studies assess health or quality of life benefits quantitatively; another two address them qualitatively.

The prevalence of health impacts and reduced air pollution reflects, in part, the prominence of clean energy projects in the CIF portfolio that reduce air pollution by reducing combustion from fossil fuels. It also reflects a decision by CIF and the evaluators to examine health impacts from reduced air pollution in the modeling analysis and case studies. Gender equality benefits have extensive coverage; they are qualitatively assessed in four of the case studies, and quantitatively assessed in two others. This is consistent with the prevalence of these DIs in the CIF portfolio and with CIF's desire to better understand these impacts. Increased economic output/value added is analyzed in four case studies, but is identified as an implied or potential DI for six others; this likely reflects the fact that economic modeling was conducted only for deep-dives. Food security is notable in that three cases mentioned it as an implied or potential DI, but no case study was able to analyze it; this speaks to the difficulty in measuring food security, which would require significant additional measurement work to determine household expenditures on food over time and/or household calorie intake over time.

Although the coverage of DIs identified and assessed provides information about this suite of cases, it is important to note that CIF and the IEc team purposefully selected cases for their potential to quantify DIs and, in particular, to use modeling approaches to expand coverage of DIs within deep-dive case studies. Lack of coverage of some DIs in the case studies should thus not be interpreted to mean a lack of connection between climate finance and any specific DI. The impact pathways shown in Figures 1 and 2 illustrate some of the broader connections between climate finance activities and DIs.

1.5 DIs Tracked by MBDs and Recommendations for Future Tracking

Table 7 presents MDB tracking of the common DIs featured in the case studies. By tracking, we are referring to MDB data collection on the DI as part of regular reporting in implementation status and results reports. Market development is the most commonly tracked DI; the MDBs tracked it in seven of the 13 case studies. The MDBs also tracked increased agricultural productivity (four cases), employment gains (four cases), reduced air pollutants (four cases), capacity building of local institutions (four cases), increased energy access (three cases), gender-related benefits (three cases), and community engagement (three cases). The IEc team evaluated these benefits in the case studies using the MDBs' data as well as new information from interviews and/or modeling analysis.

Increased economic output is not tracked by any MDB for the projects studied, which is understandable given the detailed modeling required to assess this DI. IEc modeled economic output for the Indonesia deep-dive. Improved working conditions and food security are not tracked by MDBs, likely because these are long-term and indirect results of CIF investments. However, the lack of tracking for other DIs does not have an obvious rationale. Access to essential services, tracked by only two MDBs, seems like a DI that could be readily assessed in some contexts. Similarly, electricity reliability, energy cost savings, and community engagement are DIs that appear to be likely candidates for expanded tracking, given that they are direct benefits of CIF projects, have standardized metrics available for tracking, and data typically exist to track these metrics.

Moreover, we note that three case studies had mentions of specific DIs in project formation documents that were not actually tracked by MDBs, as reflected in yellow highlighting. Table 8 summarizes the count of DIs included in project formation documents, versus those actually tracked by MBDs, and identifies DIs that were mentioned but not tracked.

Table 6. Case Study Coverage of Common DIs (including assessed and implied DIs)

Country	Sector/Subsector	Competitiveness and Industrial Development	Soil and Crop Productivity	Employment (of any type)	Economic Value Added (GDP)	Earnings (Construction and Permanent)	Expansion of Electricity to New Households and Businesses	Improved Working Conditions	Energy Sector Security and Resilience	Increased Electricity Reliability/ Decreased Outages	Energy Cost Savings	Access to Essential Services*	Reduced Air Pollutants	Health and Safety	Ecosystem and Biodiversity	Sustainable Land Use	Reduced Losses from Extreme Climate Events	Increased Food Security	Gender Benefits**	Community Engagement/ Social Inclusion	Capacity Building of Local Institutions
Bangladesh	Solar (rooftop)	Dark blue		Dark blue	Gray			Gray	Gray	Light blue	Dark blue		Light blue	Gray							
Bangladesh	Agriculture	Light blue	Dark blue	Dark blue	Dark blue	Light blue						Light blue			Light blue	Dark blue	Dark blue	Gray		Light blue	Light blue
Brazil	Agriculture	Dark blue	Dark blue	Dark blue		Gray							Dark blue		Dark blue	Dark blue		Gray	Dark blue	Light blue	
Brazil	Forestry	Dark blue		Dark blue	Gray	Light blue							Gray			Light blue	Light blue				
India	Solar (rooftop, parks), transmission	Dark blue		Dark blue	Light blue	Gray	Dark blue	Gray	Dark blue	Dark blue		Gray	Dark blue	Dark blue					Light blue		
Indonesia	Geothermal	Light blue		Dark blue	Dark blue	Light blue	Dark blue			Light blue		Light blue		Dark blue		Light blue			Dark blue	Light blue	Light blue
Indonesia	Forestry	Dark blue		Light blue	Gray	Light blue						Gray	Gray		Gray	Light blue			Light blue	Dark blue	
Kenya	Off-grid electrification	Gray		Dark blue	Gray	Gray	Dark blue		Gray	Dark blue		Gray	Dark blue	Gray							
Morocco	Solar (utility-scale)	Dark blue		Dark blue	Gray		Gray		Gray	Gray		Light blue	Gray	Dark blue							
Nepal	Biogas	Dark blue		Dark blue					Dark blue	Dark blue	Dark blue		Light blue	Light blue					Light blue		Dark blue
Niger	Agriculture		Dark blue	Light blue	Gray	Gray						Dark blue		Gray	Gray		Gray	Gray	Light blue	Dark blue	
Thailand	Wind (utility-scale)	Dark blue		Dark blue		Light blue			Light blue	Gray		Gray	Dark blue	Dark blue					Gray	Light blue	Light blue
Türkiye	Renewable energy and energy efficiency	Dark blue		Dark blue	Light blue				Light blue	Light blue		Light blue	Dark blue	Light blue					Gray	Gray	Gray

***Includes access to safe drinking water, sanitization, health care, and/or education.**

****Includes Social improvements specific to women, increase in employment opportunities for women, and business models targeting women.**

Legend:

- **The dark blue boxes indicate the DIs quantitatively assessed in the case studies.**
- **The light blue boxes indicate the DIs qualitatively assessed in the case studies.**
- **The gray boxes indicate DIs that could be realized through this investment impact pathway, but were not assessed for one or more reasons, such as expected timeframe of impact, scale of the project, or additional research and analysis requirements.**

Table 7. Tracking of Most Common DIs by MDBs

Case Study and Program	Sector/Subsector	Competitiveness and Industrial Development	Soil and Crop Productivity	Employment (of any type)	Economic Value Added (GDP)	Earnings (Construction and Permanent)	Expansion of Electricity to New Households and Businesses	Improved Working Conditions	Energy Sector Security and Resilience	Increased Electricity Reliability/ Decreased Outages	Energy Cost Savings	Access to Essential Services*	Reduced Air Pollutants	Health and Safety	Ecosystem and Biodiversity	Sustainable Land Use	Reduced Losses from Extreme Climate Events	Increased Food Security	Gender Benefits**	Community Engagement/Social Inclusion	Capacity Building of Local Institutions
Bangladesh SREP	Solar (rooftop)	✓										✓									
Bangladesh PPCR	Agriculture	✓	✓												✓		✓				✓
Brazil FIP	Agriculture		✓													✓			✓		
Brazil FIP	Forestry		✓	✓												✓					
India	Solar (rooftop, parks), transmission	✓											✓								
Indonesia	Geothermal			✓			✓													✓	✓
Indonesia	Forestry	✓																	✓	✓	
Kenya	Off-grid electrification						✓														
Morocco	Solar (utility-scale)	✓		✓									✓	✓							
Nepal	Biogas	✓																			✓
Niger	Agriculture		✓			✓													✓		
Thailand	Wind (utility-scale)			✓			✓					✓	✓								✓
Türkiye	Renewable energy and energy efficiency	✓											✓								
Total		7	4	4	0	1	3	0	0	0	0	2	4	1	1	2	1	0	3	2	4

***Includes access to safe drinking water, sanitization, health care, and/or education.**

****Includes services provided by ecosystems: provisioning (e.g., food, water, medicines); regulating services (e.g., pollination, filtering, waste management); and supporting services (e.g., water cycle, nutrient cycling).**

Table 8. DIs in Project Documents but Not Tracked by MDBs

COUNTRY	PROGRAM	SECTOR/SUBSECTOR	# OF DIS IN TRACKING PROJECT DOCUMENTS	# OF DIS TRACKED BY MDBS	DIS IN PROJECT DOCUMENTS BUT NOT TRACKED BY MDBS
Bangladesh	SREP	Solar (rooftop)	1	1	None
Bangladesh	PPCR	Agriculture	10	11	None
Brazil	FIP	Agriculture	7	4	Carbon sequestration*, increased farmer income, employment gains
Brazil	FIP	Forestry	2	2	None
India	CTF	Solar (rooftop, parks), transmission	2	2	None
Indonesia	CTF	Geothermal	11	10	Improved access to public services and infrastructure
Indonesia	FIP	Forestry	3	3	None
Kenya	SREP	Off-grid electrification	1	1	None
Morocco	CTF	Solar (utility-scale)	3	3	None
Nepal	SREP	Biogas	2	2	None
Niger	PPCR	Agriculture	4	4	None
Thailand	CTF	Wind (utility-scale)	9	6	Local/regional economic benefits, community engagement, and health benefits
Türkiye	CTF	Renewable energy and energy efficiency	2	2	None

***The Low-Carbon Agriculture (ABC) project in Brazil produced a study on GHG emissions and carbon sequestration, but carbon sequestration was not included in MDB implementation status and results reports.**

1.6 Links between DIs and the Sustainable Development Goals

The SDGs are a key framework used to align the global development community around common milestones and indicators. At an early stage of the evaluation design, we assessed how the SDGs might be used as one approach to respond to the evaluation questions. The SDGs comprise a variety of indicators, including inputs, outputs, outcomes, and impacts, but they are not presented in a theory of change format that would allow the user to understand how different indicators relate to one another or could be influenced by certain activities. The SDGs are also typically not industry- or activity-specific, although some researchers have created more industry-focused mapping for certain activities.

Given CIF's objectives of understanding *how* its activities contribute to DIs and the relative *potential and importance* of different DIs within the climate finance agenda, this evaluation instead started from CIF activities and resulting outputs, outcomes, or impacts, collectively the DI taxonomy and impact pathways outlined in this report. Some of these DIs naturally align with SDG indicators, but in many cases the DIs and pathways documented here are either more specific than the SDG indicators or measure a broader outcome or impact that could be an underlying precondition for other SDGs. For example, the DI "reduced costs of energy" would be a more specific element of SDG 7.1, universal access to affordable, reliable, and modern energy sources; or the DI "maturation of market structures" would encompass a range of market development indicators that would enable progress against other SDGs, such as SDG 8.2 "higher levels of economic productivity." As illustrated in Table 9 below, some DIs might also correspond to indicators for several SDGs, which would make it more difficult to use the overlapping SDG indicators to create climate finance impact pathways.

Climate finance practitioners with specific interest in their contributions to SDGs can use the DI taxonomy and impact pathways to assess overlap and potential alignment. Table 9 shows how the SDGs intersect with common DIs identified in the CIF case studies. We find an impressive degree of alignment, illustrating that climate finance DIs are in many cases similar to or directly related to SDG indicators, and are often aligned with more than one SDG. For example:

- Social DIs: Access to essential services is related to indicators in seven different SDGs and increased capacity of local institutions is related to indicators in 11 different SDGs, while other social DIs correspond to at least one SDG;
- Economic DIs: All three economic DIs are related to indicators in five SDGs, with a high degree of (but not exact) overlap between these five;
- Environmental DIs: All four are related to five to seven SDGs, with some overlap particularly on SDGs 11, 12, 13, and 15;
- Market development DIs: Competitiveness and industrial development corresponds to indicators for five SDGs, while energy security aligns with only one SDG.

Table 9. Comparison of Sustainable Development Goals and Common DIs Found in CIF Case Studies

DIs	1. No Poverty	2. Zero Hunger	3. Good Health and Well-Being	4. Quality Education	5. Gender Equality	6. Clean Water and Sanitation	7. Affordable and Clean Energy	8. Decent Work and Economic Growth	9. Industry, Innovation and Infrastructure	10. Reduced Inequalities	11. Sustainable Cities and Communities	12. Responsible Consumption and Production	13. Climate Action	14. Life Below Water	15. Life on Land	16. Peace, Justice and Strong Institutions	17. Strengthen Global Partnerships	Total
SOCIAL																		
Health and Safety			■															**1**
Access to Essential Services	■		■	■		■			■	■	■							**7**
Expansion of Electricity to New Households and Businesses							■					■						**2**
Increased Electricity Reliability/ Decreased Outages							■											**1**
Energy Cost Savings							■											**1**
Increased Food Security		■										■						**2**
Reduced Losses from Extreme Climate Events											■		■	■	■			**4**
Community Engagement/Social Inclusion										■						■		**2**
Capacity Building of Local Institutions	■		■			■		■	■	■	■		■		■	■	■	**11**
Improved Working Conditions								■										**1**
ECONOMIC																		
Economic Value Added (GDP)	■	■						■	■								■	**5**
Earnings (Construction and Permanent)	■	■						■	■								■	**5**
Employment (of any type)	■							■	■	■							■	**5**
ENVIRONMENTAL																		
Soil and Crop Productivity	■	■	■												■		■	**5**
Reduced Air Pollutants			■								■	■	■		■			**5**
Ecosystem and Biodiversity		■							■		■	■	■	■	■			**7**
Sustainable Land Use		■				■					■	■	■		■			**6**
MARKET																		
Competitiveness and Industrial Development	■						■	■	■								■	**5**
Energy Sector Security and Resilience							■											**1**
CROSS-CUTTING																		
Gender Benefits					■			■		■								**3**
Total	**7**	**6**	**5**	**1**	**1**	**3**	**5**	**7**	**6**	**6**	**6**	**5**	**5**	**2**	**6**	**2**	**6**	

Part 2. DI Results, Achievements, and Challenges of the CIF Portfolio

Key Findings

- At the portfolio level, economic modeling using the JIM finds that CIF investments have contributed to substantial employment impacts and tens of billions of dollars in economic value added. CTF impacts modeled using JIM are much larger than the other programs given the large scale of construction investment in utility-scale renewable energy projects under the CTF. However, JIM modeling shows employment impacts from investments across the CIF portfolio, as well as value added from project construction.
- The case studies showcase the breadth and diversity of DIs achieved by CIF-supported projects. Climate finance investments in the case studies have led to employment gains, competitiveness and industrial development, soil and crop productivity, sustainable land use, health benefits, and gender benefits.
- Several projects targeted expanded opportunities for women including employment in traditionally male-dominated fields and in community leadership roles. Additionally, the benefits for certain DIs are expected to particularly increase the wellbeing of women.
- Measuring DIs is essential but challenging. Common measurement challenges include requirements for regional or localized data and/or substantial measurement work or modeling requirements. Documenting and quantifying gender impacts is a particular challenge.
- While CIF/MDB project documents are generally comprehensive in listing the relevant DIs, more could be done to plan for, manage, and track specific economic DIs; maximize positive social DIs; and avoid or mitigate negative unintended social consequences.

This section presents key DI results across CIF's portfolio and in the case studies, noting several challenges in gathering the required measurement data. At the end, we discuss unintended impacts (positive and negative), including unexpected influences on DIs.

2.1 Portfolio Level JIM Modeling Results

CIF conducted a portfolio-level assessment of the economic impacts of the construction and operational phases of funded projects, using the Joint Impact Model (JIM). JIM is an input-output (I-O) modeling tool that relies on multipliers to estimate the effects that an initial change in economic activity has across an economy. Additional information about JIM, its methodology, and the limitations of I-O modeling approaches is provided in Appendix B.

Table 10 summarizes the results of modeling done by CIF with JIM to estimate the impacts of investments in the construction and operational stages of projects. CIF found that CTF projects had substantial indirect employment impacts during construction: up to approximately 1.75 million person-years employment from supply chain effects, and about 1.34 million person-years employment from induced economic activity. During construction, the CTF portfolio is also estimated to contribute as much as US$20 billion in direct value added and $19 billion value added from supply chain effects. The estimated impacts are much larger for CTF than for other programs, as they involve utility-scale renewable energy projects, whereas SREP and the climate resilience programs invest in smaller-scale activities. However, JIM modeling shows both supply chain and induced employment impacts from investments across the CIF portfolio, as well as value added from project construction.

Table 10. Summary of JIM Modeling Results by CIF Program

TYPE	PROJECT PHASE*	IMPACT LEVEL	CTF	SREP	PPCR	FIP	TOTAL**
Employment	Construction (temporary, in person-years)	Supply chain	1,753,036	122,632	164,533	144,214	2,184,415
		Induced	1,336,172	60,643	122,931	98,153	1,617,899
	Operations & maintenance (permanent, in jobs)	Energy-enabled	494,860	142,681	—	—	637,541
Value Added	Construction (temporary, in USD)	Direct	$20.85 B	$1.48 B	$1.85 B	$ 904 M	25.08 B
		Supply chain	$19.05 B	$631 M	$ 610 M	$ 349 M	20.64 B
	Operations & maintenance (annual value, in USD)	Energy-enabled	$3.93 B	$445 M	—	—	4.38 B

*** A person-year: one person employed full time for one year. Often used for manufacturing, installation, and construction employment, which may be temporary. For example, if a project has a construction duration of two years and supports 50 person-years of employment, this is equivalent to employing 25 people on a full-time equivalent basis for two years. The construction duration of projects varies according to project investment size, technology type, and/or energy sector intervention type.**

A job or full-time equivalent (FTE) equals one full-time position for the full operational life of the activity, facility, or project. Often used for permanent employment.

**** Summing across programs is performed under the assumption that employment and income impacts are not overlapping across the four program areas.**

A large share of the impacts shown in Table 10 is from supply chain and induced impacts. The JIM User Guide defines supply chain impacts as "impacts at the client company/project's suppliers and their suppliers," and induced impacts as "impacts associated with the spending of wages earned by employees of the client company/project, its suppliers and their suppliers." Also note that the figures in Table 10 summarize the number of jobs *supported* by each CIF program, not the jobs *created* by each program. More information can be found in the Indonesia deep-dive case study.

There are notable limitations to I-O models such as the JIM. First, I-O models rely on fixed functional relationships between inputs and outputs. For instance, if $1 million of output is produced, five employees are needed, where in reality, as a company grows there may be economies of scale, or synergies, between employees, so only three or four employees are needed to grow to $1 million in output. I-O models also assume there are no constraints on the supply of raw materials or employees (if more output is desired, materials and employees are always available), and are static with regard to prices (the price of labor never changes, regardless of the demand for employees). As a result, I-O models are best suited for assessing relatively small, short-term changes in demand. While CIF-supported projects typically involve multi-million-dollar investments, compared with total sector or country output, these investments are generally consistent with the type of small and/or short-term investments that I-O models are suitable to analyze. There is ongoing work to refine the JIM tool; users should interpret results cautiously, but can assume they point in the right direction.

2.2 Results and Achievements Featured in Case Studies

Key results and achievements across the case studies are presented in Table 11 (CTF and SREP cases) and Table 12 (FIP and PPCR cases). The tables are organized by DI, using the same common set of DIs in the taxonomy presented in Part 1. These tables are designed to provide mostly quantified, topline results across all cases, in a readable format. Many DIs that are qualitatively assessed in case studies are therefore not included. The tables showcase the breadth and diversity of DIs achieved by CIF-supported projects, including:

- **New renewable energy capacity:** This is a core climate objective of CTF and SREP projects, not a DI in our taxonomy, but it is important to note, as it paves the way for competitiveness and industrial development, and additional DIs. CTF and SREP projects resulted in extensive new renewable capacity, including over 4,000 MW of solar parks and 400 MW of rooftop solar in India, 1,815 MW of new geothermal capacity in Indonesia, 80 MW of rooftop solar in Bangladesh, and 88.5 MW of new wind capacity in Thailand. Across these three projects, new renewable capacity installed under CIF-funded projects totals 6,383.5 MW.
- **Competitiveness and industrial development:** Several projects had direct impacts on developing renewable energy markets, or markets for goods and services spurred by climate investments. In India, Morocco, Bangladesh, and Thailand, for example, projects funded by CIF acted as successful demonstrations that subsequently attracted private capital to establish and expand renewable energy markets. FIP projects also led to market development for Macaúba palm products in Brazil and ecotourism, honey harvesting, and bee keeping in Indonesia.
- **Employment:** Climate finance investments have led to direct employment gains in all 13 case studies. Across case studies, the IEc team identified at least 21,000 existing and projected direct jobs resulting from CIF investments, including both temporary and permanent direct jobs. The evaluation team was able to model indirect employment gains as well for two projects, totaling over 1,100 indirect jobs. In India, two solar rooftop programs are estimated to have created 8,545 direct jobs (construction and maintenance) and 900 indirect jobs (manufacturing of equipment) in the solar rooftop industry. In Indonesia, to date, the completed Geothermal Clean Energy Investment Project (GCEIP) led to the creation of 4,800 direct jobs. For geothermal projects in Indonesia that are not finalized, projections and modeling results suggest that 2,120 MW in added geothermal capacity by 2030 can directly create 4,350 long-term jobs and indirectly support more than 27,000 jobs.[5]
- **Expansion of electricity to new households and businesses:** CIF projects provided new or more reliable energy access to at least 130,000 households and businesses. This includes over 116,000 households that will benefit from one of the main geothermal projects in Indonesia, as well as

[5] The updated planned installed capacity for CTF-funded geothermal projects in Indonesia is 1,815 MW. The CGE modeling results were based on 2,120 MW due to the inclusion of a project that was cancelled.

13,500 people that will obtain new reliable energy access from the Kenya off-grid electrification project.

- **Improved soil and crop productivity:** PPCR and FIP case studies demonstrated increased agriculture or livestock productivity. For example, project areas in Niger were found to have on average 59 percent higher crop yields (462 kg/hectare annual yield in project sites, compared with 290 kg/hectare annual yield in control sites) and to be more resilient than control sites. In Brazil, the introduction of sustainable land management practices increased cattle stocking rates from 0.7 to 2.5 animals per hectare and cattle weight gain from 400 to 900 grams per day while reducing the time to slaughter by 17 months.
- **Increase in conservation and sustainable land use:** Projects targeting sustainable agriculture and forestry increased the amount of land under sustainable management. Some projects, including work in Brazil and Niger, expanded the number of rural producers employing sustainable management practices including crop choice, water management techniques, and tillage systems. Under the Community Action Project for Climate Resilience in Niger (CAPCR-1 and CAPCR-2), an estimated 313,296 rural producers adopted at least one sustainable land and water management practice. In Brazil, the Sector Plan for the Mitigation and Adaptation of Climate Change for a Low Carbon Emission Agriculture (ABC Plan) project resulted in approximately 3,000 farms employing sustainable management practices. Work in Brazil also targeted legal protections for land, increasing forest conservation areas by 34 percent. In Brazil and Niger, these practices lead to an estimated 6,600,000 and 24,743 tons of CO_2 equivalent sequestered, respectively.
- **Health and safety (health benefits):** Nine of the 13 case studies observed or expected health benefits due to expanded access to essential services, increased capacity of institutions, and the reduction of air pollutants. Case studies for Indonesia, Morocco, and Thailand quantified the substantial health-related savings from the expansion of renewable energy generation. In Morocco, for example, the expansion of solar generated power avoids fossil fuel emissions of 1,120 tons/year of NOx and 4,240 tons/year of SOx. The resulting health benefits are estimated at $6.9 million; this value is based on societal willingness to pay to avoid disease and death caused by air pollution. In Thailand, CTF-funded wind projects' reduction of public exposure to pollutants resulted in the avoidance of $0.8–1.46 million in health-related expenses nationally.
- **Cross-cutting gender-related DIs:** Several projects targeted expanded opportunities for women, including employment in traditionally male-dominated fields and community leadership roles. The ABC project in Brazil trained 2,300 female producers and 1,781 female field technicians in sustainable management practices. The FIP Sustainable Forest Management projects in Indonesia are expected to benefit more than 30,000 women. Besides contributing to economic empowerment, the projects also support women's involvement in community conflict resolution and women-proposed and women-led forestry initiatives. The achievement of certain DIs is also expected to particularly benefit women. In Nepal, for example, the health benefits from the substitution of harmful cooking fuels with biogas are expected to accrue more significantly to women, who are most likely to prepare meals.

The evaluation team is limited in its ability to directly compare results across cases using standardized metrics, such as benefits per hectare, or jobs created per dollar invested, because metrics and measurement vary widely across cases, and typically, quantification of benefits was partial. For example, projects often had employment information available for one or more components, but not all. The same was true for information on impacts of agricultural practices. In these situations, it is not appropriate to derive a ratio of benefit per investment or per land measurement, because we would be comparing a partial benefit in one intervention with a whole denominator in another. Moreover, we cannot scale down the denominator to match the partial benefit for most DIs and most cases, also due to data limitations.

Table 11. Key Results and Achievements of Renewable Energy Case Studies (CTF, SREP)

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
Competitiveness and Industrial Development	Bangladesh light-touch	Solar (rooftop)	23 rooftop solar PV projects have been approved to date, with a combined capacity of 80 MW. This is estimated at half of the rooftop industrial solar projects in the country.	80 MW of renewable energy capacity
	India light-touch	Solar (parks, rooftop), transmission	Over 4,000 MW of solar parks capacity and 400 MW of rooftop solar in India have been or will be installed. The seven programs have leveraged $2,047 million in co-financing and have played a catalytic role in developing investors' interest in solar rooftop and solar park projects and improving financing conditions.	Over 4,400 MW of renewable energy capacity
	Indonesia deep-dive	Geothermal	Due to CIF-backed geothermal projects, the target of 23% RE capacity nationwide by 2025 was exceeded on the local level with the development of geothermal energy in North Sulawesi, where geothermal accounted for the largest share of the electricity mix in 2021 (28%). $483.25M in CIF investments and $1,122.5M of MDB co-financing mobilized a total of $3,971.35M into geothermal energy. Actual and forward-looking geothermal capacity expansion in Indonesia supported by CIF amounts to 1,815 MW, of which at least 320 MW are completed.	1,815 MW of renewable energy capacity $3,971.35M of co-financing mobilized
	Morocco light-touch	Solar (utility-scale)	The project successfully attracted private capital to expand utility-scale solar power. The PPP structure used for the project helped to reduce risk premiums, and the low-cost debt provided by institutions is estimated to have reduced project costs by 20% compared to commercial loans.	$168M public (25%) and private (75%) capital mobilized
	Nepal deep-dive	Biogas	The project led to $18.43M of investments ($7.75M public, $10.68M private) in a local, large-scale biogas market. The technical assistance supported the promotion and adoption of new technologies and provided training and awareness raising concerning the biogas market. The project created an opportunity for biogas producers to sell not only bottled biogas, but also high-quality organic fertilizer and an opportunity for biomass producers to sell biomass as a feedstock for biogas production. This may lead to reduced import bills for chemical fertilizers and petroleum products in Nepal as chemical fertilizers are replaced by locally produced organic fertilizers from the biogas plants (digestate) and biogas is used to make CNG to fuel transport vehicles. More than 88,000 metric tons of organic fertilizer are produced each year as a result of the project, which could substitute up to an estimated $34M in fertilizer imports.	$18.4M mobilized in biogas market Produced 88,000 tons/year of organic fertilizer, replacing up to $34M worth of fertilizer imports
	Thailand deep-dive	Wind (utility-scale)	CTF-funded projects installed 88.5 MW of annual wind-power electricity capacity. From 2014 to 2017, the Theppana facility generated 57.3 GWh, and from 2017 to 2019, the Subyai plant generated 325 GWh. These first-mover projects also paved the way for the construction of additional facilities, resulting in an installed wind-power capacity of 1,510 MW in 2020 in Thailand.	88.5 MW directly installed wind capacity, leading to installation of 1,510 MW more

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
	Türkiye light-touch	Renewable energy and energy efficiency	The project helped remove existing barriers to investments in renewable energy systems in Türkiye. It also created new energy efficiency markets that continue to operate with the involvement of the two Turkish development banks.	n/a
Employment (of any type)	Bangladesh light-touch	Solar (rooftop)	The project has employed approximately 153 people to-date, with a total of 334 jobs expected by December 2021, and approved projects forecast the creation of 1,978 jobs.	153 jobs to-date and 1,978 forecasted jobs from approved projects
	India light-touch	Solar (parks, rooftop), transmission	The two solar rooftop programs are estimated to have created 9,604 direct jobs (i.e., construction and maintenance) and 950 indirect jobs (i.e., manufacturing of equipment) in the solar rooftop industry. Job creation is not estimated for the other programs (but could be expected to have similar effects).	9,604 FTEs direct jobs and 950 FTEs indirect jobs
	Indonesia deep-dive	Geothermal	To date, the completed Geothermal Clean Energy Investment Project (GCEIP, 150 MW) has led to the creation of 4,800 direct jobs. For projects that are not finalized, modeling results suggest that 2,120 MW in geothermal capacity to be added by 2030 can directly create 4,350 long-term jobs and indirectly support more than 27,000 jobs. Modeling results estimate economy-wide benefits of added geothermal capacity at $107M/year.	4,800 direct jobs and 4,350 projected direct, long-term jobs
	Kenya light-touch	Off-grid electrification	The KEMP project has already created direct, civil work employment opportunities where the mini grids are being installed, and it is expected to create future employment in construction and installation and later in operations and maintenance (O&M). Direct employment opportunities in technical and support services are also anticipated. It has been estimated that the off-grid subcomponent of the KEMP may translate into 88 direct short-term jobs (lasting for about one year), 10 annual direct jobs in O&M for a period of 25 years or the lifetime of the installed mini-grids, and 232 indirect short-term jobs.	88 direct short-term, 10 annual direct, and 232 indirect short-term jobs
	Morocco light-touch	Solar (utility-scale)	The project directly and indirectly created job opportunities: 1,977 temporary jobs during the construction phase and 78 permanent jobs during the operation phase. The latter include 61 jobs created in 2021, employing eight women and 27 local residents.	1,977 temporary and 78 permanent jobs during the project's first phase**
	Nepal deep-dive	Biogas	The biogas plant in operation is expected create 20 jobs in plants converting municipal solid waste to energy, and 50 jobs in commercial biogas plants. In the construction phase, the projects can temporarily employ up to 200 people. Additionally, the projects result in indirect job opportunities through the supply chain of the project (e.g., in waste collection and segregation), though the high-level technical skills still need to be brought over from India. Based on the number of plants constructed, the program is estimated to have directly generated about 1,000–1,200 jobs at biogas facilities across Nepal.	1,000–1,200 direct operational jobs, plus up to 200 temporary jobs in construction

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
	Thailand deep-dive	Wind (utility-scale)	The two CTF-funded wind-power facilities created a combined 669 construction jobs and 38 permanent positions. At minimum, 50 females were employed in temporary construction positions.	669 temporary jobs and 38 permanent jobs
	Türkiye light-touch	Renewable energy and energy efficiency	Significant direct and indirect job creation among principal stakeholders in the project (financial institutions), their contractors and suppliers of related machinery, and people employed during construction, operation, and maintenance of the facilities. Job creation was particularly high during implementation of energy efficiency measures, especially in (cascaded) hydro projects during their construction, but the project also created permanent jobs in the wider industry.	n/a
Earnings (Construction and Permanent)	Nepal deep-dive	Biogas	Using cattle farmers' waste as feedstock for biogas production provides additional income based on the waste volumes generated, averaging an estimated $188/month. Municipalities and other biomass suppliers could also reduce waste management costs.	$188/month additional income for cattle farmers
Expansion of Electricity to New Households and Businesses	Kenya light-touch	Off-grid electrification	It is anticipated that the installation of the KEMP mini-grids will bring electricity to about 13,500 people in remote parts of Kenya that previously had little or no electricity access.	13,500 people with reliable electricity access
	Indonesia deep-dive	Geothermal	New geothermal capacity can greatly increase energy access in vulnerable communities, where improved education and labor productivity can translate into human capital benefits of approximately $27 billion. Just one of the projects, GEUDP, is projected to increase energy access to 116,411 households or 582,000 individuals by 2025.	116,411 households with increased energy access (GEUDP)
	Nepal deep-dive	Biogas	As of 2021, 275 businesses have improved energy access (target of 350). Improved energy access for households was not monitored, but replacing fossil fuels with biogas makes heating/electricity more affordable for the local population, with energy costs savings ranging from 25% to 30%.	275 businesses with improved energy access
Energy Sector Security and Resilience	India light-touch	Solar (parks, rooftop), transmission	By replacing fossil-sourced energy with solar power, the seven projects have avoided the annual consumption of about 4.7 million tons of coal and 1.0 ton of oil equivalent (toe) of diesel.	4.7 Mt of coal use and 1.0 toe of diesel use avoided per year
	Nepal deep-dive	Biogas	The biogas produced replaced an estimated 600,000 cylinders of imported liquefied petroleum gas (LPG), valued at more than $5 million (or even more when energy prices are higher). The project has also improved on-site energy security for the project beneficiaries, which improves their productivity and indirectly creates more jobs.	600,000 replaced LPG cylinders, or $5M in import substitutions
Increased Electricity Reliability/ Decreased Outages	Bangladesh light-touch	Solar (rooftop)	Qualitative only. Because of reliability problems, Bangladeshi RMG factories often operate on diesel generators, which are expensive and a significant source of air pollution and resulting health impacts. Factories that install rooftop solar reduce or eliminate their reliance on these generators, which reduces costs for factory owners and avoids air pollution and GHG emissions.	n/a

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
Energy Cost Savings	Bangladesh light-touch	Solar (rooftop)	Average on-bill savings for factory owners is estimated at $1,700 annually. Adding storage to existing solar installations has the potential to unlock extensive on-bill savings, especially for factories that run during peak demand evening hour	Average of $1,700 in annual on bill savings
Reduced Air Pollutants	India light-touch	Solar (parks, rooftop), transmission	The displacement of fossil energy with solar energy from these seven projects has so far led to the avoidance of 10.4 million tons of CO_2. The seven projects are estimated to avoid $946 million of emissions-related socioeconomic damages annually, based on the social cost of carbon in India. The displacement of fossil energy with solar energy from these seven projects has so far led to the avoidance of 14,600 tons of SO_2, 6,200 tons of NOx, and 1,400 tons of $PM_{2.5}$ per year.	10.4 Mt CO_2 total emissions avoided $946M/year avoided emissions related costs 14,600 tons of SO_2, 6,200 tons of NOx, and 1,400 tons of $PM_{2.5}$ avoided per year
	Nepal deep-dive	Biogas	SREP subprojects have avoided about 91,000 tons of CO_2e per year, projected to amount to 1.82 Mt CO_2e over a 20-year lifetime of the biogas plants.	1.82 Mt CO_2e total emissions avoided over project lifetime
Health and Safety	India light-touch	Solar (parks, rooftop), transmission	The seven solar projects are estimated to avoid $1.36 billion of health-related costs annually, mostly from costs related to respiratory diseases linked to particulate matter.	$1.36B/year avoided health related costs
	Indonesia deep-dive	Geothermal	Geothermal electrification will result in health benefits from reduced reliance on fossil fuels (e.g., diesel generators) valued at more than $2 billion.	More than $2B avoided health related costs
	Morocco light-touch	Solar (utility-scale)	Generation of electricity through the Noor Ouarzazate I CSP plant avoided emissions of pollutants to the air that would otherwise have occurred if the same electricity had been generated from fossil sources. It is estimated that the plant displaced 68 GWh of coal, 54 GWh of gas, and 249 GWh of fuel oil—based on an ONEE study. Using economic valuation methodologies, the value of the CO_2 emissions reduction and health benefits were also estimated at US$7.1 million and $6.9 million, respectively.	1,120 tons/year of NOx and 4,240 tons/year of SOx emissions avoided $6.9 million avoided health related costs

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
	Thailand deep-dive	Solar (utility-scale)	The emissions reduction from CTF-funded facilities reduced public exposure to pollutants, avoiding $0.8–1.46 million in health-related expenses nationally. Additional avoided health impacts are expected from non-CTF funded facilities that were enabled by first-mover projects demonstrating the financial viability of utility-scale wind power and easing the regulatory environment.	$0.8–1.46M in health-related savings
Gender-Related Benefits	Nepal deep-dive	Biogas	Reduction of harmful cooking fuels particularly improves the health of women and reduces the time needed to collecting fuel wood, cooking and cleaning. There are also increased employment opportunities for women, particularly related to waste sorting.	n/a
Capacity Building of Local Institutions	Nepal deep-dive	Biogas	The project originally planned to train eight companies in evaluating and appraising large biogas subproducts, but as of 2021, 40 companies have been trained.	40 companies trained

Notes:
*** This table is designed to provide mostly quantified, topline results across all cases. Therefore, many DIs that are qualitatively assessed in case studies are not included in this table.**
**** The Morocco light-touch case study focuses only on Phase 1 of the project, which was the CIF-funded phase. The Key Metrics column reports figures for Phase 1.**

Table 12. Key Results and Achievements of Forestry and Resilience Case Studies (PPCR, FIP)

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
Competitiveness and Industrial Development	Indonesia light-touch	Forestry	The CIF-SFM projects contributed to market development and the promotion of new economic activities, in fields such as ecotourism, honey harvesting, and beekeeping, among others. FIP-1 supported the development of processing houses for coffee, lemongrass, rubber and pepper, and nursery facilities. Most of the beneficiaries were farmers and fishers, and people who had no permanent jobs.	n/a
	Brazil light-touch	Forestry	The project has planted 2,431 hectares of the Macaúba palm tree, which grows outside of typical rainforest zones and can be planted in agroforestry schemes (including on existing pastures), as an alternative to traditional monoculture palm plantations.	2,431 hectares planted
Soil and Crop Productivity	Brazil deep-dive	Agriculture	Cattle productivity increased significantly on participating ranches; stocking rates grew from 0.7 to 2.5 animals per hectare; cattle weight gain increased from 400 to 900 grams per day; and time to slaughter decreased from 36 to 19 months.	Increase of 1.8 animals/ha and increase of 500 grams/day for cattle weight gain
	Bangladesh deep-dive	Agriculture	Cropping intensity increased by approximately 12% annually in the Rabi season, and many farmers have introduced new, profitable crops, including watermelon. Cropping intensity in the other seasons has not increased due to several factors, including the need for re-excavation of canals and work on sluice gates to better control water flows and salinity.	12% increase in cropping intensity (Rabi season)
	Niger light-touch	Agriculture	Crop yields in project areas were consistently higher (59% on average) than crop yields in control sites not addressed by the projects throughout the 2015–2020 project period studied. Additional analysis found crop yields in project sites have been more resilient to external factors (e.g., variability in temperature and rainfall) than control sites, with an average overperformance of 24%.	59% increase in crop yields relative to control sites
Employment (of any kind)	Bangladesh deep-dive	Agriculture	By 2032, nearly 25,000 jobs per year will be supported by increased agricultural revenues in the region.	25,000 jobs
Economic Value Added (GDP)	Bangladesh deep-dive	Agriculture	By 2032, the $56 million increase in annual agricultural revenue will generate another $50 million in annual value added, including increased wages (41%), savings or profits (56%), and taxes (less than 4%).	$50 million in value added
Earnings (Construction and Permanent)	Bangladesh deep-dive	Agriculture	Polder rehabilitation will increase overall agricultural revenue by providing protection from storm surge and riverine flooding, as well as improving cropping intensity and farmers' ability to plant more profitable crops. According to crop revenue modeling, by 2032, the total annual benefits to farmer revenues from polder rehabilitation are estimated at $39–73 million annually, for an average of $56 million annually, relative to a business-as-usual scenario. This equates to about $90/hectare. The primary factors	$90/ha of revenue benefits

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
			increasing revenues are storm surge protection, tidal flooding protection, and cropping intensity increase.	
	Brazil deep-dive	Agriculture	Beneficiary producers in the ABC projects had an average income growth 2.7 times higher than producers in the control group and a 24–48% reduction in total costs.	2.7 times higher average income growth than in control group
	Brazil light-touch	Forestry	The Macaúba tree offers additional income to farmers, particularly outside the coffee season. When the trees become productive in the fifth year after planting, INOCAS buys Macaúba from the farmer, for a fixed price annually that is corrected for inflation, removing market risk. The project is expected to increase revenues and income, with a guaranteed annual price of $80/ton. Gross farmer revenue is expected to grow from $26,016 in year 1 to $265,598 USD in year 20. Additional income is expected from intercropping; 10 farms have signed contracts to plant crops such as cassava on 273 hectares.	$239,582 increase in gross farmer revenue projected from project year 1 to year 20
	Indonesia light-touch	Forestry	The CIF-SFM projects have improved livelihoods by providing monetary and non-monetary benefits. Monetary benefits were reflected in the communities' increased income from activities such as honey production and packaging.	71,000 people have benefited, including about 16,300 members of ethnic minorities and 32,300 women
Ecosystem and Biodiversity	Brazil deep-dive	Agriculture	This project will likely lead to expansion of pollinator habitat. If all pasturelands in the area were restored using practices promoted by FIP, pollinators would have access to 75% of the soy crops and nearly all of the coffee crops in the biome. This may improve crop productivity and/or reduce the need for farmers to provide replacement pollination services for their crops.	n/a
Sustainable Land Use	Brazil deep-dive	Agriculture	The ABC projects achieved a net carbon sequestration of 6.6 Mt CO2e relative to a control group that did not adopt improved land management practices. The ABC project resulted in a direct increase of 93,844 hectares of agricultural tracts using improved management practices, over nearly 3,000 farms. In addition, the ILM project introduced low-carbon agriculture practices on more than 11,000 ha and the DGM project spread sustainable landscape management practice over 831 ha.	6.6 Mt CO2e carbon sequestration 93,844 hectares (2,945 farms) with pasture recovery
	Brazil light-touch	Forestry	The project has planted 2,475 hectares of Macaúba, with 340 farmers and their families, establishing 114 ecological corridors to protect local biodiversity and sequestering 34,292 tons of CO_2.	34,292 tons of CO_2 sequestered

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
				2,475 ha planted, 114 ecological corridors established
	Niger light-touch	Agriculture	Targeted individuals had high corresponding adoption rates of sustainable land and water management (SLWM) practices, with 77% of the 406,878 rural producer project beneficiaries adopting at least one SLWM practice.	77% of rural producers targeted adopted at least one SLWM practice
Community Engagement/Social Inclusion	Indonesia light-touch	Forestry	The CIF-SFM projects have led to the operationalization of 10 Forest Management Units (FMUs), and training of government and farmer groups. The projects also allowed the rollout of Knowledge Management and Information Systems and a Knowledge Resource Center. DGM-1 has supported vulnerable groups to obtain recognition of tenure rights.	Capacity building for 5 government institutions 95 farmer groups supported with business development programs
	Niger light-touch	Agriculture	Nearly 500,000 rural producers and poor households in the targeted 38 communes were project beneficiaries (resulting in direct benefits experienced by 2.4 million people, about half of them women).	2.415 million direct beneficiaries
Gender-Related Benefits	Brazil deep-dive	Agriculture	The ABC project had 2,931 clients who adopted ABC technologies, 475 of whom were women (81% of the original target of 586 women).	2,931 clients adopted ABC technologies, 475 of whom were women
	Brazil deep-dive	Agriculture	By the end of the ABC project, 25–30% of participating farms were led by women or had strong participation by women. Evaluations indicated that women's involvement had a positive influence, particularly on the speed of implementation. DGM projects were particularly successful in attaining their gender empowerment objectives, due to the specific focus of activities in this area.	2,300 women received training and/or technical assistance (20.2% of the total); 1,781 female field technicians trained (22% of the total)
	Indonesia light-touch	Forestry	The projects have led to increased participation of women in some economic activities and have contributed to closing the gender gap, with women adopting traditionally	197 women trained

DI CATEGORY	CASE STUDY	SECTOR/ SUBSECTOR	SUMMARY OF RESULTS/ ACHIEVEMENTS	KEY QUANTIFIED METRICS*
			male-dominated roles within their communities. Women have benefited from capacity building programs, and as a result, the number of forestry projects proposed and led by women in the country has increased. In addition, the CIF-SFM projects have enhanced women's conflict resolution role in their communities and have strengthened the conditions for sustaining women's participation.	2,230 women benefited from DGM-1 activities
Capacity Building of Local Institutions	Niger light-touch	Agriculture	By May 2021, all 38 communes participating in the project had incorporated strategies and budgeting to build climate resilience into Local Development Plans (LDPs) and Annual Investment Plans (AIPs). Eight Maison du Paysan facilities/integrated service delivery platforms were fully operational, and five were partially operational.	n/a

Note:
***This table is designed to provide mostly quantified, topline results across all cases. Therefore, many DIs that are qualitatively assessed in case studies are not included in this table.**

2.3 Measurement Challenges

While Parts 2.1 and 2.2 focused on *achieving* DIs, *documenting and/or quantifying* DIs can be challenging. Common challenges include the requirements for regional or localized data (e.g., electricity production and emissions factors, local epidemiological data to estimate health impacts), and/or the substantial measurement work or modeling required, which would not be practical to conduct for every project (e.g., crop modeling and economic modeling). Some of the key measurement challenges and our recommendations to address them are discussed below. It is important to note that as development institutions, all the MDBs have results-based management systems at the project level that focus on development impacts and indicators to measure them. Since projects have finite resources for monitoring and evaluation, they cannot realistically measure all the DI areas of potential interest. Instead, they necessarily focus on a limited number of core indicators chosen to capture the primary results objectives of the project. However, insofar as DIs are major objectives, resources should be dedicated to measuring them effectively. Where they go beyond the core focus of the project, they may be "nice to have," but might not be able to be prioritized within a project's own measurement systems.

Other challenges also hamper the measurement of DIs. There are long lead times before some DIs materialize, especially those DIs linked to recovery of natural systems. For example, the Bangladesh Coastal Embankment Improvement Project, featured in a deep-dive case study, reduced saltwater intrusion into farmland, which gradually improves soil quality over many years, and facilitates increased cropping intensity. Complex linkages between investments in development and climate resilience make the attribution of DIs to climate finance challenging. For example, recovery of the Cerrado biome is a long-term goal of CIF-funded FIP projects in Brazil, and a potential DI associated with this goal is increased soy and coffee crop productivity that results from growing crops in a healthier ecosystem. However, analyzing these impacts is complex. The case study used ecosystem benefits modeling to explore potential impacts on pollinator abundance, one indicator of ecosystem health. A scenario-based modeling approach was utilized as actual pastureland restoration was still ongoing, many years after the launch of the program. The scenario-based modeling indicated that if all pasturelands were restored in the area, pollinators would have access to 75 percent of the soy crops and nearly all coffee crops in the biome. This may improve productivity of these crops and/or reduce the need for farmers to provide replacement pollination services for their crops. However, this is a modeled relationship based on a future potential end state. Moreover, crop productivity is driven by many factors outside of pollination. Finally, the FIP projects were only part of Brazil's overall investment in restoring the ecological health of the Cerrado. All these factors complicate the ability to attribute DIs to climate finance.

Regional or localized data requirements

Renewable energy projects require data on renewable energy production, the electric grid mix, and emissions factors to estimate what power generating sources (e.g., coal, natural gas) are displaced by renewables and the avoided emissions. While values could in some cases be gleaned from the literature (e.g., India solar projects), these were often based on global data or data from another country. Regional or localized data would be helpful for calculating DIs, including reduced air pollution, and energy security and resilience. For analysis of health impacts resulting from reduced air pollution, more detailed information about the location of future renewable energy sources and fossil-fuel based sources that may go offline due to inclusion of renewables would provide a more accurate spatial analysis (e.g., Thailand wind). Also, with sufficient local epidemiological information that details the relationships between air pollutant exposures and health impacts, future analyses could focus on specific health endpoints within the Thai population.

Substantial measurement work or modeling requirements

In Niger, measuring increases in agricultural productivity (crop yields) and silvopastoral productivity (forage yields) requires substantial measurement work. The calculation requires sample harvesting, drying, and weighing of crop yields from project and control sites. Care is needed to identify suitable sample sites to enable comparisons that reduce exogenous factors between sample and control sites. In Bangladesh, quantifying increased economic output/value added and improved income/livelihoods from the polder projects would require crop modeling and economic modeling. While these efforts could certainly be worthwhile (e.g., for large projects, to test different measuring/modeling strategies, and to improve understanding about DIs), this is probably not feasible or necessary for every project.

Difficulties documenting/quantifying gender impacts

In some cases, there were challenges with breaking down beneficiary data by gender. For example, the Nepal Extended Biogas project did not closely monitor DIs for women, including gender-disaggregated employment, even though benefits for local women were identified in project documents as potential outcomes (and were reported during case study interviews). In other cases, challenges include missing baseline data and/or results data, particularly when going beyond simple counts and considering more qualitative issues. For example, the Sustainable Forestry Management projects in Indonesia aimed to strengthen the participation and empowerment of women in traditionally male-dominated roles. Baselines describing the pre-intervention situation for women were difficult to establish, and metrics to measure impacts on women were not sufficient, according to interviewees. The information gleaned about impacts on women (e.g., enhanced conflict resolution role) was mostly anecdotal.

Survey requirements

Certain types of DIs would require a survey to assess more thoroughly, including changes in knowledge/skills and changes in attitudes/perceptions before and after a project intervention. For example, increased financial and energy literacy was an intended impact of the Türkiye renewable energy and energy efficiency project, but was difficult to quantify or document without survey data on local people's previous knowledge. Similarly, assessing the adoption of climate resilience practices and use of knowledge from training (Niger) requires household-level follow-up surveys/studies. For the polders project in Bangladesh, the current model of using a longitudinal household survey, administered by the third-party evaluator, to track changes in farming practices, incomes, and livelihoods is working very well for tracking DIs.

Data collection barriers

Certain types of data were unavailable for the case studies, but should be feasible to collect in future projects if the relevant indicators and measurement approaches are built into the project design, to ensure they are tracked during project implementation. For example, for the sustainable forestry project in Indonesia, there was very limited information about the constitution of the 10 forest management units (FMUs) and how this changed throughout the project (e.g., land area covered, number of farmers involved, etc.). There was also a lack of quantitative evidence on employment (or robust estimates of the number of jobs expected to be created) as a result of the promotion of new economic activities. In the Bangladesh rooftop solar case study, the available data only supported a qualitative assessment of more reliable electricity and reduced generator use; however, this type of information could be collected by local partners (e.g., local utilities or energy agencies).

Projected future DIs versus DI results

Some projects were still in progress and DIs were projected (e.g., Kenya mini-grids); in others, the benefits of large-scale replication or scale-up were projected using different scenarios about what will happen in the future (e.g., Thailand wind, Indonesia geothermal). While these estimates are valuable as indicators of the potential market transformation impacts of climate investments, a retrospective analysis in the future would seem warranted to confirm what was actually achieved.

Data-sharing limitations

In the renewable energy and energy efficiency case study in Türkiye, due to nondisclosure agreements (NDAs) between the borrowers and their customers, it was not possible to retrieve investment and impact data at the subproject level on the investments made by financial institutions benefiting from the credit lines provided by IBRD. Going forward, NDAs with project beneficiaries should allow funders to gather necessary (anonymized as necessary) data in order to monitor DIs and facilitate evaluation.

2.4 Unintended Impacts

This analysis defines unintended impacts as DIs (positive or negative) that were not anticipated in project plans and documentation, or unexpected circumstances that influenced the achievement of DIs.

Unanticipated DIs

Across the case studies, the IEc team tracked which DIs that were included in the impact pathways were referenced in project documents. If a DI was not referenced, it was counted as an unanticipated DI. Table 13 compares the DIs referenced in project planning documents with the DIs observed in the case studies. It shows that project documents are generally comprehensive; most project plans referenced the DIs that were eventually achieved. That is unsurprising, given that data collection measures were in place that enabled quantified analysis.

The most common unanticipated DIs were economic. Unanticipated economic benefits are typically more specific ways to evaluate an overarching DI of economic value added or employment gains. For example, the Nepal Extended Biogas Project planned for biogas market development, but did not specifically mention increased business opportunities. Similarly, the project mentioned energy security as a DI, but did not plan for reduced import costs. Typically, these unanticipated economic DIs are connected to planned DIs, as shown in the Climate Finance Impact Pathways presented in Part 1. Projects that take a theory of change/impact pathway approach to program design could better plan for and track these related DIs, and thus more comprehensively evaluate the economic DIs achieved.

In some case studies, we also found unanticipated social DIs resulting from varied accumulation of DIs across social groups. For example, investments in utility-scale wind power in Thailand resulted in unanticipated benefits from employment opportunities for women. Additionally, anecdotal reports indicated that beneficiaries used earnings and diversified incomes resulting from the project to support the education of women and girls. These social DIs would likely have been achieved on a greater scale if they were intentionally targeted through the project design and project management.

Table 13. DIs Observed and Referenced / Not Referenced in Project Documents

COUNTRY	PROGRAM	PROJECT	SECTOR	# OF DIS REFERENCED IN PROJECT DOCUMENTS	# OF DIS IDENTIFIED THROUGH THIS EVALUATION	DIS IDENTIFIED BUT NOT REFERENCED IN PROJECT DOCUMENTS
Bangladesh*	SREP	Improving and Protecting Agricultural Livelihoods in Bangladesh through Coastal Embankment Improvements	Solar (rooftop)	1	3	Employment opportunities (job creation); on-bill savings for ratepayers
Bangladesh	PPCR	Catalyzing the Industrial Rooftop Solar Market in Bangladesh	Agriculture	10	14	Better access to markets; health benefits; regional economic benefits: long-term direct and indirect induced job creation; regional economic benefits: value added
Brazil	FIP	Improving Agricultural Livelihoods in Brazil through Better Land Management and Low Carbon Agricultural Practices	Agriculture	8	10	Protection of critical habitats/expansion of pollinator habitat; decreased farmer costs
Brazil	FIP	Development of a Macaúba-Based Silvopastoral System and Value Chain	Forestry	15	15	—
India*	CTF	Scaling-up Solar Power Technologies	Solar (rooftop, parks), transmission	6	10	Health benefits; energy sector security and resilience; employment opportunities; increased electricity reliability
Indonesia	CTF	Economy-Wide Impacts of Expanding Geothermal Power Generation in Indonesia	Geothermal	11	18	Increased electricity reliability; increased labor productivity (from increased electricity reliability); local economic development; government income (tax revenue); education and awareness; geothermal market development; local institutional coordination
Indonesia*	FIP	Development Impacts of Sustainable Forest Management in Indonesia	Forestry	3	3	—
Kenya*	SREP	Development Impacts of Off-grid Electrification in Kenya	Off-grid electrification	1	4	Direct job creation; indirect job creation; reduced GHG emissions**

COUNTRY	PROGRAM	PROJECT	SECTOR	# OF DIS REFERENCED IN PROJECT DOCUMENTS	# OF DIS IDENTIFIED THROUGH THIS EVALUATION	DIS IDENTIFIED BUT NOT REFERENCED IN PROJECT DOCUMENTS
Morocco*	CTF	Noor - Ouarzazate I Concentrated Solar Power (CSP) Plant in Morocco	Solar (utility-scale)	3	3	—
Nepal	SREP	Development Impacts of Expanding Biogas Generation in Nepal	Biogas	10	14	Business opportunities; reduced import costs; reduced cost of waste management; reduction of land, air, and water pollutants
Niger*	PPCR	Mainstreaming Climate Resilience of Populations and Agricultural Production Systems in Niger	Agriculture	4	5	Institutional community engagement mechanisms
Thailand	CTF	Development Impacts of Private Sector Utility-Scale Wind Power in Thailand	Wind (utility-scale)	9	12	Diversified income; acquisition of transferable job skills; gender-related benefits
Türkiye*	CTF	Scaling up Renewable Energy and Energy Efficiency Projects in Türkiye	Renewable energy and energy efficiency	4	4	—

Notes:
*** Reflects only quantifiable DIs that were observed.**
**** Reduced emissions was not identified in the project documents for the off-grid electrification project in Kenya, but is being tracked as part of CIF's SREP Results Framework.**

In addition to the positive unintended DIs, there were instances where projects had negative development impacts. Specifically, two projects led to involuntary resettlement, which the projects anticipated and took steps to address in line with the MDBs' environmental and social frameworks. In the Indonesia sustainable forestry management project, some inhabitants of the project sites had to relocate to free up land for roads, installation of water pipelines, or ecotourism facilities. Depending on the type of impact, different forms of compensation were provided. Women and vulnerable people were invited and encouraged to attend negotiations. For the Kenya mini-grids project, the project documentation reported that the repurposing of land may result in involuntary resettlement. Precautions were taken to minimize the impacts on physical and cultural resources. These impacts were expected to be temporary (e.g., occurring during the construction phase) and minimal. It is important to note that due to the mostly remote data collection (as a result of COVID-19 travel restrictions that were in place at the time that we conducted the case study research), we relied heavily on project documents provided by the MDBs and interviews with MDB staff; we were not able to interview the impacted communities in Kenya and Indonesia to understand how they were affected by resettlement (e.g., economic, social, and/or mental health impacts). Understanding these impacts and the distribution of project benefits and costs across affected groups could be an important focus of future research.

In some cases, project documents anticipated the achievement of DIs, but did not accurately predict the communities that would benefit. For example, the development of a biogas market in Nepal was expected to generate local jobs, including in the high-skill area of routine maintenance. However, a shortage of skilled workers in Nepal meant facilities have to recruit maintenance experts from India. The jobs were still realized, but not the local benefits. While the accumulation of DIs in an unexpected location is not strictly a positive or negative outcome, it is important to note that it is a deviation from the project plans. To ensure that the realization of DIs is aligned with government priorities, projects should consider how to ensure that DIs are accruing for the anticipated communities (e.g., by providing training in maintenance skills to local populations to support local employment). These considerations should be intentionally built into project design and monitoring activities.

Unexpected Influences on DIs

While some external factors, such as the COVID-19 pandemic, are difficult or impossible to predict, other unexpected influences on DIs might have been anticipated and managed with additional planning and foresight. In the Kenya mini-grid project, an assessment of the construction of the mini-grids on one of the target islands predicted the project would create employment opportunities, particularly for casual workers from the local community, including masons and carpenters. However, interviewees indicated that the use of new technologies (e.g., automation and remote monitoring) may reduce some of the anticipated direct job creation at the local level. This finding points to the importance of planning for and accommodating lower labor intensities when introducing highly capital-intensive technologies. In such situations, planning for (and prioritization of) DIs around economic value-added and employment should anticipate and address diminishing returns to labor.

A unique but noteworthy unintended consequence was observed in the Brazil deep-dive, which evaluated multiple FIP projects aimed at promoting better land management and low carbon agricultural practices. The main challenge in achieving DIs was the identification and engagement of interested farmers and related project design issues, notably in relation to the experimental design of the Low-Carbon Agriculture (ABC) project. One of the main barriers was the deep hesitation of some farmers to adopt new practices, especially ones that were offered “free of charge,” which were viewed with suspicion. In addition, the experimental design of the ABC project disincentivized participation due to the risk of being assigned to the control group (one beneficiary group received only training, one beneficiary group received training and technical assistance, and a pure control group was not exposed to any treatment). This finding provides a cautionary note to make sure that rigorous project evaluation methodologies do not inadvertently compromise the intervention incentives and results. It is also crucial to respond robustly to participant perceptions, and to clearly articulate the potential gains or losses to participants (given that, in this instance, participation, even within the control group, posed no losses versus the business-as-usual case).

Overall, the evaluation findings indicate that while project documents are generally comprehensive in terms of including the relevant DIs, more could be done to plan for, manage, and track specific economic DIs; maximize social DIs; and avoid or mitigate negative social consequences. The Climate Finance Impact Pathways provide a useful first resource for funders to map the potential DIs associated with the planned investments and determine which DIs are of highest importance and/or probability and thus warrant inclusion in program design and monitoring plans.

Part 3. Drivers and Constraints Influencing DI Results in the CIF Portfolio

Key Findings

- Key categories of drivers and barriers to the achievement of DIs include: institutional, financial/investment, workforce/capacity development, technical/infrastructure, social inclusion, and programmatic/program management.
- Some drivers and barriers operate at a higher level than individual projects (e.g., policy frameworks) and require programmatic efforts to address, while others must be addressed at the project level given the highly context-dependent nature of interventions (e.g., the cultural attitudes and level of engagement of the local population) and the socioeconomic environments in which they are carried out.
- Realizing many DIs requires intentional project design, implementation, and monitoring.
- The effect of DIs is greater than the sum of the parts and should be analyzed synergistically. Certain DIs (such as market development, built capacity, social/gender inclusion, and local workforce development) are catalytic ("Super DIs") and influence the achievement of other DIs, necessitating even more careful attention in project planning and implementation.
- Projects that successfully engage and align the interests of government, private sector, and local/community stakeholders can unlock DIs through increased relevance, responsiveness, and buy-in, thereby leading to more robust market development and expansion.
- Concessional climate finance and innovative financing models that de-risk investments and demonstrate successful financial/business models can strengthen and enable deeper market development and economic DIs than would otherwise be achieved.
- Awareness and sensitivity to local concerns, and active steps to ensure social inclusion, are critical to achieve social DIs, gender benefits, and benefits for vulnerable populations.
- Capacity building to ensure that local communities can meaningfully participate in projects and realize DIs is a key driver that should be built into project design and followed through during project implementation.
- Technology and physical infrastructure can also help achieve DIs, if carefully managed.

This section delves deeper into the drivers and barriers that affect the achievement of DIs from climate finance. It begins with an overview of various types of drivers and barriers and a discussion of their impact on the achievement of DIs, and ends with a series of lessons learned.

3.1 Key Drivers and Barriers and Impact on Achievement of DIs

The IEc team categorized drivers and barriers based on the information collected and analyzed in the case studies. Categories include institutional, financial/investment, workforce/capacity development, technical/infrastructure, social inclusion, and programmatic/program management (which includes program design). These categories are defined in Table 14 (the tables in Appendix A list the key drivers and barriers identified in each case study).

Table 14. Categories of Drivers and Barriers to Achieving DIs

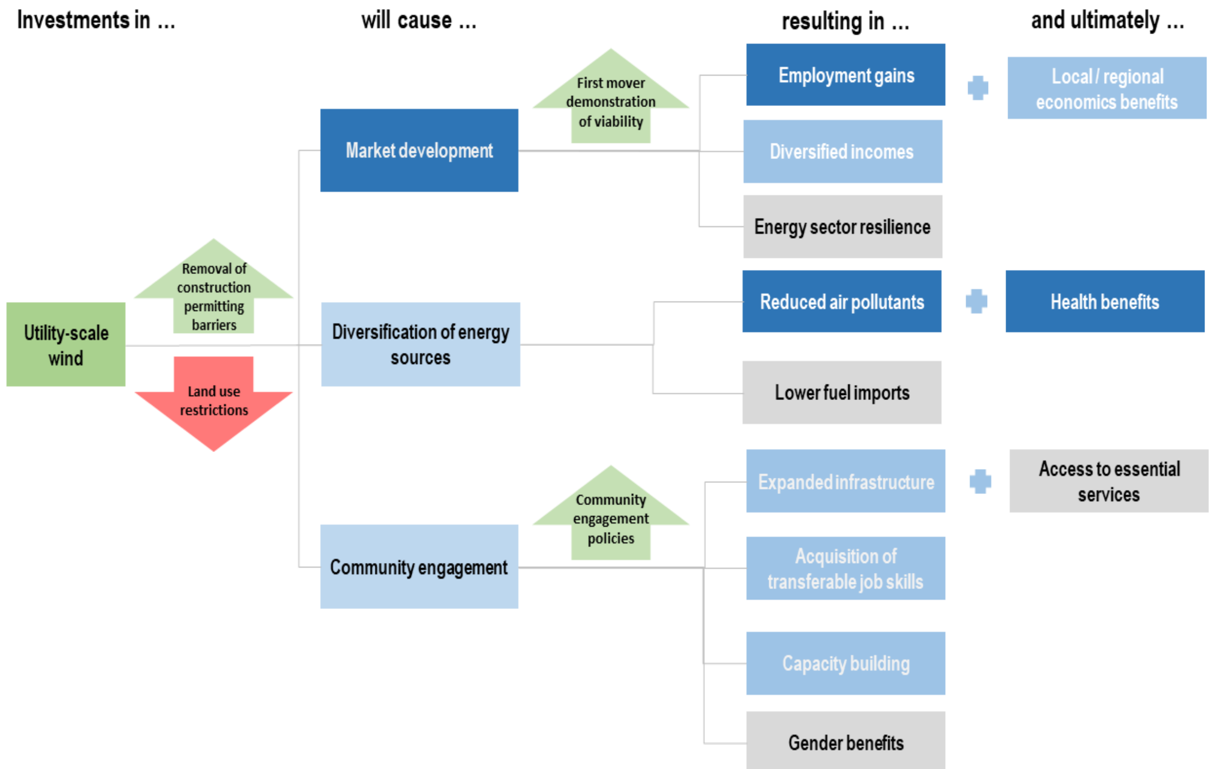
CATEGORY	DESCRIPTION
Institutional	Drivers and barriers related to government support, regulations, and policy framework
Financial	Drivers and barriers related to the availability and adequacy of financing
Capacity Building/Workforce Development	Drivers and barriers related to the capacity of government institutions, local organizations, and local workforces
Technical and Infrastructure	Drivers and barriers related to technology/infrastructure use or access
Social Inclusion and Involvement	Drivers and barriers related to the social inclusion and involvement of specific communities and vulnerable populations, including but not limited to women and girls
Programmatic Management	Drivers and barriers related to project planning and management including limitations of program design

Drivers and barriers strengthen or weaken the impact pathways to influence the achievement of DIs. They can influence any point of the impact pathways, from successful overall project implementation (which is generally a prerequisite for achieving any DIs), to the granular delivery of a specific DI. The drivers and barriers associated with overall implementation are not necessarily different from the factors generally associated with successful projects, such as a conducive regulatory environment and access to finance. However, because successful project design, implementation, and scale-up are usually necessary (though not always sufficient) for achieving DIs, these drivers and barriers were identified as important influencers of the achievement and magnitude of DIs across case studies. Drivers and barriers that relate to the granular delivery of a specific DI may be found further down the impact pathway.

Figure 3 shows how these drivers (as indicated by green, upward arrows) and barriers (as indicated by red, downward arrows) affect the DI pathways for utility-scale wind power in Thailand. The placement of "removal of construction permitting barriers" (green arrow) and "land use restrictions" (red arrow) at the beginning of the DI pathways shows how fundamental they are to the achievement of DIs. In Thailand, utility-scale wind power faced regulatory barriers that prevented the construction of wind turbines and thus the achievement of any resulting DIs. The project's coordination with the Government of Thailand was a key driver of the removal of permitting requirements for tall structures that had barred turbine construction (for both CIF-funded demonstration projects and subsequent replication projects). However, uncertainty about restrictions on wind facilities leasing land designated for agricultural purposes (on land owned by Thailand's Agricultural Land Reform Office) remains a barrier to the construction of wind facilities and the realization of resulting DIs.

As shown further along the impact pathway, community engagement policies (green arrow) directly influence the achievement of community engagement and resulting DIs such as acquisition of transferable job skills and capacity building. For example, the successful installation of wind turbines would not in itself have resulted in the acquisition of transferable job skills or capacity building benefits, absent effective community engagement policies.

Figure 3. Drivers and Barriers in the Impact Pathway for Utility-Scale Wind in Thailand

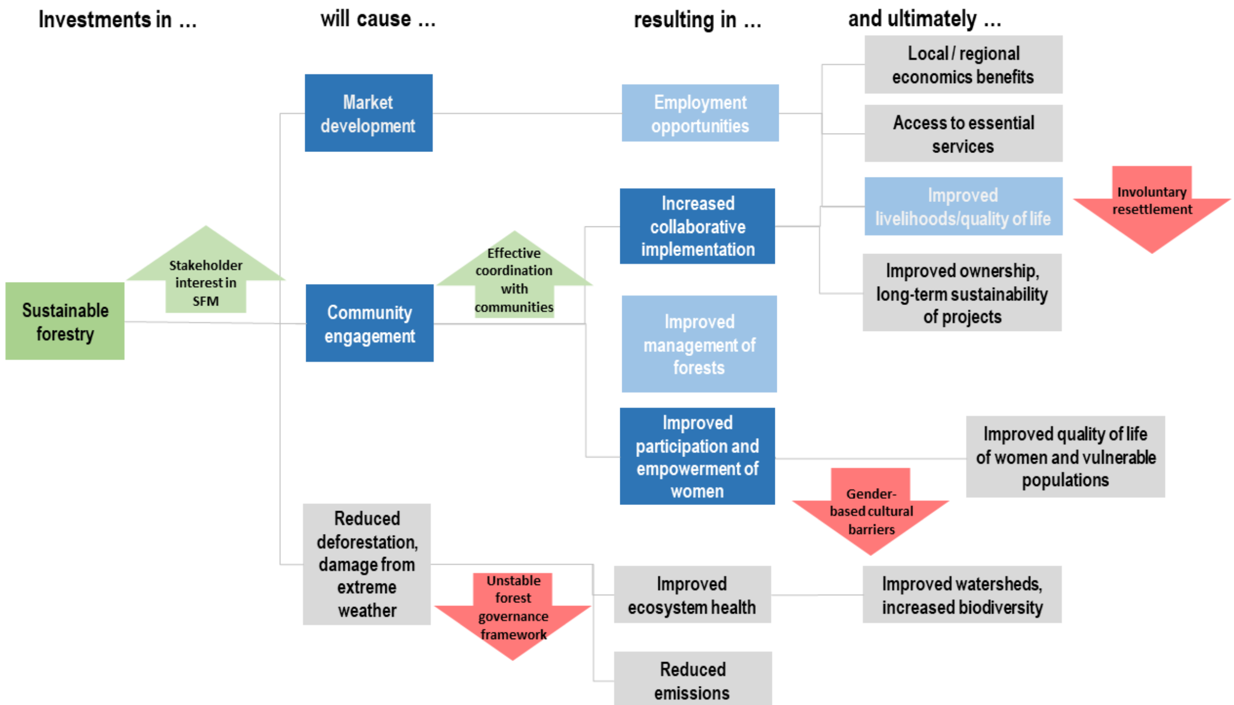


As another example, Figure 4 demonstrates how stakeholder interest in sustainable forestry management in Indonesia helped facilitate project implementation. While gender-based cultural barriers did not prevent the achievement of all DIs, they did hinder the participation and empowerment of women, and thus the DI of improved quality of life of women and vulnerable populations.

Ultimately, some drivers and barriers operate at a higher systemic level than individual projects and require programmatic efforts to address, while others relate to granular-context-dependencies and operating environments directly accessible via the intervention.

The existence of drivers and barriers further along the impact pathway demonstrates their path dependencies, and how some types of DIs may only be realized, or others only maximized, if they are intentionally built into the project design, execution, and monitoring. For example, the level of effective coordination with communities in Indonesia resulted from intentional project design, wherein the representatives of several communities were deliberately brought into the forest management process, resulting in DIs including increased quality of life and long-term sustainability of projects. However, if these coordination activities with communities had better incorporated gender policies to overcome gender-based cultural barriers, there could have been additional DIs unlocked regarding women's empowerment and quality of life. The project also fostered community engagement by helping groups obtain recognition of tenure rights and implemented capacity building efforts at multiple levels.

Figure 4. Drivers and Barriers in the Impact Pathway for Sustainable Forest Management in Indonesia



3.2 Lessons Learned about Drivers and Barriers

The IEc team offers the following lessons from our analysis of drivers and barriers across case studies.

The effect of DIs is greater than the sum of the parts and should be analyzed synergistically. Certain DIs (such as market development, built capacity, social/gender inclusion, and local workforce development) are catalytic (”Super DIs") and influence the achievement of other DIs, necessitating even more careful attention in project planning and implementation.

Interactions between certain DIs can produce greater benefits than the individual DIs on their own. For example, in the Indonesia geothermal projects, workforce development eased the expansion of the geothermal market, facilitating DIs such as employment opportunities, energy sector resilience, and gender equity. Those DIs were mutually reinforcing. Synergies between DIs can result in increased impacts. For example, increasing incomes specifically within disadvantaged communities and/or for women can unlock greater economic and social benefits, such as access to education and increased empowerment of women. In other case studies, the demonstration effect of CIF-funded projects led to market development, replication/scale-up, and additional DIs. In Thailand, market development through the de-risking of utility-scale wind power drove private investment in wind projects that resulted in significantly more health benefits from reduced air pollutants. In Brazil, community engagement drove the spread of Macaúba cultivation from neighbor to neighbor, expanding the adoption of sustainable agriculture practices and supporting DIs, including economic gains.

These “Super DIs” are catalysts that unlock other DIs. The Super DIs identified in the case studies often included industrial competitiveness and market development, social inclusion, capacity building, and local workforce development. These Super DIs are even more important to plan for during the project design stage because of their ripple effects on DI achievement. Below we discuss lessons on how to plan for and achieve these Super DIs.

Projects that successfully engage and align the interests of government, private sector, and local/community stakeholders can unlock DIs through increased relevance, responsiveness, and buy-in, thereby leading to more robust market development and expansion.

Institutional drivers were observed in 10 of the 13 case studies.[6] Government support is a key institutional driver of DIs. This includes both government interest/involvement as well as a supportive regulatory framework and enabling environment. Government engagement is essential if projects are faced with regulatory barriers that would otherwise prevent implementation. As in the Thailand case study discussed above, government support was also critical for addressing land acquisition issues required for large-scale renewable energy projects in Kenya and India. In Kenya, for example, the government granted land tenure for plots for the microgrids. Government engagement across case studies included a wide range of government ministries. In Brazil, collaboration among three ministries—the Ministry of the Environment; the Ministry of Agriculture, Livestock, and Food Supply; and the Ministry of Science, Technology, and Innovation—was necessary to align interventions with ongoing government plans and policies for the Cerrado biome. The development of geothermal in Indonesia also required cross-ministerial collaboration to address regulatory and business enabling environment issues. Across projects, governments not only facilitated project delivery, but also provided policy frameworks conducive to scale-up and replication at a national scale (such as a national plan and targets for renewable energy), thereby greatly expanding upon the DIs achieved in the original projects.

Strong institutional interest from the private sector and other non-governmental stakeholders are also important drivers. Private sector involvement, particularly by project developers and financial institutions, is important for achieving market development impacts, including competitiveness and industrial development (via expanded access to capital, increased SMEs in the market, technology introduction, and supply chain development) in renewable energy markets. In Thailand and Nepal, public-private financing models were instrumental in promoting and expanding the large-scale wind and large biogas markets, respectively, by providing necessary (and affordable) capital to build biogas plants and de-risking the market through complementary awareness raising and technical assistance activities. The role of these financing models is discussed below. In Indonesia, stakeholders agreed that the strong community and institutional involvement in sustainable forestry management projects made them important catalysts of the government's recent efforts to pursue land reforms by, for example, building knowledge about the functioning of the Forest Management Units (FMUs) and their interaction with local communities. The communities were actively involved in the development of sustainable long-term and annual forest management plans, and government institutions received capacity building support to improve the management of forest resources. Relationships between the government and the communities improved after the land reforms, which resulted in enhanced communication between actors. This closer interaction resulted in finding and introducing useful improvements from one CIF

[6] Institutional drivers related to governments were identified in the Bangladesh, India, Kenya, Indonesia, Morocco, Niger, and Türkiye light-touch case studies and the Indonesia, Thailand, and Nepal deep-dive case studies.

Sustainable Forestry Management project to another in cooperation with governmental actors at the national and subnational levels.

Engaging local stakeholders to address local barriers to uptake and to encourage behavior change is also a strong facilitator of DI achievement. In Brazil, farmers who saw their neighbors growing Macaúba were likelier to begin cultivation themselves. In Türkiye, focusing on local development parties with a strong local network generated trust in small-scale loans for renewable energy. Conversely, limited local stakeholder engagement reduces the overall achievement of DIs.

Concessional climate finance and innovative financing models that de-risk investments and demonstrate successful financial/business models can strengthen and enable deeper market development and economic DIs than would otherwise be achieved.

Financing models that develop sustainable financing or de-risk a market for private investment were identified as key drivers of economic DIs in several case studies. These models facilitated future expansion of projects beyond CIF's involvement, meaning that all resulting DIs would be increased and even serve as "Super DIs" for certain projects. As discussed above, concessional finance reduced the risk for first-mover, utility-scale wind projects in Thailand and demonstrated their financial viability. This, in turn, helped overcome the reluctance of domestic financial institutions to provide loans for these projects. Several privately funded, large-scale wind projects were installed after the initial demonstration projects without the need for concessional finance from CIF or an MDB. Resulting DIs, including reduced emissions and the health benefits of reduced air pollution, would likely have not been achieved in the same timeframe or at the same scale without the first-mover CIF-funded facilities.

Demonstrating the viability of a business model through piloting can help address financing barriers due to limited market or product expertise or heightened risk perceptions of domestic financial institutions. In Türkiye, commercial banks' lack of familiarity with financing energy efficiency projects, and SMEs' lack of awareness about the potential benefits from making energy efficiency investments, discouraged financial institutions and SMEs from entering the market for renewable energy/energy efficiency investments at the start of the project. Providing concessional financing to financial institutions for on-lending at commercial rates helped incentivize early entrance into the market. In Indonesia, resource risks and financial uncertainty around geothermal exploration are constraints to effectively mobilizing commercial capital. With the high ambitions for geothermal energy in Indonesia in the government's 2021–2030 Electricity Supply Plan, and commercial capital needed for implementation, mechanisms to onboard the private sector are critical.

Financing gaps or delays caused by unproven business models pose additional barriers to private sector participation. In Kenya, the supply and installation contract for the mini-grid electrification project was considerably delayed by challenges in agreeing on an operation and maintenance contract that ensured affordable electricity for consumers. The required business model was new in Kenya, and the process was unfamiliar to key stakeholders. As a result, the project needed more time and guidance from CIF than anticipated, including the engagement of advisors to develop a suitable business model.

At the project level, uncertainty about funding, and funding delays, can constrain or delay project activities, in turn reducing or delaying DIs.[7] Financial barriers were identified in eight of the 13 case studies. In the Niger Community Action for Climate Resilience Projects, delays in securing follow-on investments stalled some implementation activities and may undermine operation of existing Maisons du Paysan, or farmers' houses. In the Bangladesh deep-dive, the polder rehabilitation work experienced significant cost overruns. As a result, seven polders were eliminated from the currently funded project, resulting in reduced economic and social DIs. Funding delays might be avoided in the future by engaging with expert advisors who can help to develop business models upfront, transfer knowledge to local stakeholders, and build capacity for further activities.

For some projects, concessional financing demonstrated the soundness of an unproven, but traditional business model. Other projects required new financing structures to overcome barriers beyond a shortage of reliable funds. These innovative financing models can result in economic DIs, including industrial competitiveness, employment, and incomes, by creating or expanding markets. India's rooftop solar projects are a prime example. Renewable energy service company (RESCO) ecosystems developed in the Grid-Connected Rooftop Solar Program enabled firms to bring in equity from international investors, raising about $1 billion during the project. In addition, credit guarantee schemes have played an important role in incentivizing investors to support micro, small, and medium solar rooftop projects in the program. The credit guarantees, RESCO ecosystem, and co-financing have helped to reduce the reluctance of commercial lenders to provide debt financing to solar market actors including rooftop solar developers, installers, and aggregators.

In Türkiye, the CTF and the World Bank provided $1.1 billion to finance renewable energy and energy efficiency investments through two credit lines for two Turkish development banks, which in turn distributed the funds to their borrowers (SMEs, industrial stakeholders, and farmers). This provided sufficient financing for the capital-intensive energy investments that were required to develop the market. The success of deploying small-scale financing was supported by i) pairing the two credit lines with a technical assistance component for the local financial institutions, and ii) leveraging the strong local networks, reputation, and established client portfolios of trusted local financial institutions, which were able to provide small-scale loans to their customers on fully commercial terms.

Awareness of and sensitivity to local concerns, and active steps to ensure social inclusion, are critical to achieve social DIs and benefits for women and other vulnerable populations.

Capacity building, gender-responsive project designs, and the creation and capture of local opportunities are important drivers of social inclusion by addressing systemic barriers that limit the ability of certain groups to benefit from DIs. For example, several case studies found that even when women's participation was set as a project goal and tracked, it could be challenging to achieve. In the sustainable forestry light-touch case study in Indonesia, achieving the desired participation rates for women has been difficult, because the share of women working in governmental institutions is currently lower than the targeted share of women participating in capacity building exercises. In Morocco,

[7] Barriers related to financing were observed in the Brazil, India, Morocco, Niger, and Türkiye light-touch case studies and the Bangladesh, Indonesia, and Nepal deep-dive case studies.

women's participation in the solar project was limited by local gender norms that discourage work in technical and construction positions and impose household responsibilities on women that limit their ability to work outside the home.

Social inclusion is critical to ensure that economic and social DIs are equitably distributed—and, in particular, that benefits accrue to local communities and to women and other marginalized groups. This is closely linked to meaningful community engagement and participation through the entire project lifecycle, as discussed further in Part 4.1. It is also crucial to ensure that projects respect local communities' rights and, to the extent that people's resources are used or they suffer any negative impacts, compensate them appropriately. Compensation packages should be tailored to the local context and to community priorities. For example, the lease payments for wind farmers in Subyai and Theppana, combined with the employment of local workers, helped ensure that local communities reaped direct benefits from the wind projects. Meaningful community involvement and compensation for the host communities was an important component of this project that went beyond corporate social responsibility activities.

Awareness of and sensitivity to local concerns were also demonstrated in the Brazil light-touch case study, where the project implementers recognized the importance of being well versed in the local culture in order to best engage with the local farming communities. Specifically, the cattle farmers were highly conservative and hesitant to change their existing ways of raising cattle, despite the opportunities created by Macaúba for the livestock sector (e.g., increased quality of pasture and shade, resulting in improved feed, faster and increased rate of fattening, as well as reduced stress for cows). In Indonesia, the involvement of community-based organizations in the forestry project enabled smooth communication and collective work, building trust and facilitating community engagement throughout the projects. Similarly, proximity with the communities made it possible to recognize early during the COVID-19 pandemic how to support the beneficiaries to avoid or mitigate negative impacts that would have resulted from a lack of participation in the project. Specifically, according to interviews with the MDBs, the project provided "additional payments upfront" to the beneficiaries to help overcome the lack of financial resources caused by the pandemic.[8] The payments encouraged the beneficiaries to join (or not leave) the project. According to the interviews with the MDBs, the payments particularly helped to increase women's participation in the project.

Capacity building to ensure that local institutions, workers, and communities can meaningfully participate in projects is a key driver of DIs that should be built into project design and followed through during project implementation.

Capacity development drives a variety of DIs, including competitiveness and industrial development, employment, and earnings. Conversely, a shortage of skilled/trained local workers with requisite expertise limits DIs from employment gains and diversified income, constrains local supply chain development, and impedes market development.

Capacity barriers were identified in 10 of the 13 case studies. In Bangladesh, only five to six high-quality solar engineering, permitting, and construction (EPC) contractors are operating in the country. Some of

[8] We do not have information on how the beneficiaries spent the payments or the impact.

these firms have recently formed or formalized in response to the project and, more generally, the growing demand for rooftop solar. The lack of EPC contractors and limited workforce development was originally a barrier to the uptake of rooftop solar. Despite the significant growth in the past few years, additional local EPC firms and workforce development would be helpful in scaling up the industry to meet the increasing demand for rooftop solar.

Technical assistance, training, and capacity building to facilitate local workforce participation is a key driver of employment gains, development of local supply chains, and increased/diversified income in several case studies. In the most successful cases, these efforts were effectively built into the project design and then followed through during project implementation. Gender-responsive project designs were a component in a smaller subset of these cases.

It is important to ensure that the knowledge and skills built through project interventions are maintained to sustain capacity-related DIs. For this, capacity building needs to be an ongoing effort rather than a one-time intervention. In the Bangladesh deep-dive, focus group participants noted that initial training provided to local water management organizations was inadequate, and knowledge gains were lost over time, hampering the intended program design of community members actively participating in ongoing water management.

The geothermal projects in Indonesia are a good example, having provided capacity building for developers, gender-responsive designs to increase female participation, and the creation and capture of local opportunities. For example, the Geothermal Clean Energy Investment Project demonstrates how capacity building helped to increase development performance by building the competencies of a geothermal developer (PGE) and making sure the projects fulfilled technical, environmental, and social best practices and industry standards. This led PGE to become a world-leading geothermal developer and helped improve confidence in geothermal energy development in Indonesia. Another geothermal project, the GPGP, outlined a detailed recruitment plan with targets for ensuring women were represented across geothermal development activities. Such approaches, combined with Gender Action Plans, can be effective at driving progress toward gender equity.

A related key driver that helped maximize DIs in Indonesia was project designs that created and captured local suppliers and local skills, thereby helping develop local supply chains. On the supply side, the GCEIP has tracked the level of “local content” in program spending (although more concerted efforts to ensure that local suppliers and skills are optimally tapped would further maximize DIs). On the demand side, an excellent example of long-term local economic development in this case study is the emergence of a local supply chain in North Sulawesi, with an increasing number of local suppliers during the period in which CIF has been active in the region, supporting the creation and capture of local economic opportunities. In Thailand, the projects in Subyai and Theppana trained local people and provided internship and employment opportunities for them around the wind turbines. They also leased land from local farmers, ensuring that the local populations benefited from the wind projects.

Capacity building is essential because if local capacities are underdeveloped, DIs may not be achieved even when other successful conditions are in place. For example, in India, many people have become rooftop solar installers without the necessary training to ensure high-quality service, and this has created distrust among consumers. In addition, current technical training programs for installers lack hands-on field training components, and awareness of available training programs is poor among potential trainees and in the industry in general. Government actors and financial institutions do not have the capacity to provide ongoing institutional/technical support (e.g., certification and enforcement of quality and technical standards) for scaling up rooftop solar technologies. Technical training programs that provide field training and certification could help set a minimum floor for technical skills; these programs should be well advertised to potential trainees and the industry in general. Creating and robustly enforcing quality standards for the industry could further increase consumer trust. Building institutional capacity among government agencies, installers, and other stakeholders could also increase institutional engagement and drive the achievement of DIs related to stakeholder support, as discussed above.

Technology and physical infrastructure can also help achieve DIs, if carefully managed.

While technical support is often related to capacity building and workforce development, the combination of technical factors and well-designed physical infrastructure can be another important driver of DIs, while the absence of these factors can be a barrier. Technical barriers were identified in five of the 13 case studies. For example, limitations of the power grid were identified as barriers in the India and Bangladesh solar projects. Bangladesh has an older distribution network, which can lead to problems with implementing net metering and injecting power into the grid from distributed resources. While renewable energy projects can take 12–18 months, transmission infrastructure can take up to five years to complete, delaying the realization of DIs such as increased energy access and security, particularly for more distant communities.

To overcome technical barriers, projects often rely on the implementation of new technologies. In Bangladesh, the addition of on-site storage could greatly expand the value proposition of on-site solar for factory owners by addressing the intermittence issue with solar and reducing the need for net metering. Current net metering guidelines impose a maximum of 70 percent rooftop coverage, which limits the producer's maximum power generation and may not incentivize business participation enough to achieve scale-up. In India, solar parks tend to be concentrated in certain states/regions, which can lead to an unbalanced power system, where the energy supply is centralized in a few resource-rich areas and is not connected to areas where there is high energy demand. Sufficient transmission infrastructure is key to ensure that solar power generated at solar parks is fed into the grid.

The definition of technology applies not only to electronic items, but innovative practices and construction techniques that can lead to the increased achievement of DIs. An example is the construction of Maisons du Paysan (farmers' houses) in Niger. The Maison du Paysan model included construction of buildings in rural communes to support storage of agricultural inputs (seeds, fertilizer) and outputs (excess fodder and crops, animal feed), equipment (including repair facilities), and space for meetings, training, and service outreach (microfinance, provision of social protection benefits, labor service coordination). These high-quality facilities supported multiple uses and protected agricultural resources from damage by extreme weather. Their central presence in rural communes also reduced travel distances/times for rural producers and provided a tangible symbol of the value of government support to improve development impacts and quality of life. By concentrating resources in a single location, the project minimized the cost of provided and accessing services.

Unfortunately, novel technologies do not always work as intended. In Bangladesh, DIs stemming from the coastal embankment project are predicated on rehabilitated polders working as designed to manage tidal flooding and storm surges. While in general the polders are working, some technical problems are evident. For example, in some polders, main canals (khals) have had to be re-excavated for proper water management. In some places, quality of the reconstructed polders is lacking, and some of the rehabilitated polders have already started to crack due to poor workmanship. The implementation of new technologies can also require additional workforce development to realize the potential DIs from the new technology.

In conclusion, drivers and barriers influence the specific DIs and the magnitude of DIs realized. Certain DIs—including capacity building, social inclusion, local workforce development, and market development—can even serve as Super DIs, driving the achievement of other DI categories. Ultimately, project design and management—from planning through implementation—can minimize the impact of barriers and amplify drivers to further the achievement of DIs. Well-designed projects can also capitalize on the synergies between certain DIs, such as social inclusion and economic benefits, to positively influence the size and distribution of benefits.

Part 4. Recommendations for Strengthening DIs in the Context of Climate Finance Programs and Projects

Key Findings

Recommendations to strengthen contributions to DIs:

- Ensure that social and economic DIs accrue to local communities through intentional site selection, meaningful community participation, and tangible, inclusive actions to localize economic benefits, including capacity building/training, employment, and direct payments as appropriate.
- Increase women's and other vulnerable stakeholders' participation and corresponding DIs through inclusive, gender-responsive project designs and robust monitoring of gender and social impacts.
- Support innovative financing structures, paired with outreach and capacity building, to encourage the widespread adoption of clean technologies and sustainable practices that lead to DIs.
- Continue to support first-mover projects to demonstrate the business case for new/risky technologies, products and practices, and thus encourage replication and scale-up and achieve greater DIs.
- Collect additional data and apply robust methodologies to model and measure priority DIs.

Tools and approaches for measuring DIs:

- This evaluation used modeling to assess three DI categories in depth: (1) improved air quality and resulting health benefits; (2) Increased climate resilience in agriculture; and (3) Increased energy-enabled economic output. Each model was found to have advantages and disadvantages, but all the models we tested were fit for their intended purpose. Details are provided in Part 4.2.

This section draws on the case study results to offer recommendations for how programs and investments can strengthen their contributions to DIs. We also provide related measurement recommendations. Second, we draw upon the portfolio-level analysis, and our modeling experience in the deep-dive case studies, to describe promising approaches and lessons learned for modeling the DIs of climate investments.

4.1 Strengthening Contributions to DIs

The recommendations presented here are applicable to CIF and the broader climate finance community. Many are geared to the project level and may be appropriate for MDBs to consider as implementers of CIF-funded projects. At the same time, CIF can look to advance these insights as part of its programmatic approach. As CIF is currently developing toolkits to implement Integrated Results Frameworks for the new CIF programs, it can include relevant DIs (e.g., Super DIs) and suggested indicators in the toolkits. There may also be opportunities to further prioritize DIs in CIF's Transformational Change Learning Partnership (TCLP) and other thematic workshops and help participants who are developing new climate programs to integrate DIs more explicitly in their planning process.

Ensure that social and economic DIs accrue to local communities through intentional site selection, meaningful community engagement, and tangible, inclusive actions to localize economic benefits.

CIF, MDBs, and other climate funders should work with project implementers (e.g., developers, service providers, etc.) to build meaningful community participation and strategies to achieve benefits at the local level into project design, implementation, and monitoring.

This should start when selecting the communities/geographic areas where project activities will be implemented. For example, siting a renewable energy project in an area where it can expand energy access for energy-poor and vulnerable households and communities can achieve greater local benefits—social and economic—than siting the same project in an area that already has reliable energy access. Similarly, projects that promote climate-smart agriculture and connect farmers to supply chains for sustainably produced crops may be able to achieve particularly significant DIs if they target communities where most farmers are smallholders struggling with low productivity and/or significant climate change impacts. They may also benefit most from sustainable land management.

Meaningful community participation is crucial throughout the project lifecycle. This means not just informational meetings or consultations, but community-based visioning of opportunities for green and resilient development, followed by sustained engagement throughout the project lifecycle, including monitoring and evaluation. These activities must be carefully designed and implemented to be gender-responsive and ensure social inclusion, with particular attention to marginalized groups. Formal structures, such as steering committees made up of local community members and other stakeholders, can help ensure that projects address local priorities, incorporate local expertise, and deliver benefits to local people.

Capacity building is key both to support meaningful participation and to maximize economic DIs at the local level. In particular, local men and women should be trained and then hired for jobs created by the project. Targets for local content can also be incorporated in the supply chain, providing a way for local businesses to benefit from the project. When local resources are used—for instance, land for solar arrays, or water—communities and individuals should be appropriately compensated.

Applicable metrics may include the number/percent of local workers employed in project-related jobs; the percent of local content used in the project or supply chain; and amount of funding spent on services for the community.

Increase participation by women and other vulnerable stakeholders—and corresponding DIs—through inclusive, gender-responsive project designs and robust monitoring of gender and social impacts.

Project and program designs should deliberately mainstream gender and social inclusion, with meaningful participation by local women and members of other vulnerable groups. This process should include diagnosis/analysis, action plan development, implementation, and monitoring. The first step is to identify groups that might be missed or underserved by the project, as well as the underlying barriers (e.g., discriminatory gender norms, lack of decision-making power, time constraints, limited access to key assets, such as land). It is important to recognize that the challenges and opportunities for each vulnerable group may be different. Baselines should be established during the project design phase, using disaggregated data to the extent available.

A good practice is to then develop a gender action plan and/or social inclusion plan that specifies practical steps to address barriers identified, allocates a specific budget, and then monitors results throughout implementation.[9] Insights from members of the affected groups can help ensure the plan meets their needs. The plan may include specific targets or quotas for women or ethnic minorities trained/employed, for example, as well as gender-responsive features such as flexible working hours and child care, and culturally sensitive recruitment and training strategies. Projects should also track the actual numbers of people from vulnerable groups who participate in activities and are placed in jobs, to ensure targets are being met and make adjustments if needed.

In addition to maximizing positive DIs, it is essential to assess the risks associated with project activities and take steps to mitigate potential negative impacts—to protect against gender-based violence and ensure personal safety, avoid imposing mobility restrictions or involuntary resettlement, protect to local ecological integrity, etc. Even if a project is not specifically designed to empower women and/or other marginalized groups, bringing gender and social inclusion into the due diligence process will help teams identify entry points for maximizing DIs. Notably, in several of the case studies conducted for this evaluation, it was challenging to measure gender-related impacts. Any best practices for gender and social inclusion that CIF can demonstrate within its investments will encourage more proactive efforts in future investments. Suggestions for monitoring gender and social impacts are included in the final recommendation in this section.

Support innovative financing structures, paired with outreach and capacity building, to encourage the widespread adoption of clean technologies and sustainable practices that lead to DIs.

The case studies demonstrate how innovative and stakeholder-responsive financing structures can facilitate the uptake of new technologies and practices, which in turn lead to local job creation and improved access to essential services, among other benefits. For example, establishing innovative financial schemes (e.g., renewable energy service companies that finance solar power projects, and credit guarantee mechanisms) to de-risk the rooftop solar market can not only increase electricity access, but also make electricity more affordable. Pairing innovative financial arrangements and products with capacity building (e.g., for financial institutions offering innovative financial products for the first time) and outreach/awareness activities (e.g., for potential borrowers/early adopters) is crucial for expanding market adoption and the realization of DIs. Pairing innovative, first-of-their-kind financial arrangements and products with capacity building and outreach/awareness activities (e.g., for potential borrowers/early adopters) that are responsive to addressing risk perceptions and barriers to uptake is crucial for expanding market adoption. This is particularly important for drawing new market segments into delivering renewable electrification in rural areas, where larger markets can expand modern energy access and, in doing so, also significantly reduce air pollution by reducing reliance on biomass and highly polluting generators.

Similarly, the Low-Carbon Agriculture (ABC) project in Brazil's Cerrado biome paired an innovative financial instrument (a subsidized credit line for farmers to support the upfront costs of converting

[9] CIF already has a Gender Action Plan, but it may be advisable for the MDBs to develop project-specific gender action plans.

traditional agricultural practices) with a high degree of training and technical assistance to support the adoption and scale-up of sustainable agricultural practices. The demonstrated financial profitability of the ABC technologies, and the high degree of technical assistance and training for content retention, indicate a high likelihood of continued adoption of low-carbon agriculture post-project. The demonstrated viability of the ABC technologies and growing environmental awareness among Cerrado producers also influenced the neighbors of project beneficiaries, who saw that ABC technologies were economically viable and desirable and chose to adopt them as well. As a result, larger areas were brought under improved land management practices, with benefits for agricultural productivity and farmers' livelihoods.

Continue to support first-mover projects to demonstrate the business case for new/risky technologies, products and practices, thereby contributing to replication and scale-up that result in additional DIs.

The Thailand wind case study offers a compelling example of the catalytic effect of concessional climate finance and technical assistance, as discussed in Part 3. As another example, in the Minas Gerais region of Brazil's Cerrado biome, the Macaúba project formed numerous partnerships and positive, culturally sensitive relationships with local farmers—and deployed an innovative blended financing structure—to support the development of a silvopastoral value chain. The government supported the investment and secured a subsidized price for Macaúba, which encouraged early adopters. While the project has not yet reached maturity, blended finance is proving to be a successful resource to jump-start the first Macaúba value chain intended for mass commercialization and to de-risk future investments. The lead firm is planning to scale up operations in multiple parts of the value chain, which should draw new companies to the market as farms replicate their neighbors' adoption of Macaúba.

In Niger, the Community Action Project for Climate Resilience successfully demonstrated another kind of innovation. It established of "Maisons du Paysan" (farmers' houses) in targeted communes to serve as institutional platforms to scale up interventions to enhance adaptive capacities. Interview data indicate that participants found the training provided useful (e.g., on sustainable land and water management practices, including crop management and drip irrigation). Two women who were interviewed also indicated that the access to seeds and animal feed has reduced their costs and improved their household economic conditions. This recommendation is broadly consistent with previous evaluations that have validated the role of concessional finance, coupled with technical assistance, in spurring transformational change.[10]

Collect additional data and apply robust methodologies to model and measure priority DIs.

The case studies and modeling analysis highlighted several additional types of data and methods that can augment existing monitoring and understanding of DIs. We recognize the resources required to collect and analyze data, so a balance needs to be struck, based on the utility of the information. In general, we recommend expanding data collection and analysis when the data are needed and will be

[10] Itad, Ross Strategic, and ICF. 2019. "Evaluation of Transformational Change in the Climate Investment Funds." ICF. 2018. "Evaluation of the Climate Investment Funds' Programmatic Approach: Final Report and Management Response."

analyzed for key expected results. In many cases, this would entail the MDBs collecting and analyzing additional data at the project level. We also see a role for CIF, within its mandate as a learning lab, to pilot and support expanded evaluation of key DIs that are important across projects but may not otherwise be assessed by other climate investors and project implementers.[11] We acknowledge that some of these recommendations are already being implemented at some level (e.g., by CIF and/or MDBs) in at least some instances. Overall, however, the case study findings indicate the need to emphasize the consistent implementation of robust DI measurement and evaluation practices across projects.

Detailed recommendations mostly targeted at the implementing agencies for CIF projects follow:

- **Apply rigorous methods during pilot initiatives:** Invest the time and resources in selected new and pilot initiatives to ensure a robust and credible analysis to support decision-making. The agricultural productivity assessment methodology used in Niger provides a good model. The approach involved annual sampling and comparison of crop and forage yields in treated and control sites with similar characteristics, as well as active engagement of national statistical and environmental monitoring institutions to ensure transparency, accountability, and country ownership of the assessment methodologies. Robust monitoring and assessment methods can also support learning and adaptive management and establish robust and credible cases for sustaining, expanding, and scaling newer programs and projects. *(Applicable programs: Potentially all, especially new CIF programs)*
- **Establish partnerships with local statistical and monitoring institutions:** Where feasible, build partnerships with government institutions and other credible partners (e.g., in-country academic institutions, multilateral organizations) to enhance the quality and credibility of research and assessment methods, to strengthen diverse partner commitment to the program, and to build capacity for ongoing monitoring and analysis. *(Applicable programs: All)*
- **Incorporate quantitative and qualitative indicators of gender-related impacts:** Measures to track throughout project implementation might include the number of women trained; new hires who are women; the percent of women engaged in different types of employment (e.g., harvesting versus processing); and the amount and percent of wages paid to women. In addition to these quantitative metrics, projects should collect qualitative information (e.g., through interviews) about how women were engaged in the project, and also how they may have benefited indirectly (e.g., as spouses of male farmers who were trained by the project). *(Applicable programs: All)*
- **Test alternative methods to measure important social DIs (food security, livelihoods, quality of life):** Use household-level surveys (conducted remotely with cell phones where feasible, or in person) to assess progress over time; ensure that projects are sufficiently funded to enable robust assessments that can be used to inform broader agricultural productivity and climate

[11] For example, food security was an implied DI in three case studies. Although food security may not be a top-priority DI for individual projects, it could collectively be a high-priority DI for a region. We believe that CIF can play a role in filling knowledge gaps when learning more about an understudied DI would provide a collective benefit.

resilience initiatives. For example, food security was identified as an important implied DI in several case studies, but would require additional research to assess. Partnerships with national statistical agencies and universities could be useful to expand CIF's capacity to assess and monitor these DIs. *(Applicable programs: FIP, PPCR, Nature, People, and Climate)*

- **Pay more attention to biodiversity:** The Brazil deep-dive case study identified biodiversity conservation as a significant benefit with a powerful connection to DIs (i.e., the effects of land cover conversion on pollinator abundance and crop yield). Further understanding and documentation of biodiversity outcomes and related DIs could further strengthen the case for agricultural projects that provide these benefits. In the Brazil deep-dive case study, we used the Natural Capital Project's Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) Natural Capital Pollination model to map and qualitatively describe changes in pollinator abundance on soybean and coffee fields resulting from potential nearby pasture restoration. Specifically, we compared relative pollinator abundance before ("baseline") and after ("restoration") the restoration activities. The model quantifies pollinator abundance using a relative, nonlinear index ranging from zero to one that can only be translated into pollinator population density with additional field data. Similarly, the model supports modeling changes in agricultural yield, but also computes change on a relative, non-linear index ranging from zero to one. Connecting the index values to absolute changes in yield requires knowledge about the baseline crop species' yield within a field and the relationship between crop species' yield and pollinator abundance. In the Brazil case study, we were not able to apply the optional agricultural yield outputs of this model, because the relative changes in pollinator abundance could not be easily linked with a percentage change in yield. Collecting field data about the baseline crop species' yield, and information on the relationship between crop species' yield and pollinator abundance, would allow for a more sophisticated analysis using the InVEST model. *(Applicable programs: FIP, PPCR, Nature, People, and Climate)*
- **Capture additional metrics on electricity generation and emission reductions:** Require renewable energy projects to track and report actual clean energy production and reduced use of conventional energy sources. Apply emissions factors and grid factors to examine reduced GHGs and reduced air pollution MDBs should also consider obtaining a global license for the IEA emission factors dataset, which provides GHG and criteria pollutant factors by country. This would provide MDBs with country-specific data that could be used even if more granular data are unavailable. *(Applicable programs: CTF, SREP, ACT)*
- **Deploy more customized analysis/modeling when warranted:** For large projects that have significant potential to generate DIs, and/or meaningful learning about DIs, conduct customized analysis, including sophisticated modeling. Part 4.2 provides lessons learned and recommendations on approaches for modeling DI impacts. *(Applicable programs: All; the relevance of specific models depends on the DI category)*

4.2 Comparative Assessment/Cataloguing of Modeling Tools and Approaches for Estimating DIs

For the portfolio-level analysis conducted as part of this evaluation, the IEc team reviewed modeling approaches/tools and provided recommendations to estimate three high-priority DIs identified with CIF. DI categories selected for this review represent DIs that are difficult to observe or measure directly, so they were modeled instead. They are:

1. **Improved air quality and resulting health benefits:** This includes reductions in air pollutant levels due to reduced (or avoided) fossil fuel combustion and avoided health impacts; because air quality tools feed into health impact tools, these were assessed together.
2. **Increased climate resilience in agriculture:** This includes increased abilities to cope with shocks, reduced losses from climate events, and increased agricultural productivity; we conducted a high-level assessment of tools that address increased ability to cope with and adapt to climate impacts related to agriculture.
3. **Increased energy-enabled economic output:** This includes direct, indirect, and induced increases in economic output, as well as energy-enabled increases in economic output; this category covers tools that evaluate economic output, with a focus on tools that can evaluate energy-enabled output.

For each category, we reviewed several models and then applied one or more in the deep-dive case studies. While all models have advantages and disadvantages, we found that all models we tested were fit for their intended purpose. Table 2 in the introductory chapter provides a summary of the models used in the deep-dives. The case studies provide more detailed information about the modeling approach and results. The IEc team's modeling memo (a standalone work product) provides additional details about our comparative assessment and cataloguing of modeling tools and approaches.

Category 1: Improved air quality and resulting health benefits

We considered two types of potentially relevant models: (1) those designed to model changes in air quality, which are more complex and less user-friendly, and (2) those designed to model health benefits, with a simpler, but adequate approach to air quality. One candidate for more detailed air quality modeling is **GEOS-Chem**, a publicly available tool developed and maintained by Harvard University. While the tool allows for detailed air quality modeling at a variety of spatial scales, the model's hardware and software requirements are fairly involved, and using it requires someone with solid programming knowledge, and ideally a background in atmospheric chemistry.

Much more user-friendly models are available to analyze energy-related emissions and health benefits of air quality improvements. Two promising models in this category are **LEAP** (Low Emissions Analysis Platform) and **BenMap**.

LEAP was developed by the Stockholm Environment Institute (SEI) and is a scenario-based modeling tool used for policy analysis and to consider the economic and environmental effects of various programs and investments. The tool is well supported by SEI, is designed to be user-friendly, and is free to academics, governments, and NGOs. We have also applied LEAP as part of the Thailand case study within our wider study. **LEAP-IBC** (Integrated Benefits Calculator) is a variant of LEAP that allows for a more detailed analysis of the benefits of emissions changes, and is thus relevant to CIF's objectives.

BenMap is also a widely used, well supported tool that could also be useful for CIF. Developed by the U.S. Environmental Protection Agency (EPA), it is used to quantify the health and economic impacts of changes in air quality—specifically, fine particles and ground-level ozone. Health impacts are quantified through a health impact function. Economic values are calculated through the costs of illness and willingness-to-pay metrics. The tool has been applied in numerous settings, and IEc currently is working with the EPA and the World Bank to apply it in international contexts.

Both LEAP and BenMap appear to be good options for CIF to consider for health impacts modeling. These tools incorporate sufficiently robust emissions modeling for project and portfolio benefits estimation without including a more detailed atmospheric chemistry model such as GEOS-Chem. As we applied LEAP in the Thailand case study and are thus more familiar with the tool and its application, we summarize details on this software tool below. Additional details on BenMap are provided in the Modeling Memo.

Table 15. Summary Overview of LEAP

LEAP (Low Emissions Analysis Platform)	
Description	LEAP is a scenario-based modeling tool primarily used for energy policy analysis and climate change mitigation assessments. LEAP can act as a forecasting tool to consider energy supply and demand and a policy tool to consider economic and environmental effects of various energy programs and investments. LEAP-IBC (Integrated Benefits Calculator) allows analysis of energy-related emissions and resulting health impacts.
URL	https://leap.sei.org/default.asp?action=home
Complexity and Data Needs	LEAP has been designed to be accessible for decision-makers and those involved in energy and climate policy. There are low data requirements necessary to get started with LEAP, and therefore it can be used in developing countries, which may have limited data availability. Data requirements for LEAP's demand analysis include demographic data, macroeconomic data, and energy data (e.g., national balances, mitigation assessments, energy prices, energy supply).
In-house vs. Outsourced Use	LEAP is an open-source tool designed to be accessible for individuals with limited modeling background; in-house use by CIF therefore seems very possible.
Cost of Implementation and Maintenance	The LEAP tool and its training materials are free to academics, governments, and NGOs based in low- and middle-income countries, in addition to all students. For businesses and utilities, LEAP must be accessed through its licensing agreements, the costs of which range from US$500 to $3,000.
Example of Use	Applied to evaluate air quality improvements and health benefits as part of the Thailand case study on large-scale wind. Also, "Energy Efficiency Plan Benefits in Ecuador: Long-range Energy Alternative Planning Model" (*International Journal of Energy Economics and Policy*, 2018) Paper uses LEAP to forecast annual energy demand until 2035 in Ecuador.
Use Cases for CIF	(1) Investment Plans and project design: LEAP could help guide a country's energy investments by modeling economic and environmental impacts while also considering the demographic and macroeconomic context of a country. Also, through its ability to forecast energy demand, LEAP could be useful in guiding investment plans and project design. (2) Exploration and collaboration with partners: LEAP is designed to be accessible to users who do not have a hard science background. This makes it usable by different stakeholders and could promote collaboration. (3) Understanding trade-offs between investment opportunities: LEAP allows for evaluation of various interventions to improve air quality and human health. (4) Ex-post evaluation of development impacts from climate finance, as demonstrated in the Thailand case study.

LEAP (Low Emissions Analysis Platform)	
Outputs/Units	Depending on model specifications, LEAP can have numerous outputs. Outputs related to energy supply and demand metrics can be displayed as energy balance tables. These tables can be viewed for various fuels, years, scenarios, regions, and subsectors. Demand and supply metrics can be displayed in almost any unit of measurement and in various numeric formats (i.e., absolute values, growth rates, percentage shares, etc.).

As mentioned above, we applied LEAP-IBC in the Thailand large-scale wind case study to model the health benefits of increasing the share of energy from wind power. We modeled three scenarios: 1) ambitious renewables, 2) goal-meeting renewables, and 3) project-based (for the two wind projects covered in the case study). We compared the results with a baseline scenario for 2030 in which no renewables are added to Thailand's electricity generation system beyond what exists in 2022. We estimated changes in emissions of fine particulate matter ($PM_{2.5}$), nitrogen oxides (NOx), black carbon (BC), and organic carbon (OC) in each scenario,[12] and then the associated health impacts. Finally, to understand the economic benefits of these avoided health impacts, we employed the "value of statistical life" (VSL) to value avoided deaths due to air pollution from fossil fuel-based electricity generation.[13] We provided the range of economic benefits using the median and mean VSL values[14] for the three electricity generation scenarios.

Overall, the LEAP-IBC tool performed well for our purposes and showed significant potential for broader applications. The tool allowed for a relatively straightforward calculation of health impacts both at the project level and if Thailand meets more ambitious energy targets. As noted earlier, other research for this case study found that the two CIF-funded projects had a demonstration effect, helped de-risk privately funded large-scale wind projects in Thailand, addressed regulatory and financial hurdles, and helped make the business case for scaling up large-scale wind in Thailand. Several additional large-scale wind projects have since been developed without CIF financing. The modeling results complement the qualitative research by estimating what the health impacts could be if Thailand achieves its national energy targets, in part due to the market transformation that the CIF-funded projects catalyzed. This analytical approach seems broadly applicable to the CTF and SREP portfolios, where large-scale renewables have been supported, but the health impacts have not yet been thoroughly analyzed.

There are some limitations to the analysis that we performed. LEAP-IBC provides outputs at the national scale, which assumes uniform changes in emissions across the country and uniform populations who would be exposed to those emissions. More detailed information about the location of future renewable energy sources, and of fossil fuel-based generating units that may go offline due to renewables integration, would facilitate a more accurate spatial analysis. Furthermore, the benefits

[12] $PM_{2.5}$ and NOx are conventional air pollutants that are associated with health impacts such as cardiovascular and pulmonary diseases, hospital admissions and emergency department visits, and premature death. Black carbon and organic carbon are important components of particulate matter ($PM_{2.5}$ and larger).

[13] VSL is the method typically used by governments to value costs avoided due to avoided premature death; it aggregates the willingness to pay of a population for reductions in specific risks. VSL is not included in LEAP-IBC, but it can be applied to the LEAP-IBC modeling outputs.

[14] Based on the VSL from a 2020 wage-risk study on the VSL in Thailand.

calculations rely on baseline health and population data from the Global Burden of Disease study, which is an international effort and may entail more uncertainties than if data from a local-scale analysis of baseline health and population across Thailand were used. With sufficient local epidemiological information that details the relationships between air pollutant exposures and health impacts, future analyses could focus on specific health endpoints within the Thai population.

Category 2: Increased climate resilience in agriculture

The DI of "increased abilities to cope with shocks; reduced losses from climate events" (DI2) is quite broad and encompasses potentially hundreds of models that analyze impacts and adaptation options across multiple sectors. To make the category tractable, we have merged it with the DI "increased agricultural productivity" (DI14), and we consider models that allow analysis of measures to build resilience to climate change impacts on agriculture. The agricultural sector is also quite broad—for the purposes of this memorandum, we constrain our evaluation to models of rainfed and irrigated cropping systems, as there are several pre-existing and relatively user-friendly crop and water availability models in the public domain, and we are not aware of similarly accessible models of livestock systems or other agricultural value chain components that would be suitable for CIF.

Several well-established models for evaluating climate change effects on crop production are reviewed in the Modeling Memo. Of these, **AquaCrop** appears to be one of the best options, for its combination of analytical rigor, widespread use, and relatively straightforward application. The model takes daily climate inputs to analyze crop yields under different climate futures, and can be parameterized to evaluate a wide range of interventions (e.g., crop switching, heat-tolerant varieties, improved soil-water management, irrigation). The tool does not have as straightforward or polished a graphical user interface as LEAP, but its interface does not require a programming language to use. Processing necessary climate inputs would benefit from basic knowledge of R, Python, or MATLAB. If AquaCrop is too complex a tool for CIF, the UN Food and Agriculture Organization (FAO) and others have simpler options that take monthly, instead of daily, climate inputs, including AquaCrop's predecessor, **CropWat**. However, these models focus only on the effect of rainfall on crop yields, rather than the broader set of factors considered in AquaCrop (e.g., temperature, salinity, CO_2 concentrations).

Note that AquaCrop has no capacity to model upstream water availability, which is critical to understand the potential benefits of irrigation investments. The **Water Evaluation and Planning (WEAP)** tool, developed by SEI, is a user-friendly water systems model that allows users to construct a network of rivers, reservoirs, withdrawals, and flow requirements to understand how climate change and competing uses of water may affect water availability throughout a system of river basins. To understand the potential benefits of irrigation investments, we have in previous projects used a combination of AquaCrop to understand crop yield response to irrigation water inputs, and WEAP to understand system-wide water availability for irrigation withdrawals (see example of use in the AquaCrop table below). Importantly, WEAP also allows for analysis of monthly hydropower generation within the water system.

The table below describes AquaCrop characteristics, which we describe here for its direct application to evaluating changes in agricultural productivity; additional details on WEAP are provided in the Modeling Memo.

Table 16. Summary Overview of AquaCrop

AquaCrop	
Description	Developed by the FAO, AquaCrop is a crop growth model that quantifies biomass, crop production, and performance indicators in response to changes in water supply specifically for herbaceous crops. There is also a MATLAB version of the tool available through the University of Nebraska that allows for much faster processing, when large geographic areas or numerous scenario runs are needed.
URL	https://www.fao.org/aquacrop
Complexity and Data Needs	Running AquaCrop requires information on weather conditions, crop conditions, management conditions (i.e., field management, irrigation management), and soil conditions (i.e., soil profile and groundwater conditions). AquaCrop contains data on mean annual atmospheric CO_2 and tools to compute evapotranspiration. However, other data requirements must be entered by the user. Meeting these data requirements would benefit from an understanding of R, Python, MATLAB, or another similar data processing programming tool.
In-house vs. Outsourced Use	AquaCrop was designed to be used by a range of practitioners outside of the scientific community, and thus assumes a simplified relationship between biomass production and crop transpiration, which ultimately requires fewer data inputs compared to other models used in the scientific community. The accessibility of some data components within the model makes in-house use of AquaCrop seem more feasible than other options.
Cost of Implementation and Maintenance	The AquaCrop Windows program can be downloaded through the FAO website for free. Users must provide their contact information to FAO when submitting a download request. The University of Nebraska version of the tool is limited in its commercial application but is free for academic institutions and NGOs.
Examples of Use	World Bank. 2013. Looking Beyond the Horizon: How Climate Change Impacts and Adaptation Responses Will Reshape Agriculture in Eastern Europe and Central Asia. https://openknowledge.worldbank.org/handle/10986/13119?show=full Also applied to evaluate potential effects of salinization in the Bangladesh agriculture case study on the benefits of polder investments.
Use cases for CIF	(1) Investment plan and project design: By simulating crop yields as a function of different water supply conditions, AquaCrop can be helpful in identifying crops most vulnerable to changing environmental conditions. By identifying these crops, water management investments can be targeted towards farming areas that will be most impacted. (2) Exploration and collaboration with partners: AquaCrop results are easy to communicate and understand. As noted above, it is not the most user-friendly tool, but it is very powerful once learned. (3) Understanding trade-offs between investment opportunities: AquaCrop allows for evaluation of various interventions to improve yields and thus food security. (4) Ex-post evaluation of development impacts from climate finance, as applied in the Bangladesh case study.
Outputs/Units	The main model output from AquaCrop is dry yield formation measured in tons/ha, and irrigation water demand, measured in mm. There are also several other secondary outputs, such as volume of fertilizer application.

IEc used AquaCrop to evaluate the potential effects of salinization to estimate the benefits of polder investments in the Bangladesh deep-dive case study. Inputs for the modeling analysis included the World Bank's 2013 Project Appraisal Report and the CEIP-I Baseline Survey Report, which provides demographic baseline data for 2016 and 2018 for cropping intensity and yields, agricultural revenues, and other DIs. The key source of post-implementation data was the January 2022 focus group

Presentation and underlying data for 11 focus groups conducted in late 2021 with affected farmers by the government implementing agency's monitoring and evaluation contractor.[15]

The project is massive in scale and affects mostly agricultural lands; the total cultivated area across both packages is about 53,000 hectares. The rehabilitation of the polders provides a variety of benefits to farmers and agricultural lands, including storm surge protection, prevention of tidal flooding, an ability to increase cropping intensity, and the ability to plant more profitable crops. The work is being carried out in phases that are referred to as packages. Our crop revenue modeling approach used two scenarios of farmer revenues for all 10 polders included in the original Packages 1 and 2. The first is a counterfactual scenario without polder rehabilitation, where regular tidal flooding and storm surge events occur at the baseline frequency. The second is the polder rehabilitation scenario with projected increased farmer revenues as the polder rehabilitation reduces storm surges and regular tidal flooding.

For both scenarios, we evaluated three types of benefits:

- **Storm surge protection:** Polder rehabilitation enhances protection from the tropical cyclones that cause periodic floods and resulting damages, including from saltwater covering cropped areas.
- **Tidal flooding protection:** Polder rehabilitation increases the cultivated area by reducing the areas regularly flooded by high tides.
- **Rabi season cropping intensity growth:** Tidal flooding is particularly damaging in the Rabi season, because rain and river flows that may otherwise reduce saltwater intrusion subside. In Package 1, Rabi season cropping intensity has steadily increased as farmers gain confidence in the newly rehabilitated polders. In the counterfactual scenario, Rabi season cropping intensities remain at the baseline (2018) level, while in the scenario with polder rehabilitation, Rabi season harvested areas steadily increase.

We estimated the impacts to farmer revenues differently across the two project packages:

- For Package 1, where the most data are available, we used estimated storm surge recurrence intervals with and without polder rehabilitation and estimated areas regularly inundated by tidal flooding for each of four polders.
- For Package 2, we relied on the Package 1 average storm surge recurrence intervals with and without polder rehabilitation, the share of cropland regularly inundated by tidal floods, and estimated increases in cropping intensity in the Rabi season. Benefits for this package were projected starting after the completion year in 2023.

AquaCrop worked well for modeling the benefits of the polder projects, and the very large scale of the project allowed us to discern substantial project benefits. The fact that some polders were already installed allowed us to conduct detailed modeling of benefits for Package 1. The World Bank's robust

[15] The focus group information, as well as review of project documents and interviews, enabled us to qualitatively assess additional DIs, including better water management and better access to irrigation water; community capacity building; government capacity building; better access to markets; and general mobility improvement.

project documentation, combined with the rich data provided by the government's contractor, was extremely valuable for the modeling work. This underscores the importance of collecting robust baseline and monitoring data at the project level, not only for monitoring and reporting purposes, but also to inform more sophisticated benefits analyses.

Despite the overall success of the modeling approach, we were unable to model (as we had originally hoped) the effect of sea level rise on the polder rehabilitation projects, due to data limitations and uncertainties. First, georeferenced spatial information about the polder boundaries and embankments were not available. Second, topographic datasets with vertical resolution high enough to determine changes in inundated areas are not yet available. Most datasets available are only available at 1-meter increments. In such a flat area with mean sea level changes less than 1 meter, detailed topographic data is necessary. Third, and most important, an assessment of sea level rise effects for the polder areas requires information about embankment degradation, with details on the heights of the places along the embankment where sea waters are encroaching on croplands or potential cultivable areas with rehabilitation. This detailed information was not available.

Category 3: Increased energy-enabled economic output

This category focuses on tools that can evaluate changes in economic output resulting from energy investments. The Modeling Memo reviews a set of input-output (I-O) and computable general equilibrium (CGE) models, including one integrated global economic modeling platform (GCAM) that includes agricultural, energy, and other sectoral modules. The JIM is an I-O model that has the capability to analyze energy-enabled output but, unlike CGE models, does not allow for analysis of the economy-wide implications of investments. The Modeling Memo discusses the differences between I-O and CGE models and includes a review of the JIM tool.

We recommend that CIF consider two activities to better quantify energy-enabled economic output. The first involves developing a CGE modeling framework to allow for economy-wide project and portfolio analysis, and the second involves developing a set of broadly applicable, screening-level sectoral models that can generate inputs to macro models (either the JIM or a CGE framework).

The first activity would involve teaming up with another organization that already has access to a CGE modeling platform, to tailor that platform to CIF's needs. To our knowledge, three groups may be promising collaborators:

- The **Massachusetts Institute of Technology (MIT)** Joint Program on the Science and Policy of Global Change, to develop a more generalized and user-friendly version of its Emissions Prediction and Policy Analysis (EPPA) model—see the table below and Section 4 for more details. This is a global CGE model that draws on GTAP country-level data, and would allow for more integrated analysis of CIF's investment portfolio. Dr. Sergey Paltsev, who is one of the lead EPPA modelers and a team member on this activity, has expressed interest in this concept.
- The **Global Trade Analysis Project (GTAP)** team at Purdue University, to enhance their existing set of CGE models into a framework more like JIM. This may be the most straightforward approach given the uniformity across the GTAP CGE models.

- The **World Bank**, to stitch its existing set of macro models into a more cohesive framework. The Bank uses its MANAGE CGE model in some countries, and the MFMod macro-structural model in others. If it is feasible to collaborate with the World Bank on these analyses, it may be most suitable for project-level analysis, given differences in model structure across countries.

The second activity would entail developing a sectoral modeling framework that would develop more defensible inputs to the macro models, such as translating the installed capacity (in MW) of a planned hydropower project into energy generation (in MWh) using modeled streamflow under a range of scenarios. This would encompass tools to evaluate energy investments, as well as a broader suite of investments in agriculture, land use, transportation, and other sectors.

Table 17 summarizes the applicability of MIT's EPPA model.

Table 17. Summary Overview of EPPA

Emissions Prediction and Policy Analysis (EPPA)	
Description	Developed by the MIT Joint Program on the Science and Policy of Global Change, EPPA is a CGE model used for economic projections and policy analysis. EPPA allows users to quantify the economic impact of emission mitigation policies (emissions limits, carbon taxes, energy taxes, tradeable permits, and technology regulation) and also model how different emission scenarios influence atmospheric chemistry and climate change. EPPA can be run as a standalone model or in conjunction with MIT Earth System Model.
URL	https://globalchange.mit.edu/research/research-tools/human-system-model/download
Complexity and Data Needs	The global trade analysis project (GTAP) database is built into the EPPA model and provides necessary data on production, trade flows, economic data, and emissions, which EPPA aggregates into 16 regions and 21 economic sectors.
In-house vs. Outsourced Use	The accessibility of the GTAP database within the EPPA model makes in-house use of EPPA feasible.
Cost of Implementation and Maintenance	EPPA is a publicly available model that can only be used for educational or research purposes (not for commercial use). MIT does not provide any technical support or maintenance for EPPA, and users must also edit the source code to reflect economic or technological changes.
Examples of Use	"Climate Change Policy in Brazil and Mexico: Results from the MIT EPPA Model" (*Energy Economics,* 2016): This paper uses the EPPA model to quantify the monetary costs associated with Brazil and Mexico meeting UN emissions commitments. Also, a CGE model using GTAP data was used in the Indonesia geothermal case study.
Use Cases for CIF	(1) Investment plan and project design: can produce ex-ante project benefits and costs to evaluate project plans. (2) Exploration and collaboration with partners: macroeconomic results are understood widely so are effective at communication with local ministries of finance, development banks, or development partners. (3) Understanding tradeoffs between investment opportunities: By quantifying the economic costs associated with different emissions policies, EPPA can be used to better compare different investment strategies. (4) Ex-post evaluation of development impacts from climate finance: as CGEs were applied in the Indonesia case study.
Outputs/Units	The model output of EPPA can vary by specifications. Under the economic specification, outputs include gross output by sector and output supplied to each final demand sector. These outputs can be considered in terms of energy (exajoules), emissions (tons), land use (hectares), population (billions of people), natural resource stocks (exajoules, hectares) and efficiencies (energy produced/energy used). More broadly, EPPA can also produce outputs related to water, land and atmospheric changes (i.e., sea level rise, GHG concentrations, soil and vegetative carbon, net primary productivity, and global mean temperature, among others).

We used a CGE model in the Indonesia geothermal case study. We tested different shares of geothermal power (1, 5, 10, and 15 percent of total electricity generation) and evaluated economy-wide implications under different assumptions of the levelized cost of geothermal energy. The shares of geothermal power in our scenarios were chosen from an estimate of geothermal potential in Indonesia and projected electricity demand. Our CGE model produces estimates for Indonesia's economy under alternative technology, policy, and geothermal scenarios in 2030 and 2045. We calibrated the model using the GTAP database.

To assess the economy-wide impacts of developing geothermal power, we considered the following impact channels: increased electrification, education benefits of increased electrification, and air pollution health impacts. We explored the impacts of expanded geothermal on GDP, emissions, labor in the electricity sector, and the electricity mix.

The CGE modeling results indicate that supporting geothermal development may lead to sizeable impacts on Indonesia's GDP. With a larger share of new geothermal in total electricity generation, impacts on GDP grow. The largest positive contribution to GDP is from expanded electrification (under the assumption that all geothermal power is used for increased access to electricity in Indonesia). This finding has important implications for targeting geothermal development in areas of the country that do not currently have access to (reliable) electricity. Improved labor productivity from increased education provides further benefits to GDP. Health benefits from reduced air pollution are relatively small, but also valuable in terms of adding to GDP.

We also scaled our results to provide estimates of the impacts from developing individual geothermal projects funded by CIF. Similar to the health impacts modeling for Thailand, the impacts of individual projects are positive, but much smaller than the modeled economy-wide impacts.

A number of caveats and extensions to the analysis could be addressed in future work. First, additional analysis is required to quantify the shares of electrification benefits (rather than the upper limits we consider here). This would entail a detailed geographic assessment of the current electrification/ reliability rates and locations of geothermal projects. Second, for education benefits we used a rate of return of 12 percent, which is based on studies for Australia and Russia. Similar rates of about 10 percent have been estimated for the United States, Canada, Norway, and other countries, but a targeted study for Indonesia would help to confirm the applicability of this rate to the Indonesian context. Third, for air pollution benefits we used a simplified approach by applying a U.S.-based study of air pollution-related health effects, where coal-based generation is replaced by renewables (wind and solar). The actual benefits would depend on local conditions, including climatic conditions, what fuel source was displaced, etc. A specific air pollution study for Indonesia would need to be conducted for finer resolved health impacts of air pollution.

Another possible extension of the approach used in the case study would be to add a distributional analysis—different income groups, urban/rural population, etc.—to the economy-wide modeling. Merging the input-output structure of an economy-wide CGE model with detailed expenditure surveys for Indonesia would allow for the consideration of distributional impacts of different policies. Finally, there are numerous policy proposals related to low-carbon electricity deployment and economy-wide emission reductions, including a net-zero target for 2060 communicated by the Government of

Indonesia under the United Nations Framework Convention on Climate Change (UNFCCC). In this report, we focused on the pathways for evaluating the benefits of geothermal power rather than on an assessment of government goals.

Comparison between JIM and CGE Outputs for the Geothermal Case Study in Indonesia

To provide additional insight into the modeling options available to CIF and other climate funders, we compared JIM and CGE outputs for the same set of geothermal investments (CIF-funded geothermal projects in Indonesia).[16] The comparison shows the following similarities and differences (the Modeling Memo provides additional details):

- **Employment:** JIM shows the investments enable a total of 138,510 jobs, of which 35,007 are formal employment. CGE shows a similar level of formal employment (29,001 jobs) but cannot estimate informal employment, which appears to be significant.
- **GHG emissions:** JIM estimates that the projects produce 830,356 tCO_2e each year, and CGE estimates economy-wide emission reduction of 1.3 million tCO_2e. This difference can be attributed to economy-wide impacts (including the impact on other power-generation sources) captured by a CGE approach.
- **Economic impacts:** JIM estimates a total value added of $1.06 billion per year, whereas CGE estimates annual economy-wide impacts of only $107 million, or about 10 percent of the JIM estimate. This is primarily because the CGE estimates net effects, meaning that they are compared with effects in an economy where generation capacity is still constructed, but with the next-cheapest (i.e., non-geothermal) alternative. The JIM estimate provides a gross variable that is not directly comparable to a change in GDP or an economy-wide welfare impact.
- The CGE model also monetizes the **health and electrification** benefits of the projects over a 30-year period, which are $2.2 billion and $27.6 billion, respectively.

In summary, it is appropriate to apply the JIM to portfolios of projects where benefits estimates do not need to include behavioral responses of producers and consumers. For comprehensive assessments of the impacts of the projects on the economy, we suggest using the CGE tool, because it is based on a well-established economic approach that combines the production side of the projects, including resource and capacity constraints, with behavioral responses of economic agents both on the supply and demand side.

Overall, comparative assessment and testing in this evaluation identified several promising new approaches to estimating hard-to-observe DIs using modeling, which could be directly relevant to similar programs and should be further tested and expanded in use by CIF and other climate actors.

[16] Please note that the modeling results are based on 2,120 MW, rather than the planned installed capacity of 1,815 MW from CIF-funded projects in Indonesia, due to the inclusion of a canceled project.

Part 5. Conclusions

In this section we summarize some of the key findings of this evaluation, based on the analysis in Parts 1–4.

Climate finance investments can play an important role in achieving DIs.

Climate action and development are inextricably linked, and CIF's programs are designed accordingly, aiming to help countries achieve low-carbon, climate-resilient and inclusive growth through targeted climate investments. Yet, even though development impacts are understood to be a core benefit of climate finance—and this evaluation finds compelling evidence of them in CIF's portfolio—DIs are not always discussed in the planning of climate projects or included in monitoring and evaluation. Through intentional planning and tracking of DIs, there may be opportunities to achieve even greater impacts.

The secondary information review identified over 60 social, economic, environmental, and market development impacts that can be realized through interventions supported by climate finance. This evaluation organizes these DIs into a new Climate Finance DI Taxonomy and identifies potential DI pathways showing how climate finance interventions can contribute to DIs.

The most frequently identified DIs within CIF's clean energy development portfolios (CTF and SREP) include inclusive employment opportunities, access to essential services, competitiveness and industrial development, and energy sector security and resilience. The most frequently identified DIs within CIF's inclusive forestry and resilience portfolio (FIP and PPCR)[17] include improved livelihoods, wealth, and quality of life; improved soils and crop productivity; and greater gender equality and women's economic empowerment; notably, many of the benefits accrue to local stakeholders. The most frequently identified DIs in CIF's portfolio broadly align with the most commonly identified DIs in the secondary information review.

The DIs highlighted in the 13 case studies reflect both the frequency of DIs identified in the CIF portfolio analysis, and the selection criteria, designed to produce a balanced and representative mix of case studies, each involving a significant investment by CIF and known to have actual or potential significant DIs. Several include projects with both public and private sector participation. The DIs that were most amenable to being assessed and quantified were employment gains and market development. While each climate investors may prioritize different sets of impacts, the Climate Finance DI taxonomy and impact pathways should be useful to a diverse set of climate investors seeking to assess DIs.

Measuring and modeling targeted, intervention-specific DIs can support more informed investment decisions and strengthen the case for climate finance.

The results of the DI analysis are compelling and informative. This evaluation shows how measurement and modeling can be used to assess high-priority DIs, which can then support more informed investment

[17] This framework clusters CTF/SREP and PPCR/FIP projects together due to their synergies and overlaps. Still, it is important to note that they are four separate CIF programs with different objectives, scope, and areas of intervention—and thus different DIs in practice.

decisions. It can also enable investors to better capture and report on the wide range of benefits from climate investments.

For example, at the CIF portfolio level, economic modeling shows that CIF investments have contributed substantially to employment and added tens of billions of dollars in economic value to local economies. At the program/project level, the case studies showcase the breadth and diversity of DIs achieved by CIF investments. In all 13 case studies, the IEc team found that CIF investments created jobs: at least 21,000 existing and projected direct jobs altogether, including both temporary and permanent direct jobs. The IEc team also modeled indirect employment gains from two projects, totaling over 1,100 indirect jobs. Several projects helped to develop renewable energy markets, or spurred markets for goods and services. The large increases in renewable energy capacity financed by CTF and SREP also expanded energy access, increased energy security, and made energy systems more reliable and resilient. Three case studies (two PPCR and one FIP) demonstrated increased agriculture or livestock productivity. Nine of the 12 case studies observed or expected health benefits due to expanded access to essential services, reduced air pollution, and other impacts. Several projects expanded opportunities for women, including employment in traditionally male-dominated fields and in community leadership roles.

The evaluation demonstrates that DIs from climate finance can be measured, modeled, and estimated, but several measurement challenges need to be addressed. Regional or localized data often need to be collected, and substantial resources may be needed for measurement or modeling. Documenting and quantifying gender-related impacts can be particularly challenging when indicators, targets, and structures for measurement are not built into project design.

Investors can use robust information about climate finance DIs to make better investment decisions and project plans. The following conclusions focus on how to maximize the development impacts of projects:

In order to achieve and enhance DIs from climate finance, it is crucial to translate intentions into tangible project design elements, delivery, and estimation or measurement.

Progress toward achieving DIs through climate finance investments is facilitated or constrained by drivers and barriers at different levels. Some, such as policy frameworks, will require programmatic efforts to address. Others must be addressed at the project level, given the highly context-dependent nature of the interventions (tailored to local socioeconomic conditions, culture, etc.).

Because of these drivers and barriers, converting *potential* DIs to *realized* DIs requires intentional project design and implementation, starting in the early stages. For example, projects that successfully engage and align the interests of government, private sector, and local/community stakeholders can unlock DIs through increased relevance, responsiveness, and buy-in, thereby leading to more robust market development and expansion. Concessional climate finance and innovative financing models that de-risk investments and demonstrate successful financial/business models can strengthen and enable deeper market development and economic DIs than would otherwise be achieved.

Deliberate efforts to ensure economic and social inclusion, with meaningful participation by local communities, are critical to achieving social DIs and cross-cutting impacts, including benefits for the most vulnerable populations. Capacity building to facilitate local communities' participation is a key driver of well-distributed impacts, and should be built into project design and followed through during project implementation. Carefully designing projects with a programmatic approach in mind can also help ensure that local projects contribute to higher-level change.

This evaluation provides lessons and tools to help investors to consciously plan for DIs when designing programs/projects. For example, the impact pathways identified and substantiated through this evaluation could be used to identify the drivers needed to achieve DIs—particularly those that have been identified as local priorities. This would help to orient climate investments to consciously contribute to achieving those priorities. A "back-casting" approach can enable CIF to plan for more relevant DIs and shape how projects are designed, implemented, monitored, and evaluated accordingly. If climate investors design a climate intervention and then add DI objectives, they may not achieve the most important DIs in a particular place. They can achieve better results if they identify the most important DIs through diagnostic work and investment planning based on contextual profiling, for example. Then they can progressively work back to what energy source/adaptation response would meet those development needs, and perhaps consider other factors, such as alternative ownership, the distribution of benefits, and empowerment of communities.

The effect of DIs is greater than the sum of the parts and should be analyzed synergistically. Certain DIs (such as market development, built capacity, social/gender inclusion, and local workforce development) are catalytic ("Super DIs") and influence the achievement of other DIs, necessitating even more careful attention in project planning and implementation.

DIs can be mutually reinforcing and act synergistically, producing greater benefits together than they could individually. For example, in the Indonesia geothermal projects, workforce development facilitated the expansion of the geothermal market, resulting in more employment opportunities, energy sector resilience, and gender equity. Similarly, boosting the incomes of disadvantaged groups, including women, can unlock greater economic and social benefits, such as access to education and broader empowerment. In other case studies, the demonstration effect of CIF-funded projects led to market development, replication/scale-up, and additional DIs (e.g., the Thailand wind projects and the Brazil Macaúba project).

The case studies identified several "Super DIs" that are catalysts to unlocking other DIs. They include industrial competitiveness and market development, social inclusion, capacity building, and local workforce development. These Super DIs are particularly crucial to plan for in the project design. The following lessons learned address how to plan for and achieve these Super DIs.

Prioritizing women and vulnerable or geographically isolated populations can enhance DIs, distribute the benefits more equitably, and amplify uptake and effectiveness.

Many CIF projects explicitly include DI goals focused on women. The case studies highlight the benefits of prioritizing women and vulnerable groups in stakeholder consultations, and fully including them in interventions as employees, business owners, decision-makers, community leaders/members, and in other important roles. In addition to gender and social inclusion benefits, this can result in additional, knock-on DIs (e.g., increased earnings and improved quality of life).

Prioritizing vulnerable populations and/or underdeveloped geographic areas can also enhance economic DIs. For example, modeling results for the Indonesia deep-dive case study suggest that the economic impacts are mainly driven by increased electrification in unelectrified or under-electrified areas, complemented by productivity benefits from improved education and health benefits from avoided local air pollutants. Similarly, local capacity building, including workforce development, can help ensure that local communities can benefit from job opportunities and participate in supply chain development. Modeling results also show that investments in small-scale distributed solutions that employ the local workforce create direct jobs and have "multiplier" effects; for example, in India, two solar rooftop programs are estimated to have created 8,545 direct jobs (in construction and maintenance) and 900 indirect jobs (in solar equipment manufacturing).

Comparative assessment and testing in this evaluation identified several promising modeling approaches that could be used by CIF and other climate actors to estimate hard-to-observe DIs, which should be further tested and applied.

For the portfolio-level analysis conducted as part of this evaluation, the IEc team reviewed modeling approaches/tools and provided recommendations to estimate three high-priority DIs identified with CIF. The DI categories selected for this review represent DIs that are difficult to directly observe or measure. They are: (1) improved air quality and resulting health benefits from reduced (or avoided) fossil fuel combustion; (2) increased climate resilience in agriculture, including increased abilities to cope with shocks, reduced losses from climate events, and increased agricultural productivity; and (3) increased energy-enabled economic output, including direct, indirect, and induced employment and income. We also explored approaches for estimating changes in pollinator abundance and agricultural yields resulting from biodiversity conservation. For each of the DI categories listed above, we reviewed several models and then applied one or more in the deep-dive case studies. While all models have advantages and disadvantages, all were found to be fit for their intended purpose. In Part 4 of this report, we summarized the models tested and the results, and identifies key data requirements to run the models. Further testing and expanding these models would be beneficial for capturing DI results and making a compelling case for the development impacts of climate finance.

CIF, within its mandate as a learning lab for the wider climate finance community, has an important role to play in generating and disseminating lessons on the transformational impacts of climate finance on development that other climate funders can apply.

Through its programs and its robust learning initiative, including this evaluation, CIF can pilot and/or catalyze DI-centered climate finance strategies/investments, evaluate the results, and share this knowledge with other climate funders and broader audiences. This evaluation recommends paying attention to DIs at all stages of climate finance: from program design, to project design and approval, project monitoring and reporting, and project close and ex-post evaluation. However, the different actors involved have different goals and capacity levels. CIF can focus on disseminating lessons on DIs and best practices, tailoring them to diverse stakeholders while raising the general level of capacity. In addition, CIF can provide a platform to engage stakeholders and promote increased collaboration to learn together and maximize DIs. The MDBs and other climate funders, in turn, can apply these lessons and best practices to strengthen their development impacts and further expand the evidence base on the DIs of climate finance. Notably, CIF can also play an important role in addressing measurement gaps through additional research; specific focus areas were suggested in Part 4.

Appendix A – Supporting Tables

Table A1. Key Drivers to Realizing DIs

CASE STUDY	SECTOR/ SUBSECTOR	MAIN DRIVER	DETAIL	TYPE OF DRIVER
Bangladesh Deep-Dive	Agriculture	Effectiveness of rehabilitated infrastructure	DIs stemming from the coastal embankment project are predicated on rehabilitated polders working as designed to manage tidal flooding and storm surges. According to focus group participants and interviewees, in general, polders are working as designed and soil quality has greatly improved in areas where the work has been completed. The improved soil quality has allowed an increase in cropping intensity and cropping diversification that is the lynchpin to unlocking most DIs from the project.	Technical
Bangladesh Light-Touch	Solar (rooftop)	Contractor capacity development	Only 5-6 high quality solar EPC (engineering, permitting, and construction) contractors are operating in the country. Some have recently formed or formalized in response to the project and, more generally, the growing demand for rooftop solar. Additional local EPC firms and workforce development would be helpful in scaling up the industry.	Workforce
Bangladesh Light-Touch	Solar (rooftop)	Net metering	There was no net metering scheme in Bangladesh when the project was conceptualized in 2017. The government approved Net Energy Metering Guidelines in July 2018. According to interviewees, net metering is key to unlocking the cost-savings potential of rooftop solar for the ready-made garment industry.	Institutional and Technical
Brazil Light-Touch	Forestry	Adaptive management	Implementing partners demonstrated resourcefulness, perseverance and ingenuity responding to a variety of unexpected challenges including lack of engagement from stakeholders, low germination rates, and pests. The leadership of the lead firm, INOCAS, and the decision to shift the project focus towards land acquisition were key to the project's success.	Program management
Brazil Light-Touch	Forestry	Planning	Expansion of the project focused on vertically integrating the production of oil from Macaúba seedlings. INOCAS established a nursery for germinating and growing seedlings and planned early on to expand from an oil mill to an industrial scale mill providing both a source and an outlet for project activities.	Program management
Brazil Light-Touch	Forestry	Partnerships	The project formed numerous partnerships along multiple stages of the Macaúba value chain. These partnerships and positive, culturally sensitive relationships with local farmers were essential for encouraging adoption of Macaúba given the highly conservative attitudes of small-scale producers.	Institutional/ Programmatic
Brazil Light-Touch	Forestry	Capacity/ incentives	The government, most directly through the National Supply Company (CONAB), supported the investment and secured a subsidized price for Macaúba. The insulation of the price from market risk encouraged early adopters.	Financial and Institutional

CASE STUDY	SECTOR/ SUBSECTOR	MAIN DRIVER	DETAIL	TYPE OF DRIVER
India Light-Touch	Solar ((parks, rooftop), transmission	Government support/ enabling environment	India's policy measures and renewable energy targets have encouraged the uptake of rooftop solar and aided the development of solar parks. For transmission projects, state governments play a key role in facilitating land procurement. This facilitation occurs more frequently in states where renewable energy is already greatly developed.	Institutional
India Light-Touch	Solar ((parks, rooftop), transmission	RESCO ecosystems	The Renewable Energy Service Company (RESCO) ecosystems developed in the Grid-Connected Rooftop Solar Program enable firms to bring in equity from international investors, raising about $1 billion during the project. RESCOs can aggregate demand and provide the benefits of economies of scale. RESCOs also have the incentive to ensure high quality installation and thus provide quality assurance.	Financial
India Light-Touch	Solar ((parks, rooftop), transmission	Consumer awareness	Consumers, particularly residential, are not aware of the costs and benefits or financing options available for rooftop solar. The outreach to micro, small, and medium enterprises (MSMEs) in the Grid-Connected Rooftop Solar Program (through the State Bank of India) via awareness campaigns and streamlining the application process for installing residential rooftop solar has improved cooperation with important stakeholders.	Social
India Light-Touch	Solar ((parks, rooftop), transmission	Credit guarantee mechanism	While there is a large potential for rooftop solar development among MSMEs, their credit ratings tend to be too low to gain access to sufficient financing. Credit guarantee schemes have played an important role incentivizing investors to support MSME solar rooftop projects in the Grid-Connected Rooftop Solar Program.	Financial
India Light-Touch	Solar ((parks, rooftop), transmission	Financial health of DISCOMs	Within the technical assistance component of the Grid-Connected Rooftop Solar Program, there has been collaboration with electricity distribution companies (DISCOMs) to create business models to minimize revenue losses and help DISCOMs understand the benefits of grid-connected solar photovoltaics (e.g., how they will help with management of the system, particularly during peak periods).	Financial and institutional
India Light-Touch	Solar ((parks, rooftop), transmission	Limited debt financing	Financial institutions are reluctant to provide debt financing to solar market actors, and MSMEs and residential consumers do not have the means to obtain adequate financing. The investment programs have reduced this reluctance by providing less risky conditions for lenders—for instance, through co-financing, the RESCO ecosystem, and credit guarantee mechanisms for MSMEs.	Financial
India Light-Touch	Solar ((parks, rooftop), transmission	Skills/ knowledge gap	Government actors and financial institutions do not have the capacity to provide continuous institutional/ technical support (e.g., certification and enforcement of quality and technical standards) for scaling up rooftop solar technologies. The technical assistance portion of the Grid-Connected Rooftop Solar Program has addressed this issue by improving the institutional capacity.	Workforce
India Light-Touch	Solar ((parks, rooftop), transmission	Land acquisition & infrastructure	Public sector investment in road access, security, permits, and land allocation will remain key factors in making solar park projects attractive for investors.	Institutional
Indonesia Deep-Dive	Geothermal	Development capital injection	CIF's programmatic approach has helped to improve the enabling environment, and to maintain a minimum level of market confidence for the industry to flourish in the long term.	Investment

CASE STUDY	SECTOR/ SUBSECTOR	MAIN DRIVER	DETAIL	TYPE OF DRIVER
			Where funds have been directed to downstream projects, CIF capital has helped demonstrate the completion of a geothermal project (GCEIP), which provided lessons learned while the enabling environment for geothermal is being improved.	
Indonesia Deep-Dive	Geothermal	Government onboarding	CIF and the MDB have aimed to improve the enabling environment by helping align interests and facilitating governmental collaboration to accelerate geothermal development. Recent performance metrics on the creation of public-private partnerships under the GREM project show promise for onboarding state-owned developers.	Institutional and programmatic
Indonesia Deep-Dive	Geothermal	Licenses in energy-poor areas	Electrification in energy-poor areas is by far the most economically effective impact channel. To accommodate this, there must be built-in mechanisms that allow for increased energy access in energy poor areas (e.g., prioritization of geothermal baseload power generation in the electricity planning for energy poor areas).	Technical/ institutional/ programmatic
Indonesia Deep-Dive	Geothermal	Capacity building for developers	The GCEIP project demonstrates how capacity building helped to increase development performance by building competencies of a geothermal developer (PGE) and making sure that projects fulfill technical, environmental, and social best practices and industry standards. This helped PGE to become a world-leading geothermal developer and increased confidence in geothermal energy development in Indonesia.	Technical/ workforce
Indonesia Deep-Dive	Geothermal	Gender-inclusive designs	The GPGP and GREM projects outlined a detailed recruitment plan with targets for ensuring women were represented across geothermal development activities. This type of approach, along with Gender Action Plans, can help advance gender equality in Indonesia.	Programmatic/ workforce/ social
Indonesia Deep-Dive	Geothermal	Creation & capture of local opportunities	A key driver to optimize DIs is to provide effective program designs that create and capture the local suppliers and local skills that may exist and thereby help develop local supply chains. On the demand side, another key driver is to ensure that the local community benefits from geothermal development. The best example of long term local economic development in this case study may be the emergence of a local supply chain in North Sulawesi during when CIF was been active in the region.	Programmatic/ workforce
Indonesia Light-Touch	Forestry	Community and institutional interest in SFM	The interventions have demonstrated strong community interest in sustainable forest management practices. Stakeholders agreed that the CIF-SFM projects were important catalysts that contributed to the government's recent efforts to pursue land reforms by, e.g., building knowledge on functioning of forest management units (FMUs) and their interaction with communities.	Social/ institutional
Indonesia Light-Touch	Forestry	Effective coordination with the communities	The involvement of community-based organizations enabled smooth communication and collective work, building trust and facilitating their engagement throughout the projects. Similarly, proximity with the communities made it possible to recognize early during the COVID-19 pandemic how to support the beneficiaries.	Social/ institutional

CASE STUDY	SECTOR/ SUBSECTOR	MAIN DRIVER	DETAIL	TYPE OF DRIVER
Kenya Light-Touch	Off-grid electrification	Close cooperation with the government	County governments provided essential support for land acquisition, including the granting of land ownership and tenure for the implementation of project activities. This support eased a process that is typically arduous and lengthy. Active stakeholder engagement with the Ministry of Energy and Petroleum (MoEP) has helped align the project with political targets and garnered support for the project.	Institutional
Morocco Light-Touch	Solar (utility-scale)	Strong commitment by country/state	Government commitment, through a clear vision and energy strategy, together with a dedicated agency (the Moroccan Agency for Sustainable Energy, MASEN) provided a strong basis for success of the project and its subsequent phases.	Institutional
Nepal Deep-Dive	Biogas	Access to private financing	With more successful SREP subprojects, banks are more open to providing financing than they were before.	Financial
Nepal Deep-Dive	Biogas	Public-private partnership approach	The combination of the SREP financing and the government's willingness to provide matching funds were instrumental in promoting and expanding the large biogas sector in Nepal.	Institutional
Nepal Deep-Dive	Biogas	Technical assistance	The technical assistance was very helpful to the implementing agency (AEPC), project developers, and other stakeholders involved in the project to strengthen their capacity in large-scale biogas.	Workforce
Nepal Deep-Dive	Biogas	Financial attractiveness	The financial competitiveness of biogas produced in Nepal compared to imported fossil fuels was very high, with an estimated IRR of 49%. This was key for developers to further pursue and replicate the project.	Economic
Niger Light-Touch	Agriculture	Coaching and results-based management system	An enhanced coordination and communications system was needed to support effective operationalization of integrated climate resilience/agricultural productivity service delivery platforms (Maisons du Paysan) in rural communities. A coaching + results-based management system supported regular (weekly) communications, coordination, and problem-solving, combined with leadership development and coordination mechanisms between local and national coaching infrastructure.	Management and technical
Niger Light-Touch	Agriculture	Maison du Paysan model with physical building in rural areas	The Maison du Paysan (Farmer's House) model included construction of buildings in rural communes to support storage of agricultural inputs and outputs, and space for meetings, training, and service outreach. These high-quality facilities supported multiple uses and protected agricultural resources from damage by extreme weather. Their central presence in rural communes also reduced travel distances for rural producers and provided a tangible symbol of the value of government support to improve DIs and quality of life.	Technical
Niger Light-Touch	Agriculture	Government championing of idea	Interviewees indicated that the success of the Maison du Paysan model (integrated rural service delivery platform with building facilities) was enhanced since the idea came from the Government of Niger and was championed by the national government representatives.	Institutional

CASE STUDY	SECTOR/ SUBSECTOR	MAIN DRIVER	DETAIL	TYPE OF DRIVER
Thailand Deep-Dive	Wind (utility-scale)	First-mover demonstration of viability	Domestic financial institutions were reluctant to provide long-term loans to support wind power facilities. Concessionary financing reduced the risk for first-mover projects and their success demonstrated the financial viability of utility-scale wind power in Thailand.	Financial
Thailand Deep-Dive	Wind (utility-scale)	Community engagement	Community engagement activities increased public understanding and support for wind facilities. Projects trained and hired local workers, thereby helping to localize the economic benefits.	Social
Thailand Deep-Dive	Wind (utility-scale)	Removal of regulatory barriers	National construction permitting standards conflicted with wind-turbine technology. International expertise supported regulatory revisions that allowed for the construction of wind plants.	Institutional
Türkiye Light-Touch	Renewable energy and energy efficiency	Government support & policy environment	The Government showed significant commitment to the project, and at the time of the ICR was implementing various legislative measures to promote private investment in renewable energy and energy efficiency. These policies helped reduce risk to investors and helped raise awareness of the potential for energy efficiency in industry.	Institutional
Türkiye Light-Touch	Renewable energy and energy efficiency	Financial concept	Success centered on the project design concept to provide a concessional FI loan to trusted local development partners, with a strong local network and reputation and established client portfolios in the Turkish market, who then provide small-scale loans to their customers on fully commercial terms.	Financial
Türkiye Light-Touch	Renewable energy and energy efficiency	Timing of intervention	The right timing was essential for success. There was an ongoing supply security problem in Türkiye while the project was prepared. However, feed-in tariffs were already established instruments, creating a good starting point for mobilizing finance. Also, the fact that renewable energy prices started to come down internationally at the time was one of the biggest reasons that the initial targets were achieved and exceeded.	Financial and institutional

Table A2. Key Barriers to Realizing DIs

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
Bangladesh Deep-Dive	Agriculture	Effectiveness of rehabilitated infrastructure	According to focus group participants and interviewees, in general, polders are working as designed and soil quality has greatly improved in areas where the work has been completed. However, some technical problems are evident. For example, in some polders, main canals (khals) have had to be re-excavated for proper water management. In some places, quality of the reconstructed polders is lacking, and some of the rehabilitated polders have already started to crack due to poor workmanship.	Technical
Bangladesh Deep-Dive	Agriculture	Limitation of cropping intensity	Economic benefits of polder rehabilitation are driven in part by ability to increase cropping intensity. However, focus group participants note several limitations to increasing cropping intensity outside of the Rabi season.	Technical
Bangladesh Deep-Dive	Agriculture	Cost overruns and need to scale back the project	Economic and social benefits of polder rehabilitation are obviously tied to the scale of the project. CEIP-I experienced significant cost overruns that led to the elimination of Package 3 polders from the currently funded project. Although one interviewee indicated that the Bangladeshi government would fund Package 3 to rehabilitate the remaining 7 polders, this has not yet occurred, and other interviewees were uncertain about the prospects for funding Package 3. The DI implication is simply that the scale of economic and social benefits is smaller than if Package 3 were funded.	Financial
Bangladesh Deep-Dive	Agriculture	Water management organizations/ associations (WMOs/WMAs) off to slow start	WMOs and WMAs are important organizations for maintaining some day-to-day operations of polders. However, we have mixed information on the performance of WMOs and WMAs to-date. Focus group participants stressed that WMOs need to properly control sluice gates for water flows with respect to tidal movement, and that there is continuous leakage even when gates are closed. Also, focus group participants indicated that WMAs lack working relationships with the BWD (the federal water department).	Institutional
Bangladesh Light-Touch	Solar (rooftop)	Trained contractor	Only 5-6 high quality solar EPC (engineering, permitting, and construction) contractors are operating in the country. Despite significant growth in the past few years, additional local EPC firms and workforce development would be helpful in scaling up the industry to meet the increasing demand for rooftop solar.	Workforce
Bangladesh Light-Touch	Solar (rooftop)	Net metering/ distribution system	There was no net metering scheme in Bangladesh when the project was conceptualized in 2017. The government approved Net Energy Metering Guidelines in July 2018. Current net metering guidelines impose a maximum of 70% rooftop coverage, which limits the producer's maximum power generation. Some stakeholders indicate that the guidelines do not incentivize business participation enough to achieve scale up.	Institutional and technical

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
Bangladesh Light-Touch	Solar (rooftop)	Solar limitations	Bangladesh has an older distribution network, which can lead to problems with implementing net metering and injecting power into the grid from distributed resources. Addition of on-site storage could greatly expand value proposition of on-site solar for factory owners by addressing intermittence issue with solar, and reduce need for net metering. Site-level funding should also be available to address obvious energy efficiency gaps prior to installing solar.	Technical
Brazil Deep-Dive	Agriculture	Stakeholder participation	The project had challenges recruiting farmers due to reluctance to adopt new practices and the risk of being assigned to the control group. The project design was eventually modified because there were not enough participating farms to implement the original experiment. Retention of participations was an initial concern, but results show retention rates were high.	Programmatic
Brazil Deep-Dive	Agriculture	Institutional structures/ Processes	Institutional structures and processes were an initial barrier to implementation due to unfamiliarity with project management and financing. These challenges caused initial delays, but were addressed over the life of the project. Inter-agency coordination remained a weakness.	Institutional
Brazil Light-Touch	Forestry	Stakeholder participation	Local stakeholders including farmers and partner organizations were reluctant to join the project given conservative attitudes towards new agricultural practices and the multi-year time frame for Macaúba to become productive.	Programmatic/ institutional
Brazil Light-Touch	Forestry	Lack of established market demand	Moving forward, establishing commercially-viable, at-scale production of Macaúba-based products will be important to maintain prices as Macaúba production increases. Biofuel production is a potential source of demand for Macaúba oil, but there is not currently a domestic market, partially due to negative environmental associations.	Economic
Brazil Light-Touch	Forestry	Access to finance	There was little investor interest given the 15- to 20-year horizon on the investment, INOCAS' lack of and established track record, and the failure of similar projects. Demonstration of the viability of this model has increased investor interest.	Financial
Brazil Light-Touch	Forestry	Labor conditions	Access to harvesters and fair labor conditions are a major cost factor and potential barrier. The project is working to establish health and safety standards for harvest workers, but still lacks a grievance mechanism.	Social/financial/ Workforce
Brazil Light-Touch	Forestry	Female representation	There have not been sufficient female candidates to equitably fill positions at INOCAS and the board currently has no female representation. Cultural barriers limit female employment in certain activities such as harvesting.	Equity
Brazil Light-Touch	Forestry	Regulatory framework	While the regulatory environment has started to adapt to Macaúba production, certain laws remain barriers to the cultivation and/or use of related products. National regulations protecting Macaúba as a protected, native tree contradicts laws encouraging the cultivation of Macaúba products. Restrictions on the sale of oilseed to biofuel companies also limits the market for Macaúba products.	Institutional

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
India Light-Touch	Solar ((parks, rooftop), transmission	Weak institutional coordination	There is weak coordination between central and state government agencies, and between government agencies and private stakeholders in the rooftop solar industry.	Institutional
India Light-Touch	Solar ((parks, rooftop), transmission	Consumer awareness	Consumers, particularly residential ones, are not aware of the costs and benefits, or of the financial options available for rooftop solar technologies.	Social
India Light-Touch	Solar ((parks, rooftop), transmission	Financial health of DISCOMs	DISCOMs do not have the financial and technical capacity to deal with increasing renewables. Some state-owned DISCOMs have poor financial health and are discouraged from adopting net metering and other GRPV policies. This pressure has fostered a reluctance from DISCOMs to promote rooftop solar.	Financial and institutional
India Light-Touch	Solar ((parks, rooftop), transmission	Limited debt financing	Due to previous exposure to the power sector, financial institutions are reluctant to provide debt financing to solar market actors including rooftop solar developers, installers, and aggregators. Additionally, MSME and residential consumers do not have the means to obtain adequate financing.	Financial
India Light-Touch	Solar ((parks, rooftop), transmission	Lack of experienced rooftop solar installers	The rooftop solar industry in India is fragmented with many installers involved due to the low barriers to entry. This fragmentation creates a lack of trust among consumers. Current technical training programs lack field training, and awareness of training programs is poor among potential trainees and the industry in general.	Workforce
India Light-Touch	Solar ((parks, rooftop), transmission	Skills/knowledge gap	Government actors and financial institutions do not have the capacity to provide continuous institutional/technical support (e.g., certification and enforcement of quality and technical standards) for scaling up rooftop solar technologies.	Workforce
India Light-Touch	Solar ((parks, rooftop), transmission	Transmission bottlenecks	Solar parks tend to be concentrated in certain state/regions within India, which can lead to an unbalanced power system, where the energy supply is centralized in a few resource-rich areas and is not connected to areas where there is high energy demand. Furthermore, some states in India require renewable energy projects to only sell electricity to DISCOMs within the state.	Technical and institutional
India Light-Touch	Solar ((parks, rooftop), transmission	Coordinating solar park and transmission projects	Sufficient transmission infrastructure is key to ensure that solar power generated at solar parks is evacuated to the grid. However, while renewable energy projects can take 12–18 months, transmission infrastructure can take up to five years to complete.	Technical and institutional
India Light-Touch	Solar ((parks, rooftop), transmission	Difficulty in land acquisition & insufficient infrastructure	Some barriers that the Solar Park Transmission Program addresses will remain an issue in other regions of the country including obtaining suitable land and promoting clearance for solar parks (transmission projects).	Institutional
Indonesia Deep-Dive	Geothermal	Government onboarding	Challenges remain with the geothermal enabling environment. Being more costly than fossil fuels in the near term creates an unfavorable market position in which geothermal energy development relies on effective fiscal and regulatory incentives to be competitive.	Institutional and programmatic

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
Indonesia Deep-Dive	Geothermal	Private sector onboarding	Resource risks and financial uncertainty around geothermal exploration are constraints to effectively mobilize commercial capital. With the high ambitions for geothermal energy in Indonesia in the Supply Plan, and the estimations of needed commercial capital to implement geothermal projects, mechanisms to onboard the private sector are critical drivers for geothermal development. Challenges include a proper definition of the role of state-owned grid operator PLN in working together with developers.	Financial/ institutional/ programmatic
Indonesia Deep-Dive	Geothermal	Geothermal licenses in energy-poor areas	Challenges in implementing and achieving electrification in energy-poor areas are related to geographical remoteness (e.g., more costly), and creating public acceptance through community onboarding while respecting the cultural heritage and social structures in underdeveloped remote geographical areas.	Technical/ institutional/ programmatic
Indonesia Deep-Dive	Geothermal	Creation & capture of local opportunities	Some projects, such as the GCEIP, have tracked the level of "local content" in program spending, but more concerted efforts are needed to ensure that local suppliers and skills are optimally tapped. The findings from this case study suggest that creation and capture of local opportunities are issues which are being addressed, but which are not optimally integrated into project plans and project development objectives.	Programmatic/ workforce
Indonesia Light-Touch	Forestry	Unstable framework for forest governance	Recent government initiatives partly changed forest management roles in Indonesia, which required CIF-SFM project responsibilities to be reassigned, delaying some activities.	Institutional
Indonesia Light-Touch	Forestry	Cultural barriers that limit female participation	Achieving DIs concerning the number of female participants has been difficult because the share of women working in governmental institutions is currently lower than the goals set by the projects. Women are not always able to engage actively in the project activities due to their other responsibilities.	Social
Indonesia Light-Touch	Forestry	Involuntary resettlement	Some inhabitants of the project sites had to free up land for roads, installation of water pipelines, or ecotourism facilities. Depending on the type of impact, different forms of compensation were provided.	Social
Kenya Light-Touch	Off-grid electrification	Lack of familiarity with novel business models that increase private sector participation	The supply and installation contract for the KEMP mini-grids was considerably delayed by challenges in agreeing on an operations and maintenance contract that ensures affordable electricity for consumers. The required business model was new in Kenya and the process was unfamiliar to key stakeholders. As a result, the project has needed more time and guidance from CIF than anticipated, including the engagement of transactional advisors to develop a suitable business model.	Institutional
Kenya Light-Touch	Off-grid electrification	New technologies used for the mini-grids may reduce some of the anticipated direct job creation	An impact assessment of the construction of the mini-grids on one of the target islands predicted that it will create employment opportunities, particularly for casual workers from the local community including masons, carpenters, etc. However, interviewees indicated that the use of new technologies (e.g., automation and remote monitoring) may reduce some of the anticipated direct job creation at the local level.	Technical

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
Kenya Light-Touch	Off-grid electrification	Involuntary resettlement	The project documentation reported that the repurposing of land may result in involuntary resettlement. Precautionary measures have been taken to minimize the impacts on physical and cultural resources. These impacts are expected to be temporary (e.g., occurring during the construction phase) and minimal.	Social
Morocco Light-Touch	Solar (utility-scale)	Uncertainties in project preparation	During the project preparation phase, the project costs and pool of bidders were uncertain, key project risks could not be fully assessed as the competitive bidding process was not completed, and negotiations of key project documents did not occur.	Financial and Institutional
Nepal Deep-Dive	Biogas	COVID-19 pandemic	The COVID-19 pandemic had a negative impact on the progress of the subprojects, which slowed down technical assistance, project identification, preparation and construction. Project activities continued, but at reduced scale and speed.	Social/ workforce
Nepal Deep-Dive	Biogas	Project Implementing Unit Staff shortage	Also related to the pandemic, the Project Implementing Unit suffered staff shortages, partially due to the closure of the Nepal Rural and Renewable Energy Program, but as of July 2020, it was fully staffed.	Workforce
Nepal Deep-Dive	Biogas	Lack of demand for organic fertilizer	It was a challenge convincing local farmers to switch to organic fertilizer, since most believed that chemical fertilizer led to higher yields. This reduced profitability for sellers of organic fertilizer relative to their business plan forecasts.	Economic
Nepal Deep-Dive	Biogas	Lack of maintenance expertise	Routine maintenance required by the large-scale biogas industry needs to be performed by Indian maintenance experts, but bringing in these experts comes at a higher cost and does not create maintenance jobs in Nepal.	Workforce
Nepal Deep-Dive	Biogas	Access to private financing	The requirement of 60% private financing for projects was a major challenge for developers, even though there was interest. Lack of understanding of the risk on the financial institution side meant that not enough debt financing was available.	Financial
Nepal Deep-Dive	Biogas	High interest rates of commercial banks	Current interest rates at commercial banks are high (14–18%), which poses a major hurdle for project developers to make a positive business case.	Financial
Nepal Deep-Dive	Biogas	Funding against assets only	Funding was provided against assets only, and not for land acquisition, which was an obstacle for some project developers.	Financial
Niger Light-Touch	Agriculture	Financing gaps	Interviewees noted that delays in securing project follow-on investment have stalled some implementation activities and may undermine operation of existing Maison du Paysan (integrated rural climate resilience and agricultural productivity service delivery platforms).	Financial and institutional
Thailand Deep-Dive	Wind (utility-scale)	Removal of regulatory barriers	National construction permitting standards conflicted with wind-turbine technology. International expertise supported regulatory revisions that allowed for the construction of wind plants.	Institutional
Thailand Deep-Dive	Wind (utility-scale)	Land use restrictions	A 2017 Supreme Administrative Court ruling prevents wind-power facilities on public lands designated for agricultural purposes. Uncertainty about land access discourages future wind-power construction.	Institutional

CASE STUDY	SECTOR/ SUBSECTOR	MAIN BARRIER	DETAIL	TYPE OF BARRIER
Türkiye Light-Touch	Renewable energy and energy efficiency	Commercial gap/ limited awareness	Commercial banks' lack of familiarity with financing energy efficiency projects, and SMEs' lack of awareness of the benefits of energy efficiency investments, made it difficult to translate the intended benefits into attractive opportunities at the start of the project. According to stakeholders, even the largest developer in Türkiye at the time could not meet the safeguarding rules for building the renewable energy assets, which made it significantly challenging to kick off financing in the first year of the project.	Institutional and financial
Türkiye Light-Touch	Renewable energy and energy efficiency	Safety and environmental rules	Safety and environmental rules were not followed to the desired standards when building some small hydro plants during the project. Better planning, as well as precautionary regulatory measures would have been necessary to avoid the negative environmental impacts to water bodies and surrounding ecosystems.	Institutional
Türkiye Light-Touch	Renewable energy and energy efficiency	Gender-related impacts not recorded	While the climate impacts of these types of projects are prioritized and pushed for evaluation, there is a need to broaden look at other impacts as well. Most projects (especially those that started 10–15 years ago) were not designed with a gender component in mind, and gender considerations are not given in-depth treatment in evaluations. While indicators such as the number of women involved in the projects provide some sense of gender impacts, they do not reflect the medium- and long-term change in societies' perceptions and inclusion of women.	Programmatic/ methodological

Table A3. Main Challenges to Documenting and/or Quantifying DIs

CASE STUDY	SECTOR	DI CATEGORY	MAIN CHALLENGES TO DOCUMENTING AND/OR QUANTIFYING DIS
Bangladesh Deep-Dive	Agriculture	Soil and crop productivity	Need crop modeling to capture these benefits.
Bangladesh Deep-Dive	Agriculture	Economic value added (GDP)	Need crop modeling and economic modeling to capture these benefits.
Bangladesh Deep-Dive	Agriculture	Earnings (construction and permanent)	Need crop modeling and economic modeling to capture these benefits.
Bangladesh Light-Touch	Renewable energy (Industrial Rooftop Solar)	Employment (of any kind)	Need modeling to capture indirect and induced jobs.
Bangladesh Light-Touch	Renewable energy (Industrial Rooftop Solar)	Energy cost savings	The Infrastructure Development Company Limited (IDCOL) does not have standardized bill factors to apply; bespoke analysis required.
Bangladesh Light-Touch	Renewable energy (Industrial Rooftop Solar)	Increased electricity reliability/decreased outages	Reduced generator use, in terms of reduced diesel usage or costs, could be collected by IDCOL or the Sustainable and Renewable Energy Development Authority (SREDA).
Brazil Deep-Dive	Agriculture	Multiple	One of the projects in the case study were too recent to demonstrate DIs. The Dedicated Grant Mechanism (DGM) project was too broad, diverse, and splintered to aggregate and compare results in a systematic way.
Brazil Deep-Dive	Agriculture	Multiple	The experimental design may have distorted the original intentions of the Sustainable Production in Areas Previously Converted to Agricultural Use (ABC) Project.
Brazil Deep-Dive	Agriculture	Soil and crop productivity	Connecting the (relative) index values in the Integrated Valuation of Ecosystem Services and Tradeoffs (InVEST) pollination model to absolute changes in yield requires knowledge about the baseline crop species' yield within a field and the relationship between crop species' yield and pollinator abundance. Data limitations prevented us from linking the relative changes in pollinator abundance with percentage change in yield.
Brazil Light-Touch	Forestry	Economic value added (GDP)	Collection of additional data on the leveraging of finance would be needed.
Brazil Light-Touch	Forestry	Economic value added (GDP)	Eventual assessment of the innovative financing model, including the exit option.
Brazil Light-Touch	Forestry	Economic value added (GDP)	Collection of additional data on other scaling effects including uptake by other farmers in other regions of the country and broader region would be needed.
India Light-Touch	Solar power	Energy sector security and resilience	Need to estimate based on assumptions of how much solar power replaces coal/oil.

CASE STUDY	SECTOR	DI CATEGORY	MAIN CHALLENGES TO DOCUMENTING AND/OR QUANTIFYING DIS
India Light-Touch	Solar power	Employment (of any kind)	Difficult to estimate job creation for solar park transmission, as it depends on several elements.
India Light-Touch	Solar power	Reduced air pollutants	Costs estimated based on the social carbon cost in India from the literature.
India Light-Touch	Solar power	Reduced air pollutants	Need to estimate based on emissions factors for fossil fuel displacement.
India Light-Touch	Solar power	Health and safety	Need to estimate based on the monetary health cost value from the literature.
India Light-Touch	Solar power	Gender-related benefits	Most of the gender benefits are indirect and difficult to quantify.
Indonesia Deep-Dive	Renewable energy (geothermal)	Economic value added (GDP)	Difficult to quantify direct versus indirect job creation.
Indonesia Deep-Dive	Renewable energy (geothermal)	Competitiveness and industrial development	To qualitatively assess or quantify market impacts (or market confidence) were difficult largely because private capital remains to have been effectively unlocked due to a lack of fiscal/regulatory incentives – e.g., Power Purchase Agreement (PPA) Regulation.
Indonesia Deep-Dive	Renewable energy (geothermal)	Community engagement and social inclusion	Difficult to quantify the impact of energy reliability. Other methods (e.g., survey) would be more appropriate to assess the perceived impact of geothermal energy by the local community members (e.g., what is really the impact for the poorest and low-income people).
Indonesia Light-Touch	Sustainable Forest Management	Competitiveness and industrial development	Quantitative evidence of the number of people employed (or robust estimations of the number of jobs expected to be created) as a result of the promotion of new economic activities is not available.
Indonesia Light-Touch	Sustainable Forest Management	Competitiveness and industrial development	Quantitative evidence of non-monetary support is very limited. It is not possible to determine which of the economic activities led to most substantial DIs.
Indonesia Light-Touch	Sustainable Forest Management	Community engagement and social inclusion	There is not sufficient information about the constitution of the 10 Forest Management Units (FMUs) and how it changed throughout the project (area covered, number of farmers involved, etc.)
Indonesia Light-Touch	Sustainable Forest Management	Gender-related benefits	Impacts on women (e.g., enhanced conflict resolution role) mostly based on anecdotal experiences. Metrics to measure impacts on women are not sufficient, according to interviewees. Baselines describing the current situation of women are difficult to establish.
Kenya Light-Touch	Off-grid renewable energy	Expansion of electricity to new households and businesses	Project is still ongoing. The DIs reported are mainly based on estimations/forecasts.
Kenya Light-Touch	Off-grid renewable energy	Employment (of any kind)	Project is still ongoing. The DIs reported are mainly based on estimations/forecasts.
Kenya Light-Touch	Off-grid renewable energy	Reduced air pollutants	Project is still ongoing. The DIs reported are mainly based on estimations/forecasts.

CASE STUDY	SECTOR	DI CATEGORY	MAIN CHALLENGES TO DOCUMENTING AND/OR QUANTIFYING DIS
Morocco Light-Touch	Utility-scale renewable energy (solar CSP & PV)	Employment (of any kind)	Employment appears to have been relatively well tracked. Complexities were mainly in breakdowns of figures for gender and/or local employment.
Morocco Light-Touch	Utility-scale renewable energy (solar CSP & PV)	Health and safety	Emissions reductions are estimated in comparison to equivalent electricity generation by a fossil source. Selection of the fossil source and assumption of plant characteristics have a large impact on the DI, and these assumptions were made by a National Office of Electricity and Potable Water (ONEE) study.
Morocco Light-Touch	Utility-scale renewable energy (solar CSP & PV)	Competitiveness and industrial development	Understanding precisely the impact on risk perception of such a project is complex.
Nepal Deep-Dive	Biogas	Energy sector security and resilience	Evidence from monitoring is limited, mostly anecdotal from interviews.
Nepal Deep-Dive	Biogas	Energy cost savings	Evidence from monitoring is limited, mostly anecdotal from interviews.
Nepal Deep-Dive	Biogas	Access to essential services	Evidence from monitoring is limited, mostly anecdotal from interviews.
Nepal Deep-Dive	Biogas	Employment (of any kind)	Evidence from monitoring is limited, mostly anecdotal from interviews.
Nepal Deep-Dive	Biogas	Competitiveness and Industrial Development	Evidence from monitoring is limited, mostly anecdotal from interviews.
Nepal Deep-Dive	Biogas	Capacity building of local institutions	Based on monitoring documents.
Nepal Deep-Dive	Biogas	Reduced air pollutants	Calculations quite simple. Actual biogas production unclear.
Nepal Deep-Dive	Biogas	Reduced air pollutants	Would need to know actual biogas production to estimate reduction of air pollutants.
Nepal Deep-Dive	Biogas	Health and safety	Is unclear to what extent the biogas produced actually reached households directly; most appears to have been marketed business-to-business. Without knowing number of households reached, and actual production of biogas, cannot quantify health benefits.
Nepal Deep-Dive	Biogas	Increased electricity reliability/decreased outages	Evidence from monitoring is limited, mostly anecdotal from interviews.
Niger Light-Touch	Resilience of rural populations and agricultural production systems	Capacity building and local institutions; energy sector security and resilience	Assessing adoption of climate resilience practices and use of knowledge from training requires household-level follow-up surveys/studies.
Niger Light-Touch	Resilience of rural populations and agricultural production systems	Capacity building and local institutions	Measures of the number of plans and institutions developed does not afford much insight into their quality and impact.

CASE STUDY	SECTOR	DI CATEGORY	MAIN CHALLENGES TO DOCUMENTING AND/OR QUANTIFYING DIS
Niger Light-Touch	Resilience of rural populations and agricultural production systems	Soil and crop productivity	Substantial measurement work required. Calculation requires sample harvesting, drying, and weighing of crop yields from project and control sites. Care is needed to identify suitable sample sites to enable comparison that reduces exogenous factors between sample and control sites.
Niger Light-Touch	Resilience of rural populations and agricultural production systems	Soil and crop productivity	Substantial measurement work required. Calculation requires sample harvesting, drying, and weighing of crop yields from project and control sites. Care is needed to identify suitable sample sites to enable comparison that reduces exogenous factors between sample and control sites.
Thailand Deep-Dive	Renewable energy (utility-scale Wind Power)	Health and safety; reduced air pollutants	More detailed information about the location of future renewable energy sources and fossil-fuel based sources that may go offline due to inclusion of renewables would provide a more accurate spatial analysis. Also, with sufficient local epidemiological information that details the relationships between air pollutant exposures and health impacts, future analyses could focus on specific health endpoints within the Thai population.
Türkiye Light-Touch	Renewable energy and energy efficiency	Health and safety	Only assumptions can be made based on air pollution data and nationwide health records.
Türkiye Light-Touch	Renewable energy and energy efficiency	Employment (of any type)	Exact numbers hard to quantify due to the long supply chain, as well as maintenance being done after construction.
Türkiye Light-Touch	Renewable energy and energy efficiency	Economic value added (GDP)	Only anecdotal information available on local employment.
Türkiye Light-Touch	Renewable energy and energy efficiency	Capacity building of local institutions	Hard to quantify and document given the lack of e.g., a survey on locals' knowledge beforehand, anecdotal information available.

Table A4. Recommendations to Strengthen Contributions to DIs and Advice for Measuring DIs

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
Bangladesh Deep-Dive	Agriculture	PPCR; Nature, People, and Climate	Key to ultimately realizing DIs from this type of project is to make sure the engineering design is faithfully constructed, and that those charged with everyday operations and maintenance ensure that the polder systems are working as intended. This means having better institutional processes and controls in place to ensure the quality of the workmanship to avoid some quality problems already identified by farmers, such as cracks in the polders. Better government coordination with WMOs/WMAs would help to ensure that everyday operations and maintenance of the polders is in keeping with the community's vision. Finally, WMO/WMA members likely require more than one-time training from NGOs hired by the government; they likely require some level of ongoing technical assistance or at least periodic training. In short, more continuous work is needed to build capacity of these organizations and ensure effective local governance of the polder systems.	Soil and crop productivity; economic value added (GDP)	Measure organizational capacity building inputs and short-term outcomes, in addition to measuring medium and long-term changes in cropping patterns and yields. Ratchet up quality control measures for engineering, define key quality control metrics for engineering, and measure them often, using external independent reviewers. Keep the current model of using a longitudinal household survey, administered by the third-party evaluator, to track changes in farming practices, incomes, and livelihoods. This feature is working very well for DI tracking purposes.
Bangladesh Light-Touch	Solar (rooftop)	SREP, CTF	To facilitate analysis of on-bill savings, criteria air pollutant emissions, and potentially health benefits, require projects to track and report reduced use of conventional energy sources when installing solar, including backup diesel generators, using a standardized approach.	Energy cost savings	On-bill savings: Utility or utility commission should provide or develop on-bill savings factors to support CIF projects
				Reduced air pollutants	Criteria emissions: apply existing factors for diesel generators; natural gas combustion; and/or grid or country-specific factors for electricity

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
				Health and safety	Health impact analysis will likely be limited to large-scale interventions and each analysis will need to be customized.
Brazil Deep--Dive	Agriculture	FIP; Nature, People, and Climate	Multiple types of project activities can benefit biodiversity including protecting critical habitats, re-establishing biological and hydrological flows, and connecting fragmented habitats. Implementing multiple project types can increase the impact on biodiversity beyond the scope of individual projects through a “multiplication effect,” creating more significant benefits overall.	Ecosystems and biodiversity	Estimate the effects of land cover conversion on pollinator abundance (index value), pollinator abundance.
		FIP; Nature, People, and Climate	The understanding and replication of low carbon agricultural practices is critical for their broader uptake beyond the projects and impact at scale. The ABC project demonstrates how adoption of these practices can prove their viability and encourage neighboring farmers to adopt them as well.	Sustainable land use	Collect qualitative evidence of replication effects.
Brazil Light-Touch	Forestry	FIP; Nature, People, and Climate	INOCAS is planning to scale up operations in multiple parts of the value chain. Expansion should draw new companies to the market as farms copy their neighbors’ adoption of Macaúba. The addition of more actors will further de-risk the market. Additionally, Macaúba trees grow in many South and Central American countries, where the project model could be replicated. The scaling up of Macaúba should, in the long term, reduce deforestation and its associated impacts.	Sustainable land use	Collect qualitative evidence of replication effects.
		FIP; Nature, People, and Climate	Next steps include the creation of sustainable food and aviation fuel markets. These markets should provide demand for Macaúba-based products to	Sustainable land use	Monitor demand and prices for Macaúba-based products

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
			maintain the price as more producers enter the market.		
India Light-Touch	Solar (rooftop)	CTF; Renewable Energy Integration	To improve energy access, particularly in rural areas, there should be outreach to scale up rooftop technologies in new market segments. This will inherently create a bigger market for rooftop solar as well as reduce emissions/pollution.	Expansion of electricity to new households and businesses	Job creation: for solar park transmission, field research is required to provide a quantitative estimate.
			Set up innovative financial schemes (RESCO ecosystems, credit guarantee mechanisms) to de-risk the solar rooftop market and keep costs low, which will lead to not only more electricity supply but also more affordable electricity.	Competitiveness and industrial development	Community/regional economic benefits: quantifying this benefit would require more extensive analysis of the regional impact on the long term.
			Integration of battery storage with on-site solar power will reduce pressure on DISCOMs and increase the supply of reliable electricity and reduce the use of back-up diesel generators.	Expansion of electricity to new households and businesses; reduced air pollutants; health and safety	
			Make rooftop solar more system friendly, such as making a distributed solar registry available to DISCOMs, which will improve DISCOMs' ability to support solar power integration.	Energy sector security and resilience	n/a
India Light-Touch	Solar (Park Transmission)	CTF; Renewable Energy Integration	Replicate the solar transmission project in other (rural) states/regions to drive further electrification in hard-to-reach regions, which will improve energy access/reliability and reduce emissions/pollution.	Expansion of electricity to new households and businesses	n/a
India Light-Touch	Solar (Rooftop and Park Transmission)	CTF; Renewable Energy Integration	Support regulatory developments to enhance power system flexibility, such as time-of use (ToU) tariffs, to help facilitate balancing the energy	Competitiveness and industrial development	n/a

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
			supply in order to make the renewable electricity supply more reliable.		
			Make the solar industry more accessible to women—for instance, by having online training programs. For jobs in the solar industry, it is also important to ensure flexibility (i.e., maternity leave, flexible working hours) and safety (i.e., ensure safe access to project sites and enforce sexual harassment policies).	Gender-related benefits	
Indonesia Deep-Dive	Geothermal	SREP, CTF; Accelerating Coal Transition	Further strengthen the fiscal and regulatory enabling environment for geothermal energy to increase market confidence in- and de-risk geothermal projects.	Competitiveness and industrial development	Track the number of PPPs created and signed; the ratio of PPAs per licensed project (i.e. how many licenses lead to final investment decisions every year); and commercial capital mobilized (actual).
			Target energy-poor and vulnerable communities for increased electrification to maximize energy access (and in turn maximize economic benefits + social and economic equality).	Economic value added (GDP); community engagement and social inclusion	Track the number of licenses in energy-poor areas and the actual number of individuals/households with increased access to electricity.
			Create mechanisms as part of the program/project design that help to ensure educational benefits from electrification are being reaped. This could be efforts pursued in collaboration between local government, developer, other stakeholders, and CIF—e.g., investment in local education via revenue from geothermal energy sales (e.g., geothermal production bonus).	Economic value added (GDP); community engagement and social inclusion	Track the number of people with access to education, as well as spending on education.
			Use Gender Action Plans to support gender-responsive recruitment practices.	Economic value added (GDP); community	Track the % of new hires who are women and the % of women in different geothermal and non-

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
				engagement and social inclusion	geothermal work categories (e.g. direct versus indirect employment).
			CSR activities should be complementary to official project development objectives, which are long-term in nature, to avoid having CSR activities only create one-off short-term gains. Scope of CSR activities could be defined in project approval documents, e.g. Examples may include systemic issues that affect development (e.g., education and gender equality).	Economic value added (GDP); community engagement and social inclusion	Track the number of gender-related CSR activities and of education-related CSR activities, as well as increases in access to education as a result of CSR activities and increased female representation in the workforce as a result of CSR activities.
Indonesia Light-Touch	Forestry	FIP	Establish a common steering committee (or other mechanisms) for projects with complementary objectives for sharing best practices and ensuring effective implementation (e.g., to increase female participation)	Community engagement and social inclusion	Develop metrics that better reflect the DIs on women, as these are not fully reflected in the project indicators and generally underestimated. Besides counting the number of women trained, projects could "tell the story" about how women became interested in SFM over the course of the project. Furthermore, the interviews suggested considering a broader scope of indicators, such as women who are indirect beneficiaries as the spouses of male farmers who were trained.

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
Kenya Light-Touch	Off-grid electrification	SREP	Promote the diversification of the sources of capital for energy projects. Compared to the traditional approach, the involvement of private contractors is expected to significantly reduce the costs of electricity and foster the use of innovative and more effective technologies.	Increased electricity reliability/decreased outages	Improve metrics to measure impacts on women, increasing the data available on their needs, and the characteristics of their energy demand; as well as unequal access to assets and land ownership, which directly affects women’s access to electricity.
		SREP	Future CIF interventions in Kenya should aim to ensure that the workforce is trained to benefit from the jobs created. It has been estimated that by 2022–2023, the decentralized renewable energy sector in Kenya will provide more than 17,000 direct formal jobs, and about 29% of these jobs will support the growing mini-grid sector.	Employment (of any type)	n/a
Morocco Light-Touch	Solar (utility-scale)	CTF; Accelerating Coal Transition	Future projects would benefit from the lessons in project preparation and implementation that can optimize the technical design specifications and legal and procurement processes. The specifications should allow for sufficient flexibility, while some legal issues can be dealt with upfront in procurement, which can shorten the negotiation period.	All	Further follow-up surveys or contact with local communities would be important to track the DIs expected to follow from the main impacts.
			Social impacts are important and can be improved through more active support to involve local workers in the project. For women, the provision of daycare services and/or training would be valuable in enabling their participation.	Employment (of any type)	Particularly the impacts on local employment, gender related issues, energy security, access to essential services, local economic benefits, health benefits.
Nepal Deep-Dive	Biogas	SREP, CTF	Future projects could support in setting up biogas plant maintenance companies in Nepal. This will reduce costs for project developers and improve the biogas market development, which will lead to	Competitiveness and industrial development	Since the project was mostly targeting the commercial biogas sector in Nepal, several development impacts were not closely monitored or overlooked.

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
			job creation, access to energy, reduction of GHG emissions and health benefits.	Employment (of any kind)	Gender balance and co-benefits arising from the project were not closely monitored and evaluated.
			Large projects should have funding disbursed at milestones instead of at the end, as this creates cash flow issues. This will help with financing barriers and improve biogas market development, which will lead to job creation, access to energy, reduction of GHG emissions and health benefits.	n/a	n/a
			n/a	n/a	Local economic benefits: The number of household beneficiaries was roughly estimated by AEPC and project developers but was not properly assessed.
			To support the business opportunity of selling organic fertilizer, awareness raising to local farmers of the benefits of organic fertilizer is needed.	Employment (of any type); health and safety; reduced air pollutants	n/a
			n/a	n/a	Health benefits: positive health impacts were qualitatively assessed, even though it was a major outcome of the project.
			Capacity building is needed at financing institutions to make the process of acquiring loans from commercial banks easier. This will help the market development, which will lead to job creation, access to energy, reduction of GHG emissions and health benefits.	n/a	n/a
					Emissions: the method of estimating project’s emissions reductions by AEPC was not very accurate due to lack of knowledge. Therefore, it is important to provide the means

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
					and tools for project developers and the implementing agency AEPC on how to assess these development impacts, since they lack expertise in this area in Nepal.
Niger Light-Touch	Agriculture	PPCR; Nature, People and Climate Investment Program	To facilitate understanding of how climate resilience projects addressing agricultural and silvopastoral productivity impact food security, livelihoods, and quality of life, require and fund projects to conduct household-level studies (including studies that assess impacts over time).	Soil and crop productivity	Agricultural productivity: use robust analysis approaches (e.g., that compare project and non-project control sites through sampling and weight analysis), as was done in Niger.
				Increased food security	Food security, livelihoods, quality of life: use household-level surveys (conducted remotely with cell phones where feasible or in-person) to assess progress over time; ensure that projects are sufficiently funded to enable robust assessment which can be used to inform broader agricultural productivity and climate resilience initiatives. Partnerships with national statistical agencies and universities could be useful to expand assessment and monitoring capacity of these DIs.
				Earnings (construction and permanent)	

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
		PPCR; Nature, People and Climate Investment Program	To facilitate learning and adaptive management in projects and to establish robust and credible cases for sustaining, expanding, and scaling newer programs and projects, invest resources, staff capacity, and time to develop and implement robust monitoring and assessment methods.	All	Rigorous methods: invest the time and resources in selected new and pilot initiatives to ensure a robust and credible analysis to support decision making. The CAPSR agricultural productivity assessment methodology provides a good model for a robust assessment methodology.
					Partnerships with established statistical and monitoring institutions: where feasible, build partnerships with government institutions and other credible partners (e.g., in-country academic institutions, multilateral organizations) to enhance the quality and credibility of research and assessment methods, to strengthen diverse partner commitment to the program, and to build capacity for ongoing monitoring and analysis.
		PPCR; Nature, People and Climate Investment Program	To enable strong adaptive management systems that support effective implementation of resilience projects with high coordination and problem-solving needs.	Reduced losses from extreme climate events	Coaching, results-based management, and leadership development model: recognize that coordination and communication challenges can plague implementation of climate resilience initiatives and integrated service platform models; build flexible adaptive

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
					management systems that provides coaching support to program managers and implementers, along with flexible and nimble pathways to quickly elevate and resolve issues.
Thailand Deep-Dive	Wind (utility-scale)	CTF; Accelerating Coal Transition	Localize economic benefits by training and hiring local workers, and providing financial compensation (e.g., lease payments) to local residents and businesses around where the turbines are sited.	Economic value added (GDP); community engagement and social inclusion	n/a
Thailand Deep-Dive	Wind (utility-scale)	CTF; Accelerating Coal Transition	The project design should encourage developers to conduct community engagement activities that are meaningful to the local community –e.g., investment in locally prioritized projects, infrastructure improvements, and cultural activities generate support for new facilities. Opportunities for community members to engage with a renewable energy facility including school trips, internships, and a community liaison educate the public on renewable technology.	Community engagement and social inclusion	n/a
		CTF; Accelerating Coal Transition	Support first-mover projects that will demonstrate the viability of a technology facilitates later private investments. This support can include financial investment and technical support in addressing regulatory barriers resulting from unfamiliarity with the technology or approach.	Competitiveness and industrial development	n/a
Türkiye Light-Touch	Renewable energy and energy efficiency	CTF	Create dialogue with local communities and NGOs to create buy-in for local RES projects to demonstrate the benefits and how potential local negative environmental and social impacts can be mitigated.	Economic value added (GDP); employment (of any type); gender-related benefits	Local and regional economic benefits: quantifying this would require more extensive analysis of the regional impact and cascading effects in the long term.

CASE STUDY	SECTOR/ SUBSECTOR	PROGRAM AREA COVERED IN RECOMMENDATION (INCLUDING NEW CIF PROGRAMS)	RECOMMENDATIONS TO STRENGTHEN CONTRIBUTIONS TO DIS	DI CATEGORY COVERED IN RECOMMENDATION	ADVICE FOR MEASURING THE DI?
					Employment: reporting throughout the whole supply chain and field research is required to provide a quantitative estimate.
			Track indicators on community and regional economic benefits, in terms of economic growth, employment, and gender equity in the renewable energy and energy efficiency field, relating to direct or indirect impacts.		Gender-related impacts: introduce quotas for training spots for women, create financial incentives for them as well as awareness campaigns.

Impact Pathways from Case Studies

Below, we provide the impact pathways specific to each case study (Figures A1 – A13). The case-specific impact pathways provide more detail on how specific investments result in a chain of outcomes that produce DIs. On each pathway diagram, we use the following color coding:

- The dark blue boxes indicate the DIs quantitatively assessed in the case study.
- The light blue boxes indicate the DIs qualitatively assessed in the case study.
- The gray boxes indicate DIs that could be realized through this investment impact pathway, but were not assessed for one or more reasons, such as expected timeframe of impact, scale of the project, or additional research and analysis requirements.

Figure A1. Bangladesh SREP: Impact Pathway for Rooftop Solar in the Ready-Made Garment Sector

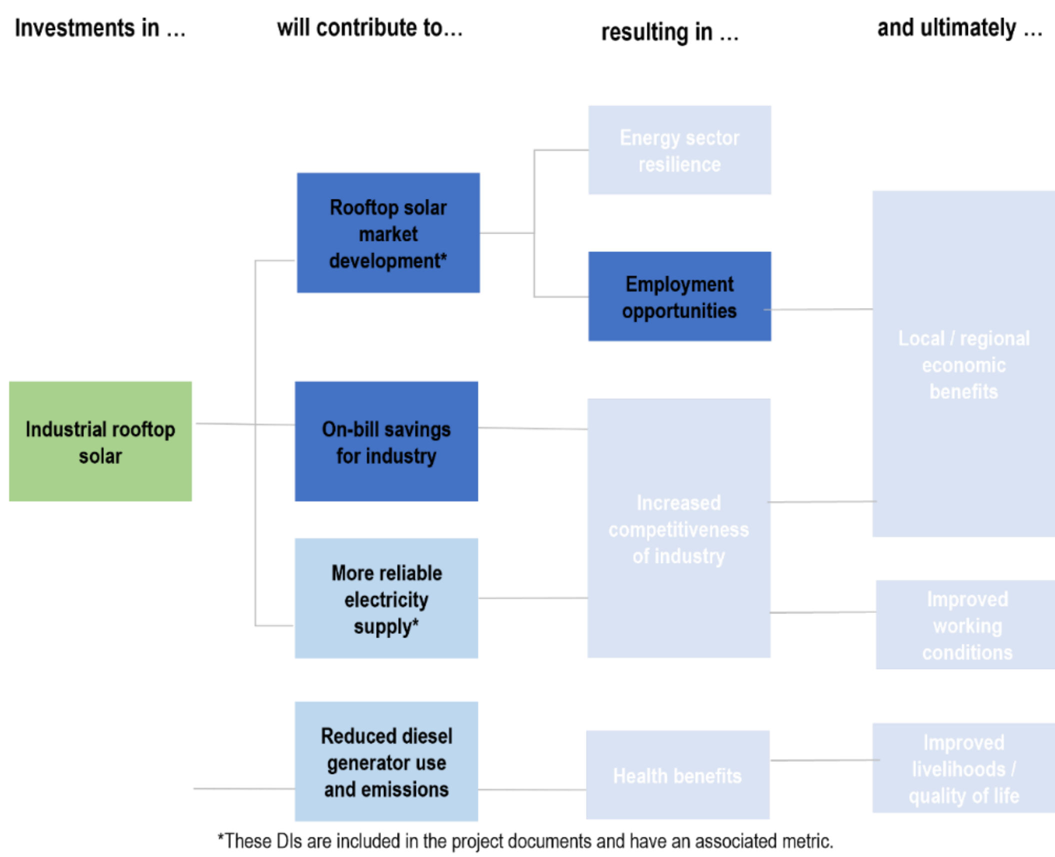


Figure A2. Bangladesh PPCR: Impact Pathways for Coastal Embankment and Polder Rehabilitation

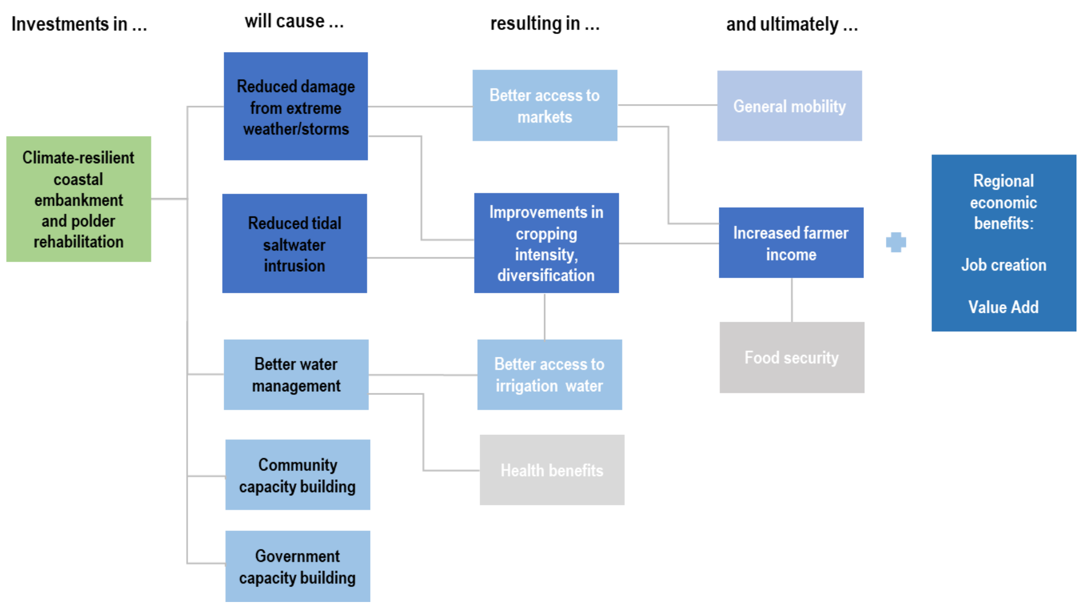


Figure A3. Brazil PPCR: Impact Pathways for Low Carbon Agriculture and Integrated Landscape Management

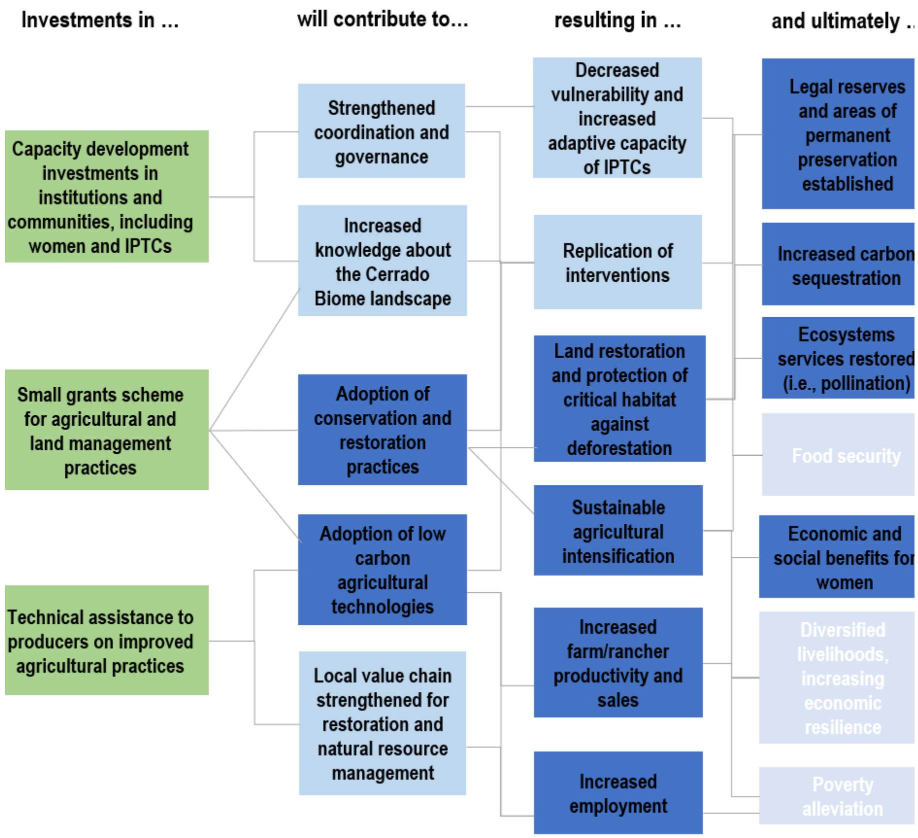


Figure A4. Brazil FIP: Impact Pathways of a Macaúba Value-Chain

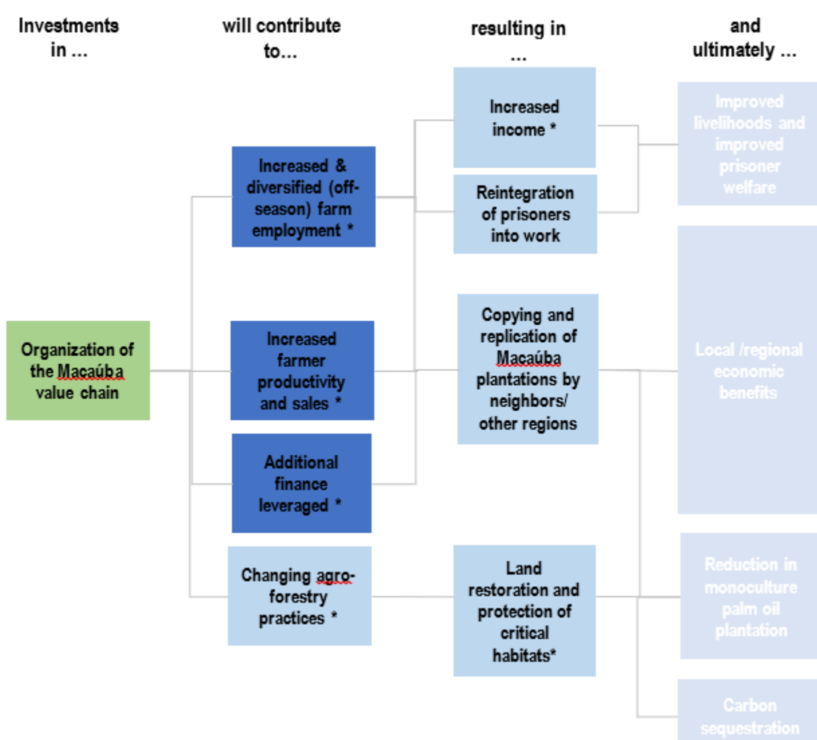


Figure A5. ndia CTF: Impact Pathways for India's CTF Programs Related to Renewable Energy

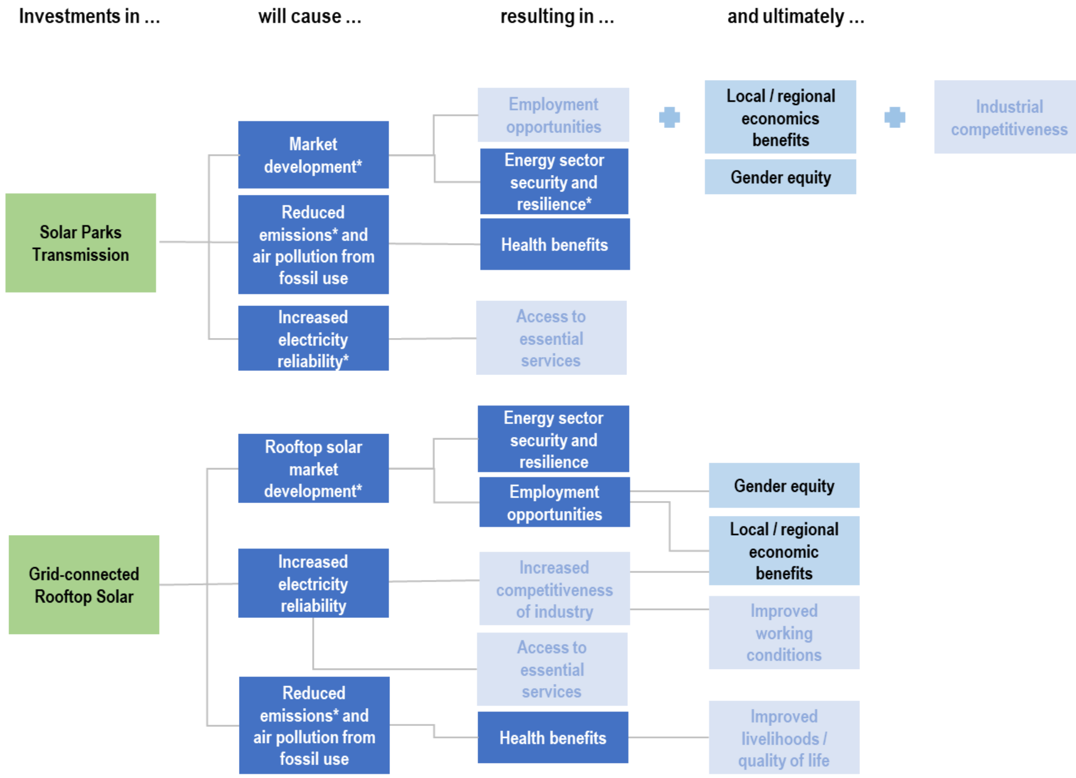


Figure A6. Indonesia CTF: Impact Pathways for Geothermal Energy Development

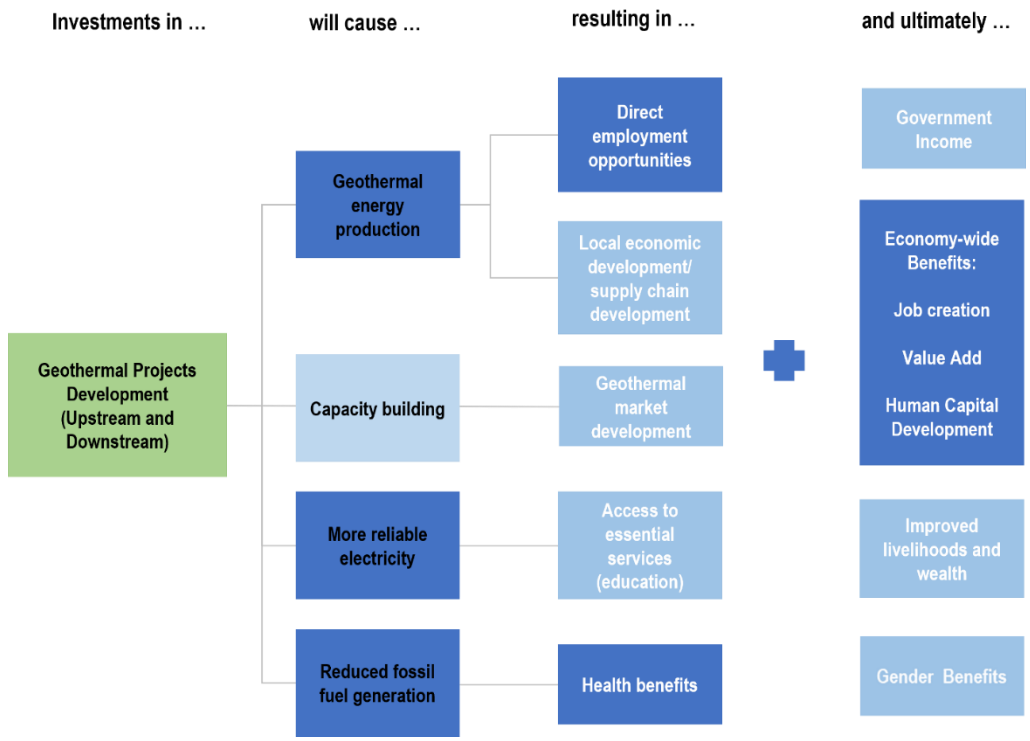


Figure A7. Indonesia FIP: Impact Pathways of Sustainable Forestry in Indonesia

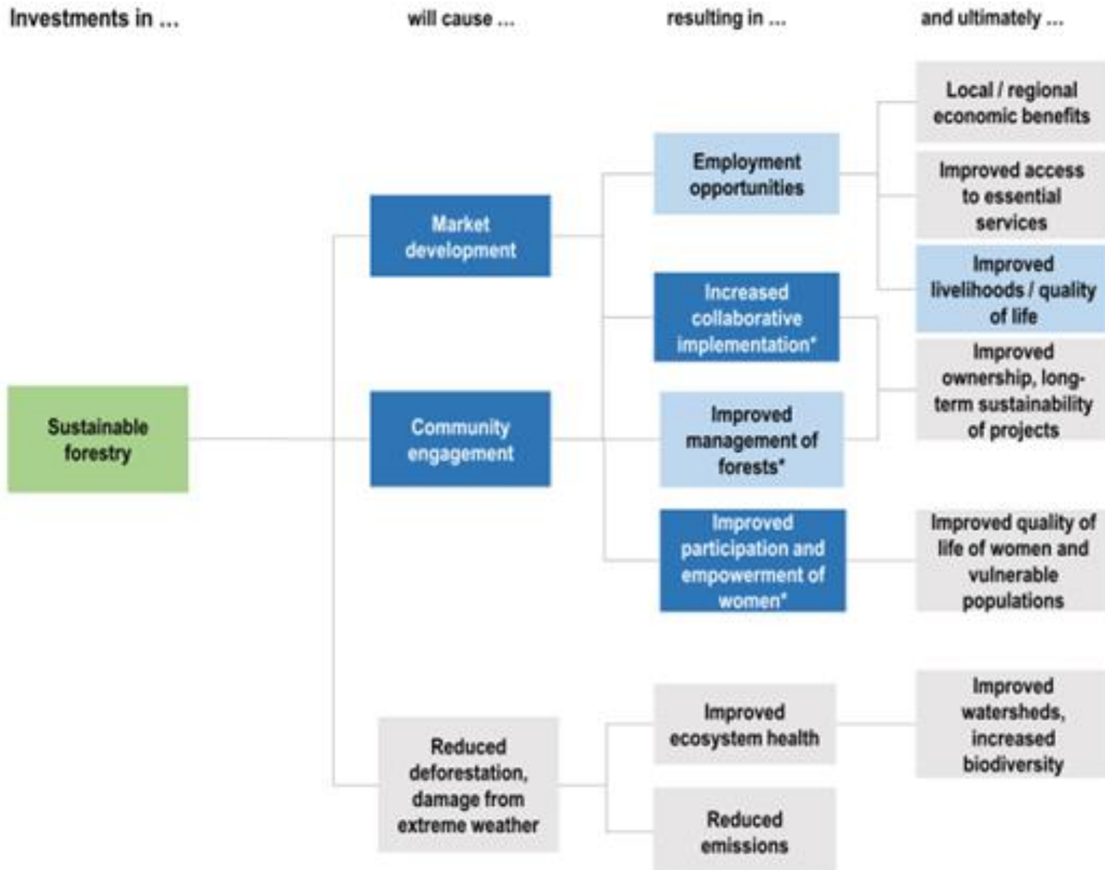


Figure A8. Kenya SREP: Impact Pathways of Off-Grid Electrification in Kenya

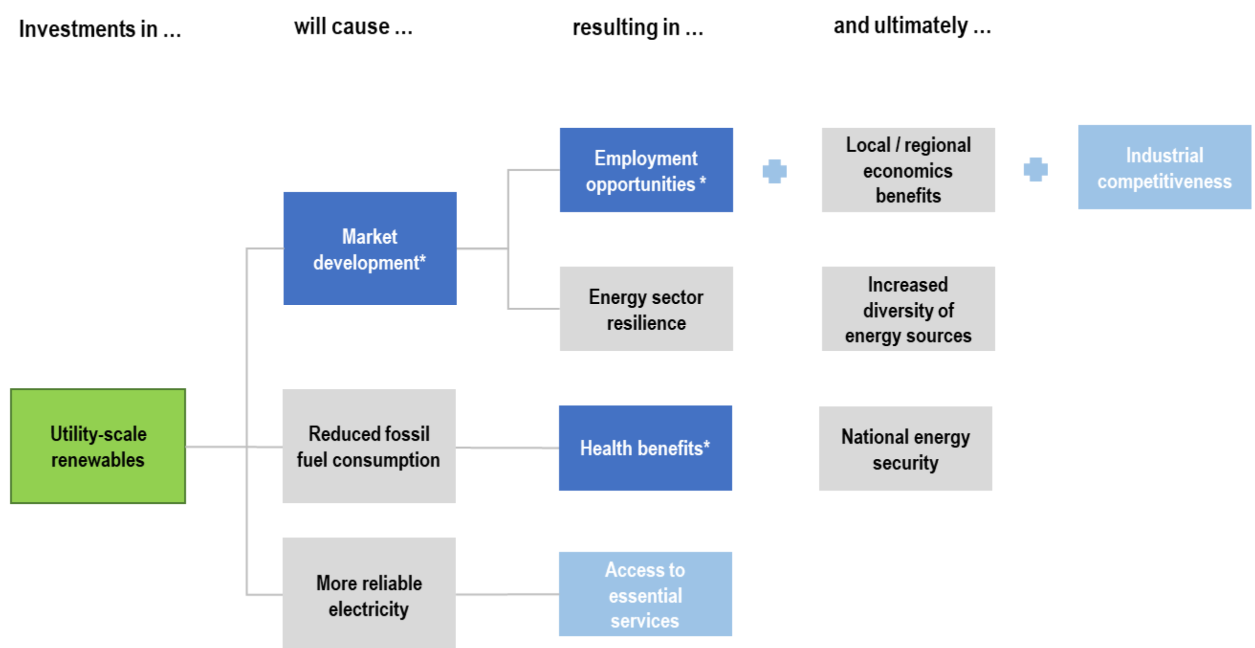


Figure A9. Morocco CTF: Impact Pathways for Noor Ouarzazate I Concentrated Solar Power (CSP) Project

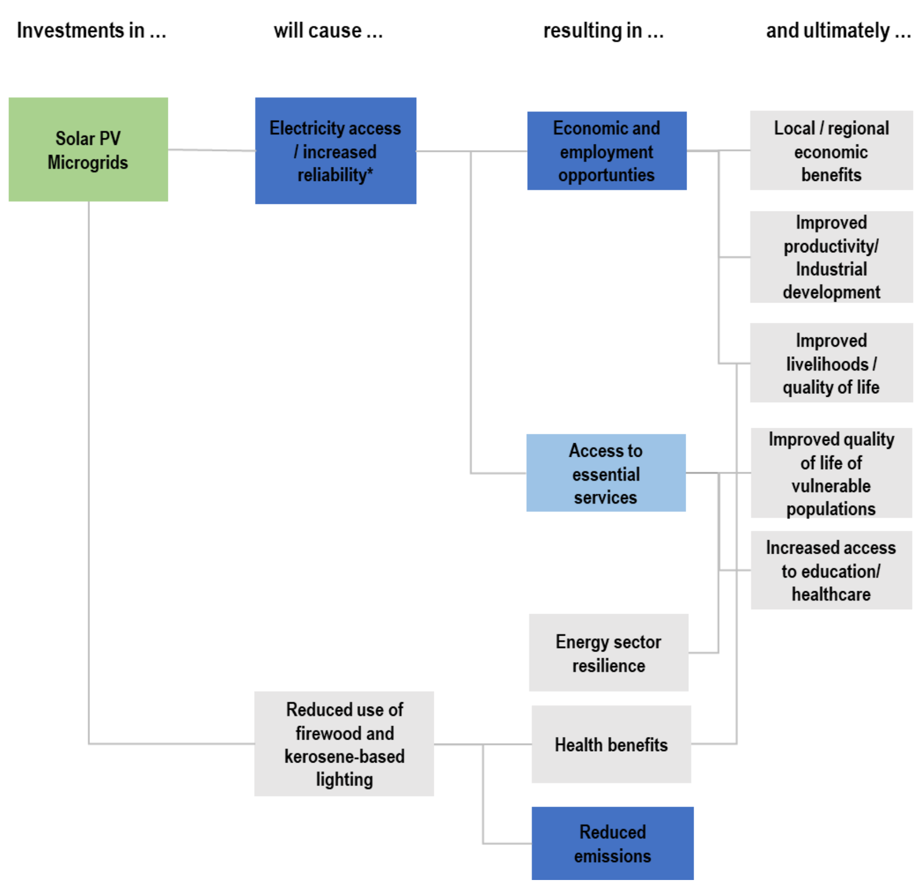


Figure A10. Nepal SREP: Impact Pathways for Extended Biogas Project

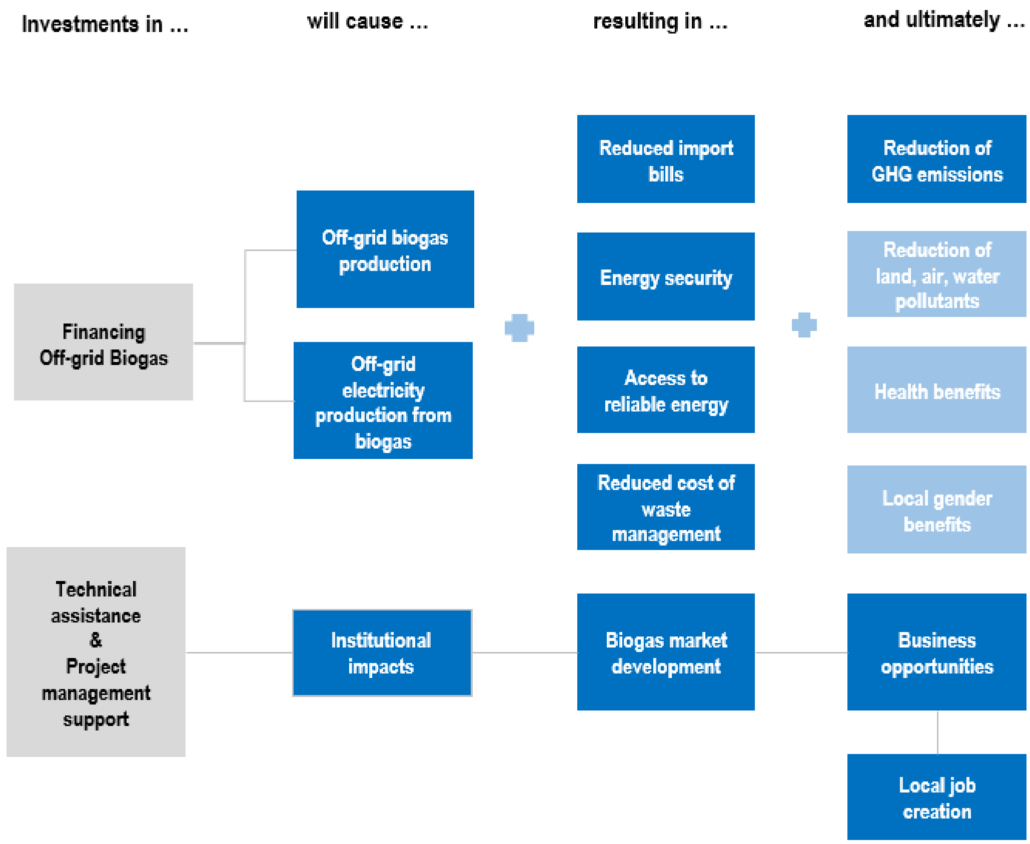


Figure A11. Niger PPCR: Impact Pathways of Community Action Projects for Climate Resilience in Niger

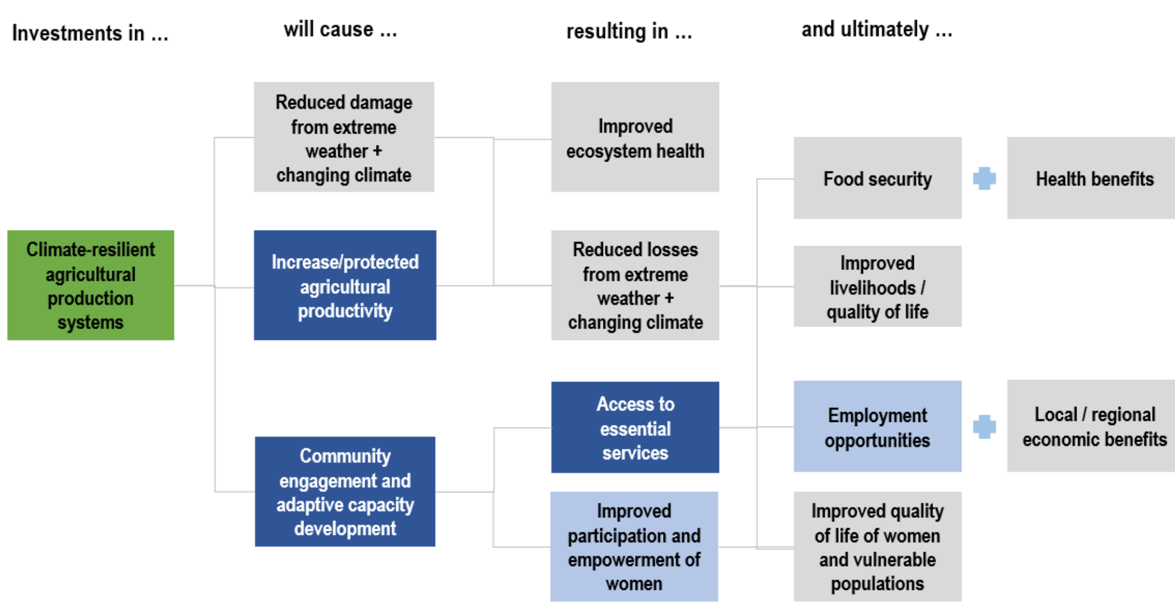


Figure A12. Thailand CTF: Impact Pathways of Utility-Scale Wind Power

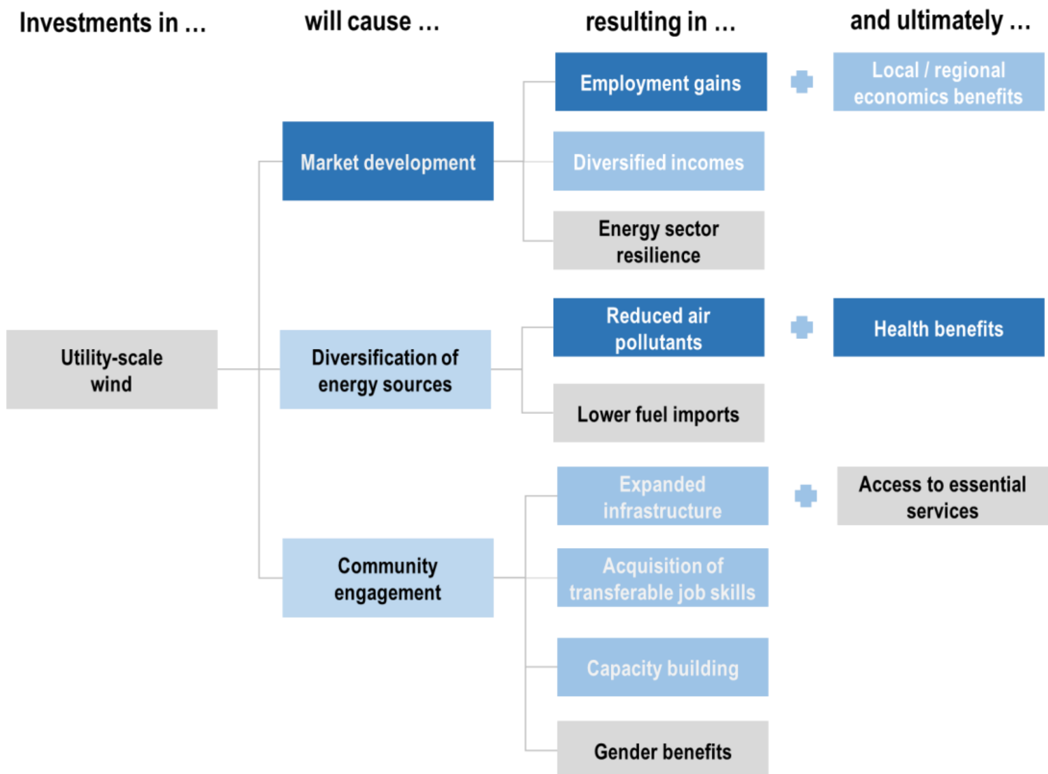
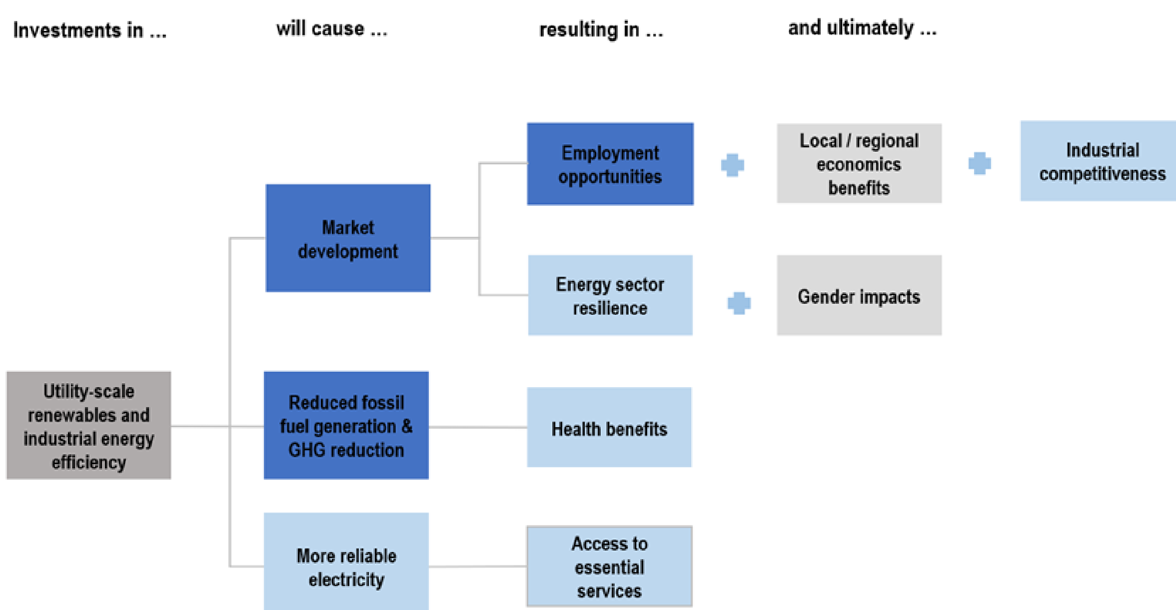


Figure A13. Türkiye CTF: Impact Pathways of Energy Efficiency and Renewable Energy Development



Appendix B – Overview of the Joint Impact Model

JIM is an input-output (I-O) modeling tool that relies on multipliers to estimate the economy-wide effects of an initial change in economic activity. The initial change may involve the construction of a new project or an infusion of funding to a particular sector due to an increase in private sector investment, government spending, or consumer spending, for example. I-O models use data from a variety of sources to map the buying and selling relationships between industries, governments, and households within a region. For example, the model may include a coefficient where for every $200,000 of output from a given industry, one full-time employee is needed to produce that output, and the employee costs $40,000. The strength of I-O models stems from the detailed set of relationships between industries that allow users to quantify the impact of demand changes on particular industry sectors within a region.

The JIM tool looks at the construction and operation phases of particular projects and produces estimates for different categories of impacts. According to the JIM documentation, these categories are: direct impacts of the project itself, induced impacts from an increased spending of wages by workers associated with the project and by the workers corresponding with the supply chains, and indirect impacts. While the JIM documentation does not provide a definition of "indirect," based on the model logic, most likely, indirect impacts are impacts on the supply chains, both upstream and downstream, and induced impacts.

However, there are notable limitations to I-O models. First, I-O models rely on fixed functional relationships between inputs and outputs. For instance, based on the formula above, if $1 million of output is produced, five employees are needed, but in reality, as a company grows, there may be economies of scale or synergies, so only three to four employees may be needed to grow to $1 million in output. I-O models also assume there are no constraints on the supply of raw materials or employees (if more output is desired, materials and employees are always available), and they are static with regard to prices (the price of labor never changes, regardless of the demand for employees). As a result, I-O models are best suited for assessing relatively small, short-term changes in demand. While CIF-supported projects typically involve multi-million-dollar investments, compared with total sector or country output, these investments are generally consistent with the type of small and/or short-term investments that I-O models are suitable to analyze. If the level of investment becomes large enough that changes in prices or the relationships (coefficients) between industries, governments, and households are possible, however, I-O models will often overestimate the economic impacts, because of the fixed nature of the relationships embedded in such models. Part 4.2 of the main report discusses computable general equilibrium (CGE) models as a possible alternative to I-O models for certain types of large-scale portfolio analysis.

Appendix C – Case Study Selection

Case Study Selection Criteria

The IEc team, in collaboration with CIF, developed the following case study selection criteria:

- **Significant investment**
    - Significant CIF investment in the country
    - Total investment in the country: CIF plus co-financing
- Countries with programs and projects that have **exhibited or have the potential to exhibit significant development impacts** from CIF investment given sufficient implementation progress of CIF-supported projects
    - Maturity of the country portfolio and projects
    - Countries with potential early signs of transformational change as indicated through Transformational Change Learning Partnership (TCLP) Phase 1 portfolio analysis
    - Projects/programs that illustrate establishing enabling conditions for realizing development impacts (governance, regulatory structure)
- **Balance and representation across cases**
    - Balance across anticipated types of development impacts (i.e., economic, social, environmental, market)
    - Representation across CIF programs (CTF, SREP, PPCR, FIP)
        - Focus more cases on less-studied programs, including FIP and PPCR, as well as less-studied themes, such as climate resilience
    - Representation across technologies and sectors
    - Representation of both low-income and middle-income countries
    - Balance across geographic regions (e.g., Europe, Africa, Middle East, Asia, Latin America)
    - Representation across all six MDBs
- Countries with programs and projects that are **likely to have data available** to inform assessment:
    - Basic data: Investment levels, leveraged funds, timing and counts of projects implemented
    - Key data to support quantitative assessment, including direct jobs created, and energy data such as installed renewable capacity or reduced load
    - Existing economic models that can be leveraged, or existing data to support modeling (e.g., existing CGE model, existing GTAP data to develop a CGE model, existing data on cropping patterns to support crop modeling)
- **Practical Considerations**
    - Extent to which the country has been profiled in other CIF case studies

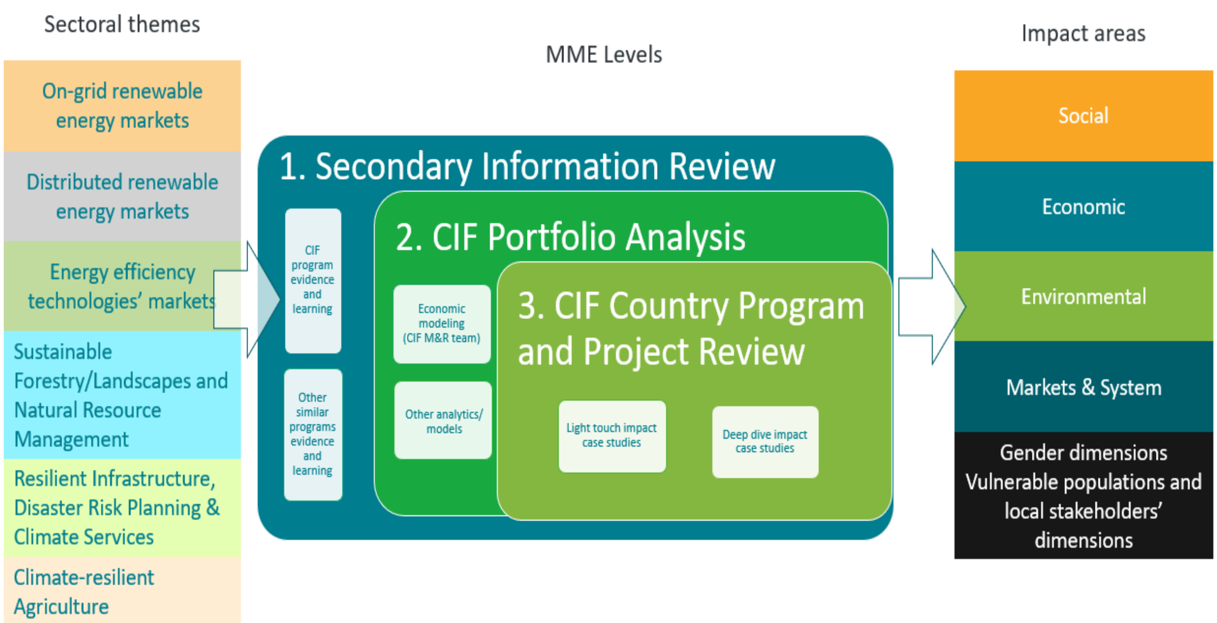
- Anticipated receptiveness of in-country partners to participating in case study development

Case Study Selection Process

The IEc team used multiple approaches to select case studies and DIs to include in this evaluation, including identifying potential cases from the secondary information review and early portfolio-level analysis conducted by the CIF team, both noted above, and by conducting a project characterization analysis of the CIF portfolio. The IEc team undertook a project characterization to identify and categorize CIF project types within CTF, SREP, PPCR, and FIP; identify DI categories anticipated for different project types; and cross-reference project types and potential DI categories with geographies served by CIF. Project types include on-grid renewable energy markets; distributed renewable energy markets; energy efficiency technology markets; sustainable forestry/landscapes and natural resource management; resilient infrastructure, disaster risk planning and climate services; and climate-resilient agriculture. For DI categories, we used the broad categories of social, economic, environmental, and market DIs for project characterization, in addition to gender impacts and impacts on vulnerable populations and local stakeholders. The IEc team triangulated information across these sources to identify potential case studies and assess how they fit selection criteria.

Figure C1 below provides a summary of evaluation levels and methods, sectoral themes (project types), and DI areas.

Figure C1. Summary of Sectoral Themes (Project Types), Evaluation levels, and DI Areas



Appendix D – Case Study Summaries

Bangladesh Light-Touch Case Study: Catalyzing the Industrial Rooftop Solar Market

Project Details	Funding
Name: Scaling Up Renewable Energy **Country:** Bangladesh **CIF Program Area:** Scaling-up Renewable Energy Program in Low-Income Countries (SREP) **Bank approval:** March 2019 **Effective since:** December 2019 **Expected closing:** July 2025 **MDB:** World Bank	**Total Value:** $413.04 million **CIF:** $29.25 million **Co-financing:** $383.79 million **MDB:** $156 million **Government of Bangladesh:** $48.79 million **Bilateral agencies:** $179 million **Instrument type:** Loan, grant **Sector:** Public

Key Highlights

- The Bangladesh Scaling up Renewable Energy Project (Bangladesh SREP Project) is a $413.04 million investment in renewables.
- The CIF contribution is $26.38 million in loans and $2.87 million in grants. The remaining $383.79 million was funded by a World Bank International Development Association (IDA) loan of $156 million, $48.79 million from the Government of Bangladesh, and $179 million through bilateral agencies, including $120 million in commercial financing/private capital mobilized.
- This case study focuses on industrial rooftop solar funded in part through SREP.

Topline Findings on Development Impacts

- **Market growth:** Twenty-three rooftop solar PV projects have been approved to date, with a combined capacity of 80 MW.
- **Employment:** The project has employed approximately 153 people to date, with a total of 334 jobs expected by December 2021, and 1,978 jobs forecast for approved projects.
- **Bill savings:** Average on-bill savings for factory owners is estimated at $1,700 per year. Adding storage to existing solar installations has the potential to unlock extensive on-bill savings, especially for factories that run during peak demand evening hours.
- **Other DIs:** Additional benefits include reduced diesel generator use and reduced criteria air pollution and greenhouse gas (GHG) emissions, a more reliable electricity supply for the country's largest industrial sector, and decreased reliance on imported fossil fuels.
- Long-term benefits could include increased competitiveness of the sector, improved working conditions, and improved health and quality of life benefits.

Bangladesh Deep-Dive Case Study: Improving and Protecting Agricultural Livelihoods through Coastal Embankment Improvements

Project Details	Funding
Name: Coastal Embankment Improvement Project Phase 1 (CEIP-I) **Country:** Bangladesh **CIF Program Area:** PPCR **Bank approval:** June 2013 **Effective since:** November 2013 **Expected closing:** December 2023 **MDB:** World Bank	**Total Value:** $400 million **CIF:** $25 million **Co-financing (IDA):** $375 million **Instrument type:** Loan, grant **Sector:** Public

Key Highlights

- Of the total CEIP-I project value of $400 million, the CIF contribution was a $25 million grant, or about 6 percent of the total project's value. The remaining funds came through an International Development Association (IDA) concessional loan from the World Bank.
- Of the total CIF grant amount, $20 million is funding the rehabilitation and improvement of polders, which are tracts of low-lying land that are reclaimed from a sea or river and enclosed on all sides by dykes or embankments, separating them hydrologically from the main river system and offering protection against tidal floods, salinity intrusion, and sedimentation. The rest is funding long-term monitoring, research, and analysis of Bangladesh's coastal zone.
- According to interviewees, CIF's $5 million for long-term research was critical for securing stakeholder support for the CEIP-I project, as environmental groups opposed the overall project unless there was rigorous monitoring and evaluation (M&E).

Topline Findings on Development Impacts

- **Farmland protection:** Polder rehabilitation is protecting cropland from being regularly inundated by tidal flooding, which causes soil salinization and crop losses. For polders that have already been rehabilitated, storm surges have declined, as have community fears about storm surges.
- **Cropping intensity:** Cropping intensity is increasing by approximately 12 percent annually in the cooler Rabi season, and many farmers have introduced new profitable crops, including watermelon.[18] Cropping intensity in the other seasons has not increased due to several factors,

[18] Based on data from 2018 and 2021. According to the October 2022 Implementation Status & Results Report, cropping intensity in the project sites increased from 140 percent from baseline data in April 2013 to 186 percent in August 2022. This percentage represents the total gross cropped area (single, double, and triple crops) divided by total cultivable land in a cropping season for ten selected polders of CEIP-I expressed in % (the number of crops a farmer grows in a given agricultural year on the same field).

including the need for re-excavation of canals and work on sluice gates to better control water flows and salinity.

- **Increased agricultural revenues:** Polder rehabilitation will increase overall agricultural revenue by providing protection from storm surges and riverine flooding, improving cropping intensity, and enabling farmers to plant more profitable crops. According to crop revenue modeling, by 2032, polder rehabilitation will increase farmer revenues by an estimated $39–73 million per year, for an average of $56 million per year, compared with a business-as-usual scenario. This equates to approximately $90/hectare of benefits. The primary factors increasing revenues are storm surge protection, tidal flooding protection, and cropping intensity increase.
- **Regional jobs and economic impacts:** By 2032, nearly 25,000 jobs will be supported annually from the increase in agricultural revenues in the region. By 2032, the $56 million increase in annual agricultural revenues generates another $50 million per year in value added. This is made up of increased wages (41 percent), savings and profits (56 percent), and taxes (less than 4 percent).
- **Other DIs:** Additional benefits of CEIP-I include access to markets, general mobility, food security, and capacity-building benefits.

Brazil Deep-Dive Case Study: Improving Agricultural Livelihoods through Better Land Management and Low Carbon Agricultural Practices

Project Details	Funding
Name: Brazil Investment Plan (BIP) projects: Sustainable Production in Areas Previously Converted to Agricultural Use Project (Support for Brazil's ABC Plan for Low Carbon Agriculture; also known as the "ABC project"); Integrated Land Management (ILM) project; and Dedicated Grant Mechanism (DGM) Project (community engagement in climate change programming) **Country:** Brazil **CIF Program Area:** FIP **Multilateral Development Bank (MDB) approval:** 2012 **Effective since:** July 2014 **Expected closing:** 2023 **MDB:** World Bank	**Total Value:** $37.81 million grant **CIF:** $37.81 million grant **Co-financing:** In kind only **Instrument type:** Grant **Sector:** Public

Key Highlights

- This case study evaluates the development impacts (DIs) of improved land and agricultural management, and low carbon agricultural practices, including economic impacts of improved agricultural production and farmer livelihoods in the Cerrado biome, and environmental benefits including increase in pollinator habitat and carbon sequestration.
- Most quantified DIs are from the ABC project (not the broader ABC Plan of the government), which has five years of implementation experience. The ILM project launched in 2018. The DGM project is focused more on community engagement and empowerment generally, and less on quantifying specific agricultural outcomes.
- CIF contributed 100 percent of the projects' combined total value of $37.81 million.

Topline Findings on Development Impacts

- **Improved land management:** The ABC project resulted in a direct increase of 93,844 hectares of agricultural tracts using improved management practices, over nearly 3,000 farms. The ABC project also increased the land area under regulated, environmental protection by 34 percent. The ILM project introduced low-carbon agricultural practices on more than 11,000 ha, and the DGM project extended sustainable landscape management practices to 831 ha.
- **Expansion of pollinator habitat:** If all pasturelands in the area were restored using practices promoted by FIP, pollinators would have access to 75 percent of the soy crops and nearly all of the coffee crops in the biome. This may improve crop productivity and/or reduce the need for farmers to provide replacement pollination services for their crops. This information was obtained through the modeling work conducted by the IEc team.

- **Carbon sequestration:** A net carbon sequestration of 6.6 million tons CO_2e was achieved by the ABC projects, compared with a control group that did not adopt improved land management practices.
- **Agricultural productivity:** Cattle productivity increased significantly on participating ranches; stocking rates grew from 0.7 to 2.5 animals per hectare; cattle weight gain increased from 400 to 900 grams per day; and time to slaughter decreased from 36 to 19 months.
- **Farmer livelihoods:** ABC producers had an average income growth 2.7 times higher than producers in a control group, and a 24–40 percent reduction in total costs.
- **Gender-related benefits:** By the end of the ABC project, 25–30 percent of participating farms were led by women or had strong participation by women. Evaluations indicated that women's involvement had a positive influence—particularly on the speed of implementation. DGM projects were particularly successful in attaining their gender empowerment objectives, due to the specific focus of activities in this area.

Brazil Light-Touch Case Study: Development of a Macaúba-Based Silvopastoral System and Value Chain

Project Details	Funding
Project Name: Macaúba-based Silvopastoral System Project **Country:** Brazil **CIF Program Area:** Forest Investment Program (FIP) **Bank approval:** July 2017 **Effective since:** July 2017 **Actual closing:** December 2022 **MDBs:** Inter-American Development Bank (IDB)	**Total Value:**[1] $6 million CIF: $3 million (FIP equity investment) **Multilateral Investment Fund (MIF):** $1.326 million (reimbursable technical cooperation) **Counterpart:** $1 million (local investors) **Co-financing:** $0.643 million **Instrument type:** Equity, loan, reimbursable grant **Sector:** Private

Key Highlights

- The Macaúba Project is a US$6 million investment, with an innovative financing structure including a direct equity investment channeled through the MIF/IDB Lab, to develop a Macaúba, palm-based silvopastoral system and value chain.

Topline Findings on Development Impacts

- **Biodiversity protection:** The project has planted 2,475 hectares of Macaúba, with 340 farmers and their families, establishing 114 ecological corridors to protect local biodiversity and sequestering 34,292 tons of CO_2. The goal is to plant 30,000 hectares of Macaúba by 2030.

- **Increased farmers' income**: Farmers confirmed that the Macaúba Project was expected to increase revenue and income, with a guaranteed annual price of $74/ton, corrected for inflation. Additional income is expected from intercropping, with 10 farmers having signed contracts for planting crops, such as cassava, on 288 hectares.

- **Employment:** Macaúba harvesting provides employment opportunities outside of the regular coffee season in the region. Direct employment by Innovative Oil and Carbon Solutions (INOCAS) has already increased from eight to 26. The full-time employment equivalent is expected to grow to 226 by 2048. Many of these workers are hired from the local prison and provided a normal wage.

- **Land restoration:** The planting of Macaúba promotes land restoration and helps farmers avoid some of the negative impacts of climate change. The project contributes to the achievement of Brazil's Nationally Determined Contribution (NDC), with an estimated 933,750 tons of carbon sequestered in 20 years. If the INOCAS project were replicated on 25 percent of the degraded pastures of the Cerrado, it would fully cover Brazil's NDC commitment.

India Light-Touch Case Study: Scaling Up Solar Power Technologies

Project Details	Funding
Name: Clean Technology Fund Investment Plan for India (including seven projects) **Country:** India **CIF Program Area:** Clean Technology Fund (CTF) **Bank approval:** *see Table 3 for individual project dates* **Effective since:** *see Table 3 for individual project dates* **Expected closing:** *see Table 3 for individual project dates* **MDBs:** Asian Development Bank (ADB) and World Bank	**Total Value:** $7,539 million **CIF:** $723 million **Co-financing:** $6,816 million **MDB:** $1,630 million **Government of India:** $1,010 million **Other:** $4,176 million **Instrument type:** Loan, grant **Sector:** Public

Key Highlights

- CIF created a $723 million Clean Technology Fund (CTF) Investment Plan for India focused on scaling up renewable technologies, with an additional $6,816 million of co-financing from multilateral development banks (MDBs), the Government of India, private lenders, and bilateral agencies.
- The CTF Investment Plan contains seven distinct programs. This case study emphasizes the development impacts of two that were funded partly through CTF: the ADB's Solar Park Transmission and the World Bank's Grid-Connected Rooftop Solar programs.

Topline Findings on Development Impacts

- **Market development:** The seven programs have leveraged $2.45 billion in co-financing and have played a catalytic role developing investors' interest in solar rooftop and solar park projects and improving financing conditions.
- **Local job creation**: The two solar rooftop programs are estimated to have so far created about 9,604 direct jobs (i.e., construction and maintenance) and 950 indirect jobs (i.e., manufacturing of equipment) in the solar rooftop industry. Job creation is not estimated for the other programs.
- **Increased energy access and reliability:** The seven projects have provided an additional 11,787 GWh of power annually; this additional energy supply is expected to benefit 770,000 households in India annually.
- **Energy security:** By replacing fossil-sourced energy with solar power, the seven projects have avoided the annual consumption of about 4.7 million tons of coal and 1.0 tons of oil equivalent (toe) of diesel.
- **Reduction of GHG emissions and air pollutants:** The displacement of fossil energy with solar energy from these seven projects has so far led to the avoidance of about 10.4 million tCO_2e as well as 14.6 kt SO_2, 6.2 kt NOx and 1.4 kt $PM_{2.5}$ annually. The seven projects are estimated to avoid $946 million of emissions-related costs annually.

- **Health benefits:** The seven projects are estimated to avoid $1.36 billion of health-related costs annually, which is mostly from costs related to respiratory diseases from particulate matter.
- **Other DIs:** Additional benefits include increased gender equality through new job opportunities and improved access to essential services.

Indonesia Deep-Dive Case Study: Economy-Wide Impacts of Expanding Geothermal Power Generation

Project Details	Funding
Name: Geothermal Clean Energy Investment Project (GCEIP); Geothermal Energy Upstream Development Project (GEUDP); Geothermal Resource Risk Mitigation Project (GREM); Geothermal Power Generation Project (GPGP) **Country:** Indonesia **CIF Program Area:** CTF **Bank approval:**[1] July 2011 (GCEIP) **Effective since:**[1] May 2012 (GCEIP) **Expected closing:**[2] October 2029 (GREM) **MDB:** World Bank (GCEIP, GEUDP, GREM); Asian Development Bank (GPGP)	**Total Value:**[3] \$4,454.6 million **CIF:** \$483.25 million **Co-financing:** \$3,971.35 million (\$1,122.5 million is MDB co-financing) **Instrument type:** Loan, grant **Sector:** Public
Notes: (1) CIF approved the country Investment Plan in March 2010. "Bank approval" and "effective since" use the dates listed for the first project GCEIP. (2) "Expected closing" uses the closing date for the last project GREM. (3) Funding values include all CIF-supported geothermal projects in Indonesia, four of which are the primary focus of this case study (in sites including Ulubelu in South Sumatra; Lahendong in North Sulawesi; Wae Sano in East Nusa Tenggara; several sites in Eastern Indonesia; Dieng, Central Java; and Patuha, West Java).	

Key Highlights

- For more than a decade, CIF investments have supported geothermal energy development in Indonesia through upstream (de-risking exploration and drilling) and downstream (geothermal project development) projects.
- CIF's \$483.25 million for Indonesia's geothermal development brought in \$3.97 billion in co-financing and will mobilize additional commercial capital.
- Concessional finance provided by CIF lowered the cost of capital and helped make the projects competitive. MDB and CTF funds also helped to provide financial certainty and market confidence.
- Actual and forward-looking geothermal capacity expansion in Indonesia supported by CIF amounts to 1,815 MW, of which at least 320 MW were completed at the time of writing.

Topline Findings on Development Impacts

- **Geothermal market development:** Through geothermal investment funded by CIF, North Sulawesi exceeded Indonesia's national target of 23 percent renewable energy capacity nationwide by 2025. In addition, the project significantly reduced systemic power shortages and regular blackouts that previously plagued the region.
- **Job creation:** The geothermal projects supported by CIF directly created or will create an estimated 4,350 long-term jobs, and indirectly support more than 27,000 jobs. Most of these jobs are during the construction phase of development, although some are operational jobs.

- **Economy-wide impacts:** The geothermal projects supported by CIF have economy-wide impacts estimated at $107 million per year.
- **Education and human capital:** Expanded access to electrification, and more reliable electricity, facilitates increased access to education, and increased human capital valued at approximately $27 billion.
- **Health benefits:** Reducing reliance on fossil fuels for electricity generation, including diesel generators for backup power, produces health benefits of over $2 billion.
- **Other DIs:** Additional benefits of geothermal market development include local economic development and development of local supply chains, increased government revenues, improved access to public services and infrastructure, and capacity building benefits including improved local government coordination, and improved policy and regulatory environment.

Indonesia Light-Touch Case Study: Development Impacts of Sustainable Forest Management

Project Details	Funding
Project Names: Community-Focused Investments to Address Deforestation and Forest Degradation (FIP-1) Promoting Sustainable Community-Based Natural Resource Management (CBNRM) and Institutional Development Strengthening Rights and Economies of Adat and Local Communities (DGM-1) **Country:** Indonesia **CIF Program Area:** Forest Investment Program (FIP) **Bank approval:** September 2016 (FIP-1); April 2016 (CBNRM); May 2017 (DGM-1) **Effective since:** December 2016 (FIP-1); May 2016 (CBNRM); June 2017 (DGM-1) **Expected closing:** June 2023 (FIP-1); December 2022 (CBNRM); November 2022 (DGM-1) **MDBs:** Asian Development Bank (ADB), World Bank	**Total Value:** US$18.7 million (FIP-1); US$22.42 million (CBNRM); US$6.3 million (DGM-1) **CIF:** US$17 million (FIP-1); US$17.35 million (CBNRM); US$6.3 million (DGM-1) **Instrument type:** Grants **Sector:** Public

Key Highlights

- The CIF Sustainable Forest Management (SFM) projects aim to address deforestation and forest degradation in Indonesia while reducing emissions, strengthening institutional and local capacity for decentralized forest management, and improving livelihoods in targeted areas.
- This case study focuses on three CIF Forest Investment Program (FIP) projects in Indonesia with a total CIF investment of US$40.6 million.

Topline Findings on Development Impacts

- **Market development:** Improved access to markets and thus the creation of economic and employment opportunities is among the main development impacts (DIs) of these interventions, leading to new activities and alternative sources of income.
- **Community engagement:** Community engagement in SFM and social inclusion have also been significantly improved throughout the projects.
- **Benefits to local stakeholders:** A total of nearly 113,000 people are expected to benefit from the three projects, who are to a large extent customary law communities and Indigenous Peoples and local communities (IPLCs).
- **Women's empowerment:** More than 30,000 women are expected to benefit from the CIF-SFM projects. Besides contributing to economic empowerment, the projects also enhance women's involvement in conflict resolution and strengthen the enabling conditions to ensure their sustained participation.

- SFM measurement and reporting can be improved by using metrics that better reflect the DIs of the projects, in particular impacts on women. According to interviewees, the reported DIs for women are generally underestimated.

Kenya Light-Touch Case Study: Development Impacts of Off-grid Electrification

Project Details	Funding
Name: Kenya Electricity Modernization Project **Country:** Kenya **CIF Program Area:** Scaling-up Renewable Energy Program in Low-Income Countries (SREP) **Bank approval:** March 2015 **Effective since:** June 2015 **Expected closing:** December 2022 **MDB:** World Bank	**Total Value:** $462 million **CIF:** $7.5 million grant **Co-financing:** $454 million **MDB**: $250 million loan, $200 million guarantee **Kenya Power and Lighting Co.:** $3.5 million **Instrument type:** Grant, loan, guarantee **Sector:** Public *Note: Totals are based on the December 2022 Implementation Status & Results Report.*

Key Highlights

- The Kenya Electricity Modernization Project (KEMP) is a US$462 million project that aims to increase access to electricity, improve service reliability, and strengthen the financial position of the national electric utility company.
- This case study focuses on the C2 subcomponent of the KEMP project, off-grid electrification, with a total CIF investment of US$7.5 million.
- The C2 subcomponent has not yet been fully implemented, but important progress has been made. At the time of this writing, implementation was expected by December 2022.

Topline Findings on Development Impacts

- **Access to essential services:** Off-grid electrification is expected to bring electricity to about 13,500 people in remote areas of Kenya, significantly improving access to essential services.
- **Gender-inclusive benefits:** Improved access to electricity is expected to specifically benefit women, who are traditionally responsible for collecting firewood for household energy in rural Kenya.
- **Employment:** The C2 KEMP subcomponent may translate into 88 direct short-term jobs (about one year) and about 10 annual direct jobs for 25 years. We estimate that the off-grid subcomponent may translate into 232 indirect short-term jobs.
- This program marks the first time in Kenya that an agreement was reached where the private sector is responsible for both operations and maintenance (O&M), and engineering, procurement and construction (EPC) of an off-grid electricity generation contract in the public sector. This agreement should significantly reduce the costs for the national electric utility KLPC and foster innovation, while maintaining the current national electricity tariff for beneficiaries.

Morocco Light-Touch Case Study: Noor Ouarzazate I Concentrated Solar Power (CSP) Plant

Project Details	Funding
Name: Noor Ouarzazate I Concentrated Solar Power (CSP) **Country:** Morocco **CIF Program Area:** Clean Technology Fund (CTF) **Bank approval:** November 2011 **Effective since:** June 2013 **Actual closing:** May 2015 **MDBs:** African Development Bank (AfDB), World Bank	**Total Value:** $854.5 million **CIF:** $97 million through the World Bank, $100 million through the AfDB **Co-financing:** $657.5 million **MDBs:** $386.5 million **Government of Morocco and private partners:** $168 million **Bilateral agencies:** $103 million **Instrument type:** Loan **Sector:** Public

Key Highlights

- Noor Ouarzazate Concentrated Solar Power (CSP) was an $854.5 million project that supported Morocco in the development of a 580 MW solar power complex. CIF contributed $97 million to this project through the World Bank and an additional $100 million through the AfDB. Financed through a public-private partnership (PPP), the project aimed to increase power generation from solar power and to mitigate greenhouse gas (GHG) emissions and local environmental impacts.

- The CIF funding was directed to Component 1 (CIF also supported the Noor Quarzazate II and III component of the four phases of the Noor Quarzazate complex). Component 1 included the development and construction of Noor Ouarzazate I, a 160 MW CPS plant that was completed in 2015, components II and III added 200MW and 150MW in 2018. Noor Ouarzazate I is the focus of this case study.

Topline Findings on Development Impacts

- **Increased access to electricity:** The project directly benefits 347,780 people per year by increasing their access to electricity and accordingly improving their livelihoods.

- **Employment:** The project had direct and indirect economic and employment opportunities including the creation of 1,977 temporary jobs created during the construction phase. During the operation phase, the plant has employed 78 permanent staff, including 38 local residents (49 percent) and 7 women (9 percent).

- **Reduced GHGs and air pollution:** The project avoided about 255,000 tCO_2e of GHG emissions in 2016, as well as 1,120 tons of NO_X emissions and 4,240 tons of SO_X emissions.

- **Improved energy security:** Long-term benefits included improved competitiveness and industrial integration, and improvements to Morocco's energy sector security resilience.

Nepal Deep-Dive Case Study: Development Impacts of Expanding Biogas Generation

Project Details	Funding
Name: Extended Biogas Project **Country:** Nepal **CIF Program Area:** SREP **Bank approval:** August 2014 **Effective since:** November 2014 **Closed:** August 2021 **MDB:** World Bank	**Total Value:*** Planned: $14.8 million; actual: $7.75 million **CIF:** Planned: $7.9 million; actual: $4.2 million **Co-financing**:* Planned: $6.9 million from Government of Nepal; actual: $3.6 million **Instrument type:** Grant **Sector:** Public **Note: The project also leveraged at least $8.4 million in private investment. Consistent with project documents, private sector funds are excluded from the total value. The difference between planned and actual cost is attributable to several challenges in the project, including delays due to the COVID-19 pandemic.*

Key Highlights

- The Extended Biogas Project supported market-led approaches to commercially viable, large-scale off-grid biogas production from municipal and commercial waste using public-private partnership approaches. The project addressed barriers to widespread adoption of biogas through a combination of financial and technical assistance.
- As of August 2021 (project close), 194 large-scale biodigesters were installed ranging in size from 12 to 200 m^3; and 11 very large biogas projects with capacities around 3,000–4,000 m^3 were on the verge of completion. Five of these were municipal plants and the others were commercial plants.
- The biogas is used for a variety of applications, including thermal (industrial heat) applications, as a replacement for LPG in restaurants and hotels, and electricity generation. Digestates produced as a byproduct of biogas production can also be sold to the market as organic fertilizers to replace chemicals fertilizers.

Topline Findings on Development Impacts

- **Biogas market development:** The project led to large matching investments in the biogas market from the public sector ($6.9 million committed, $3.6 million disbursed); in addition, the project leveraged private sector investment of at least $10.68 million. The project contributed to the development of a local large-scale biogas industry in Nepal through commercially viable business models, raised awareness about the biogas market, and promoted biogas adoption. It also trained 40 companies in evaluating and appraising large biogas projects.
- **Local job creation:** Biogas plants create an estimated 20 jobs in municipal solid waste-to-energy plants and 50 jobs in commercial biogas plants. In the construction phase, biogas projects can temporarily employ up to 200 people.

- **Energy security:** The biogas produced from the SREP-supported biogas projects replaced an estimated 600,000 liquefied petroleum gas (LPG) cylinders, equivalent to more than $5 million of import substitution.
- **Reduced cost of waste management:** Municipalities and biomass suppliers could realize waste management cost savings; in addition, farmers can earn additional income, based on the volume of animal biowaste they provide to biogas plants, averaging an estimated $188 per month.
- **Access to reliable energy:** As of 2021, 275 businesses gained improved energy access through the project. Improved energy access for households was not monitored, but the replacement of fossil fuels with biogas makes heating/electricity more affordable for the local population, with estimated energy cost savings of 25–30 percent.
- **Reduction of greenhouse gas emissions:** The SREP-funded biogas projects have avoided an estimated 90,754 tCO_2e annually, translating to 1.815 $MtCO_2e$ over a 20-year lifetime of the biogas plants. A Program of Activities under the Kyoto Protocol has been designed to bundle the SREP-funded projects, as well as future projects, to mobilize carbon financing.
- **Reduction of land, air, and water pollutants and improved soil quality:** The waste used in biogas plants is estimated to reduce landfill waste on site by at least 50–60 percent. The project also supported the production of more than 88,000 tons of organic fertilizer that farmers can use instead of chemical fertilizers, improving soil quality and yields and reducing fertilizer import bills by up to $34 million.
- **Health benefits:** Indoor air quality improvements are expected to result from substituting harmful cooking fuels with biogas, in turn reducing adverse health impacts.
- **Benefits to local women:** The project reduced the time needed to collect fuel wood, cook, and clean, activities which are often done by women. It also provided employment opportunities for women, particularly related to waste sorting.

Niger Light-Touch Case Study: Mainstreaming Climate Resilience of Populations and Agricultural Production Systems

Project Details	Funding
Project Names: Community Action Project for Climate Resilience (CAPCR-1) Niger Community Action Project for Climate Resilience (CAPCR-2) **Country:** Niger **CIF Program Area:** Pilot Program for Climate Resilience (PPCR) **Bank approval:** January 2012 (CAPCR-1); April 2019 (CAPCR-2) **Effective since:** May 2012 (CAPCR-1); September 2019 (CAPCR-2) **Actual closing:** May 2021 (CAPCR-1 and CAPCR-2) **MDBs:** World Bank	**Total Value:** Total US$77.6 million; includes US$63 million (CAPCR-1); US$14.6 million (CAPCR-2) **CIF:** US$72.6 million **World Bank:** US$5.0 million **Instrument type:** Grant (US$35 million), loan (US$37.6 million) **Sector:** Public *Note: While the total planned value of the two projects was US$77.6 million, the World Bank Implementation Completion Report (ICR) indicates that actual disbursements were US$74.7 million.*

Key Highlights

- The Community Action for Climate Resilience Project (CAPCR) projects in Niger sought to improve the resilience of the populations and agricultural production systems to climate change and variability in 38 targeted communes.
- The projects focused on mainstreaming climate resilience coordination between the national and local levels, with the centerpiece establishment of "Maisons du Paysan" (farmers' houses) in targeted communes to serve as institutional platforms to enable scaling up of interventions in rural areas to improve adaptive capacities of populations and agricultural systems.
- This case study focuses on two CIF Pilot Program for Climate Resilience (PPCR) projects in Niger with a total CIF investment of US$72.6 million.

Topline Findings on Development Impacts

- **Increased agricultural productivity:** The combination of enhanced agricultural inputs (e.g., seed, fertilizer, fodder, equipment) and extension services (e.g., training, equipment repair services, technical assistance, microfinance) increased crop yields by an average of 59 percent annually and enhanced the resilience of agro-silvopastoral production systems in the project areas.
- **Benefits to local stakeholders:** Nearly 500,000 rural producers and poor households in the targeted 38 communes were project beneficiaries (resulting in direct benefits experienced by 2.415 million people, including 1.155 million women), with high corresponding rates of sustainable land and water management practices.
- **Access to essential services:** Community engagement and development of climate resilience capacity was also advanced in target populations and among local institutions, increasing access to a range of agricultural extension and social protection services.

- Measurement and reporting can be improved by using metrics that better reflect DIs of the projects, including impacts on women empowerment, and food security and changes in livelihoods experienced by households.
- An analysis by the CAPCR project team of the development impacts of an innovative project approach—the use of a coaching system paired with results-based management to support effective operationalization of the Maisons du Paysan—provides valuable insights.

Thailand Deep-Dive Case Study: Development Impacts of Private Sector Utility-Scale Wind Power

Project Details	Funding
Name: Clean Technology Fund (CTF) Private Sector Renewable Energy Program and Renewable Energy Accelerator Program **Country:** Thailand **CIF Program Area:** CTF **Bank approval:** 2009 **Effective since:** 2012 **Actual closing:** 2016 **MDB:** Asian Development Bank (ADB)	**Total Value:** $163.59 million plus equity **CIF:** $34 million **Co-financing total:** $129.59 million **ADB:** $57.15 million **Bank of Ayudhya:** $72.44 million) **Instrument type:** Grant, Loan **Sector:** Private

Key Highlights

- Thailand's Integrated Energy Blueprint sets a target of 3,002 MW of installed wind power capacity by 2036. The CIF projects directly installed 88.5 MW and facilitated the installation of additional private wind facilities. As of 2020, Thailand had 1,510 MW of installed wind capacity.
- CIF's Clean Technology Fund (CTF) supported the successful construction of two utility-scale wind-power facilities: Theppana (7.5 MW) and Subyai (81 MW). CTF provided a total of $4 million in funding for the Theppana plant and $30 million for the Subyai facility. The projects were also supported by ADB and the Bank of Ayudhya.
- The CTF-funded projects were the first movers for utility-scale wind power in Thailand. CTF support was important in overcoming the financial and regulatory barriers that had prevented earlier wind-power activities and in facilitating future investments in wind power.

Topline Findings on Development Impacts

- **Market development:** Installed wind power capacity has increased from less than 10 MW in 2008 to 1,510 in 2020. This expansion would not have been possible without demonstration of the financial viability of wind power and adaptations to the regulatory environment that were facilitated under the Theppana and Subyai projects. These first-mover utility-scale wind power projects paved the way for future projects.
- **Employment gains**: Combined, the two CIF-financed facilities created 669 construction jobs and 38 permanent positions.
- **Income diversification**: Local farmers leased land to the plants, earning higher rents than the expected returns for farming cassava, helping to localize the economic benefits of the wind projects in the surrounding communities.
- **Diversification of energy sources**: The two plants provided an alternative to imported natural gas or coal generated energy and helped unlock the potential for future wind projects.
- **Expanded infrastructure**: Construction efforts included expansion of community-accessible roads and improvements to water management systems.

- **Acquisition of transferable job skills:** Both facilities offered opportunities for local residents to gain skills related to wind power operations through scholarships and internships. The Theppana plant trained four plant operators.
- **Community engagement:** The projects invested in local infrastructure and sponsored a variety of corporate social responsibility activities to benefit and engage the local community.
- **Health benefits from reduced air pollution:** The expansion of renewable wind energy displaces the emission of air pollutants from natural gas and coal, which can cause adverse health impacts. To understand the economic benefits of these avoided health impacts, economists may apply the value of statistical life (VSL). The health benefit measured with the VSL of the Theppana and Subyai facilities alone is estimated at $1.46 million—and the potential benefits if Thailand meets its national wind energy goals are substantially larger.
- **Capacity building**: CTF and ADB provided technical expertise to increase the capacity of Thai financial and regulatory institutions with regards to wind power and renewable energy.

Türkiye Light-Touch Case Study: Scaling Up Renewable Energy and Energy Efficiency Projects

Project Details	Funding
Name: Private Sector Renewable Energy & Energy Efficiency Project **Country:** Türkiye **CIF Program Area:** Clean Technology Fund (CTF) **Bank approval:** May 2009 **Effective since:** June 2009 **Project close:** December 31, 2016 **MDB:** World Bank	**Total Cost:** $3,099.56 million **MDB:** $950.66 million **CIF:** $100 million **Co-financing (donors and sponsor equity from FIs):** $2,048.9 million **Instrument type:** Loan **Sector:** Private

Key Highlights

- CIF's Clean Technology Fund (CTF) and the World Bank have provided US$1.051 billion to finance renewable energy and energy efficiency investments via two credit lines for two Turkish development banks.
- This case study focuses on the development impacts of CIF's Renewable Energy and Energy Efficiency Projects, which were funded by this budget.

Topline Findings on Development Impacts

- **Market development:** The project helped remove a key barrier to renewable energy investments in the country: the limited availability of financing for capital-intensive energy sector projects. The World Bank and CTF loans made it possible to grow previously underdeveloped energy efficiency markets and financing strategies. The two participating financial institutions have also set up dedicated energy efficiency departments.
- **Reduction of GHG emissions and air pollutants:** GHG emission reduction outcomes from energy efficiency exceeded targets (102 percent), while those from renewable energy reached 84 percent, as the benefits from the largest geothermal power plant funded were smaller than projected.
- **Other DIs:** Additional benefits include local job creation and health benefits from improved local air quality, and increased gender equality through new job opportunities and improved access to essential services.