CIF CLIMATE INVESTMENT FUNDS

EVALUATION OF THE DEVELOPMENT IMPACTS FROM CIF'S INVESTMENTS

// March 2023

EVALUATION AND LEARNING INITIATIVE//

Summary Brief

CIF Programs: All

TOPICS

- Social Inclusion
- Economic Benefits
- Climate Finance

ACKNOWLEDGMENTS

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The CIF Administrative Unit would like to recognize and thank the many people who have contributed to this work, starting with the Industrial Economics (IEc) evaluation team: Daniel Kaufman (Team Lead, IEc), Angela Vitulli (IEc), Brent Boehlert, PhD (IEc), Christine Lee (IEc), Kenneth Strzepek, PhD (IEc), Maura Flight (IEc), Stefani Penn, PhD (IEc), Catherine Foley (IEc), Greg Englehart (IEc), Charles Fant (IEc), Emily Evenden (IEc), Melanie Jackson (IEc), Sydney Austin (IEc), Antonia Farrell (IEc), Margaret Cella (IEc), Tabeen Hossain, Jeroen van der Laan (Trinomics B.V.), Matthew Smith (Trinomics B.V.), Peter Janoska (Trinomics B.V.), Tatiana Cuervo Blanco (Trinomics B.V.), Nora Cheikh (Trinomics B.V.), Csinszka Bene (Trinomics B.V.), Marwa Mahmoud, Vegard Dahl, Tim Larson (Ross Strategic), Heather Christopher (Ross Strategic), Johanna Polvi, PhD (ojutu solutions oy), Sergei Paltsev, PhD (MIT), and Jennifer Morris, PhD (MIT). We would also like to thank the national consultants hired by the IEc team: BIGD, BRAC University (Bangladesh), Fabrica Ethica Brasil (Brazil), and PT Inovasi Dinamika Prata (Indonesia). We are very grateful to the MDB and CIF Administrative Unit staff who have provided strategic input on the direction of the evaluation and reviewed its various drafts. Their input has substantially contributed to the relevance, quality, and usefulness of the findings.

The core team leading this work from CIF include Neha Sharma (Team Lead), Brittney Melloy, Madu Selvakumar, and Nicole Pasricha.

This summary document was prepared by Nicole Pasricha, Senior Consultant at CIF, with input from Neha Sharma and Brittney Melloy. This document is based on the Evaluation of Development Impacts from CIF's Investments. The IEc team lead, Daniel Kaufman, has reviewed this document to ensure its accuracy and alignment with the independent evaluation reports.

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LIST OF ABBREVIATIONS

ADB	Asian Development Bank
AfDB	African Development Bank
CGE	Computable general equilibrium
CTF	Clean Technology Fund
DI	Development impact
EPPA	Emissions Prediction and Policy Analysis
FAO	Food and Agriculture Organization
FIP	Forest Investment Program
GDP	Gross Domestic Product
GHG	Greenhouse gas
GTAP	Global trade analysis project
GWh	Gigawatt-hours
IDB	Inter-American Development Bank
IEc	Industrial Economics, Inc.
I-O	Input-output
JIM	Joint Impact Model
LEAP	Low Emissions Analysis Platform
LEAP-IBC	Low Emissions Analysis Platform—Integrated Benefits Calculator
MDB	Multilateral development bank
MIT	Massachusetts Institute of Technology
MW	Megawatts
NOx	Nitrogen oxides
PPCR	Pilot Program for Climate Resilience
SDGs	Sustainable Development Goals
SMEs	Small and medium enterprises
SOx	Sulfur oxides
SREP	Scaling Up Renewable Energy Program

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1. INTRODUCTION

Climate action and development are inextricably linked. Although development impacts (DIs) can be a core benefit of climate finance, these impacts are often not planned for or understood, and hence not tracked in implementation. Through the intentional planning and tracking of DIs, there may be opportunities to achieve greater impacts.

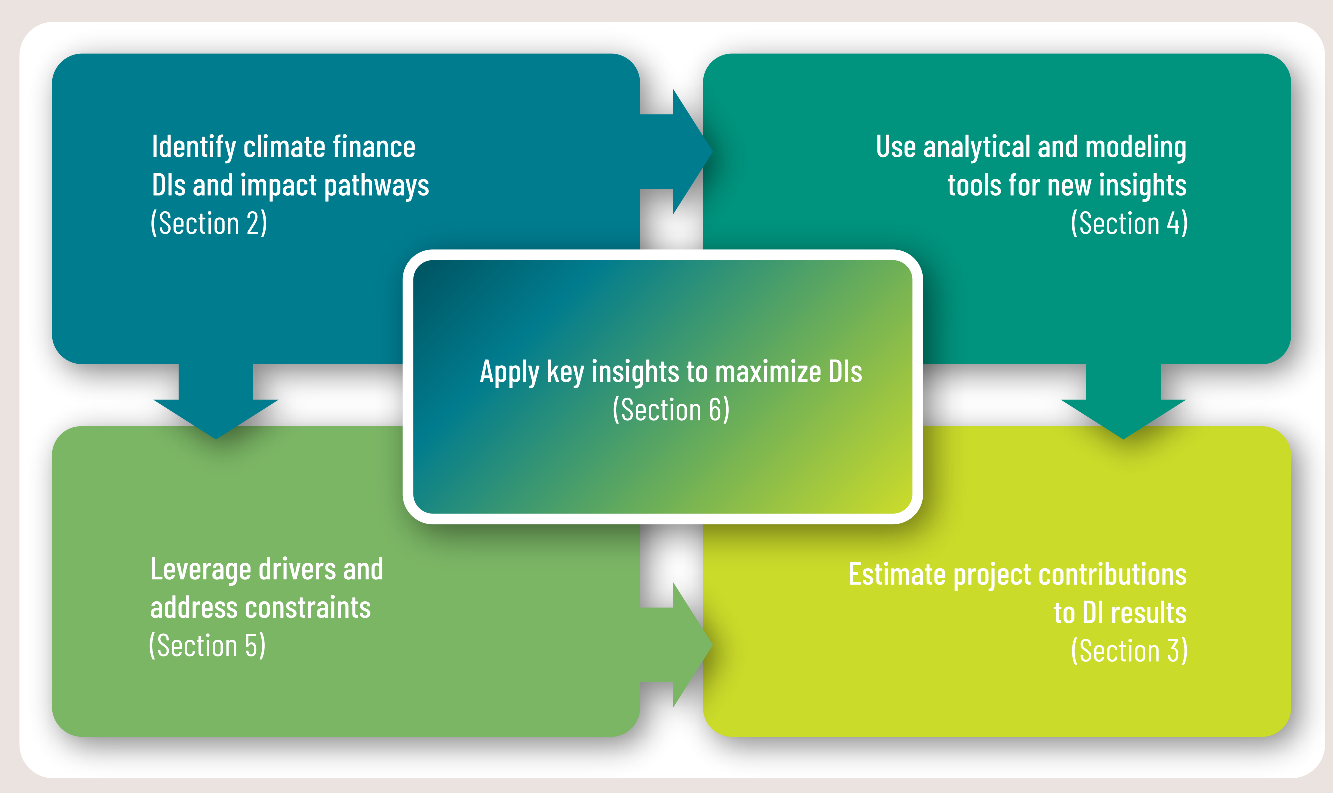
To develop a better understanding of the links between climate finance and development, CIF commissioned a mixed-methods evaluation of four programs: the Clean Technology Fund (CTF), the Scaling Up for Renewable Energy Program (SREP), the Pilot Program for Climate Resilience (PPCR), and the Forest Investment Program (FIP). This evaluation is expected to expand the evidence base on the DIs that are linked to climate finance, strengthen the case for more ambitious climate action, and enable key decision-makers to make more informed and impactful decisions that can lead to broader and more inclusive development.

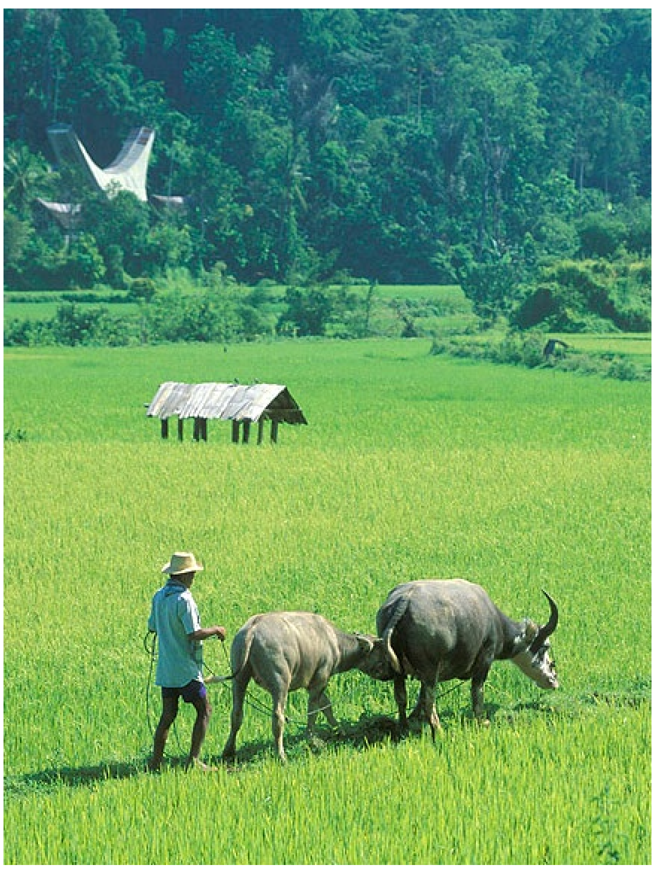
The evaluation addresses four key questions:

1. What are the primary DIs that the CIF portfolio — and by extension, other climate finance — may contribute to, and through which impact pathways or modalities?
2. What are the key DI results and achievements that CIF's investments have contributed to? What have been the main challenges or unintended impacts?
3. What are the additional tools and models that can help to better measure and estimate the DIs of climate finance — at different stages of the investment lifecycle?
4. What are the drivers and constraints that influence the extent to which CIF investments contribute to DIs? How can climate finance programs maximize their contributions to DIs?

The evaluation concludes with key recommendations. This CIF DI Evaluation Summary Brief is a synthesis of the full report — Evaluation of the Development Impacts from CIF's Investments, authored by Industrial Economics (IEc), based on the independent evaluation it conducted in 2021–2022.

FIGURE 1. Development Impacts Linked to Climate Finance: Report Framework





The evaluation combines quantitative and qualitative methods, and three levels of evaluative activities: a secondary information review, a portfolio-level analysis and cataloguing of modeling tools, as well as 13 original project-level case studies. The case studies are divided into two types: five deep-dive cases with new primary research and modeling, and eight light-touch cases developed mostly from secondary research and interviews. The cases represent a balanced cross-section of CIF programs, geographic regions, climate finance sectors and technologies, along with projects across CIF's multilateral development bank (MDB) partners. [Access the full case studies here.]

Examining DIs in aggregate is challenging, as the impacts are sectorally and geographically diverse, grounded in the nuances of the country and sectoral contexts, and require a range of methods to analyze them. Still, by combining case studies, a modeling / portfolio analysis, and secondary information, this evaluation has generated new insights that are relevant for CIF and other climate funders.

TABLE 1. Snapshot of Development Impact Case Studies

CASE STUDY DETAILS							DI CASE STUDY COVERAGE					
No.	COUNTRY	CIF PROGRAM	MDB PARTNER	CASE STUDY TYPE	SECTOR	INVESTMENT IN	SOCIAL	ECONOMIC	ENVIRONMENTAL	MARKET DEVELOPMENT	CROSS-CUTTING—GENDER	CROSS-CUTTING—CAPACITY
1	**Bangladesh**	SREP	World Bank	Light-Touch	Renewable Energy	Rooftop solar for factories	♦●	♦	●	♦		
2	**Bangladesh**	PPCR	World Bank	Deep-Dive	Agriculture	Coastal embankment improvements	♦●	♦●	♦●	●		●
3	**Brazil**	FIP	World Bank	Deep-Dive	Agriculture	Low-carbon / sustainable agriculture	●	♦	♦	♦	♦	
4	**Brazil**	FIP	Inter-American Development Bank (IDB)	Light-Touch	Forestry	Macaúba value chain development	●	♦	●	♦		
5	**India**	CTF	Asian Development Bank (ADB), World Bank	Light-Touch	Renewable Energy	Utility-scale and rooftop solar and transmission	♦	♦●	♦	♦	●	
6	**Indonesia**	CTF	ADB, World Bank	Deep-Dive	Renewable Energy	Upstream and downstream support for geothermal	♦●	♦●	●	●	♦	●
7	**Indonesia**	FIP	ADB, World Bank	Light-Touch	Forestry	Sustainable forest management	♦	●	●	♦	●	
8	**Kenya**	SREP	World Bank	Light-Touch	Renewable Energy	Mini-grid electrification in rural areas	♦	♦	♦			
9	**Morocco**	CTF	African Development Bank (AfDB), World Bank	Light-Touch	Renewable Energy	Utility-scale concentrated solar power plant	♦●	♦		♦		
10	**Nepal**	SREP	World Bank	Deep-Dive	Renewable Energy	Expansion of off-grid biogas	♦●	♦	●	♦	●	♦
11	**Niger**	PPCR	World Bank	Light-Touch	Agriculture	Climate resilience interventions	♦	●	♦		●	
12	**Thailand**	CTF	ADB	Deep-Dive	Renewable Energy	Utility-scale wind power generation	♦●	♦●	♦	♦●		●
13	**Türkiye**	CTF	World Bank	Light-Touch	Renewable Energy & Energy Efficiency	Small-scale renewables and energy efficiency	●	♦●	♦	♦●		

Legend: ♦ At least 1 DI in this category quantitatively assessed ● At least 1 DI in this category qualitatively assessed

2. DEVELOPMENT IMPACTS AND PATHWAYS

The secondary information review of 35 CIF-related reports and 24 external reports has identified over 60 DIs that can be realized through interventions supported by climate finance. For ease of further reference, these DIs are organized into a new Climate Finance DI Taxonomy around four main DI categories — social, economic, environmental, and market development — and 11 subcategories, in addition to the cross-cutting dimensions, as illustrated in the table below. The cross-cutting dimensions—relevant across all DI categories— are 1) impacts on women and other vulnerable or excluded populations and 2) built capacity. Several aspects of inclusivity and justice are also included as specific DIs under market development, where they were identified in the secondary review.

TABLE 2. Climate Finance DI Taxonomy

SOCIAL
1. Livelihoods, wealth, and quality of life
Increased or diversified income
Wealth generation
Recognition of tenure rights
Increased access to markets
Acquisition of transferable job skills
Improved working conditions
Increased ability to cope with shocks
Reduced losses from extreme climate events
Increased capacity of local institutions
Community engagement / collaborative implementation
2. Health and safety
Increased food security
Reduced illegal activity
Avoided negative health impacts from fossil fuels
3. Essential services
Increased access to electricity (households / businesses)
Increased electricity reliability / decreased outages (households / businesses)
Reduced costs of essential services (households / businesses)
Increased access to public transportation
Increased access to water or improved reliability
Increased access to healthcare / medicine
Increased access to infrastructure
Increased access to education
ECONOMIC
4. Employment opportunities
Increase in direct employment (permanent [perm] or temporary [temp])
Increase in indirect employment (perm / temp)
Increase in induced employment (perm / temp)
Increased earnings from employment (all types)
5. Economic value add (GDP)
Increased economic outputs
CROSS-CUTTING DIMENSIONS
Inclusion and empowerment
Gender inclusion, impacts on women and girls
Vulnerable populations and local stakeholders impacts
Capacity
Built capacity (within specific stakeholders)

ENVIRONMENTAL
6. Natural resources
Reduced air pollutants
Improved water quality
7. Ecosystem and biodiversity
Improved legal / regulatory framework
Improved forest management planning
Enhanced forest stocks
Increase in sustainable land use
8. Soil and crop productivity
Increased productivity of agriculture
Improved soil health
Reduced use of inputs or natural resources
MARKET DEVELOPMENT
9. Competitiveness and industrial development (all sectors)
Increased small and medium enterprises (SMEs) in the market
Improved integration / connectivity of systems
Supply chain development
Maturation of market structures
Increased technology adoption
Expanded access to capital
Reduced operating costs (e.g., energy)
Increased affordability of low-carbon technologies
Increased / diversified product offerings
Reduced trade imbalance
More projects / products meeting international standards
Improved legal / regulatory framework, capacity, governance
10. Energy sector security and resilience
Increased market entrants
Increased local energy generation
Reduced transmission / distribution line losses
Diversification of energy sources
Increased sector integration
Increased financial stability
Reduced fuel imports
Increased regulatory / governance capacity
Improved planning for shocks and stresses
11. Inclusiveness and justice
Inclusiveness and energy justice
Inclusive business models (e.g., women, others)
Inclusive regulation (e.g., women, others)

The secondary review also assessed which DIs were most frequently referenced in the 59 external and internal reports: the top DI subcategories were "Livelihoods, Wealth, and Quality of Life," "Essential Services," "Employment Opportunities," and "Energy Sector Security and Resilience."

To help CIF identify the DIs that are the most relevant for its programs, as well as those that would lend themselves well to further research and tools development, the entire CIF investment portfolio of 249 projects was reviewed[1] to locate all documented references at the project level to the list of 62 DIs. As Table 3 shows, a range of DI subcategories and cross-cutting dimensions are frequently referenced in more than 50 percent of investments across the four CIF programs, and all 11 subcategories are mentioned in CIF investments. Market development DIs are most often referenced in CTF and SREP investments, while gender-related impacts, benefits to local stakeholders, and environmental DIs are most frequently mentioned in FIP and PPCR investments.

TABLE 3. Mapping of CIF Programs to DI Subcategories

DI SUBCATEGORY	CTF (N=93)	SREP (N=40)	FIP (N=43)	PPCR (N=73)
1. Livelihoods and wealth	49%	18%	65%	40%
2. Health and safety	17%	35%	0%	41%
3. Essential services	51%	88%	5%	36%
4. Employment opportunities	62%	60%	26%	8%
5. Economic value added (Gross Domestic Product [GDP])	43%	30%	65%	14%
6. Natural resources	3%	3%	0%	22%
7. Ecosystem and biodiversity	16%	5%	30%	10%
8. Soils and crop productivity	1%	3%	56%	41%
9. Competitiveness and industrial development	66%	88%	9%	14%
10. Energy sector security and resilience	59%	80%	7%	8%
11. Inclusiveness and energy justice	35%	65%	42%	18%
Gender inclusion / impacts on women	25%	73%	44%	70%
Local stakeholders' inclusion / impacts	0%	0%	56%	60%

Legend: Percent of projects that mentioned one or more DIs in this subcategory.	50–100%	25–49%	1–24%

The DI taxonomy provides a baseline reference for the range of DIs that could be realized through climate finance activities, but it does not explain how the DIs may be realized. The impact pathways developed for this evaluation help illustrate how climate investments can lead to different DIs. The two diagrams below illustrate the impact pathways for two CIF projects — one in utility-scale energy and another in sustainable forestry. Figure 1 illustrates how investments in utility-scale wind projects can lead to increased wind market activity and development, thereby producing DIs such as employment opportunities and local and regional economic benefits. Similarly, Figure 2 illustrates that investment in sustainable or resilient land management can protect crops and boost or diversify livelihoods, resulting in DIs such as increased women's participation, reduced deforestation, and improved access to essential services.

FIGURE 2. Illustrative Impact Pathway — Utility-Scale Renewable Energy Generation

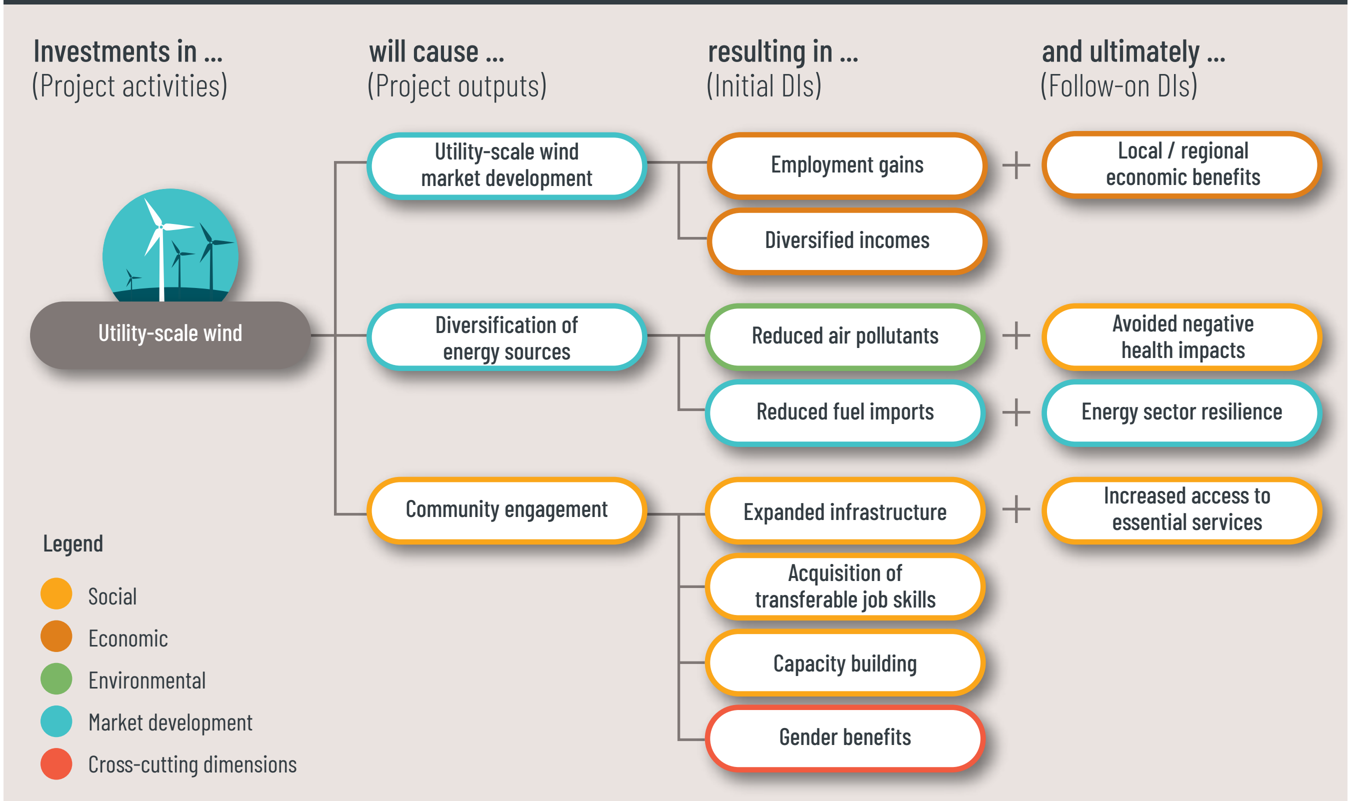
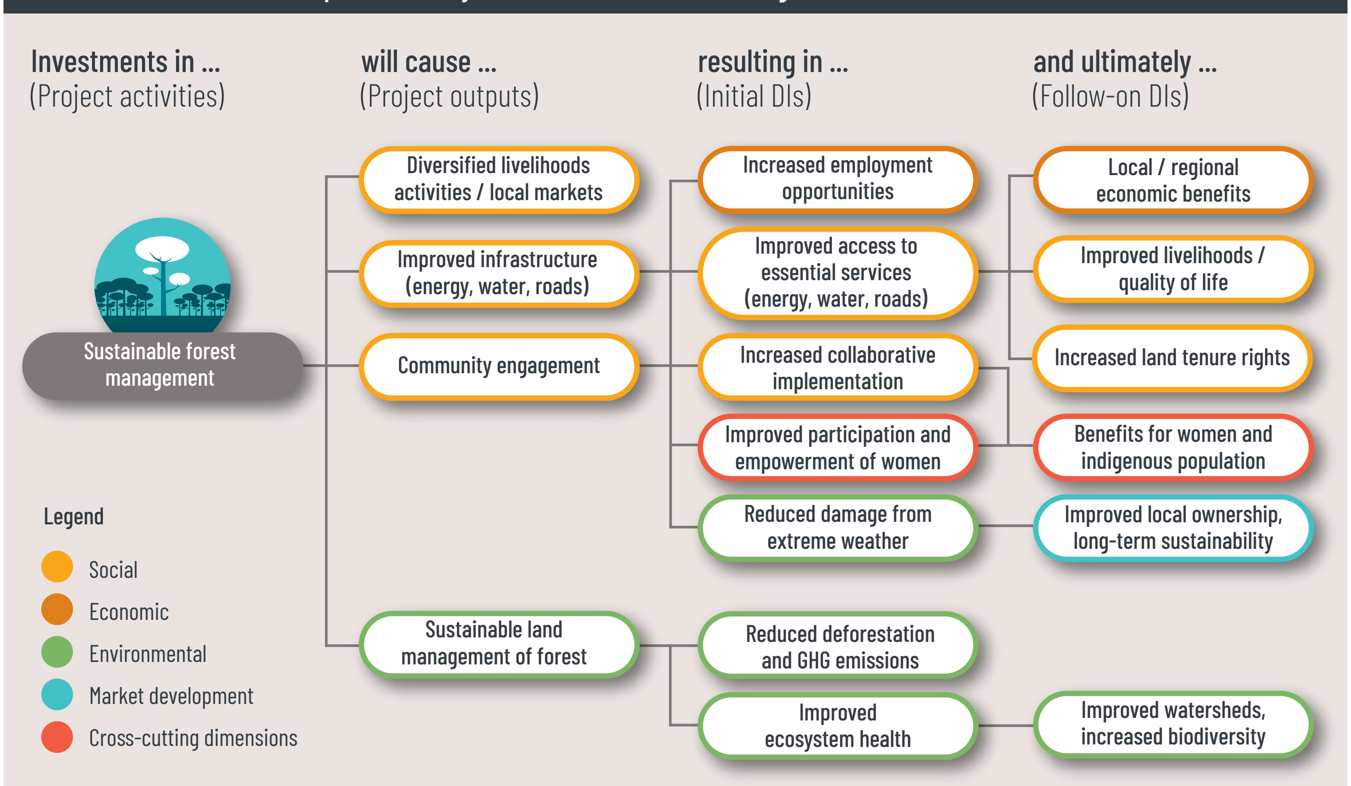


FIGURE 3. Illustrative Impact Pathway — Sustainable Forest Management



Generalized impact pathways for programs and investments in energy, forestry, and resilience, and specific impact pathways for all 13 cases are available in the case studies report. While the impact pathways were developed for CIF programs, they could be broadly applied to other climate finance portfolios that focus on similar sectors/interventions. It should be noted that the impact pathways do not address distributional impacts (e.g., within impacted groups, which subpopulations benefit the most or are at highest risk) or the net impacts of interventions (i.e., benefits minus costs).

Another framework often used to align project milestones and indicators are the Sustainable Development Goals (SDGs). Climate finance DIs are well-aligned with SDG indicators, but they may be more specific than SDG indicators or measure a broader outcome or impact. Climate finance practitioners with specific interest in their contributions to SDGs can use the DI taxonomy and impact pathways to assess the overlaps and the potential alignment. See the evaluation report for a comparison of SDGs and common climate finance DIs.

3. EVALUATION RESULTS

At both the portfolio level and project level, CIF has achieved key DI results that span all four categories of impacts, including key results in more than 20 different DIs across the 13 case studies. A combination of portfolio-level modeling, qualitative and quantitative secondary and primary case study research, and project-level DI analysis / modeling was used to assess the key DI results of the CIF portfolio.

3.1. Results — portfolio level

To estimate the economic DI contributions of CIF's investments, such as economic value added and jobs supported, CIF conducted a portfolio-level assessment using the Joint Impact Model (JIM). The 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, along with the benefits and limitations of I-O modeling approaches, is provided in the Appendix B of the evaluation report.

The economic modeling performed shows that CIF investments are expected to contribute substantially to employment and to add tens of billions of dollars in economic value to local economies throughout the lifetime of projects. Estimated impact contributions include:

- **Direct impacts** of USD25 billion in economic value added by investment projects and their clients
- **Indirect impacts** including 2.1 million annual short-term jobs ("person-years of employment"[2]) and USD20.6 billion in economic value added through project supply chains
- **Induced impacts** of 1.6 million annual short-term jobs ("person-years of employment") generated by spending of wages generated in direct or indirect project activities
- **Energy-enabled impacts** of 637,000 annually recurring jobs[3] and USD4.3 billion in annual recurring economic value added from increased economic output due to increased power generation

TABLE 4. Portfolio-Level Economic Impacts of CIF – JIM Modeling Results

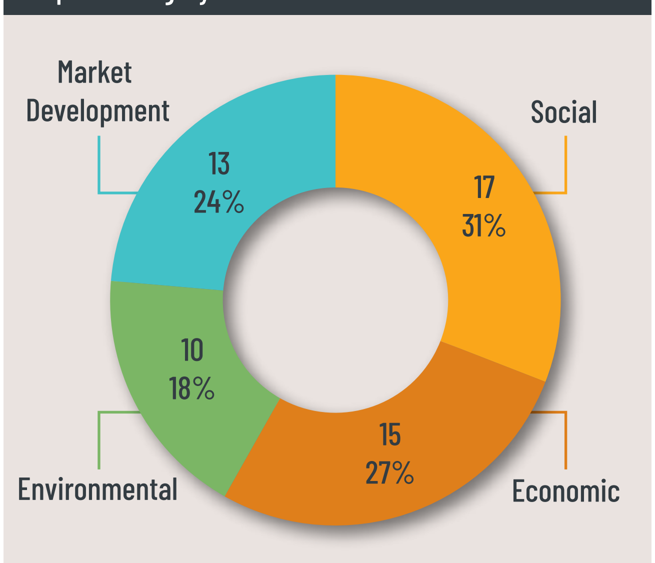
DI MODELED, USING JIM	TOTAL, CIF	CTF	SREP	PPCR	FIP	PROJECT PHASE	UNIT
Employment — Supply chain	**2,184,415**	1,753,036	122,632	164,533	144,214	Construction	No. of person-years
Employment — Induced	**1,617,899**	1,336,172	60,643	122,931	98,153	Construction	No. of person-years
Employment — Energy-enabled	**637,541**	494,860	142,681	n/a	n/a	Operations & maintenance	No. of recurring jobs
Economic value added — Direct	**$25.08**	$20.85	$1.48	$1.85	$0.90	Construction	USD billions (total value)
Economic value added — Supply chain	**$20.64**	$19.05	$0.63	$0.61	$0.35	Construction	USD billions (total value)
Economic value added — Energy-enabled	**$4.38**	$3.93	$0.45	n/a	n/a	Operations & maintenance	USD billions (annual value)

The evaluation also provides a critical analysis of the JIM methodology in comparison with other economic modeling tools and approaches, such as computable general equilibrium (CGE) models, and suggests areas of potential improvement to further refine the portfolio-level results generated. Of note, the evaluation demonstrates, for example, that I-O models (such as the JIM) estimate the gross effects in an economy of an investment, whereas CGE models estimate net effects. This means that the results of I-O models may be higher than those of CGE models. For a deeper discussion of the differences between I-O models and CGE models, refer to the accompanying Memo on Modeling Approaches, as well as Section 4 of the evaluation report. Project-level modeling approaches are discussed in Section 4.

3.2. Results — project level

All 13 cases studies identified numerous impact pathways and DIs that could be assessed, using qualitative and quantitative research techniques or project-specific modeling. From the over 60 DIs identified in the taxonomy, the case studies identified key DI results for more than 20 different DIs — spread evenly across all four key DI categories. For a detailed list of the key DI results across the 13 case studies, including which DIs were observed in which cases, whether the DI was quantitatively measured, and whether there was a cross-cutting dimension to the DI, refer to Annex 1.

FIGURE 4. Project-Level Results by Development Impact Category



3.3. Social impacts

Improved livelihoods, capacity, and community engagement: The case studies had diverse impacts in the livelihoods subcategory, including increased / diversified income, improved tenure rights, the acquisition of transferable job skills, as well as the capacity building of local institutions, community engagement, and social inclusion, in particular.

- In Case (7) Indonesia — sustainable forestry, the creation of 10 forest management units and the promotion of new economic activities, such as ecotourism and beekeeping, resulted in improved and diversified livelihoods for farmers, fishers, and unemployed persons.
- In Case (11) Niger, climate-resilient agriculture had strong local capacity outcomes, with 38 communes incorporating climate resilience strategies and budgets into local development plans and annual investment plans.
- In Case (3) Brazil, sustainable agriculture successfully engaged women in the project, with 30 percent of the participating farms led by women. This engagement was shown to have a positive influence on project implementation.

Improved health outcomes from the avoidance of fossil fuels: Nine case studies have observed or expected health benefits due to the expanded access to essential services, the increased capacity of institutions, or the reduction of air pollutants from reduced fossil fuels, and at least four cases have quantified economic benefits from avoided negative health impacts.

- In Case (10) Morocco — utility solar, modeling results[4] show that the expansion of solar power prevented the air pollution of 1,120 tons / year of nitrogen oxides (NOx) and 4,240 tons / year of sulfur oxides (SOx). This translates into health benefits of USD6.9 million — the value of avoided morbidity and mortality from air pollution.
- In Case (5) India — rooftop and utility solar, the project resulted in USD1.36 billion of avoided health-related costs annually, mostly from reduced respiratory diseases linked to particulate matter.

3.4. Economic impacts

Employment opportunities: All 13 case studies demonstrated direct employment gains, and at least eight cases produced quantitative results on employment at various levels, such as the direct supply chain and induced employment, using different measurement and modeling approaches. Several case studies also quantified the employment impacts for women or local populations.

- In Case (2) Bangladesh — coastal agriculture, JIM modeling estimates that by 2032, nearly 25,000 jobs will be supported annually, of which 16,500 will be direct (45 percent women), 4,750 supply chain (36 percent women), and 3,750 induced (33 percent women).
- In Case (6) Indonesia, geothermal investments have created 4,800 direct jobs to date, with CGE modeling estimating that the total CIF investment (2,120 megawatts [MW]) could create 27,000 construction-phase jobs and 4,350 long-term jobs in the construction sector and geothermal operations by 2030.
- The Case (5) India rooftop and utility solar project created 9,600 direct jobs in construction and maintenance, as well as 950 indirect jobs in equipment manufacturing.

Increased earnings: Beyond employment, many projects referenced expected or actual increased earnings for project beneficiaries, including for farmers, and at least four cases provided a quantification of this DI.

- Using crop revenue modeling (AquaCrop)[5], the (2) Bangladesh coastal agriculture case estimated changes in agricultural revenue due to benefits derived from polder rehabilitation at an annual amount of USD56 million[6] by 2032 — an increase of USD90 per hectare (ha) per year.
- In the (10) Nepal off-grid biogas case, the use of waste from cattle farmers as feedstock for biogas provided an additional income of USD188 per month. It was also noted that municipalities and other biomass suppliers could also reduce waste management costs by using this technology.

- In Case (6) Indonesia — geothermal, the health benefits from the reduced reliance on fossil fuels, including coal as a primary fuel and diesel generators for backup power, were projected by using economic modeling, and they were valued at US2.2 billion.
- In Case (10) Nepal — off-grid biogas, the researchers concluded that the project reduced local air pollutants (indoor and ambient), and in turn, led to positive health impacts, especially for women, although quantitative data was not available.

Increased and improved access to electricity: The CIF case studies together demonstrated impacts on new or more reliable energy access for at least 130,000 households and businesses, as well as more than 600,000 individuals.

- The Case (6) Indonesia geothermal project will increase energy access to more than 116,000 households (or 582,000 individuals) in vulnerable communities by 2025.
- In Case (10) Nepal, off-grid biogas resulted in 275 businesses having improved energy access, and replacing diesel has made electricity more affordable, generating costs savings of 25–30 percent.
- In Case (8) Kenya — off-grid electrification, mini-grid installations will bring first-time electricity access to 13,500 individuals in remote parts of Kenya.

- In Case (3) Brazil — sustainable agriculture, participating producers using sustainable methods had an average income growth that was 2.7 times higher than the control group, as well as a 24–48 percent reduction in costs.

Economic value added: Economic modeling, including the new applications of crop revenue modeling and CGE modeling, was used to estimate the significant potential economic value added of project cases.

- In Case (2) Bangladesh — coastal agriculture, the projected USD56 million in additional agricultural revenue by 2032 will generate another USD50 million in annual value added, including increased wages (41 percent), savings or profits (56 percent), and taxes (4 percent).
- Using the CGE model, the (6) Indonesia geothermal case estimates economy-wide impacts of USD107 million annually from the additional geothermal capacity installed. There are also potential economic impacts from electrification that could total up to USD27.6 billion over a 30-year period.

3.5. Environmental impacts

Reduced air pollutants: Several renewable energy case studies had qualitative or quantitative results on the expected decrease in air pollution resulting from CIF investments.[7]

- In Case (5) India, rooftop & utility solar displaced fossil fuel energy with solar, leading to the avoidance of 14,600 tons of SO_2, 6,200 tons of NO_x, and 1,400 tons of $PM_{2.5}$ (fine particulate matter 2.5) per year.
- In Case (9) Morocco, utility solar resulted in avoided emissions of air pollutants; specifically, the plant displaced 68 gigawatt-hours (GWh) of coal, 54 GWh of gas, and 249 GWh of fuel oil.

Sustainable land use, biodiversity, productivity, and resilience: Three CIF programs (FIP, PPCR, and SREP) had cases that showed DI results related to improved conservation or sustainable land use, or increases in productivity and resilience.

- In Case (3) Brazil, sustainable agriculture resulted in over 192,000 ha of Legal Reserve and Permanent Protection Areas, the recovery of over 93,000 ha of degraded pastures, and the transition to integrated landscape management of 11,000 ha of farmland, with the expected outcome of expanding pollinator habitat.
- In Case (11) Niger climate resilient agriculture case, 312,000 rural producers (77 percent of all participants) adopted at least one sustainable land and water management (SLWM) practice.
- In Case (11) Niger climate-resilient agriculture, crop yields in project areas were consistently higher (59 percent on average) than crop yields at control sites. The crops in project areas were also more resilient to external factors, such as variability in temperature and rainfall, with an overperformance of 24 percent.

3.6. Market development impacts

Increased technology adoption, cost savings, product offerings, and market maturation: Across CIF programs, different elements of market development were included in project activities and appeared frequently in case study impact pathways, some with gender dimensions.

- The technical assistance provided in the (10) Nepal off-grid biogas case promoted the adoption of new biogas technologies and allowed producers to sell bottled biogas, organic fertilizers, and biomass feedstock, thus diversifying production channels.
- Training in the (3) Brazil sustainable agriculture case led to nearly 3,000 producers adopting recommended practices and technologies, 16 percent of whom were women.
- First-mover wind power generation projects (88.5 MW) funded by CIF in the (12) Thailand utility-scale wind case were critical to market maturation and catalyzed additional investment, resulting in 1,510 MW in wind power generation by 2020.

Expanded access to capital: CTF and SREP cases most likely played a catalytic role in developing further investor interest in specific markets or removing barriers to investments, thus increasing capital availability and / or reducing costs for further market development.

- In the (6) Indonesia geothermal case, CIF investments of USD455 million and MDB co-financing of USD1.9 billion mobilized a total of USD8.9 billion into geothermal energy.
- The (5) India rooftop & utility solar programs mobilized USD2.0 billion in co-financing and played a catalytic role in developing investors' interest in solar projects and improving financing conditions.
- The (13) Türkiye renewable energy & energy efficiency project helped remove existing barriers to investments in renewable energy systems in Türkiye and engaged with local private banks to build ongoing financing capacity for the market.

Energy security benefits through reduced imports: For energy and related markets such as fertilizer, reducing imports was observed as a key market development impact.

- The biogas produced in the (10) Nepal off-grid biogas case led to the replacement of 600,000 cylinders of imported liquefied petroleum gas (LPG) valued at more than USD5 million, while the organic fertilizer produced could also substitute up to USD34 million in fertilizer imports.

The results of the CIF's DI performance analysis to date are compelling and informative. The evaluation shows that measurement and modeling can be used to assess a wide range of DIs, which can ultimately enable investors to better capture and report the wide range of benefits from climate investments.

3.7. Measurement challenges

Measuring DIs can be challenging, but insofar as DIs are major objectives of climate investors, resources should be dedicated to measuring them effectively. Some common challenges observed in the evaluation, and possible solutions, are outlined here.

- **Missing regional or local datasets relevant to DIs:** In several case studies, local datasets –on electricity grid mix, pollution, emissions factors, etc.—were unavailable, making it more difficult to accurately estimate DIs such as reduced air pollution, health impacts, energy security, and resilience. Where available, global or similar country data can be substituted for local datasets, as was done in several of the CIF cases. Projects can also make contributions to local datasets from their own monitoring and evaluation activities.
- **Long lead times to realize some types of DIs:** Some DIs, such as those associated with recovery of natural systems, may take several years to materialize, making it more difficult to show progress on an annual basis using simple metrics. For example, in case (2) Bangladesh coastal agriculture, reduced saltwater intrusion on farms will likely gradually improve soil quality (and thus yields) over many years, but these benefits might not be fully captured in the project lifecycle.
- **Substantial measurement work or modeling requirements:** Complex DIs, such as changes in agricultural productivity or improved health from reduced pollution, often require more substantial measurement work—for example regular yield sampling from both project and control sites. In the case studies, large projects with complex planned DIs had often set up robust measurement frameworks to capture the level of detail required for DI estimates. In general, projects that aspire to achieve complex DIs will need to consider data collection and / or modeling approaches to estimate these DIs, ideally early in the project lifecycle.
- **Lack of attention to gender-disaggregated data:** In some case studies, even when project documents identified specific benefits for women, DI tracking was not always disaggregated to monitor how women were impacted. This can be resolved by ensuring that project baseline studies assess the pre-intervention situation for women

and help to identify the correct DI metrics to monitor progress on a disaggregated level.

- **Measuring attitudinal or perceptional changes requires longitudinal data:** Understanding achievement of DIs, such as increased financial and energy literacy or the adoption of sustainable agricultural practices, requires a tighter methodological approach, such as pre- and post-intervention surveys of individuals' knowledge, skills, and changes in attitudes or perceptions. Where these DIs are important, longitudinal household surveys, as was employed in Case (2) Bangladesh coastal agriculture, should be factored into project monitoring plans and costs.
- **Attribution challenges between development investments and climate resilience:** Complex linkages between investment interventions and climate resilience outcomes make attribution challenging. For example, case (3) Brazil sustainable agriculture has a long-term goal of Cerrado biome recovery and a potential short-term DI of increased crop productivity from improved ecosystem health. To assess increased crop productivity, scenario-based modeling was used (since pastureland restoration is ongoing), and the results should be interpreted as modeled relationships on only one or two factors, rather than measured evidence attributable to project interventions.
- **Weak project data collection systems, or data sharing restrictions:** Meaningful monitoring and evaluation activities depend on robust data systems at the project and / or partner level. The evaluation found that in some cases, certain types of basic project data were omitted from data collection systems, such as the number of participants, land area covered, or employment figures. Data sharing restrictions impacted case ((13) Türkiye renewable energy and energy efficiency), where non-disclosure agreements between partner banks and their customers prevented the collection of data on project-finance investments. During project design, a review of priority DIs and their associated data collection requirements with all stakeholders can help to align systems and partners with the project's DI objectives.

Unintended impacts are DIs (positive or negative) that were not anticipated by projects, as well as unexpected circumstances that influenced DI results. There are opportunities to improve in both areas.

An assessment of **unintended positive impacts**, also called unanticipated impacts, found that overall, project plans and DI results in the case studies were well-aligned. The most common unintended, and thus unmeasured, positive DIs were economic, especially economic value added and employment gains. This includes the gender dimension of employment, which as noted above, was not often tracked. Usually, these unintended positive DIs stem from other anticipated / intended DIs, which means that projects that take an impact pathway / theory of change approach to project design would be more likely to anticipate and track these important economic DIs. Other identified, but unmeasured, DIs included market access, regional economic benefits, the protection of critical habitats, and energy security (details available in the evaluation report).

Unintended negative impacts also occurred in some projects. In two cases, involuntary resettlement was needed, and the projects took steps to address this negative impact in line with the MDBs' environmental and social frameworks, for example, by providing compensation and involving communities, women, and vulnerable groups in negotiations. Precautions were also taken to minimize impacts on physical and cultural resources, and most impacts were expected to be temporary. However, the evaluators were not able to speak directly to those impacted by the resettlement, and hence, further research will be required to draw firsthand conclusions on the impacts of the project and mitigation strategies.

The evaluation also assessed "unexpected influences" on DIs, these are external or internal factors that influence DI results. The findings from this assessment closely align with the drivers and constraints outlined in Section 5 of this brief.

4. DEVELOPMENT IMPACT MODELING TOOLS

The direct measurement of DIs is not always feasible for climate investors such as CIF due to program structures or other measurement challenges (see Section 3). For this reason, a comparative assessment and testing of alternative modeling tools formed part of the evaluation and identified several options that are fit-for-purpose for estimating DIs in climate finance. CIF has identified **four priority use-cases of modeling development impacts of climate finance** for climate investors and project implementers, at several stages of the project lifecycle:

1. **Refinement of investment plans and project design:** better diagnostics, ex-ante estimations, or scenario analysis to ground planning in evidence and refine designs for enhanced DI results;

2. **Knowledge-based collaboration with partners:** provision of new tools and insights to facilitate discussions with partners, such as MDBs, national governments, and donor governments;

3. **Assessment of tradeoffs between investments:** allowance of a more holistic view of potential DI benefits or negative impacts of a range of investment opportunities for more informed decision-making; as well as

4. **Ex-post evaluation of climate finance DIs:** application of tools during and after project implementation to gain insights into DI performance and / or adapt ongoing projects as needed.

Given that all DIs could not be assessed for new tools, a subset of 14 priority DIs was selected to assess their modeling potential, based on the results frameworks of CIF's four original programs (CTF, SREP, FIP, and PPCR) and those of three new programs (Accelerating Coal Transition [ACT]; Nature, People, and Climate [NPC]; and Renewable Energy Integration [REI]), as well as the portfolio-level DI characterization already completed. Table 5 shows the priority DIs selected for further tools analysis.

TABLE 5. Subset of Priority DIs Assessed for Modeling Potential

PRIORITY DIS ASSESSED FOR MODELING POTENTIAL
Increased or diversified income
Increased abilities to cope with shocks;* Reduced losses from climate events*
Avoided health impacts from reduced fossil fuels*
Increase in employment (direct / indirect / induced) Increase in employment (energy-enabled) Increase in high quality employment
Increase in economic output (direct / indirect / induced) Increase in economic output (energy-enabled)*
Reduced air pollutants / Improved air quality*
Increased agricultural productivity*
Improved energy sector integration Increased local energy generation
Increased supply chain / small and medium-sized enterprise (SME) development

*DIs prioritized for testing modeling suitability in case studies

These 14 priority DIs were then assessed for their relevance for modeling against five different criteria: 1) whether modeling approaches exist in literature; 2) the level of complexity of the approaches (six levels); 3) the spatial scale of available modeling; 4) the timeframe over which the DI could be modeled; and 5) whether public or private modeling tools exist.[8] The outcome of the assessment pointed to **three grouped categories of DIs that warranted deeper research into potential modeling tools** applicable to CIF's use-cases:

1. **Improved air quality and the resulting health impacts,** often assessed together in models;
2. **Increased climate resilience in agriculture,** including reduced losses or increased productivity, or biodiversity impacts on agriculture; and
3. **Increased economic value added / output,** especially from additional energy generation.

For each of the three categories, the researchers conducted a comparative scoping of potential modeling tools, and then applied one or more of the tools to a deep-dive case study. See Table 6 for a summary of the models reviewed and selected for testing during the evaluation.

TABLE 6. Assessment and Testing of Modeling Approaches for Three Priority DI Groupings

PRIORITY DI GROUPING	IMPROVING AIR QUALITY AND RESULTING HEALTH BENEFITS	INCREASED YIELDS / CLIMATE RESILIENCE IN AGRICULTURE	INCREASED YIELDS / CLIMATE RESILIENCE IN AGRICULTURE	CHANGES IN ECONOMIC OUTPUT RESULTING FROM ENERGY INVESTMENTS
DI grouping	1	2	2	3
Models reviewed	GEOS-Chem, LEAP-IBC, BenMap, Air Q+, COBRA, and FASST	DSSAT, AquaCrop, EPIC, WEAP, APSIM, CropSyst, HERMES, and InVEST	DSSAT, AquaCrop, EPIC, WEAP, APSIM, CropSyst, HERMES, and InVEST	Input-output and CGE models, such as GCAM, JIM, EPPA, GTAP, and ENVISAGE
Models applied in cases	LEAP-IBC applied to (12) Thailand utility wind project	AquaCrop applied to (2) Bangladesh coastal agriculture	InVEST applied to (4) Brazil sustainable agriculture	GTAP-calibrated CGE model and JIM applied to (6) Indonesia geothermal
Model description	LEAP is a scenario-based modeling tool for energy policy analyses and climate change mitigation assessments. LEAP-IBC (Integrated Benefits Calculator) enables the analysis of energy-related emissions and the resulting health impacts.	Crop growth model that quantifies biomass, crop production, and performance indicators in response to changes in water supply	Calculates the effects of land cover conversion on pollinator abundance (in terms of changes of an index value) and potential changes in crop yield (also based on an index value)	CGE models capture all income and expenditures in an economy based on a social accounting matrix (SAM). They include supply and capacity constraints, a change in production structure coefficients, and other features. I-O models also use a SAM, but without the additional features of CGE models.
Applicable investor use cases	1 (Refinement of investment plans and project design), 2 (Knowledge-based collaboration with partners), 3 (Assessment of tradeoffs between investments), 4 (Ex-post evaluation of climate finance DIs)	1 , 2, 3, 4	1, 2, 3, 4	1, 2, 3, 4
Modeled DIs	Estimate health benefits from increasing the share of wind power in Thailand	Increased earnings from the benefits of polder investments in three areas of agricultural performance and resilience: storm surge protection, tidal flooding protection, and the Rabi season cropping intensity growth	Map and qualitatively describe changes in the pollinator abundance on pollinator-dependent crops (soybean and coffee), resulting from the potential nearby pasture restoration.	Economy-wide impacts of increased geothermal power capacity, assessed through three impact channels: increased electrification, the education and labor productivity benefits of increased electrification, and air pollution health impacts.
Scenarios modeled	Three scenarios in 2030: 1) ambitious renewables; 2) goal-meeting renewables; and 3) project-based (2 CIF projects)	Two scenarios of farmer revenues in 2025 and 2035: 1) counterfactual / baseline scenario without polder rehabilitation; 2) polder rehabilitation scenario with reduced storm surges / tidal flooding	Comparison of relative pollinator abundance before ("baseline") and after ("restoration") the project's pastureland restoration activities	Alternative technology, policy, and geothermal scenarios in 2030 and 2045
Quantified DI metrics	Changes in the emissions of PM2.5, NOx, BC, and OC, along with associated health impacts; value of statistical life (VSL) used to estimate the economic benefits of avoided deaths	Changes in farmer revenues as a result of the polder investments above	Pollinator abundance; no. of ha / percentage of agricultural land within a pollinator's maximum flight distance	Changes to the economic value added (GDP), as a result of changes in the GHG emissions, changes in labor in the electricity sector, and the changes to the electricity grid mix

Overall, the comparative assessment and testing conclude that several of the modeling tools are fit-for-purpose for estimating DIs in climate finance, and their usage could be further tested and expanded by CIF and other stakeholders. In each case, models often assessed more than one DI, so the DIs were grouped according to their ability to be modeled together using the same tool.

1 For priority DI grouping — **air quality and resulting health benefits:**

- The **LEAP-IBC model** allowed for relatively straightforward analysis of energy-related emissions and resulting health impacts, and showed significant potential for broader applications for CIF and other climate investors interested in understanding the health benefits of renewable energy investments.

2 For priority DI grouping — **increased yields / climate resilience in agriculture:**

- The **AquaCrop model** worked well to model the revenue benefits of agriculture resilience investments. In the (2) Bangladesh coastal agriculture case, the project's large size meant that significant benefits were identified that were not previously estimated. Robust project documentation and data provided by the lead MDB (World Bank) and the government's contractor were extremely valuable for the modeling work, thus underscoring the importance of robust baseline and monitoring data.
- The **InVEST model** demonstrates that pastureland restoration increases pollinator abundance and that these benefits improve agricultural productivity in neighboring crop fields, as well as produces a map of relative pollinator abundance before and after the restoration activities. Collecting field data about the baseline crop species' yield, along with information on the relationship between crop species' yield and pollinator abundance, would allow for a more sophisticated analysis using InVEST.

3 For priority DI grouping — **changes in economic output from energy investments:**

- **CGE modeling** is an effective way to estimate the sizable impacts of energy investments on GDP. Furthermore, it can disaggregate the impacts amongst the different impact channels / pathways: for example, in this case, the largest DI contribution was from expanded electrification, and future investments could consider this finding.
- In comparing the **CGE model** and **JIM model** results, the models performed similarly on employment and GHG, with recognized caveats: whereas the CGE model was able to estimate the net economic impacts, the JIM (an I-O model) could only model gross economic impacts, which were 10 times higher than the CGE results.
- The **CGE model** also estimated the economic impacts of health and electrification, which were significant; JIM does not model these impacts. However, the tradeoff between model complexity / investor capacity and granularity / confidence levels of results needs to be considered when selecting economic models; CGE models are more intensive to deploy.

The research shows that depending on the sector, project or program scope, and interventions, there are a variety of tools and resources that could be deployed to estimate the DIs of climate finance. CIF could consider further work to refine the capabilities of tools, for example, through additional analysis to quantify the electrification benefits of new renewable power projects, or improve localized data on the education rates of return benefits and air pollution / health effects.[9] The distributional analysis of the impacts — for example, on income strata or rural / urban groups — could also be added to the modeling, using expenditure surveys. The complete comparative analysis of all the tools reviewed is available in the Memo on Modeling Approaches to Measure Development Impacts, and the deep-dive tool application results are available in the case studies report.

5. DRIVERS AND CONSTRAINTS

The evaluation has generated key insights into the drivers and constraints related to the maximization of DI results and a suite of recommendations to help maximize DI results and achievements in the three operational areas of climate finance: standards and inclusion, innovation and scaleups, and increased DI intelligence.

Progress toward achieving DIs through climate finance is facilitated or impeded by drivers and constraints at different levels of the project's implementation and impact pathway. The evaluation identifies six main types of drivers and constraints, Table 7 defines these and provides an example of each.

TABLE 7. Drivers and Constraints Affecting Development Impact Results

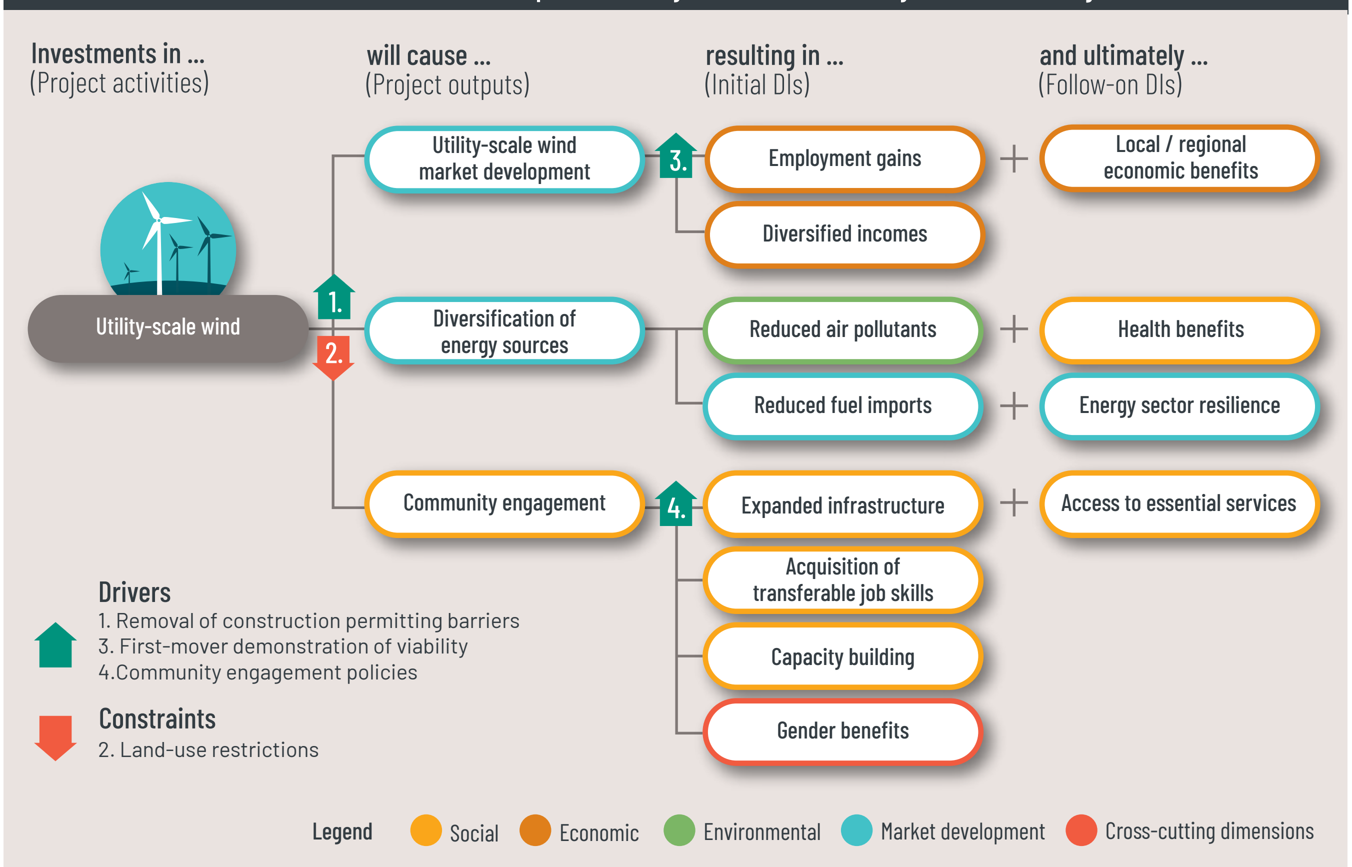
DRIVER / CONSTRAINT TYPE	DESCRIPTION	EXAMPLE
Institutional	Government support, regulations, and policy framework	Constraint: Regulatory barriers preventing wind turbine construction
Financial	Availability and adequacy of financing	Constraint: Perception of high risk, preventing investors from financing activities in the geothermal sector
Built capacity and workforce development	Capacity of government institutions, local organizations, and local workforces	Driver: Capacity building for local technicians / firms on new rooftop solar technologies
Technical and infrastructure	Technology and infrastructure use or access	Constraint: Limitations in power grid function
Community engagement and social inclusion	Engagement and inclusion of specific communities and vulnerable groups (for example, women)	Driver: Meaningful community participation and / or benefits
Programmatic management	Project / investment planning and management, including program / project design	Driver: Adequate data collection capacity to monitor DI objectives

Because successful project design, implementation, and scale-ups are necessary (though not always sufficient) for achieving DIs, drivers and constraints were identified as important influences on the achievement and magnitude of DIs across case studies. To illustrate, Figure 5 shows how drivers and constraints affected the DI pathways for the (12) Thailand utility-scale wind case study.

- **Driver** (green arrow): Regulatory barriers in Thailand prevented the construction of wind turbines, and thus, the achievement of any resulting DIs, but the project's coordination with the government was a key driver in the removal of permitting requirements.
- **Constraint** (red arrow): The uncertainty about restrictions on the ability of wind facilities to lease land designated for agricultural purposes was and remains a barrier to the construction of wind facilities and the realization of resulting DIs.

The placement of drivers and constraints along the impact pathway is important: the closer the driver or constraint is to the left or beginning of the impact pathway, the more important it will be to the realization of the project objectives and thus DI achievements. Some drivers and constraints operate at a higher systemic level and require programmatic efforts to address (such as the regulatory barriers in the Thailand case), while others relate to activities and operating environments and are more directly accessible by project interventions. The case studies catalogue 40 drivers and 50 constraints; the full details are available in Annex A of the evaluation report.

FIGURE 5. Drivers and Constraints in the Impact Pathway for Thailand's Utility-Scale Wind Project



The analysis of drivers and constraints across the CIF case studies has illuminated important design considerations and lessons on how to more effectively convert potential DIs into realized DIs:

- **DI drivers and constraints require intentional and early considerations in project design and implementation.** As can be seen in the Thailand utility-scale wind case and others, if drivers and constraints appear in the early stages of impact pathways, proper attention in the planning stages will have a strong influence on the achievement of the DIs that follow.
- **Institutional drivers and constraints play a key role in DI realization, regardless of secto**r. Institutional drivers — whether involving the government or the private sector, regulatory frameworks, or others —were observed in 10 of 13 case studies. Projects that successfully aligned the interests of the government, the private sector, and local stakeholders (such as the Thailand utility-scale wind case) were able to unlock higher DIs, through increased relevance, responsiveness, and buy-in.
- **Using innovative climate finance structures can overcome constraints associated with technical or financial elements of risk perception and drive enhanced economic DI results.** Climate finance models that incorporate concessional / innovative structures and help to de-risk a market for private investment or demonstrate business model viability were identified as key drivers of economic DI results in several case studies. These models facilitated future market expansion beyond CIF's involvement, thus scaling the DI achievements.
- **Social inclusion and meaningful community engagement are both first-order DIs and key drivers that help ensure that other economic and social DIs are achieved and equitably distributed.** Where local norms may discourage the participation of certain groups, an even more careful contextual analysis of these types of constraints may be needed. For example, in Case (3) Brazil sustainable agriculture, local implementers were able to navigate constraints associated with conservative farming communities to achieve good rates of technology adoption and a range of impacts. While the project did not initially include a focus on inclusion, following a midterm review it incorporated women's empowerment objectives and activities, which in addition to increasing the economic wellbeing of women, also had a positive influence on the speed of implementation, thereby accelerating the achievement of additional DIs.
- **Capacity-related activities and outcomes are key drivers of a variety of DIs, including competitiveness and industrial development, employment, and earnings.** Capacity constraints impacted 10 of the 13 case studies. Technical assistance, training, and capacity building to facilitate local workforce participation are key drivers of employment gains, the development of local supply chains, and increased / diversified income in several case studies. Capacity building is often a key requisite to achieving these distributed impacts—meaning impacts that affect vulnerable or traditionally excluded groups; thus, it needs to be factored into project budgets and funding plans.
- **Adequate technology and physical infrastructure can be an important driver of DIs, while their absence can be a constraint.** Technical constraints were identified in five of 13 case studies, such as power grid limitations in India and Bangladesh; however, in some instances, these constraints may have been beyond the scope of the projects to address. The introduction of new technologies can also be undermined by unexpected performance issues (as in Case (2) Bangladesh coastal agriculture) or it can have an unplanned influence on other DIs, such as lowering employment numbers due to increases in productivity, thus resulting in less employment creation than may have been anticipated.

6. INSIGHTS AND RECOMMENDATIONS

The case study approach generated a wealth of insights into how a variety of factors, such as project design, implementation approaches, management systems, as well as drivers and constraints, could contribute to DI results. The over-a-dozen key insights and practical recommendations generated can be grouped under three key DI insights areas: **standards and inclusion, innovation and scaleups, and DI intelligence**. The recommendations are summarized in Table 8 and discussed below; moreover, they are also tagged to a relevant stakeholder group and program / project stage for reference.

TABLE 8. Insights and Recommendations for Maximizing DI Results of Climate Finance

	IF CLIMATE FINANCE STAKEHOLDERS WISH TO:	THEY SHOULD:	RELEVANT FOR	RELEVANT AT STAGE
Maximize development impacts via standards & inclusion	Support the design of interventions and plans that maximize DI contributions	Create standardized theories of change / impact pathways by investment area / sector that identify priority DIs and key DI metrics	Investors Programs	Strategy, Design
	Engage a range of stakeholders, including host country governments and external funders, and align on local priorities	Start from a common DI foundation — grounded in evidence — to identify drivers and constraints, and incorporate into planning	Programs Projects	Design
	Prioritize and support a focus on Super DIs (e.g., capacity building, community engagement, etc.) that will, in turn, influence follow-on DI results	Ensure that projects plan budgets and resources wisely to ensure that Super DIs receive adequate support, especially in the early stages of project implementation	Investors Programs	Strategy, Design
	Strengthen DI results at the local community level	Build meaningful community engagement strategies into project design, implementation, and monitoring and evaluation	Projects	Design, Implementation, Monitoring, Evaluation
		Ensure intentional site selection that considers DI trade-offs	Projects	Design
		Provide capacity building to support community participation	Projects	Design, Implementation
	Increase the participation of women and other vulnerable stakeholders, and/or their distributed shares of corresponding DI results	Deploy inclusive, gender-responsive project design, baselines, and monitoring plans, including quantitative and qualitative gender indicators	Projects	Design, Implementation, Monitoring
		Assess potential risks and take steps to minimize the negative impacts on women or vulnerable groups	Projects	Design, Monitoring
Maximize development impacts via innovation & scaleups	Support learning and adaptive management and / or establish robust cases for sustaining, expanding, and scaling new or successful programs and projects	Support first-mover projects to demonstrate the business case for new / risky technologies, products and practices, especially through blended finance	Investors Programs	Strategy, Design
		Apply rigorous assessment/ measurement methods during new or pilot initiatives, and dedicate adequate resources to these	Investors Programs Projects	Design, Monitoring
	Increase the adoption of clean technologies and sustainable practices that lead to DIs	Support innovative financing structures that are paired with outreach and capacity building	Programs Projects	Design, Implementation

	IF CLIMATE FINANCE STAKEHOLDERS WISH TO:	THEY SHOULD:	RELEVANT FOR	RELEVANT AT STAGE
Maximize development impacts via DI intelligence	Enhance the quality and credibility of research and assessment methods, or build capacity for ongoing monitoring and analysis	Establish partnerships with local statistical and monitoring institutions, including governmental and academic organizations	Programs Projects	Design, Implementation, Monitoring, Evaluation
	Improve the measurement of and reporting on social DIs (food security, livelihoods, and quality of life) to better inform agricultural productivity and climate resilience initiatives	Dedicate resources to test and deploy alternative methods (e.g., longitudinal household surveys) to measure important social DIs (food security, livelihoods, and quality of life)	Programs Projects	Design, Implementation, Monitoring, Evaluation
	Improve the ability to report the secondary DIs of energy investments, such as air quality and health impacts	Track and report actual clean energy production and the reduced use of conventional energy sources in renewable energy projects	Programs Projects	Design, Monitoring, Evaluation
	Strengthen the business case for projects that provide ecosystem benefits and follow-on economic impacts	Ensure that project data systems track relevant field data (e.g., crop species yields), including baselines, to support the modeling of biodiversity and follow-on economic impacts	Programs Projects	Design, Monitoring, Evaluation
	Gain broader and deeper insights into DI results that cannot be measured for more informed investment decisions, stakeholder engagement, or monitoring and reporting	Deploy more sophisticated tools such as modeling, especially for large projects or programs that have significant potential to generate DIs and / or meaningful learning about DIs	Programs Projects	Design, Monitoring, Evaluation

6.1. Maximize development impacts via common design standards and a focus on inclusion

1 **The most effective projects incorporate DIs intentionally and early, starting with project design and planning.** Converting *potential* DIs into *realized* DIs requires intentional project design and implementation, starting in the early stages. If investors design a climate intervention and then add DI objectives, they may not achieve the most important DIs or reach the groups that would benefit most. More effective is a “backcasting” approach whereby investors first identify the most important DIs through diagnostic work and investment planning, based on contextual profiling, for example. Then, they can use these insights to determine what energy / adaptation / climate response would meet those development needs, and thus ensure that interventions, monitoring frameworks, and reporting will also support the DI objectives.

2 **Starting from a common DI foundation, grounded on evidence, can help to align climate finance stakeholders.** While each climate investor may prioritize a different set of impacts, the climate finance DI taxonomy and impact pathways provide a useful foundation to help a diverse set of stakeholders to articulate and map their DI objectives. It also provides a common language for stakeholder engagement and collaboration, as the impact pathways can be used to identify the drivers needed to achieve DIs, particularly those that have been identified as local priorities.

3 **Prioritizing vulnerable groups, including women, can enhance DIs, distribute DI benefits more equitably, and amplify climate investment effectiveness.** The case studies highlight the benefits of prioritizing women and vulnerable groups in stakeholder consultations, and fully including them in interventions, not only as "beneficiaries," but also as employees, business owners, decision-makers, community leaders / members, and occupants of other important roles. Beyond the resulting gender and social inclusion benefits, the cases show that project strategies for improving the participation and empowerment of these groups can enhance DIs more broadly and directly lead to other DIs, such as increased earnings and improved quality of life.

4 **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 a lack of agency, which could impact performance — both on climate objectives and DIs. It can also highlight any potential risks or unintended negative impacts for vulnerable groups.

5 **Creative community engagement strategies can help 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, as well as responsive monitoring and evaluation, to ensure strong engagement and the localization of DI benefits. For projects with supply chain aspects, including local content or employment requirements was also a way to localize DI benefits.

6.2. Maximize development impacts via a focus on innovation and scaleup

1 **Apply rigorous assessment methods during pilot initiatives to ensure a robust and credible analysis to support a scaleup.** In Case (11) Niger climate-resilient agriculture, the project used annual sampling and comparisons of crop and forage yields in treated and control sites with similar characteristics, as well as actively engaged national statistical and environmental monitoring institutions, to ensure transparency, accountability, and country ownership. Robust assessment methods during pilots can support learning and adaptive management, and establish credible cases for expanding, adapting, or scaling new / unproven programs and projects.

2 **To increase the 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 project finance 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 (for example, for financial

institutions offering innovative financial products for the first time) and outreach / awareness activities (for example, for potential borrowers / early adopters) is crucial for expanding market adoption and the realization of DIs.

3 **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 Case (12) Thailand utility-scale wind and Case (4) Brazil macaúba value chain; this is a finding that is consistent with other evaluations. The demonstration of a viable business case helps to encourage early adopters and replication by other businesses; its intent is to lead to the mass commercialization of new technologies and value chains, which leads to the multiplication of DI benefits, even beyond the original investment.

6.3. Maximize development impacts via enhanced DI intelligence approaches

1 **The effect of DIs is greater than the sum of the parts and should be analyzed synergistically, especially to maximize the benefits of "Super DIs."** The evaluation shows that DIs can be mutually reinforcing and act synergistically, therefore producing greater benefits together than they could individually. Certain DIs — such as elements of market development, built capacity, social / gender inclusion, and local workforce development — are catalytic: they are "Super DIs" that influence the achievement of other DIs; therefore, they require careful attention during project planning and implementation (see below for further Super DI strategies).

2 **Establish partnerships with local statistical and monitoring institutions to build credibility and capacity.** Projects that struck partnerships with government institutions, local academic institutions, or multilateral organizations were able to enhance the quality and credibility of research and assessment methods, strengthen the commitment of diverse partners to the program, and build capacity for ongoing monitoring and analysis.

3 **For energy projects, ensure the tracking of clean energy production and reduced use of conventional energy sources to assess follow-on DIs, such as air quality and health impacts.** Analytic techniques, such as the application of emissions factors (such as the International Energy Association (IEA) dataset) and grid factors, or other models as demonstrated in the cases, can allow projects to report not only emissions reductions but also important environmental and social DIs.

4 **Incorporate quantitative and qualitative indicators of gender- and inclusion-related impacts to enhance DI achievements.** In several of the cases, it was challenging to measure gender-specific impacts due to a lack of data. This can be avoided by incorporating a gender / inclusion lens throughout the diagnostic, action plan, intervention, and monitoring stages of the project to ensure that the appropriate budget, staff, and monitoring frameworks are in place. Ensuring that DI metrics, such as local ownership, empowerment and benefits distribution, are included in monitoring frameworks can help focus implementation efforts on social inclusion impacts

5 **Employ alternative methods, such as household surveys, to measure important social DIs, such as food security, livelihoods, and quality of life.** In several cases, social DIs, such as food security, were identified as important, but they could not be assessed due to a lack of information. Robust methods, such as household surveys, are especially useful for informing broader agricultural productivity and climate resilience initiatives. If control and treatment group approaches to measure changes in household level outcomes are used, project designers should be careful not to create disincentives to participation, as inadvertently happened in Case (3) Brazil sustainable agriculture where farmers were reluctant to participate due to the possibility of being assigned to the control group.

6 **Promising modeling approaches can be used strategically by climate finance investors to estimate hard-to-observe DIs, especially in the case of large projects or programs with significant DI potential.** 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 tradeoffs 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.

ANNEX 1: RESULTS FROM CASE STUDIES

Development Impacts Results in CIF Case Studies

DEVELOPMENT IMPACTS	CASE STUDIES	QUANTIFIED DI(S)	CC DIMENSION(S)
Increased or diversified livelihoods	7. Indonesia sustainable forestry (FIP)	No	Vulnerable groups
Capacity building of local institutions	10. Nepal off-grid biogas (SREP)	Yes	Built capacity
	11. Niger climate resilient agriculture (PPCR)	No	
Recognition of tenure rights	7. Indonesia sustainable forestry (FIP)	No	Vulnerable groups
Acquisition of transferable job skills	3. Brazil sustainable agriculture (FIP)	Yes	Gender
Community engagement / social inclusion	3. Brazil sustainable agriculture (FIP)	Yes	Gender Built capacity
	7. Indonesia sustainable forestry (FIP)	Yes	Vulnerable groups Built capacity
	11. Niger climate-resilient agriculture (PPCR)	Yes	Gender
Increased access to electricity (businesses / households)	6. Indonesia geothermal (CTF)	Yes	Vulnerable groups
	8. Kenya off-grid electrification (SREP)	Yes	
	10. Nepal off-grid biogas (SREP)	Yes	
Decreased costs of essential services	10. Nepal off-grid biogas (SREP)	Yes	
Avoided health impacts from fossil fuels	5. Indian rooftop & utility solar (CTF)	Yes	
	6. Indonesia geothermal (CTF)	Yes	
	9. Morocco utility solar (CTF)	Yes	
	10. Nepal off-grid biogas (SREP)	No	Gender
	12. Thailand utility-scale wind (CTF)	Yes	

DEVELOPMENT IMPACTS	CASE STUDIES	QUANTIFIED DI(S)	CC DIMENSION(S)
Employment (direct and / or indirect)	1. Bangladesh rooftop solar (SREP)	Yes	
	2. Bangladesh coastal agriculture (PPCR)	Yes	
	5. Indian rooftop & utility solar (CTF)	Yes	
	6. Indonesia geothermal (CTF)	Yes	
	8. Kenya off-grid electrification (SREP)	Yes	
	9. Morocco utility solar (CTF)	Yes	Gender
	10. Nepal off-grid biogas (SREP)	Yes	
	12. Thailand utility-scale wind (CTF)	Yes	Gender
	13. Turkey RE & energy efficiency (CTF)	No	
Increased earnings	2. Bangladesh coastal agriculture (PPCR)	Yes	
	3. Brazil sustainable agriculture (FIP)	Yes	
	4. Brazil macaúba value chain (FIP)	Yes	
	10. Nepal off-grid biogas (SREP)	Yes	
Economic value added (GDP)	2. Bangladesh coastal agriculture (PPCR)	Yes	
	6. Indonesia geothermal (CTF)	Yes	
Reduced air pollutants	1. Bangladesh rooftop solar (SREP)	No	
	5. Indian rooftop & utility solar (CTF)	Yes	
	9. Morocco utility solar (CTF)	Yes	
Biodiversity impacts	3. Brazil sustainable agriculture (FIP)	No	
Sustainable land use	3. Brazil sustainable agriculture (FIP)	Yes	Gender
	4. Brazil macaúba value chain (FIP)	Yes	
	10. Nepal off-grid biogas (SREP)	Yes	
Increased agriculture productivity	2. Bangladesh coastal agriculture (PPCR)	Yes	
	3. Brazil sustainable agriculture (FIP)	Yes	
	11. Niger climate-resilient agriculture (PPCR)	Yes	
Increased technology adoption	3. Brazil sustainable agriculture (FIP)	Yes	Gender
	7. Indonesia sustainable forestry (FIP)	No	
	10. Nepal off-grid biogas (SREP)	No	Built capacity
Increased / diversified product offerings	10. Nepal off-grid biogas (SREP)	No	
Maturation of market structures	12. Thailand utility-scale wind (CTF)	Yes	
Energy cost savings	1. Bangladesh rooftop solar (SREP)	Yes	
Expanded access to capital	5. India rooftop & utility solar (CTF)	Yes	
	6. Indonesia geothermal (CTF)	Yes	
	9. Morocco utility solar (CTF)	Yes	
	10. Nepal off-grid biogas (SREP)	Yes	

DEVELOPMENT IMPACTS	CASE STUDIES	QUANTIFIED DI(S)	CC DIMENSION(S)
Improved legal / regulatory framework	13. Turkey RE & energy efficiency (CTF)	No	
Reduced fuel imports	10. Nepal off-grid biogas (SREP)	Yes	
Reduced trade imbalance	10. Nepal off-grid biogas (SREP)	Yes	
Women's empowerment / gender equality	7. Indonesia sustainable forestry (FIP)	Yes	Gender Built capacity

ANNEX 2: MODELING TOOLS TESTED

LEAP (LOW EMISSIONS ANALYSIS PLATFORM)	
Description	Developed by the Stockholm Environmental Institute (SEI), LEAP is a scenario-based modeling tool that is primarily used for energy policy analyses and climate change mitigation assessments. LEAP can act as a forecasting tool to consider energy supply and demand as well as a policy tool for considering the economic and environmental effects of various energy programs and investments. LEAP-IBC (Integrated Benefits Calculator) allows for the analysis of energy-related emissions and the resulting health impacts.
URL	https://leap.sei.org/default.asp?action=home
Complexity and Data Needs	LEAP is designed to be accessible for decision-makers and those involved in energy and climate policy. LEAP has low data requirements making it relevant for use 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, and energy supply).
In-House vs. Outsourced Use	LEAP is an open-source tool designed to be accessible for individuals with limited modeling background; therefore, in-house use by CIF 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 USD500 to USD3,000.
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 the annual energy demand until 2035 in Ecuador. https://www.econjournals.com/index.php/ijeep/article/view/6503/3784.
Use Cases for CIF	**(1) Investment plans and project design:** LEAP can 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 the energy demand, LEAP can 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 for different stakeholders, thereby promoting collaboration. **(3) Understanding trade-offs between investment opportunities:** LEAP allows for the evaluation of various interventions to improve air quality and human health. **(4) Ex-post evaluation of development impacts from climate finance:** This is demonstrated in the Thailand case study.

Outputs / Units	Depending on the model's 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. The demand and supply metrics can be displayed in almost any unit of measurement and various numeric formats (i.e., absolute values, growth rates, percentage shares, etc.).
AQUACROP	
Description	Developed by the Food and Agriculture Organization (FAO), AquaCrop is a crop growth model that quantifies biomass, crop production, and performance indicators in response to changes in the water supply specifically for herbaceous crops. There is also a MATLAB version of the tool, which is available through the University of Nebraska. It allows for much faster processing, when large geographic areas or numerous scenario runs are involved.
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 and irrigation management), and soil conditions (i.e., soil profile and groundwater conditions). AquaCrop contains data on the mean annual atmospheric CO2 and tools to compute evapotranspiration. However, other data requirements must be entered by the user. An understanding of R, Python, MATLAB, or another similar data processing programming tool would be beneficial to deploy the model.
In-House vs. Outsourced Use	AquaCrop is designed to be used by a range of practitioners outside of the scientific community. Therefore, it assumes a simplified relationship between biomass production and crop transpiration, which ultimately requires fewer data inputs compared with other models used in the scientific community. The accessibility of some data components within the model makes the 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 it 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 the 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 the crops that are the most vulnerable to changing environmental conditions. By identifying these crops, water management investments can be targeted at farming areas that will be the most impacted. **(2) Exploration and collaboration with partners:** AquaCrop results are easy to communicate and understand. It is not the most user-friendly tool; nonetheless, it is very powerful once learned. **(3) Understanding trade-offs between investment opportunities:** AquaCrop allows for the evaluation of various interventions to improve yields and thus food security. **(4) Ex-post evaluation of development impacts from climate finance:** This is 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 the volume of fertilizer application.

EMISSIONS PREDICTION AND POLICY ANALYSIS (EPPA)	
Description	Developed by the Massachusetts Institute of Technology (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, tradable permits, and technology regulation) and also model how different emissions scenarios influence atmospheric chemistry and climate change. EPPA can be run as a standalone model or in conjunction with the 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 the necessary data on production, trade flows, economic data, and emissions. EPPA then aggregates the data into 16 regions and 21 economic sectors.
In-House vs. Outsourced Use	The accessibility of the GTAP database within the EPPA model makes the 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. https://www.sciencedirect.com/science/article/pii/S0140988315001292.
Use Cases for CIF	**(1) Investment plan and project design:** It can produce ex-ante project benefits and costs for evaluating project plans. **(2) Exploration and collaboration with partners:** As macroeconomic results are understood widely, they are effective for the purpose of communication with local ministries of finance, development banks, or development partners. **(3) Understanding trade-offs 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:** 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 the gross output by sector and the output supplied to each final demand sector. These outputs can be considered in terms of energy (exajoules), emissions (tons), land use (ha), 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 rises, GHG concentrations, soil and vegetative carbon, net primary productivity, and global mean temperature, among others).

ENDNOTES

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→ 1 The review focused on three sections of implementing partner MDB project documentation: "Project Development Outcome (PDO)," "Development Impact Narrative," and "Development Impact Targets or Estimates", and coded each identified DI using the framework developed for the secondary review.

→ 2 One person-year is equivalent to 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.

→ 3 One recurring job or full-time equivalent (FTE) is equivalent to one full-time position for the full operational life of the activity, facility, or project. This unit is often used for permanent employment.

→ 4 For DI results that reference modeling, refer to Section 4 and Annex 2 for details on the modeling approaches used.

→ 5 Refer to Section 4 and Annex 2 for more information about the Aquacrop model.

→ 6 USD56 million is the mid-range scenario analyzed. The low scenario is estimated at USD39 million annually and the high scenario is estimated at USD73 million annually in increased revenue.

→ 7 The follow-on health benefits are described in the key social impacts above.

→ 8 For more information, please see the Memo on Modeling Approaches to Measure Development Impacts of Climate Finance.

→ 9 Electrification benefits are the economic returns generated from increased electrification as a result of new power generation. Education rates of return benefits are the increase in labor productivity due to increased education resulting from increased electrification. For both of these rates of return, the rates often need to be sourced from developed countries if studies do not exist for CIF's priority investment countries.

THE CLIMATE INVESTMENT FUNDS

The Climate Investment Funds (CIF) is one of the largest multilateral climate funds in the world. It was established in 2008 to mobilize finance for low-carbon, climate-resilient development at scale in developing countries. 14 contributor countries have pledged over US$10 billion to the funds. To date CIF committed capital has mobilized more than $62 billion in additional financing, particularly from the private sector, in 72 countries. CIF's large-scale, low-cost, long-term financing lowers the risk and cost of climate financing. It tests new business models, builds track records in unproven markets, and boosts investor confidence to unlock additional sources of finance.

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