Chapter 12
Unpacking the Black Box of Technology Distribution, Development Potential and Carbon Markets Benefits

Jasmine Hyman

Abstract In 2005, the international carbon market was launched under the Kyoto Protocol, creating an innovative financing design for low-emissions development initiatives. Just over 10 years after its inception, the carbon market can now provide insight on the opportunities and limitations of "blended finance" approaches, whereby private-public partnerships are employed to pursue global development goals such as poverty alleviation and development. Utilizing process-tracing and value chain methods, this chapter adds granularity to debates on whether and how carbon markets can support local economic development, as measured through the creation of local enterprises and the support of local livelihoods. It offers a "Livelihood Index" to assess the employment impact of the carbon intervention in order to address the core question: how is the carbon credit pie divvied up? Three carbon projects in Cambodia, aimed at household level interventions (water filters, biodigesters for cooking and fertilizer production, and fuel-efficient cookstoves) are evaluated through the livelihood index and results indicate that distribution strategies matter for local economic gains. Distribution strategies to deliver low-carbon technologies within the carbon market are currently a "black box", understudied and undocumented in the project pipeline; this paper argues that opening the black box may be useful for policymakers, standard setting organizations and academics interested in promoting pro-poor impacts through carbon market interventions.

Keywords Carbon markets • Waterfilters • Cookstoves • Biodigesters • Climate finance • Climate change • Market mechanisms

J. Hyman (✉)
School of Forestry & Environmental Studies, Yale University, New Haven, CT, USA
e-mail: jasmine.hyman@yale.edu

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12.1 Introduction

Efforts to provide clean cooking and water filtration facilities to the poor have been pursued in earnest by aid agencies, government ministries and the non-governmental sector for decades, though many initiatives have been stymied by inadequate and inconsistent funding, the introduction of inappropriate technologies, and a lack of follow-up (Clasen et al. 2004; Baumgartner et al. 2007; Lantagne et al. 2008).

In 2005, the international carbon market was launched under the Kyoto Protocol and the concept of "carbon finance" entered the world stage. Carbon finance marked an innovative approach to development finance in that it was designed to harness the motor of private finance to goals for the public good by awarding fungible "carbon offsets" for the delivery of development services that displaced activities that would otherwise generate greenhouse gas emissions (UNFCCC 1997). Two years later, the voluntary carbon market was launched and remained a viable channel for financing low-carbon projects even as support for the Kyoto Protocol's market mechanisms waned (Peters-Stanley 2013) The projects analysed in this chapter draw from both the Kyoto Protocol's market mechanism for developing countries, the "Clean Development Mechanism" (CDM) and the similarly structured voluntary carbon market. While the CDM and the voluntary market are both undergoing transformation as the Kyoto Protocol's implementation period draws to a close, consensus on the Paris Agreement at the 21st Conference of the Parties to the UNFCCC in December 2015 indicates that market mechanisms will continue to play a role in the upcoming climate regime. As such, lessons derived from the first generation of carbon market efforts under the Kyoto Protocol are relevant towards the design of the next generation of market-oriented climate finance tools.

Projects that aim for a high social and local development component are called "pro-poor carbon projects" (Verles and Santini 2012), "charismatic carbon projects" (Cohen 2011), "premium carbon" (The Gold Standard 2010) or "carbon with a human face" (World Bank 2002). These terms encompass carbon projects targeting the least well-off, either by introducing technological innovations to underserved households or by being physically located in Least Developed Countries where the emissions footprint is already low and investment risks are high (and therefore the incentive to invest in carbon reductions is minimal).

The majority of pro-poor projects are household-level interventions for responding to basic needs, such as fuel-efficient cook stoves, water filtration devices, and mini biodigesters that convert livestock and organic household waste into gas for cooking and household lighting. Significantly, pro-poor projects emphasize "co-benefits," or sustainable development deliverables, to the project recipients beyond offsetting emissions alone: they promise the creation of skilled job opportunities, increased household income, improved health outcomes, etc. Premium certification schemes, such as the Gold Standard for both the CDM and the voluntary carbon market, specialize in verifying that both emissions reductions and co-benefits have been achieved (though the Gold Standard does not hold a monopoly on pro-poor projects).

There is an underlying development narrative associated with pro-poor carbon projects, namely, that market-driven development tools can attract private resources into public services resulting in a win-win outcome for the environment and for the poor. The premise of the "win-win" outcome has been challenged (Simon et al. 2012) and the need to add granularity and precision to discussions on private-public partnerships is also well-established (Kwame Sundaram et al. 2016). This chapter builds upon these discussions to identify some of the conditions that might make "win-win" outcomes more likely: what kinds of elements determine the likelihood of local economic benefit when aid organizations, donor agencies, and private actors join together? Analysis reveals that the technology dissemination strategy is a significant, yet presently invisible, driver for pro-poor outcomes. Administratively, dissemination strategies are absent from project design documents; as a research topic, they are under-represented in the literature. This chapter argues that technology dissemination strategies merit more focus and attention given its bearing on livelihood outcomes for market-driven climate projects targeting the poor.

The chapter is structured as followed. A literature review on household interventions in the carbon market establishes that critiques of win-win market approaches and public-private partnership models are well documented and that there is an established need for further research on the conditions and variables that determine whether innovative financing partnerships will lead to their intended outcomes. The literature review also reviews current tools for evaluating low-emissions development projects and presents an adapted version of an evaluation tool forwarded by the Global Alliance for Clean Cookstoves. This adapted version of the tool, named the "Livelihood Index," provides a rough indicator on projects' local economic impact, specifically on a project's ability to catalyze skilled and long-term employment opportunities at the local level. The second section describes the methods of analysis and the parameters for case study selection. Next, the cases are described. The final section applies the Livelihood Index to the cases, alongside an analytical discussion as to the implications of each distribution strategy. Finally, the chapter concludes by arguing that the success or failure of a green technology to benefit its target population relates as much to the question of "how is the technology distributed?" as to "what is distributed in the first place?" The conclusion addresses areas for further research and suggests a new round of questions for a continued exploration of the conditions for designing climate finance projects that benefit the poor.

12.2 Literature Review

Carbon projects are, by definition, complicated subjects for impact evaluations. They represent dense policy experiments due to their pursuit of multiple goals, i.e. to support local sustainable development while mitigating global climate change. It follows that "project success" is a multifaceted term that can be measured in terms of avoided greenhouse gas emissions, expanded economic opportunities within the host country, improved local health outcomes or even in terms of social ideals such as increased gender equity or enhanced participation in decision making processes. The promise of "win-win" outcomes associated with environment and development projects is readily critiqued (Visseren-Hamakers et al. 2012; Mayrhofer and Gupta 2016). To add further to the conceptual tangle, the success of the project is contingent upon the household's willingness to utilize the technology, a behavioral feature that involves considerations such as cultural appropriateness (Troncoso et al. 2007; Shankar et al. 2014), intra-household dynamics (Shankar et al. 2014), and aftercare (Levine et al. 2013).

Globally, Wang et al. (2015) tracked 277 cookstoves, 134 biodigesters projects and 11 water filter projects that were either preparing for registration, registered, or issuing credits with both CDM and other voluntary standards as of June 2014 (Wang et al. 2015). Of this total, 112 projects had issued credits at least once and 222 projects were registered, with the remaining 88 projects in various stages of preparation (idem).

Given that these carbon projects have multiple goals, it is likely that evaluations for their "success" can differ greatly, depending on the goal of interest. The likelihood of unintended negative consequences resulting from a development intervention have been well documented in the general development literature (Ferguson 1994; Scott 1998) and in specific assessments of carbon credit projects. However, existing studies tend to focus on the theoretical merits and pitfalls of market-based approaches either by providing a global assessment of the market (Abadie et al. 2012; Kossoy and Guigon 2012; Climate Policy Initiative 2014; Climate Funds Update 2016) or by utilizing illustrative case studies to bolster a position on the carbon market's merits in general (Haya 2007; Bumpus and Cole 2010) or that achieving climate and development co-benefits is context dependent (Simon et al. 2012). Rather than condemn or condone carbon markets as a concept, there is a need to uncover causal mechanisms that can explain variations in development outcomes between carbon project types and designs.

12.2.1 Conceptualizing Local Economic Development Impacts for Carbon Finance Projects

There are numerous attempts in the academic and gray literature as to how one might approach evaluating the sustainable development impact of a household intervention. Household interventions which are subsidized by carbon finance are often called "charismatic carbon" "premium" or "pro-poor" projects (The Gold Standard 2010; Cohen 2011; Verles and Santini 2012) given that they directly address the development needs of the rural and urban poor and are therefore assumed to have higher sustainable development impact than projects which focus on reducing industrial gas or manufacturing emissions. While inconclusive on best practices, the academic literature provides the contours of how program design features may engage with intended outcomes (Bailis et al. 2009; Mobarak et al. 2012). This body of research has informed the policy-making community, most notably with the development of the Gold Standard certification scheme for best practices in carbon offset project design (The Gold Standard 2010) and the Global Alliance for Clean Cookstoves' (GACC) recent presentation of a conceptual framework on how to measure and monitor sustainable development against project indicators (GACC 2014).

12.2.2 Measuring Sustainable Development in Carbon Interventions

Most practical attempts to measure sustainable development impacts across the market landscape mirror or modify the Gold Standard's sustainable development matrix, which identifies environmental, economic and social indicators and asks the project developer to rank the project's impact using a scaled score chart from -2 to 2. Numerous academic and gray assessments of carbon projects utilize a portfolio analysis approach in which they conduct a textual analysis of the project's benefits, extracting information from the sustainable development matrix (Olsen and Fenhann 2006; Sutter and Parreño 2007). A limitation across these assessments is an absence of information on the causal pathways that link the indicator of interest to a development outcome.

The GACC is currently working with the International Center for Research on Women to create conceptual frameworks that link project indicators with three development outcomes of interest: women's empowerment; the pathway between technology adoption and social/economic wellbeing and finally, the pathway between project implementation and livelihood enhancement (Fig. 12.1). These conceptual frameworks are based upon the GEF's Theory of Change, a policy design paradigm that makes transparent the assumed relationships between policy actions (indicators), policy impacts (components) and outcomes (goals).

An earlier GACC publication by Troncoso presents an adoption index and project impact index for comparing project effectiveness within a portfolio (Troncoso 2014). Troncoso's approach simply identifies key variables for the outcome of interest and weights them according to relevance. Adapting Troncoso's general method for creating an impact index derived from the GACC's conceptual framework results in the creation of a new tool – a Livelihood Index (LI) – for valuing livelihood impacts from carbon-financed interventions.

Before delving further into the assumptions underlying and the application of the livelihood index, it is worth addressing why local economic impacts matter. The vast majority of studies on carbon markets and environment-development projects more generally focus on the user experience: how and why users adopt a new

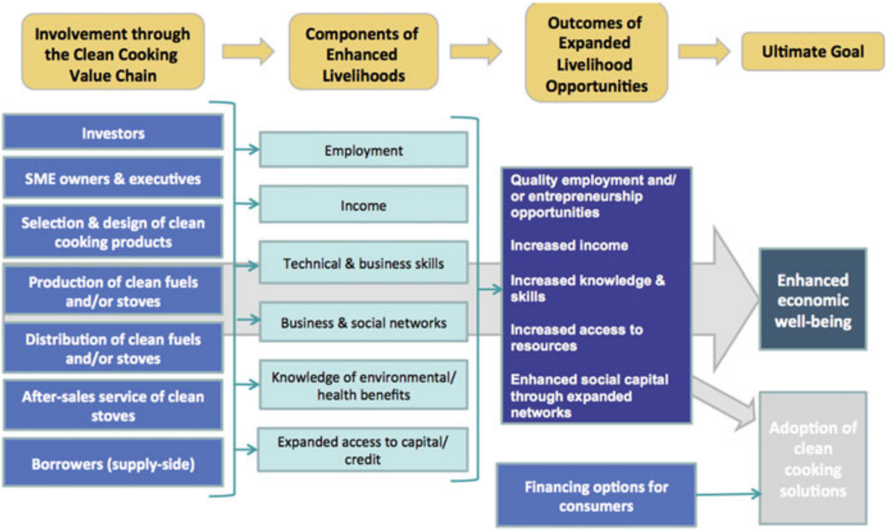

Fig. 12.1 GACC social impact, conceptual framework

technology, whether or not they replace it, whether or not it is appropriate for their local settings, and how their livelihoods are enhanced in terms of social, environmental and economic outcomes. This body of literature is crucial for the discussion of carbon finance evaluation and effectiveness, as it addresses whether and how climate-compatible technologies can enhance the lives of target communities while supporting the global goal of climate change mitigation and adaptation. However, user-focused studies cannot address a primary assumption within the environmental markets policy narrative, namely, that market approaches support the development of local economies and are therefore more empowering than the traditional aid model.

The Livelihood Index is derived from the GACC's conceptual framework on social impacts from cookstove projects, which are often carbon finance projects as well. It adapts GACC's broad notion of "involvement in the value chain" on the far left of the diagram, and converts the listed categories of project involvement into "actors" whose jobs are assessed for evidence of an enhanced livelihood and social impact: Investors; SME owners and executives; selection and design of clean cooking technologies; production of clean cooking fuels/stoves; distribution of clean fuels/stoves; after sales service of clean stoves; borrowers (supply-side). These categories are adapted to the broader range of project types and the specific range or actors when carbon credit creation is involved: (1) Carbon credit buyers/ investors; project developers (i.e. executives) and SMEs (when applicable); clean technology producers; clean technology distributors; after sales service agents; borrowers and users. In addition, we have added the third party validator and verifier to the supply chain, an actor whose role is specifically created by the carbon market to validate the quantifications associated with greenhouse gas emissions reductions. Within a carbon offset project, the project developer selects the clean cooking technology design, so this category has been eliminated. In all, the far left column of the GACC's conceptual framework translates intuitively into carbon offset project's value chain, determining the categories of actors that we assessed for evidence of access to and gains associated with utilizing the carbon market.

The second column of the GACC framework, "components of enhanced livelihoods" includes the following categories: employment; income, technical and business skills; business and social networks; knowledge of environmental health/benefits; expanded access to health and credit. The semi-structured interviews with actors in the first column touched upon all of these elements of an enhanced livelihood, and aspects of these interviews will be discussed in the case analysis. However, due to variability in the categories that were relevant for all actors in the value chain, the livelihood index we utilize here references those aspects of an enhanced livelihood that were pertinent in every single interview: steady and predictable employment; income for labor, enhanced opportunities engendered by skilled labour and enhanced opportunities engendered my managerial positions (i.e. positions with some degree of decision making power). The need for expanded access to capital and credit was not always a prerequisite for acquiring the new technology; in some cases, households were given the technology for free. The relationship between users, borrowers and the local impact of integrating them into the formal economy through enhanced credit options is significantly complex that it is the subject for another paper.

The third column articulates varying "outcomes of enhanced livelihoods:" quality employment and/or entrepreneurship opportunities; increased income; increased knowledge and skills; increased access to resources; and enhanced social capital through expanded social networks. Quality employment and entrepreneurship opportunities arguably encompasses other outcomes, such as increased skills and resources, increased networking opportunities and enhanced social capital and status. Another outcome worth further investigation would be increased employment choices. For example in addition to the outcomes identified within the GACC framework, avoided sacrifices where money was not the priority outcome were also positively mentioned; i.e. "employment with the carbon offset project enables me to work close to my village, and without this job I would be forced to live far away from my family.

Pressed further, this particular interviewee admitted that he could earn a better income in Vietnam, but the benefit of living with his family at home in Cambodia and engaging with the environment-development project far outweighed the potential increase in income. This type of benefit is not clearly captured in the conceptual framework or the livelihood index as it currently stands; further research is required to establish how and under what conditions carbon finance can engender or hinder livelihood choices where income is not the salient driving factor.

Thus, the livelihood index offers a rough proxy as to the impact of a carbon finance project on local incomes and livelihoods within the economy that surrounds the carbon finance intervention; while imperfect, the livelihood index can help to

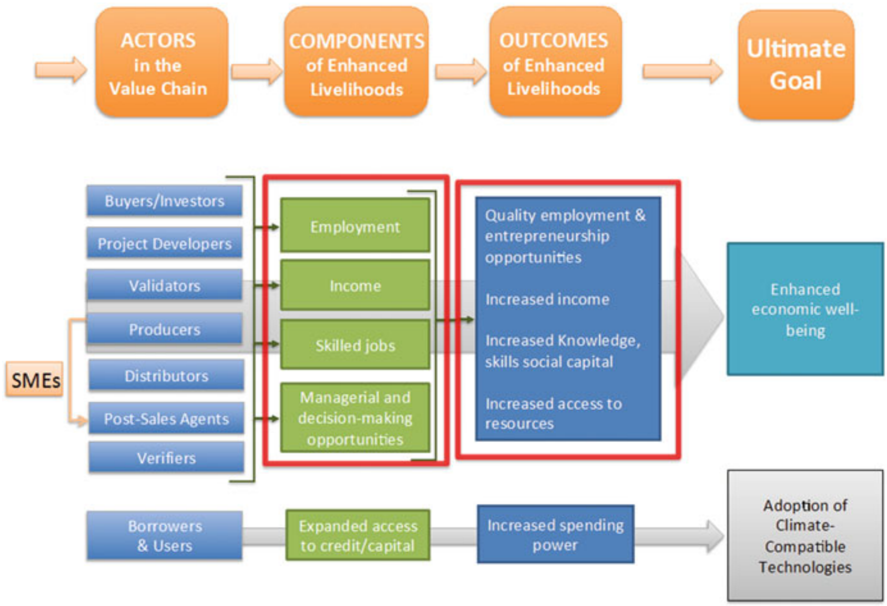

Fig. 12.2 Livelihood impact of a carbon project, conceptual framework

begin a conversation on the economic distribution of innovative environmental financing tools (Fig. 12.2).

Working from the conceptual framework, the formula for the index is as follows:

$$\text{Livelihood impact} = (2*\text{SKL}) + (\text{PAY}) + (\text{SAT}$$

$$\text{Livelihood Index}(\text{LI}) = \frac{\text{Sum of job impact values}}{\text{Total number of jobs in value chain}}$$

The score for "Skill" includes employment in terms of jobs created and employment in terms of jobs containing skilled and managerial opportunities, thus the variable is double-weighted given that its value encompasses half of the indicators of interest in the conceptual framework. Along the employment spectrum, unskilled work means that there was no training involved for the position and managerial work implies that the employee has a degree of decision making power within the enterprise. "Pay" relates to the type of employment, given that not all of the jobs are financially compensated. Along this continuum, "Volunteer" labor includes consistent work for the carbon finance project that is paid outside of the formal economy (i.e. through company swag or promises of future employment). Commissioned labor lies at the midpoint of the "PAY" valuation scale given that there is a predictable financial gain from work effort, but the risks of project failure are born by the employee. While there is indeed the possibility of high reward through commissioned work, of the 88 people interviewed who are directly involved with the field-level implementation of the projects under review, only one person cited "commissioned work" favorably. Payment structures varied among the three projects, but there was near consensus from workers that a salary was preferable to commissioned pay. The single respondent who positively described the commissioned payment structure had been hired just 2 months prior to the interview. "Salaried" work receives the highest score in the index.

Evidence of job satisfaction (SAT) is a qualitative assessment based on the open-ended interviews wherein the self-reported ability to save and/or self-reported personal benefits from doing the job are volunteered within the interview process. All interviewees were asked to nominate their favorite and least favorite aspects of their job: mention of looking for a new job ranked at zero, while apparently genuine and detailed feelings of pride in the work and specific reasons that the job was appreciated (i.e. job location and the ability to achieve work/life balance) garnered the full rating of 1. The LI's maximum score is 4, while each variable has a scale between 0 and 1 (Table 12.1).

The LI's main utility is in comparing – rather than determining in absolute terms – the ability of a project to distribute economic benefits across the value chain. The strength of the index is that it accounts for equality – a few elite members within the value chain have little influence on the LI if the majority of workers are undercompensated. A more nuanced livelihood index would better capture how expanded access to credit, business and social networks and knowledge relate to improved livelihoods; this rough index assumes that skilled jobs will include some degree of technical and business skill, and that managerial jobs will include some component of training, networking and increased opportunity. While there are surely examples where these assumptions prove faulty, the presence of skilled

Table 12.1 Values of the livelihood index

Value Scale	**0**	**.25**	**.5**	**.75**	**1**
Quality employment/ Skilled Labour (SKL)	Unskilled work	Semi-skilled labor at minimum wage equivalent	Skilled, manual labor	Skilled, white-collar work	Managerial position
Employment Type/Income Type (PAY)	Unpaid, uncompensated labor		Commissioned Labor		Salaried Labor
Evidence of satisfaction through enhanced personal options (SAT)	Mentions or demonstrates desire to leave job	Explains why current job is favorable to past work	Mentions pride in work and positive aspects of the job	Mentions lifestyle benefits associated with the job and/or describes trainings and skills acquired at job	Demonstrates signs of upward mobility (refers to savings/future investments).

labor and managerial labor is not a likely hindrance to the outcomes of interest. Thus, this preliminary livelihood index offers insight into a project's ability to improve local economic well-being by focusing on the necessary (though possibly insufficient) components of an enhanced livelihood.

12.3 Field Methods

The three projects under evaluation have been registered under the Gold Standard or Voluntary Carbon Standard since 2012, enabling adequate time for the projects to perform and to begin to make an impact on the community of interest. The projects are located in Cambodia each project is national in scope. The projects all market their carbon assets as "pro-poor", "Gold Standard" or useful for sustainable development, citing community benefits as a salient marketing feature of their project in addition to the environmental benefits.

This research is based on 144 semi-structured interviews with 91 individual carbon asset managers, project managers, and financiers. Interviewees included the full range of people involved with, and impacted by, the project, including: technology producers (including designers, factory workers, supervisors, and distributors), technology promoters, micro credit agents, local banking institutions, recipient households (both husband and wife when possible), households that opted not to participate in the project, agricultural extension workers involved in project dissemination, carbon asset managers, carbon asset brokers, financiers, foreign consultants to the projects, hedge fund managers, and researchers who had previously written on or had reportedly observed my projects of interest.

In formulating the interviews and research approach, process tracing provided the analytic basis; it is a method that focuses on identifying sequential processes and mechanisms that determine outcomes of interest (Checkel 2008; Bennett 2010). Process tracing favors "thick" (in-depth) analysis of a small set of cases because of its primary interest in sequential processes within a case, as opposed to comparing correlations of data across a large N case-set. For example, the semi-structured interviews, conducted with a translator, followed a basic template designed to quantify gains (and losses) from project participation in terms of income, time, and opportunity costs, while also covering qualitative questions on the participants' assessment of their quality of life in general terms, and the impact of the project on their livelihoods and choices. Open-ended questions such as "what is your greatest concern about the project?" helped to identify the criteria for locally-relevant project success. The theory in question here relates to the belief that carbon market projects that target households and utilize point-of-use technologies for public health are going to support local, sustainable development and are therefore worthy of premium carbon credit labels such as the "Gold Standard" or the privileged position of being named "charismatic carbon" within the carbon market community. Process tracing can dig deeply into the assumption that household-scale interventions are synonymous with local development.

In addition, value chain analysis disintegrates commodity production into discrete stages – from product design to raw material acquisition to retail – to identify where high value activities are located and how they can govern the activities in the lower-value regions (Gereffi et al. 2005). In practical terms, this means interviewing every type of worker involved in the project to determine how they benefited from project participation; their salary and method of compensation and their complaints or sources of joy and pride in their work.

The organizing idea for value chain scholars is that "disintegrated production" can explain the unintended phenomena of immiserizing growth, i.e. economic growth accompanied by increased inequality (Bhagwati 1968). Importantly, high value activities are characterized as having high entry barriers – in the case of the carbon market the largest barrier to entry is technical understanding of an opaque and highly complex commodification process (Bair and Gereffi 2001). Low value activities have low-entry barriers. Consequentially, the lower rungs are subject to excess labor supply resulting in competitive pressure on wages and output. It follows that increased productivity and employment can result in diminishing economic returns for low-value activities in the chain.

Given that the carbon market was created under the Kyoto Protocol to simultaneously reduce global greenhouse gas emissions at their point of least cost while also stimulating technology transfer and development revenue by integrating developing countries into the global marketplace for green technologies, value chain analysis is a well-tailored tool to assess how geographical position and asset accumulation relate within the carbon offset context. By mapping the different pathways for economic accumulation for a patronage and a partnership style carbon project, value chain analysis can show how and how much the distribution system actually matters.

12.4 Case Study Attributes

Cambodia is a newly graduated lower-income developing country in Southeast Asia, which was a Least Developing Country prior to 2016 when the fieldwork was conducted. It has a population of 14, 864,646 and an average income of $ 2.59 USD per day. Eighty percent of the population lives in rural conditions, and 75 % of all households lack access to grid-powered electricity (GACC 2015). Cambodia suffers from one of the highest rates of deforestation in the world, in part due to the fact that over 80 % of Cambodians rely on wood and charcoal for their daily cooking and water boiling needs. While charcoal is officially banned from use, it is the de facto fuel source of choice, and its consumption alongside woodfuel accounts for more than 4.7 million tonnes of forest mass consumed annually just for domestic cooking (Nexus 2015). The economic conditions and the degree of environmental degradation within Cambodia have made it an attractive host for carbon market investments, and as such three national programs to distribute water filters, cookstoves, and household biodigester systems have been established with headquarters in Phnom Penh.

12.4.1 Cookstove Case

The New Laos Stove (NLS) project was managed by the French NGO, "Groupe Energies Renouvelables, Environement et Solidarites" (Geres), Cambodia. The charcoal stove, designed for urban households but almost equally utilized in rural communities, has sold over a million units since 1998. Carbon finance from the voluntary market financed the rull range of the project's operational costs from 2006 to 2013, when the carbon crediting period closed (Geres 2013).

NLS utilized a low cost technology of improved biomass cookstove, valued at approximately 5 USD per unit, which is produced in local centers in region of the country known for artisanal stove production. The project developers used an "intrinsic revenue model" (Verles 2015), whereby they fund technical workshops to teach local artisans to execute their design, and then recycle funds from carbon finance into expanding the program and monitoring the implementation. Within this model, carbon credits act as a temporary subsidy for the establishment of a long-term national industry and local supply chain (idem). Given the close alignment between project participation and livelihood incentives, the value chain and the project structure are impossible to distinguish.

Geres attributes their considerable success in technology distribution to the strategic use of already existing production and dissemination networks within Kampong Ch'nang province, the traditional ceramics region of Cambodia. Utilizing historic production channels also offered monetary benefits: distributors received the technology on good faith from the producers, pedaling their wares thousands of miles away from the home factory based on generations of trust. This social aspect of the distribution system enabled the administrators to avoid financing difficulties in disseminating the locally produced stoves nationwide. However the emissions reductions per household serviced are the low, while the breadth of the dissemination and local livelihood index score for local economic gain is the strongest in the set.

The relatively high Livelihood Index score is derived from Geres' decision to train existing ceramics factories to produce their stove model, and they achieved the transition in production type through frontloading financial incentives for the producers during the training and in the first years of production. By feeding subsidies to the producers, and not to the consumers, Geres effectively transformed the cookstove producing region of Kampong Ch'nang into their improved stove model. Notably, the 35 stove factories that are registered NLS producers are all locally owned and managed, raising the LI due to the strong presence of managers, decision makers, and skilled labor positions engendered by the project. Another advantage to utilizing fully local production and distribution methods is that risk insurance, crediting, and norms for product guarantees were already in place due to the multi-generational history between the stove distributors and producers.

12.4.2 Water Filter Case

Hydrologic Ceramic Water Purifiers (CWP), has distributed over 150,000 locally produced clay waterfilters throughout rural Cambodia and is currently undergoing its first validation for the Gold Standard voluntary credit stream. The project initially received traditional donor aid from USAID in 2002 and partnered with the Red Cross to develop the CWP model; since switching to carbon finance the project is now views the Red Cross as a competitor (Hydrologic Social Enterprise 2012).

Hydrologic also utilizes an intrinsic revenue model, locating its single water filter factory outside of the national capital, also in Kampong Ch'nang. This location is not only strategic due to the localized expertise in clayware, but it is also a more residential area than the textile factories outside of Phnom Penh where the majority of the water filter factory workers previously worked.

The filters produce a greater emission reduction per unit and a significant health benefit in terms of reducing cholera and typhoid. Factory wages are similar to garment worker wages, yet laborers unanimously agreed that working at the Hydrologic factory was preferable to working at the garment district due to strategic positioning near their home (enabling mothers to remain close to their children and spend the long lunch hour with their family) and the work conditions themselves. However, unlike the NLS project where the majority of technology producers owned their own company, the workers at the CWP factory were frequently paid on commission leading to income uncertainty and distress, accounting for the lower LI score. Only one factory worker of the 15 interviewed reported using a CWP at home, which they had won at a company party. The remaining laborers interviewed said that the CWP was "too expensive" and three of the laborers interviewed mentioned that they had missed work due to "stomach and water problems."

Hydrologic has created three distribution channels: direct sales; indirect sales; and wholesale to NGOs for charitable use/emergency aid campaigns. A sales coordinator manages inventory, communicates with headquarters and trains local villagers in sales. Sales agents are paid on commission with a 5-dollar monthly stipend for gasoline; the presence of a set gasoline reimbursement incentivizes the sales agents to stick close to home and pocket the gasoline cost savings. A problematic partnership with a microfinancing NGO also hinders sales: the microcredit organization has little incentive to travel long distances to disseminate the micro-technology widely, preferring instead to offer multiple loan types within a single village for ease of administrative follow up. The absence of a reliable financing partnership is likely to undermine the program's resilience and long-term capacity.

An indirect sales channel (aka the retail channel) is somewhat simpler and the model of choice for urban areas –project managers sell the filters directly to market vendors at bulk rates. Given that urban vendors usually lack the capital to buy the filters upfront, sales supplies the vendors with filters and pays them on commission for each sale, approximately $1.50 per $23 unit. A cheaper version of the same filter (housed in a less attractive casing) is only offered to NGOs at $13 per unit. Perverse incentives exist for pharmacists who were originally targeted for retail given the health benefits associated with the technology. The pharmacists earned less money by avoiding cholera and typhoid cases than by charging the sick for treatment.

The principle difference between the NLS and the Hydrologic distribution system is that the NLS builds upon pre-existing local networks, whereas Hydrologic has built a distribution system from ground zero. An absence in social inroads, i.e. the presence of distributors who can deliver on good faith credit given their longstanding relationship with the stove producers, means that Hydrologic company must incentivize all aspects of the supply chain. In an attempt to reduce costs from salaried work, the project managers rely on commissions for the successful sale and delivery of the filter to deleterious effect for the lowest laborers on the rung: they assume risk for product failure and high turnover rates undermine the longevity of the project.

On the other hand, the project managers are Khmer nationals and receive an extraordinary amount of networking opportunities and skill enhancement by participating in the project, including international travel, exposure to the highly-specialized carbon finance project cycle, and entrée to international conferences on environment-development project design. The water filter project manager said that he is not fully satisfied with his job at Hydrologic, but that he had been able to amass adequate savings to launch his own company in the near future. Thus, while gains were less distributed in the Hydrologic model, managerial jobs offered high reward.

12.4.3 Biodigester Case

The National Biodigester Programme in Cambodia was initiated in 2002 by Dutch development agency SNV, and is now a joint collaboration with the Cambodian Ministry of Agriculture, Forestry and Fisheries. The program has installed nearly 18,000 plants to households throughout the country, 95 % of them are still in operation. Biogas plants are locally made by Khmer-run Biogas Companies; the project was certified to the Gold Standard voluntary stream in 2011. Dutch aid agency Hivos will buy all the credits (NBP 2012).

Of all the technologies, these are the most aspirational – graduating their users from biomass burning stoves to piped indoor gas burners with accompanying light fixtures for methane-fueled indoor lighting. The project manager has a policy that it will always partner with the local government, enabling it to utilize a similar technology dissemination structure as the NLS whereby inroads into the product distribution channels are already made. Government partners hail from local ministries of agriculture and livestock, and the government contribution is training through agricultural extension workers as to how the biodigesters might benefit a family that owns at least two cows. The technology is unaffordable for the very poor; the smallest biodigester costs $400 dollars and requires dung from the equivalent of two cows or four pigs in order to run. In order to ensure that poor farmers (albeit not the poorest of the population) can access the technology, the project managers have created a flat subsidy of $150 and have partnered with local banks wherein they assist in approving regular commercial loans. The default rate on the loans is an astonishing zero percent, reflecting the high savings associated with a biodigester's ability to essentially eliminate fuel and manure costs, while contributing to indoor lighting needs.

In addition to partnering with the government, the project developers in the NBP utilize a local NGO that assists in the training of masons and technicians to install the biodigesters. This workforce is trained by the project manager, and is paid on commission – though commission is substantially higher ($90 per unit) than for the Hydrologic sales agents. By training and employing masons, technicians, and involving local agriculture extension services in their marketing strategy, the NBP has managed to achieve national coverage with a seemingly unaffordable product. However, since 2012 the subsidy is being phased out and uptake has drastically declined (Tables 12.2 and 12.3).

Table 12.2 Case study attributes

Case Study Snapshot	New Laos Stove	Hydrologic	National Biodigester Program
Households serviced	2- 2.5 million	65,064	23,000
Technology deployed	Cookstoves	Water filters	Biodigesters
Total emissions reductions to date	1,200,000 tons	146,378	335,519
Certification Type	Verified Carbon Standard	Gold Standard	Gold Standard
Unit cost in dollars[a]	$5	$23	$250
Satisfaction rate[b]	Unknown	94.10%	97%
Last mile distribution mechanism	NA	Yes, for 30%	Yes, subsidy
Distribution Strategy	Local technology production and local markets for distribution	Local production and assisted distribution (markets and some subsidized market channels)	Local production and subsidized distribution
Livelihood index score	**2.53**	**2.19**	**1.80**

[a]All projects are located in a Least Developed Country except project D. Monthly income is 60–120 dollars a month in the communities of interest

[b]As evidenced by drop out rate in user surveys, reported in project documents by developers

Table 12.3 Livelihood index calculations by case

Case	Employment Functions	Jobs (#)	SKL	PAY	SAT	Job Impact	Total job impact	LI
New Laos Stove	Supplier	253	0.25	0.5	0.5	1.5	**1303**	**2.53**
	Producer	84	1	1	1	4		
	Distributors	171	1	0.5	0.75	3.25		
	Administrator	8	1	1	1	4		
Hydrologic Water Filters	Field Manager	4	1	1	1	4	**378**	**2.19**
	Carbon Sales Manager	8	1	1	1	4		
	Field Sales Agent	*50*	0.5	0.5	0.75	2.25		
	Distributor	30	0	0.5	0.5	1		
	Urban Sales Agent	10	0.5	0.5	0.75	2.25		
	Retailer	30	0.75	0.5	0.75	2.75		
	Factory Manager	1	1	1	1	4		
	Laborer	39	0.25	1	0.5	2		
National Biodigester Program	Administrator	6	1	1	1	4	**1499**	**1.80**
	Construction Managers	252	0.75	0.5	0.5	2.5		
	Labor Assistants	504	0.25	0.5	0.25	1.25		
	Technicians	66	1	0.5	0.75	3.25		

12.5 Discussion

There is considerable variation in the projects previously described, in terms of their approach to existing inroads in distribution networks, existing entrypoints to local markets, the quality of the technology on offer, and the unit cost. All of these projects offer a carbon-saving technology, an aspect of sustainable development benefit, and a focus on poor communities. However, by peering into the blackbox of project design and distribution strategy, it becomes apparent that dissemination method is an invisible and meaningful factor in determining a carbon project's ability to promote livelihood enhancement in the global south.

While carbon offset projects are often presented as win-win solutions, the cases presented here support an entirely different notion: development outcomes may compete rather than compliment one another. The cases with the most aspirational technologies have the lowest LI value, and the biodigester program is reliant on a donor subsidy to stimulate the local market that it creates. Further, the highest economic benefit from a carbon offset project (NLS) utilizes the least effective emissions reduction technology. While the carbon market was originally created to promote both sustainable development at the local level while reducing global greenhouse gas emissions, does this very design mask hard trade offs between the creation of locally appropriate market mechanisms and the short term delivery of modern energy technologies?

Further research is necessary to add granularity on local acceptance of the technologies, and on the long-term prospects for the technology to be adopted and disseminated. The LI must be further explored in longitudinal studies in order to determine if distribution networks with strong emphasis on local livelihood enhancement do indeed lead to longer project lifelines. Furthermore, the livelihood index may be refined to better capture prospects for upward mobility, aspirational employment, and entry into high level networks – all features of gainful employment mentioned by the GACC in their conceptual framework but poorly captured here. Still, the LI is useful as a starting point for considering how and why seemingly similar projects perform so differently in the field. These cases give weight to the view that distribution models deserve more attention in pro-poor policy design.

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