

DOEN FOUNDATION

SELCO FOUNDATION EVALUATION

■ NATIONALE ■
POSTCODE LOTERIJ



External evaluation of SELCO Foundation and its ecosystem - July 2021

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Executive Summary

In November 2020, the DOEN Foundation commissioned this external evaluation of SELCO Foundation and the ecosystem approach they have pioneered over the last decade. The evaluation comes at a point when SELCO Foundation and DOEN have entered into their fourth and fifth collaboration, focused on building and growing the ecosystem for sustainable energy in India (the fourth) and on global replication of the SELCO ecosystem model (the fifth). With both sides clearly interested in continuing their impact forward, the suggested “mood” of this evaluation was one that struck a balance between an assessment and an analysis, and one from which both sides can identify the successes worth replicating, and gaps worth fixing.

The evaluation focused on two sets of research questions. The highest emphasis was on a set of systems questions: How do we define the “ecosystem approach”? How well does the approach fare as compared to its own potential and to project-based approaches for achieving the desired impact? Is the approach worth replicating elsewhere? Can it be replicated? If so, under what conditions? We answered this set of questions by applying the Eco-scope, a tool that we developed as part of this evaluation (more below).

The second emphasis was on a set of longitudinal questions: How is SELCO Foundation performing as an organization? What are its strengths, challenges, opportunities and threats (SWOT) vis-à-vis best practices? How aware are they of it? What is its impact on energy access and overall livelihood sustainability in India? These questions are complementary to the ecosystem questions because they reflect how SELCO Foundation has organized itself to deliver on its vision of building ecosystems for ending energy poverty. We answered these questions with a 360 degree survey and some 25 hours of interviews with members of the SELCO Foundation, SELCO India (the distributed renewable energy (DRE) based energy access infrastructure providing enterprise whose work first gave rise to the ecosystem approach), and funding agencies, DOEN and others. A critical

complement to both sets of analyses above was two weeks of fieldwork for validation. SELCO Foundation is henceforth referred to simply as SELCO, and SELCO India is referred to in full.

The fieldwork focused on SELCO’s work in two regions (the state of Karnataka, and the Northeast region of India) and on two interventions (livelihood and health). We chose such a sample to ensure that we study the entire spectrum of ecosystem implementations, ranging from nascent to intermediate implementations in the Northeast, and mature ones in Karnataka, a region where both SELCO and SELCO India have served the longest. We chose livelihood interventions because we could sample implementation along the entire spectrum, thereby keeping the intervention constant while studying the various stages of an ecosystem that supported it. The health interventions were selected to understand an ecosystem that has an institution - driven context as different from the individual entrepreneurs - driven context of the livelihood interventions.

The early conversations in this study had made it clear that the SELCO supporter’s collective consciousness about ecosystems stood at the following crossroad: while one could see the impact of ecosystems when they visited it on the ground, they could not explain it effectively to others. This situation is analogous to the idea of designing for simplicity or elegance - one knows it when they see it, but cannot explain it easily to others. To overcome this challenge, we built a matrix analysis-based tool akin to a microscope for the ecosystems - an Eco-scope - designed to help one understand the state as well as the evolution of an ecosystem. The tool helps analyze who are the stakeholders in an ecosystem and what are their functions. Moreover, how complete, mature, and stable is an ecosystem.

This study posits that, if the objective is a sustainable co-evolution of energy access and income increase through its productive end-use, then an ecosystem is a

system of actors and their transactions to meet such an objective. Such a definition is built upon the premise that when energy access is available to a poor person or household, it is only natural for them to want to plug into it more and more of those appliances that bring them entertainment and gainful occupation. It is imperative then that the purpose of such ecosystems is not just access to energy, but also its productive use. The entrepreneur should be able to leverage the ecosystem to pay for both the DRE infrastructure that brings them the electricity, the productive interventions that work with the mechanical infrastructure (e.g., silk rope making machine), and ultimately earn additional income to increase their well-being.

We group the actors of an ecosystem built for energy access into three sometimes overlapping categories: end users (the end-product and service supply chain), essentials, and enablers. While positively impacting the end users is the ultimate goal of both DOEN as well as SELCO, it is at times easier to think about those end entities as the end-supply chain. For example, in a livelihood intervention SELCO India serves the entrepreneur who then sells products (e.g., roti from a solar-powered roti-roller) to the end-consumer via a local shop. The essential actors are those without whom DRE and mechanical infrastructure would not be possible to be physically installed, financed and productively used. In livelihood interventions, for example, the essential actors are the enterprises supplying, installing, maintaining, and servicing the DRE and mechanical infrastructure; the sub-suppliers to the enterprise who provide materials and equipment servicing etc.; the finance provider; and relevant government agencies. The enablers are the actors who make the essential actors converge towards the desired outcomes. In the process, they ensure inclusivity from the end users' perspective. SELCO starts out as a special type of enabler we can call the ecosystem builder that actively fills the gaps in the ecosystem. As the ecosystem matures, they become more like other enablers.

The boundary of a given ecosystem can be construed more regionally, and is marked by having a set of personnel representing the essential actors (technology providers and users, finance providers, etc.) who support and actively manage all of the various interventions and relationships within it. A single ecosystem may support multiple interventions simultaneously.

An intervention, and therefore the ecosystem as a whole, matures through three phases: innovation, incubation, and replication. To build and mature an ecosystem,

SELCO undertakes two key activities: innovation and incubation. In the innovation phase, when the central question is what makes for a viable intervention, there is much iteration through prototyping, failing, and retrying. In this phase SELCO Foundation, the ecosystem builder, plays a vital role by identifying champion users and convincing them, putting together a minimally viable solution, identifying key actors to implement the solution and, where they cannot be found, stepping in to play the role of such missing entities.

With a successful innovation, the ecosystem enters the incubation phase, where the central focus is on incubating - creating nurturing conditions for - the DRE energy access infrastructure providing enterprises, strengthening the other essential actors and the relationships among them, and putting in place the enablers performing the inclusive functions. At this stage too, the ecosystem builder continues to perform a few functions that are unattended or require strengthening.

With successful innovation and incubation, which can occur simultaneously, the ecosystem enters a mature replication phase, where all of the essential and enabling actors have viable and stable "business models" and SELCO, the ecosystem builder, has no more functions to perform for the given intervention. The notion of a business model must be broadly construed here because the purpose of an ecosystem is to maximize impact while ensuring that each actor produces value worth paying for. For essential actors such as an entrepreneur, technology-providing enterprise, or finance provider, profitability for sustainable growth - instead of profit maximization - remains the right measure and therefore the classical notion of a viable business model makes sense to use. In contrast, for actors like government agencies, market linkage providers, training providers, or SELCO itself, the notion of viability must be broadened. The question becomes, does their cost justify their expected impact. At the highest level, it is about a sustainable co-evolution of energy access and its productive use.

We found that the ecosystem builder can indeed "exit" an intervention; meaning, it can transition from being the one nurturing the intervention to one advising it. For example, SELCO Foundation has no active role to perform anymore in the scaling of the roti-rolling intervention in northern Karnataka, where there are close to two thousand roti rollers and growing. In such cases, the solar enterprise (e.g., SELCO India) becomes the anchor of the intervention. This is natural because growing their

customer base of such entrepreneurs and building a strong relationship with them is core to the business of the solar enterprise. An open question here is this: what is the best way for the ecosystem builder to retreat to an advisory role? A potential mechanism for it could be to create an ecosystem-level advisory body, where the ecosystem builder becomes a permanent member, that focuses on increasing savings, exploring opportunities, providing connections and nurturing more entrepreneurs. Such ideas need further consideration.

Eco-scope: A tool for examining an Ecosystem

Example: the ecosystem that allows you to buy a toothbrush from your neighboring grocery store

	You (End-consumer)	Grocery Store Near You (Retailer)	Manufacturer of your Toothbrush (Manufacturer)	
You (End-consumer)	You Consume # of buyers Value	Buy #		1. Who are the stakeholders? <i>A measure of how complete is the ecosystem (e.g., if a stakeholder is absent the ecosystem is incomplete).</i>
Grocery Store Near You (Retailer)	Sell #	Store Retail # of Stores Profit	Buy #	2. What functions do they perform? <i>In an incomplete ecosystem, someone must step in to perform the function</i>
Manufacturer of your Toothbrush (Manufacturer)		Sell #	Store Retail # of Stores Profit	3. How many do exist? <i>A measure of the size of and competition in the ecosystem (e.g., competition requires two or more retailers, manufacturers)</i>
				4. How viable are the value proposition or business models? <i>A measure of the stability (e.g., in a stable ecosystem consumer value > price, and retailer/manufacturer business models are viable)</i>
				5. What is the transition from the stakeholder (row) to stakeholder (column)? Size and frequency of transaction? How formal is it? <i>A measure of how formal and replicable are the transactions/contracts</i>

We arrived at the above findings using the aforementioned Eco-scope. The Eco-scope is a matrix where the same set of ecosystem functions are placed along both rows and columns to study which actors are performing them (recorded on the diagonal of such a matrix). The figure takes the experience of buying a neighboring grocery store to illustrate how the Eco-scope works. Each matrix element, at the row-column intersection cell, records transactions between the row actor to the column actor. We asked five sets of questions about the actors and their transactions: (1) What are the functions that are part of the ecosystem - a measure dimension of its completeness (2) Who are actors performing each of the functions - another dimension of the completeness of an ecosystem, (3) How many of such

actors exist - a measure of size of and competition in the ecosystem, (4) How viable is the "business model" of each actor - a measure of stability of the ecosystem, and (5) What are the transactions between different actors, and how formal are they - a measure of how replicable are the contracts? The application of this tool is what gave us an insight into the state and the evolution of an ecosystem. While we limited ourselves to these questions for our evaluation, numerous other questions can be asked to describe the ecosystem state better. For example: (1) How long the transfer of resources takes and if it can be sped up with the number of transactions (2) Which actor has to initiate the transaction?

Turning to the question of measuring the impact of ecosystems: this measure needs to be three dimensional. On one dimension is the question of scale, in terms of users reached, how many installations of each intervention, including installations in new ecosystems (geographies). The second dimension is the resilience, meaning creation of actors and linkages between actors that didn't exist beforehand as measured using the Eco-scope. Engaging and increasing connections between actors, with the goal of moving the ecosystem to the replication phase, ensures increased self-propagation. Along the third dimension, there is the question of value, which may have three sub-dimensions: in an ecosystem, (a) how much has the prosperity of end users and other actors increased? (b) how much has environmental sustainability increased? (c) how much has the equity increased? Measuring these systematically requires an exercise exclusively focused on it; however, this much is clear: in a successful ecosystem, the prosperity must increase, environment sustainability must not go down, and equity must not go down.

In summary, it is clear that the ecosystem approach works, whether one assesses the impact of solar energy access from the perspective of sustainability or enhancing quality of life. We found that, at the highest level, ecosystem building is needed irrespective of whether the solar energy access is provisioned via an end user-centric-bottom-up approach (e.g., the one by SELCO) or a top-down approach (e.g., one followed by large scale public or private DRE energy access infrastructure projects) because it is the ecosystem that produces the income for the entrepreneur to pay for the new energy demand. Thus, the ecosystem perspective is unavoidable if the objective is to create a sustainable path for meeting the growing energy demand of the development sector.

Principal Findings and Recommendations

The objective behind building Energy Ecosystems: A sustainable co-evolution of energy access and its productive use to end energy poverty.

A definition of ecosystem: A system of stakeholders and their transactions to meet the above objective

Eco-scope: A matrix-based tool to analyze ecosystems at a higher granularity than we have done so far. Eco-scope analyzes five questions: (1) What are the functions that constitute the ecosystem - a measure of the completeness of an ecosystem, (2) Who are the actors performing those function - another dimension of completeness, (3) How many of such actors exist - a measure of size and competition, (4) How viable is the "business model" of each actor - a measure of stability of the ecosystem, and (5) What are the transactions between different actors, and how formal are they - a measure of how replicable are the contracts?

State and Evolution of Ecosystems (lessons based on livelihood and health interventions):

- An ecosystem built for energy access has three types of actors: end users (or end-supply chain for the product or service) whose enablement is the purpose for an ecosystem, essentials without whom the ecosystem is incomplete, and enablers who either fill gaps in an incomplete ecosystem or make it more inclusive. SELCO Foundation (henceforth, SELCO) is a special type of enabler acting as the ecosystem builder.
- A single ecosystem, bounded regionally, may be supporting multiple interventions (e.g., livelihood, health, agriculture, etc.) at a time.
- An intervention, and therefore the ecosystem as a whole, matures through three phases: innovation phase is undertaken to generate a set of renewable energy-based intervention that is desirable by the entrepreneur, incubation phase is undertaken to incubate essential and enabling actors to install, maintain and

finance the interventions. The innovation and incubation phase may proceed simultaneously. Finally, the replication phase is reached once each actor in the ecosystem has a viable "business model."

- In the innovation and incubation phase, the ecosystem builder fills the gaps by playing the role of missing actors or by performing unattended functions. Upon success of these two phases, the ecosystem builder becomes redundant and is ready to "exit" the intervention in that ecosystem.
- The question of what is the best way for the ecosystem builder to exit requires more investigation. A few aspects are clear: when the ecosystem builder is ready to exit, the distributed renewable energy (DRE) infrastructure-providing enterprise becomes the anchor for the given intervention. Further, by exiting, the ecosystem builder's role can go from being the one actively nurturing the ecosystem to advising. One can conjecture that a novel ecosystem-level "body" may take over the further scaling of a mature intervention in that ecosystem. Such an exit will allow both SELCO and its funders to redeploy resources and capacities to new interventions/ecosystems.

Ecosystems vs. Centralized (top-down) approaches: Ecosystems excel over centralized approaches when (a) expanding to new livelihood interventions over

the DRE infrastructure (b) making entrepreneurs capable of paying for the new intervention/energy demand, and (c) distributing benefits to stakeholders through asset ownership and future opportunities. Top-down approaches excel for those parts of the solution that require large investments and compliance.

An Ecosystem Theory of Change: SELCO's energy access ecosystems are built to secure a sustainable co-evolution of energy access and its productive use, in the following steps: SELCO identifies the opportunity for interventions and engages in innovation and incubation. This spurs two virtuous cycles. First, every successful intervention enables an ecosystem to nurture and support new product or service providers who earn enough to pay for their share of energy demand, strengthening all actors supporting the intervention. Second, every new installation brings more customers to the incubated technology-providing solar enterprise, who eventually anchors mature interventions and lets the ecosystem builder exit. Both cycles can co-evolve with relative independence.

Towards a science of ecosystem building:

- Four pre-conditions to an ecosystem: a few champion users and partners, a patient funder, a solar technology provider, and an ecosystem builder willing to design from the end user perspective. Each of them is necessary. Depending upon the initial condition of the place at which there is intervention, they may be present in varying degrees.
- The Eco-scope takes us a step closer to producing a manual for ecosystem design and implementation. Such a manual can help with scoping, monitoring, comparing, and strategizing ecosystems. The next step is to pilot a manual inside SELCO.

Highest Level Finding: the ecosystem perspective is necessary regardless if solar energy access is provisioned via an end user-centric-bottom-up (e.g., SELCO) or a top-down (e.g., large scale projects) approach. The perspective is unavoidable if the objective is to create a sustainable path for meeting the growing energy demand of the development sector. Ecosystems create such a path by increasing the end entrepreneur's paying capacity.

Measuring the impact of ecosystems: impact can be measured along three dimensions. On one dimension is the question of scale, how many installations

of each intervention, and in turn such ecosystems are present. On the second dimension is the question of resilience, which is increased by improving the interlinkages of actors in a given ecosystem and moving ecosystems toward the replication phase. In the final dimension, there is the question of value, which may have three sub-dimensions: in an ecosystem, (a) how much has the prosperity of end users and other actors increased? (b) how much has environmental sustainability increased (at least does not reduce)? (c) how much has equity increased (at least does not reduce)?

Table of Contents

Executive Summary

Principal Findings and Recommendations

1.0 Purpose, Research Questions and the Tenor of Evaluation

1.1 Research Questions

2.0 A Brief Methodological Overview

2.1 Eco-scope: A Tool for Comprehensive Ecosystem Mapping

3.0 Results: Building Ecosystems

3.1 Innovation stage: Silk reeling in Loharghat, Assam

3.2 Incubation stage: Tailoring in Nalbari, Assam

3.3 Replication stage: Roti Rolling, in Hubli-Dharwad, North Karnataka

3.4 Healthcare ecosystem: Community health clinic in Cherrapunji, Meghalaya

3.5 Lessons for Ecosystem Maturation

5.0 Integrating Learnings Towards Future Ecosystems

5.1 SELCO: Towards Organizing for More Effective Ecosystem Building

5.1.1 Exploiting Efficiently What Works While Exploring Strategically What's Next

5.1.2 "Exiting" Mature Ecosystems

5.1.3 Strategizing for Policy Influence

5.1.4 Internalizing the Learnings from the Eco-scope

5.2 Towards a "Science" of Ecosystem Building and Replication

5.2.1 Preconditions to an Ecosystem

5.2.2 Towards an Ecosystem Planning and Implementation Manual

5.2.3 Internalizing the Learnings from the Eco-scope

5.2.4 Building the Next Layer of Tools

5.2.5 An Ecosystem Theory of Change

6.0 The Criticality of the Ecosystems Perspective

7.0 Appendix

7.1 Innovation Stage Eco-scope: Silk reeling in Loharghat, Assam

7.2 Incubation Stage Eco-scope: Tailoring in Nalbari, Assam

7.3 Replication Stage Eco-scope: Roti Rolling, in Hubli-Dharwad, North Karnataka

7.4 Livelihood Sector Eco-scope Legend

7.5 Health Sector Eco-scope: A community health clinic, a primary health clinic or a sub-centre in the Cherrapunji region of Meghalaya

7.6 Health Sector Eco-scope Legend

7.7 Learning rate analysis using Incubation stage Eco-scope

7.8 SELCO Foundation Survey Questions

7.9 Full List of SWOT Analysis Themes and Their Frequency

7.8 A Depiction of the Theory of Change behind the Work of Selco Foundation

1.0 Purpose, Research Questions and the Tenor of Evaluation

In November 2020, DOEN Foundation commissioned this external evaluation of SELCO Foundation (henceforth, simply SELCO) as they looked to continue their collaboration on ecosystem-based approach to increasing sustainable energy access, and to maximize the impact of the approach. The evaluation comes at a point when SELCO and DOEN have entered into their fourth and fifth collaboration, recognizing the tremendous positive impact of the approach on the sector, and focused on building and growing the ecosystem for sustainable energy in India (the fourth) and on global replication of SELCO's ecosystem approach (the fifth). With both sides clearly interested in continuing their impact forward, the suggested "mood" of this evaluation was one that struck a balance between an assessment and an analysis, and from which both sides can identify the successes worth replicating, and gaps worth fixing.

1.1 Research Questions

The evaluation focused on two sets of questions. The highest emphasis was on a set of systems questions: How do we define the "ecosystem approach"? How well it fares as compared to its own potential for impact? Is the approach worth replicating elsewhere? Can it be replicated? If so, under what conditions can it be replicated? We answered this set of questions by applying the Eco-scope, a tool that we developed (more in Section 2.1).

The second emphasis was on a set of questions about the internal working of SELCO: How is the organization performing? What are its strengths, challenges, opportunities and threats (SWOT) vis-à-vis best practices? How aware are they of their SWOTs? What is their impact on energy access and overall livelihood sustainability in India? These questions are complementary to the ecosystem questions because they reflect how SELCO has organized itself to deliver on its vision of building ecosystems for ending energy poverty.

2.0 A Brief Methodological Overview

To conduct the assessment, we did a 360-degree survey of nine members of SELCO Foundation (six senior and three mid-level managers), four members of SELCO India (senior managers), and four funders other than DOEN Foundation (Lemelson Foundation, Ford Foundation, IKEA Foundation and Tata Trusts). SELCO India is the distributed renewable energy (DRE) infrastructure-based energy access providing enterprise that initially championed the ecosystem approach. It is henceforth referred to in full, to distinguish from the SELCO Foundation. The survey consisted of both querying directly about strengths, challenges, weaknesses and threats questions, and mapping of SELCO Foundation's structure. A sample survey showing the questions in the survey are shown in the Appendix (Section 7.8). In addition, over 25 hours of recorded conversations and interviews were scheduled with the survey participants, and members of DOEN Foundation who coordinate with SELCO. The discussion topics for these engagements were shaped by the survey and extensive review of historical documents obtained from DOEN, SELCO and SELCO India. To analyze the survey and interview notes, the recordings were codified to identify the emergent themes and their frequency (i.e., how many times a particular theme was expressed across the different responses). The learnings discussed in Section 5 and 6 were also presented during the conversations to assess feasibility and to refine the path forward.

To verify the findings based on the previous three activities, two weeks of fieldwork were conducted in Karnataka and the north-east (Assam and Meghalaya) studying interventions in two sectors (livelihood and health). We chose such a sample to ensure that we study the entire spectrum of ecosystem implementations, ranging from nascent to intermediate implementations in the Northeast, and mature in Karnataka, a region where both SELCO India and SELCO Foundation have served the longest. We chose livelihood interventions because we could sample implementation along the entire spectrum, thereby keeping the intervention constant while studying the various stages of an ecosystem. The health interventions were selected to understand its institution-driven context, which

is in contrast with the individual entrepreneurs-driven context of the livelihood interventions. The fieldwork consisted of recorded stakeholder interviews, taking pictures of interventions, interpretive conversations and stakeholder relationship narratives with fellow SELCO Foundation and SELCO India travelers. The Eco-scope described below was filled out based primarily on the fieldwork. Wherever possible, project documents and contract agreements kept with SELCO India, SELCO Foundation and stakeholders were reviewed to map the footprint of the ecosystem.

2.1 Eco-scope: A Tool for Comprehensive Ecosystem Mapping

The Eco-scope is an analysis tool used to systematically map an ecosystem. The tool is derived based on the use of Domain Structure Matrix in the field of engineering systems which has its foundation in the area of graph theory in mathematics. Analogues to a microscope, the Eco-scope helps analyze the state as well as evolution of an ecosystem by mapping functions, actors, their interlinkages, and transactions. By analyzing our observations using the Eco-scope systematically, we are able to discern the completeness, maturity and stability of a given ecosystem. Such a tool can be quite versatile in that it allows for analyzing ecosystem qualitatively or quantitatively. For example, transactions between different stakeholders can be documented descriptively or quantitatively. Similarly, one can analyze such transactions more closely to understand whether they are formal or informal, and thereby gauge which parts of an ecosystem can be sped up and which ones require more hand-holding.

	End-consumer	Buyer (and other intermediaries)	Entrepreneur	Enterprise	Finance Provider	Scheme Providing Government Agencies	Solar Materials Provider	Mechanical Solution Manufacturer	SELCO Foundation	Loan Guarantor, Gap Support	Entrepreneur Linkage and Support	Training Provider
End-consumer	Customer	↔	↔	X	X	X	X	X	X	X	X	X
Buyer (and other intermediaries)	↔	Khanavadi (Canteen)	↔	X	X	X	X	X	X	X	X	X
Entrepreneur	↔	↔	Benedicta(?)	↔	↔	X	X	X	X	X	X	↔ Money
Enterprise (Solar solution provider)	Sometimes, depending on vulnerability	Sometimes, depending on vulnerability	↔ Intervention, Reliable servicing	SELCO India	Unlocking finance	Unlocking schemes	↔	↔	X	X	↔ Ideas for livelihood solutions	↔ Clients
Finance Provider	X	X	↔	X	Syndicate Bank, SKDRDP	X	X	X	X	X	X	X
Scheme Providing Government Agencies	X	?	Schemes for women, physically handicapped	Might try for tenders	Schemes such as PMEGP	NABARD	Certification	Certification	X	X	X	X
Solar Materials Provider	X	X	X	↔ Materials	X	X	Suppliers	X	X	X	X	X
Mechanical Solution Manufacturer	X	X	X	↔ Supply the solution	X	X	X	Star	X	X	X	X
SELCO Foundation	X	X	X	X	X	X	X	X	SELCO Foundation	X	X	X
Loan Guarantor, Gap Support	X	X	Sometimes, depending on vulnerability, shock-proofing, gap support	Financing from bank	Sometimes, depending on vulnerability, guarantee	X	X	X	X	Guarantee (SELCO India) Gap Support (SELCO Foundation)	X	X
Entrepreneur Linkage and Support	Sometimes depending on vulnerability, leads	Sometimes depending on vulnerability, leads	Sometimes, depending on vulnerability, shock-proofing, livelihood ideas, training linkage	↔ Sometimes, depending on vulnerability, leads	Unlocking Finance	X	X	X	X	X	RAPID, Namma Bhoomi, SKDRDP	X
Training Provider	Sometimes depending on vulnerability, leads	Sometimes depending on vulnerability, leads	↔ Training	↔ Clients	X	X	X	X	X	X	X	

Figure 1. Example Eco-scope as applied to the replication stage ecosystem for roti rolling, in Hubli-Dharwad, North Karnataka

Figure 1 shows an example where the Eco-scope is used to map and study a replication stage, mature ecosystem intervention like roti-rolling. Appendix (Section 7.0) shows the Eco-scopes generated for other stages of a livelihood intervention. The tool requires us to lay out the unique functions that constitute a livelihood or healthcare ecosystem as the rows and columns of a matrix. On the diagonal, we list the specific actors (organization or people) that perform the functions. Each off-diagonal cell documents a transaction from the actor in the column to the actor in the row. Functions that constitute the goods supply chain (collectively known as the end users) are clustered at the top left. Transactions along this chain generate income

for the entrepreneurs and value for the end customer and intermediaries. We also color code the cells to note the centrality of that actor or transaction into two other categories: essentials and enablers. For example, green cells indicate transactions or actors that are essential to physical delivery of the intervention. Blue cells indicate transactions or actors that enable inclusivity and smooth functioning of the ecosystem approach. The full definition of color codes is given in the Appendix (Section 7.4 and 7.6). We also note which transactions are win-win with the “↔” symbol and which potentially win-win transactions require extra effort from one of the actors, with “→”. As an example of tracking additional parameters, in Section 7.7, we track which transactions require a fresh start for each instance, versus which ones can be routinized. This information can help uncover the rate-limiting steps to building the ecosystem.

3.0 Results: Building Ecosystems

We apply the Eco-scope to map the actors, their linkages, and joint transactions, during various stages of the ecosystem evolution. In the livelihood sector, we study three cases: (i) innovation in a new geography (ii) incubation in a new geography and (iii) replication in a mature geography. For (i) we study silk spinning in Loharghat, Assam, and term it as the “early” stage of ecosystem formation, since SELCO is just starting to experiment with this novel solar-powered livelihood intervention. For (ii) we study tailoring in Nalabari, Assam, and term it the “formative” stage of the ecosystem, since the intervention has been successfully replicated for providing livelihoods in Karnataka, and now the aim is to expand it into a new geography through incubation of enterprises. It is important to note that “innovation” and “incubation” activities can be initiated in any order, or in parallel. Incubation of enterprise is highly beneficial to undertaking innovation activities, since the enterprise can install and maintain the DRE and mechanical infrastructure. Similarly, innovating in a new geography can be a low-investment way to test if sufficient actors exist in the geography to support a future ecosystem. For (iii) we study roti rolling in the Hubli-Dharwad area of Karnataka, where the replication stage is being championed by the enterprise, SELCO India, and SELCO has no further role to play in the proliferation of the particular intervention in the particular geography. In which case, we can consider the SELCO to have “exited” the ecosystem. We also apply the Eco-scope to a Community Health Clinic in Cherrapunji, Meghalaya to study the insights it can provide in the healthcare sector. Figure 2 shows some photographs from the fieldwork during interview of various actors.

While filling the Eco-scopes, we ask the following five questions: (1) What are the key functions that constitute the ecosystem, (2) Who are the actors performing each function - both measures of the completeness of an ecosystem, (3) How many of such actors exist - a measure of size, competition and maturity in the ecosystem (4) How viable is the “business model” of each of the actors - a measure of resilience and maturity of the ecosystem and (5) What are the transactions between different



Figure 2: Select photographs from interview of actors during fieldwork. Interview of Entrepreneur Linkage and Support (top left), SELCO field staff (top right), Enterprise (bottom left) and doctors at a clinic (bottom right)

actors, and how formal are they - a measure of replicability. The application of this tool is what gave us an insight into the state and the evolution of an ecosystem. While we focused our fieldwork on these questions for our evaluation, numerous other questions can be asked to describe the ecosystem state better. For example: (1) How long the transfer of resources takes and if it can be sped up with the number of transactions (2) Which actor has to initiate the transaction? These questions help future elaborate on the stability and replicability potential of an ecosystem.

3.1 Innovation stage: Silk reeling in Loharghat, Assam



Figure 2: A silk reeling entrepreneur working at work. (Picture courtesy of SELCO)

The Eco-scope for this case is shown in the Appendix, Section 7.1, with the legend included in Section 7.4. A silk reeling entrepreneur at work is pictured in Figure 2. This stage is perhaps the most energy intensive for the SELCO since it must do all the groundwork to identify and link pre-existing actors together toward enabling the successful piloting of the intervention. Simultaneously, where preexisting actors do not cooperate or exist, SELCO must step in and fulfill the function. Reading across the row for the Foundation, we find that its transactions include, identifying potential leads for buyers or end-consumer, working with the entrepreneur to convince them to take the risk of trying the new livelihood intervention to generate income, coordinating with the DRE and mechanical infrastructure installing enterprise, working with the mechanical infrastructure provider to iterate on the mechanical infrastructure prototype, and coordinating with the local supporting organization to provide any support necessary for the success of the intervention. Reading across the “Loan Guarantor” row we find the Foundation also provides

shock-proofing in case of any unanticipated event in the entrepreneur’s life and also direct financing for prototype iterations. If financing is obtained from a bank for the intervention, the Foundation might also provide a loan guarantee.

We find that critical actors that can really help ease the Foundation’s efforts in the incubation phase are the entrepreneur linkage and support, and the enterprise. The entrepreneur linkages and support can help identify market leads, convince the first set of entrepreneurs (“champion users”) to try the intervention and help unlock financing. The enterprise can undertake DRE and mechanical infrastructure installation and maintenance. The finance provider, government-scheme provider, and training provider can also assist by reducing the financial, regulatory and training burden; however, their role becomes much more critical for scale-up activities. Involving them during this stage however, is useful for laying the groundwork for future engagement.

3.2 Incubation stage: Tailoring in Nalbari, Assam



Figure 2: A silk reeling entrepreneur working at work. (Picture courtesy of SELCO)

The Eco-scope for this case is shown in the Appendix, Section 7.2, with the legend included in Section 7.4. Figure 3 shows a discussion in progress with a tailoring entrepreneur during the fieldwork. In the formative stage, the enterprise becomes the central actor of the ecosystem. The enterprise is the DRE and mechanical installation providing company, while the entrepreneur purchases these installations to generate value. The enterprise has a set of livelihood interventions available for marketing based on successful innovations previously developed by the Foundation, either in the current geography or another geography. Reading across the row for the enterprise, we find that the enterprise makes one-off linkages between the entrepreneur and end customers, convinces the entrepreneur to try an intervention and then provides reliable installation and maintenance, works with the finance and subsidy providing agencies to connect them with the entrepreneurs and facilitate access to schemes. The enterprise must also build up the supply chain for DRE and mechanical infrastructure to the new geography. Finally, the enterprise must also work with any local linking organization or training provider to ensure maximum support for the nascent “champion entrepreneurs” who will serve as role models. Many of the functions undertaken by the enterprise require enormous time and energy investment on its part. Specifically, they find the initial set of entrepreneurs, convince finance and scheme providers to support the solar-powered interventions, and convince suppliers to send resources to the new geography. All these relationships have the potential to evolve into win-win with the evolution of the ecosystem. However, we found that unlocking of bank financing and government schemes remained very time consuming even with maturation of the enterprise, highlighting the importance of policy action. It is this phase that the funding agency’s patient investment is often supporting.

The Foundation’s role still remains critical for supporting the growing installations by the enterprise. This can include everything from teaching them to maintain accounts, to doing high-quality installations, to connecting them with quality suppliers. Another major role for the Foundation is to help unlock finance by training regional bankers in providing finance for entrepreneurs. SELCO can also provide some shock-proofing, gap support and loan guarantee to catalyze the unlocking of initial financial products (See Loan Guarantor, Gap Support row).

As mentioned before, the incubation stage can proceed in parallel with the

innovation stage, since a newly incubated enterprise can focus on standard solar-lighting installations rather than livelihood interventions. The enterprise can also draw on the pool of innovations developed in other geographies. Tailoring and Lok Seva Kendra (photocopying) seem particularly suitable for this cross-geography scaling, given their relatively low up-front financial investment.

3.3 Replication stage: Roti Rolling, in Hubli-Dharwad, North Karnataka



*Figure 4: A roti-rolling trainer training entrepreneurs
(Picture courtesy of SELCO).*

entrepreneur and the market - collectively categorized as the goods supply chain. The next 6x6 matrix (including the entrepreneur) forms the essential transactions necessary to physically install the intervention, including the supply-chain and financing. The peripherals are enabler actors. Their transactions are necessary for initiating and smoothing transactions between the essential actors, and to ensure

The Eco-scope for this case is shown in the Appendix, Section 7.3, with the legend included in Section 7.4. Figure 4 shows a roti-rolling trainer training interested entrepreneurs. In the replication stage, the Foundation has exited, since the key linkages between the actors in the ecosystem have been established. At this point we can say that the ecosystem has Dhriti - an internal drive and ability for growth. In the Eco-scope diagram overall, we see the ecosystem in the mature stage can be divided into three distinct sections. The top-left 3x3 matrix (denoted by the borders highlighted in orange) is the connection between the

the ecosystem is as inclusive as possible in providing livelihood to entrepreneurs with various disadvantages. Here, ideally a local organization, or a larger organization must take the lead in terms of providing additional support such as gap financial support, creating market linkages, and connecting new entrepreneurs to trainers. A critical observation at this stage is that nearly all transactions necessary to sustain the ecosystem have become win-win. The transactions that remain challenging are the unlocking of the financing and schemes by the enterprise on behalf of the entrepreneur.

3.4 Healthcare ecosystem: Community health clinic in Cherrapunji, Meghalaya



Figure 5: A solar-powered Health Sub Centre.

The Eco-scope for this case is shown in the Appendix, Section 7.5, with the legend included in Section 7.6. Figure 5 shows a solar-powered Health Sub Centre. In the healthcare ecosystem, the doctors, auxiliary nurse midwives, community health (ASHA) workers or lab technicians at the clinic are the key anchoring actors. They

are the users of the solar health equipment. The key role for the Foundation is innovation on solar-powered medical devices, incubating enterprises and financing champion clinics. The Eco-scope diagram is for a case where the Foundation's primary role was financing. In a mature ecosystem, the financing will be facilitated by the government, either directly or through a local-body patient welfare committee (RKS) that exist at health clinics at the level of Primary Health Centres (PHC) and above. While the installation and maintenance can be done by the enterprise, additional local organizations can also take the lead in maintenance. The transactions can be divided into those necessary for physical installations (denoted by green cells), and those helpful in ensuring long-term functionality (denoted by blue cells). We found that the ownership of the system either at the clinic level or by a local organization was critical to deriving long-term value for the patients from the installation. Not all the "long-term functionality" transactions are critical, but the existence of some are, for successful long-term operation of the system.

3.5 Lessons for Ecosystem Maturation

Based on the analysis of the three cases in the livelihood sector (Section 3.1-3.3), we are able to offer a definition of maturation for each of the key actors, listed in Table 1. In the Appendix, Section 7.7 we have also expanded the Eco-scope for the Incubation stage to provide an example of additional parameters that can be tracked. The analysis shows that identifying potential entrepreneurs and unlocking finance are bottleneck transactions that remain challenging to speed up even after much experience. It is worth investing additional resources thinking through how these two transactions can be sped up through either policy action or other regional workshops or events. See Section 5.2.3 for further detail.

Table 1: Suggested definitions of maturation for key actors in the livelihood sector ecosystem

Actor	Suggested definition of maturation
Entrepreneur	When the creation of a DRE and mechanical intervention-based champion entrepreneur is no longer necessary by the enterprise to inform other entrepreneurs about the potential of the livelihood intervention. In other words, when the entrepreneur understands their business model and can advocate for its value to their contacts.
Enterprise	The company can exist without any incubation support (financial documentation, technical capacity, unlocking finance etc.) and has steady revenue stream (turnover > Rs. 1-2 crore) (\$ 133,000-266,000),
Solar Materials Provider	The company has reliable supply-chain to the region.
Mechanical Solution Manufacturer	The company is delivering equipment to that region and also providing reliable servicing.
SELCO Foundation	Only innovating on new interventions (unless Enterprise is able to take the initiative), not supporting the stability of the Enterprise. Maybe providing some subsidy support for the highly vulnerable entrepreneurs.
Training Provider	This function increases inclusion and is intervention dependent. Depending on the needs of the entrepreneur, it is easily accessible.
Entrepreneur Linkage and Support	This function increases inclusion and is intervention dependent. Essential for highly vulnerable users. Depending on the needs of the entrepreneur, it is easily accessible.
Finance Provider	Willing to finance DRE solar livelihoods that cost between Rs. 20,000-5,00,000 (\$ 260-6,666).
Loan Guarantor, Gap Support	Function should disappear in a mature ecosystem. Generally, initially done by the Foundation when unlocking the first set of financial providers.
Scheme Providing Government Agency	Function is essential since there is not adequate inclusion of rural customers into the financial ecosystem. Also, providing some subsidy schemes for vulnerable entrepreneurs.
Intermediary Buyer	Function not essential. In some cases, when raw material is procured by such an intermediary, they significantly erode the Entrepreneur's margin (e.g., in the case of milk). They can provide good market access for finished products (e.g., tailored uniforms).
End-consumer	Aware of the reliability and quality of service provided by the entrepreneur.

Based on our analysis of the health center interventions (Section 3.4), we are able to offer the definition of maturation for each of the actors in Table 2.

Table 2: Suggested definitions of maturation for key actors in the health sector ecosystem

Actor	Suggested definition of maturation
Patients	Aware of the increased reliability of services offered by the clinic with solar systems.
Clinic Users	The company can exist without any incubation support (financial documentation, technical capacity, unlocking finance etc.) and has steady revenue stream (turnover > Rs. 1-2 crore) (\$ 133,000-266,000),
(Nurses, Doctors etc.)	Aware of the increased reliability of services possible to be offered by the clinic by installing solar system. Knows how to do regular maintenance of the system (battery water refilling, panel cleaning).
Local-Body Patient Welfare Committee (RKS, PHC and above)	Sees enough benefit from the system to be willing to invest some of the discretionary money on system installation or at least nudge for the system to be installed.
Financers	Allocates money for the system to be installed by the clinics that would want them (ideally, rather than mandating that they be installed everywhere).
Maintenance Provider	Doing regular (~6 month) check-ups on the condition of the system regardless of the remoteness of the clinic.
Technology Provider	Willing to do installation in the region, no matter how remote and does regular servicing for the first few years until the Clinic Users learn to do it themselves.

5.0 Integrating Learnings Towards Future Ecosystems

5.1 SELCO: Towards Organizing for More Effective Ecosystem Building

In the near term, several recommendations follow from the above analysis for SELCO Foundation's workings. They are listed below in no particular order.

5.1.1 Exploiting Efficiently What Works While Exploring Strategically What's Next

It may be time to focus on strengthening the template of the ecosystems and interventions that work well. This will make replication easier, and streamline the organizational structure and processes. Focusing on exploitation may require being strategic about how many new innovations to explore, and how they feed into the overall portfolio of innovation available for replication. It is clear that, SELCO Foundation has a voracious appetite for exploring new ideas. Over the past year of the Covid-19 pandemic, it is also evident how nimble they have been at responding to crises and supporting their constituents. Even so, in the short run, it might be beneficial to refocus and prioritize exploitation of already generated knowledge.

The idea of further structuring what works well is not meant to be at odds with SELCO's nimbleness, which is a strength that comes handy in supporting stakeholders during the Covid-19 pandemic. Our explorations on the ground showed that having a strong ecosystem meant that when needs for financing or other support arose in pockets during the pandemic, SELCO and partners were able to step up. The suggestion to exploit what works well is more for the normal times when there is no crisis at hand.

It may even be helpful to engage a third-party to look at the organizational restructuring. Maybe, this is an area where DOEN can support SELCO engage in such an activity.

5.1.2 "Exiting" Mature Ecosystems

The application of Eco-scope to the livelihood ecosystems at various stages of maturity, performed in Section 3, indicates that there is indeed an opportunity for the ecosystem builder like SELCO to "exit" a given intervention (e.g., roti-rolling in North Karnataka) once it reaches a mature stage. We have found that the role of the ecosystem builder goes through a distinct progression as the ecosystem matures. In nascent ecosystems, the ecosystem builder fills any transactional and institutional gaps by stepping in to play the role of mission actors, and it performs the transactions that no one is there to perform. As the ecosystem matures, all of the necessary actors as well as the other actors that ensure inclusivity become more established. At this point, the ecosystem builder can "exit" the given intervention. They can go from being the one nurturing that intervention to one advising the scale up of such an intervention.

When it is ripe for SELCO to "exit", one may consider forming a "body" at the ecosystem level that is akin to an advisory board of a company of which SELCO is a permanent member. Such a body may have other stakeholders as appropriate to scale the ecosystem further (by increasing savings, exploring opportunities, providing connections and nurturing more entrepreneurs).

It is important to note that the enterprises that provide the DRE infrastructure, such as SELCO India and Suraj Solar, will likely never exit a mature ecosystem, since a trust-based customer relationship is critical to the enterprise business model. The locus of activity in a mature ecosystem is with the enterprise. Alternatively, the "ecosystem level body," SELCO might take an advisory role in the enterprise board. SELCO can then provide pro-bono support (financial and managerial) to push the enterprise to keep scaling the solution.

5.1.3 Strategizing for Policy Influence

Influencing public policy around successful interventions such that government programs can be built around them at district, state, national, and international levels seem attractive for scaling SELCO's work on a large scale. Presently, at SELCO, like with many other organizations, this area of work seems to be adopting a "champion-centric" approach. The theory is, one uses a personal rapport with a person in the position with resources and power, who not only has the appreciation for the organization's work but also has some discretion to do something about it. This approach does produce successes, but the process is very probabilistic.

5.1.4 Internalizing the Learnings from the Eco-scope

It is possible to integrate the use of the Eco-scope in the organizational processes so as to fine-tune the efficiency of ecosystem building as well as keep the organizational structure of the ecosystem building in sync with the nature and the needs of the ecosystem at hand.

5.2 Towards a "Science" of Ecosystem Building and Replication

We believe that this work puts us one step closer to making ecosystem building a "science" - a structured methodical process to map the ecosystem and track its progress toward maturation. Discussed below are topics that pave a way for such a discussion. Each topic below is in its formative stage and is a topic that will require focused effort to crystallize further.

5.2.1 Preconditions to an Ecosystem

The trajectory along which an ecosystem matures may be visualized as an S-shaped curve where there are two inflection points. The first point is when the essential actors are in place. Below this point, the absence of meeting a certain set of preconditions may prevent the ecosystem from "taking off" or having Dhriti. Beyond this point, the ecosystem begins to have some momentum of its own even though outside energy is required to ensure it serves all the potential beneficiaries. The second inflection point is the one where the ecosystem builder can exit and allow the inclusive ecosystem to flourish on its own.

We hypothesize that the following preconditions must be met for an ecosystem to get beyond the first inflection point. Importantly, these findings were in the energy access ecosystem in India. Intuitively, they may hold in other geographies too, although this claim needs to be tested.

- Presence of a few intended beneficiaries/partners with entrepreneurial spirit To seed an intervention that gets an ecosystem started, it is essential to have at least a handful of intended beneficiaries and partners who have the entrepreneurial spirit to take the risk. Such are people who have an intrinsic drive to propel forward in any situation. Fortunately, in all geographies and cultures at least a small number of such people usually exist. The key is to find them and convince them to try the intervention - this exactly is the job of the ecosystem builder like SELCO.

- Presence of a patient funder
A patient funder of the likes of DOEN Foundation is of vital importance for development-oriented ecosystems to succeed. In the early stages, it is the patient funder that underwrites the many failures and iterations that a new innovation goes through before the intervention stabilizes. At a later stage once the essential actors are in place, a patient funder with their insistence on inclusivity can lead to creating those actors and interlinkages that will ensure inclusion.
- A technology provider that is deeply interlinked with the beneficiaries
Innovative interventions are feasible in an ecosystem when the entity that ultimately anchors the ecosystem, for example the technology providing enterprise in the livelihood interventions we studied, has the pulse of the end beneficiary's needs. It is the deep understanding of their need that allows for fine tuning the solution and creating a value proposition for the end beneficiary as well as other actors of the ecosystem. This understanding is also what leads to continuous improvement.
- An ecosystem builder that steadfastly keeps the beneficiary at the center
The single most important factor that ensures that the problems are articulated from the perspective of the end users is the ecosystem builder keeping them at the center. This in turn ensures that the ecosystem first and foremost serves this intended beneficiary, and that the value created from building such an ecosystem do not get captured by other actors disproportionately. Keeping the end users in focus at all times is not easy, as anyone aspiring to build an ecosystem in the development sector has many forces pulling them in different directions.

4. Engage actors that exist, and fill in the roles of the actors that don't exist.
5. Monitor business models of the actors and work towards strengthening them (esp. entrepreneur, technology provider, financier). Monitor transactions to formalize where possible.
6. As an ecosystem builder, go from filling institutional/transactional gaps to being redundant.
7. Exit after adequate choice (redundancy/competition) exists in the system to preserve equity.

While the present study has been carried out in the context of energy access ecosystems; we believe the above structure is generic enough to be applicable to other structures. We hypothesize that when applied to innovations in other sectors such as education, environment, etc., their exact dynamics will be different from what we have uncovered in the energy sector. For example, who the essential and enabling actors are, who anchors the ecosystem will change; however, all of that may be studied using such an approach.

5.2.3 Internalizing the Learnings from the Eco-scope

It is possible to integrate the use of the Eco-scope in the organizational processes so as to fine-tune the efficiency of ecosystem building as well as to keep the organizational structure of the ecosystem building in sync with the nature and the needs of the ecosystem at hand. To build ecosystems more efficiently, one may begin to ask what is the clock speed of the various transactions. As depicted in Appendix Section 7.7, transactions in an ecosystem fall into three categories: (a) where clear and enforceable contract can be made between the two parties as in the case of the enterprise supplying solar panels to the entrepreneur - here, over time learning brings efficiency; (b) where every instance of the transaction must be customized as in the case of entity mentoring the entrepreneur create the supply chain linkages - here, every new interaction must be customized and remains iterative; and (c) where both contract plus customization is required as in the case of financier lending to entrepreneur - here, a loan may be a contract but getting a loan requires trust between the two parties. Disaggregating transactions into such subsets can allow for driving formalizing contracts where it is possible, and

5.2.2 Towards an Ecosystem Planning and Implementation Manual

The present work takes us one step closer to making ecosystem building a "science." Such a work can be further made available to a less experienced ecosystem builder if we could commit to developing an implementation manual that would articulate the following steps:

1. Understand the context of the sector.
2. Ensure that the pre-conditions are in place or can be put in place.
3. Map the intended ecosystem: actors, functions, and their transactions.

strengthening relationships where that's more important. Other broader strategies might also be devised to increase the clock speed of types (b) and (c) transactions.

Internal to the organization like SELCO, it is possible to document the various aspects of the ecosystem systematically: the presence and maturity of the actors, and the formalization and efficiency of the transactions between them. These then can be linked to the conventional bookkeeping to build a more comprehensive record-keeping of the organization that is more from the perspective of the ecosystems it is building. Acting upon such a suggestion requires more discussion and a plan.

5.2.4 Building the Next Layer of Tools

The Eco-scope as a tool can be used in many ways and can also be automated. Below are a few of its uses that take us beyond the application discussed in the present work:

- Scoping Ecosystems - as discussed above, the Eco-scope provides a way to scope out the ecosystem one intends to build by articulating pre-existing actors, their functions, and transactions between them.
- Monitoring Ecosystems - as demonstrated in this work, one can monitor the stage and evolution of the ecosystem.
- Comparing Ecosystems or its Stages - one may compare snapshots of two different ecosystems or of a given ecosystem at two different stages for further action.
- Strategizing Next Steps in an Ecosystem- one may project a desired, future stage of the ecosystem and create a strategy to get there.

5.2.5 An Ecosystem Theory of Change

Conventionally, the idea of mapping a theory of change considers five linearly connected elements: input, activity, output, outcome, and impact. For the ecosystems studied above, the inputs are the knowledge of the needs of the end users, technology, and finance. The activities are innovation, incubation support, technology installation and services, training, mentoring, and connection to policy. The output is innovation in interventions, and incubation of actors necessary for

replication. The outcome is replication of solar-energy based interventions that are economically, environmentally, and socially sustainable. Finally, the impact is better livelihood, health, etc., as desired. As one may notice, such a linear conception still misses the point of illuminating how the ecosystem comes about and how its core engine works. To understand that, one must appreciate the virtuous cycles enabled by the various activities as described below.

SELCO's energy access ecosystems are built to secure a sustainable co-evolution of energy access and its productive use, in the following steps: SELCO identifies the opportunity for the next intervention and engages in innovation and incubation. This spurs two virtuous cycles. First, every successful intervention enables an ecosystem to nurture and support new product or service providers who earn enough to pay for their share of energy demand, strengthening all actors supporting the intervention. Second, every new installation brings more customers to the incubated technology-providing solar enterprise, who eventually anchors mature interventions and lets the ecosystem builder exit. Both cycles can co-evolve with relative independence. Section 7.10 offers a depiction of this way of visualizing a theory of change.

6.0 The Criticality of the Ecosystems Perspective

The DRE Energy access infrastructure can be provided by a centralized, top-down fiat as often is the case with many governments or by a decentralized, bottom-up effort like the one led by the SELCO that aims to build an ecosystem. Based on patterns on investments one may argue that the current debate seems to be, which one is better. The present work finds that, while each approach comes with its strengths and weaknesses, if the objective were to meet the growing energy demand of the development sector while having a way to pay for it going forward, it would be difficult to do so without acquiring the ecosystem perspective. We arrive at such a conclusion based on the following analysis.

Imagine a thought experiment where everything that is needed by the entrepreneur is provisioned by a single, top-down entity as opposed to a bottom-up ecosystem. What would be their strengths and weaknesses? When such a thought experiment is done on the matrix (e.g., Section 7.3), we observe the following:

- Several aspects are equally feasible to deliver through either top-down or bottom-up approach, such as infrastructure, service, and maintenance; single, targeted application such as light bulb, phone charging, etc.; unlocking finance and occasional loan guarantee; inclusive schemes for the disadvantaged; and linking schemes to appropriate beneficiaries.
- Several aspects are difficult to deliver whether the infrastructure provisioning was top-down or bottom-up, such as winning government contracts if you are a private player or certification/standardization of new innovations.
- The public or private actor providing top-down solutions is likely to excel at aspects such as the ability to raise investments especially when the entity is for-profit structure, to provide deep discounts and compete better, and to lobby for new government schemes.
- The bottom-up ecosystem builder excels at a few aspects, particularly those that require customizing incubation support to the specific needs of an entrepreneur. This includes, nurturing entrepreneurs with training, and creating market linkages

to make them capable of paying for the new solutions/energy demand. Activities that expand scope also happen more effectively, such as innovating on new applications that were not envisioned, and creating a system where stakeholders enjoy asset ownership and partner equally to identify future opportunities.

These strengths and weaknesses flow from the difference in the underlying business models. Top down, private business models are tightly designed for a large-scale replication. They struggle to keep the margin necessary to accommodate new innovations. Additionally, as the profit is not distributed across many local stakeholders, capacity building becomes a challenge. Thus, if the objective were to meet the growing energy demand of the development sector while having a way to pay for it, adopting ecosystem perspective to complement it may be unavoidable whether the infrastructure is provisioned in a top-down or a bottom-up fashion. In this respect, the ecosystem approach of SELCO may help make even the top-down efforts impactful, if they choose to adopt it.

7.0 Appendix

7.1 Innovation Stage Eco-scope: Silk reeling in Loharghat, Assam

	End-consumer	Buyer (and other intermediaries)	Entrepreneur (Silk reeler)	Enterprise	Finance Provider	Scheme Providing Government Agencies	Solar Materials Provider	Mechanical Solution Manufacturer	SELCO Foundation	Loan Guarantor, Gap Support	Entrepreneur Linkage and Support	Training Provider
End-consumer	Customer	↔	↔	X	X	X	X	X	X	X	X	X
Buyer (and other intermediaries)	↔	Wholesale Buyer	↔	X	X	X	X	X	X	X	X	X
Entrepreneur (Silk reeler)	↔	↔	Mansha (?)	X	↔	X	X	X	Problems with the prototypes	X	X	↔ Money
Enterprise (Solar solution provider)	X	X	Installation	Technovillage, Suraj Enterprises	X	X	X	X	X	X	↔ Reliable servicing to beneficiaries	X
Finance Provider	X	X	↔ Money	X	North East Grameen Vikas Bank	X	X	X	X	X	X	X
Scheme Providing Government Agencies	X	?	Schemes for women, physically handicapped, tribes	X	Various schemes such as PMEGP	NABARD	X	X	X	X	X	X
Solar Materials Provider	X	X	X	Materials	X	X	Suppliers	X	X	X	X	X
Mechanical Solution Manufacturer	X	X	Equipment, servicing	X	X	X	X	Singer, USHA (?)	↔ New prototypes	X	X	X
SELCO Foundation	Potential leads	Potential leads	Conviction to try solar	Installation requirements	X	?	X	↔ Innovation Ideas	SELCO Foundation	X	↔ Conviction to try solar	X
Loan Guarantor, Gap Support	X	X	Shock-proofing	Direct financing of Prototyping	Loan Guarantee	X	X	X	X	SELCO Foundation, Diya Foundation	X	X
Entrepreneur Linkage and Support	Potential leads	Potential leads	Additional conviction to try solar	X	Unlocking finance	X	X	X	↔ Champion user	X	Diya Foundation	X
Training Provider	X	X	↔ Training	X	X	X	X	X	X	X	X	USHA Tailoring School (?)

7.2 Incubation Stage Eco-scope: Tailoring in Nalbari, Assam

	End-consumer	Buyer (and other intermediaries)	Entrepreneur	Enterprise	Finance Provider	Scheme Providing Government Agencies	Solar Materials Provider	Mechanical Solution Manufacturer	SELCO Foundation	Loan Guarantor, Gap Support	Entrepreneur Linkage and Support	Training Provider
End-consumer	Customer	↔	↔	X	X	X	X	X	X	X	X	X
Buyer (and other intermediaries)	↔	Wholesale Buyer	↔	X	X	X	X	X	X	X	X	X
Entrepreneur	↔	↔	Mansha	Money	↔	X	X	X	X	X	X	↔ Money
Enterprise (Solar solution provider)	Sometimes, depending on vulnerability	Sometimes, depending on vulnerability	→ Conviction to try solar, Intervention, Reliable servicing	Technovillage, Suraj Enterprises	Unlocking finance	Unlocking schemes	→ Push to supply to North-East	→ Push to supply to North-East	X	X	↔ Reliable servicing to beneficiaries	→ Demos, Clients
Finance Provider	X	X	↔	X	North East Grameen Vikas Bank	X	X	X	X	X	X	X
Scheme Providing Government Agencies	X	?	Schemes for women, physically handicapped, tribes	Might try for tenders	Various schemes such as PMEGP	NABARD	Certification	Certification	X	X	X	X
Solar Materials Provider	X	X	X	Materials	X	X	Suppliers	X	X	X	X	X
Mechanical Solution Manufacturer	X	X	X	Solution	X	X	X	Swinger, USHA	X	X	X	X
SELCO Foundation	X	X	X	All the knowledge to run the business	Banker training	?	Facilitation with Enterprise	Facilitation with Enterprise	SELCO Foundation	X	X	Demos
Loan Guarantor, Gap Support	X	X	Shock-proofing	Gap support money	Loan Guarantee	X	X	X	X	SELCO Foundation, Diya Foundation	X	X
Entrepreneur Linkage and Support	Potential leads	Potential leads	Conviction to try solar (access to training, subsidy, finance)	↔ Potential leads	Unlocking finance for beneficiaries	X	X	X	X	X	Diya Foundation	Demos
Training Provider	X	X	↔ Training	Clients	X	X	X	X	X	X	X	USHA Tailoring School

7.3 Replication Stage Eco-scope: Roti Rolling, in Hubli-Dharwad, North Karnataka

7.4 Livelihood Sector Eco-scopes Legend

Row to Column transfer, diagonal gives example of entities

	Functions that must exist for stated business activity to take place.
	Functions that make the ecosystem inclusive.
	Minor or one-off interaction.
	This interaction will go away after the innovation phase is complete.
	This interaction is optional in the innovation phase.
?	Did not hear about this link, but it might exist.
↔	A positive-sum transaction.
→	This direction requires much, much more effort even though there is a potential for a win-win relationship.
X	Doesn't exist.

7.5 Health Sector Eco-scope: A community health clinic, a primary health clinic or a sub-centre in the Cherrapunji region of Meghalaya

	Patients	Clinic (Users of DRE and Health Infrastructure)	ARS (Aarogya Raksha Samiti) (PHC and above)	Financers	Maintenance Provider	Maintenance Provider
Patients	Patients	X	Collect need information	X	X	X
Clinic (Users of DRE and Health Infrastructure)	Better services	Doctor, Auxiliary Nurse Midwife, ASHA Worker, Lab Technician	Collect need information	Nudge to provide system	Info for repair	X
ARS (Aarogya Raksha Samiti PHC and above)	X	X	Doctor, Asha Worker, Community Member	Nudge to provide the system, some financing	Ensure proper maintenance, some financing	Ensure proper installation
Financers	X	X	Some money to allocate	Government, Sustain+ (SELCO Foundation)	X	Purchasing Money under scheme
Maintenance Provider	X	Repair knowledge	Training Update	X	Karuna Trust, Technology Provider	X
Technology Provider	X	The system, repair knowledge	X	X	System information	Lits and Lights, Envo Solar, SELCO India

7.6 Health Sector Eco-scope Legend

Row to Column transfer, diagonal gives example of entities

	Functions that must exist for the system to be installed in the clinic.
	Functions that ensure the system remains functional long-term.
	Minor or one-off interaction.
X	Doesn't exist.

7.7 Learning rate analysis using Incubation stage Eco-scope

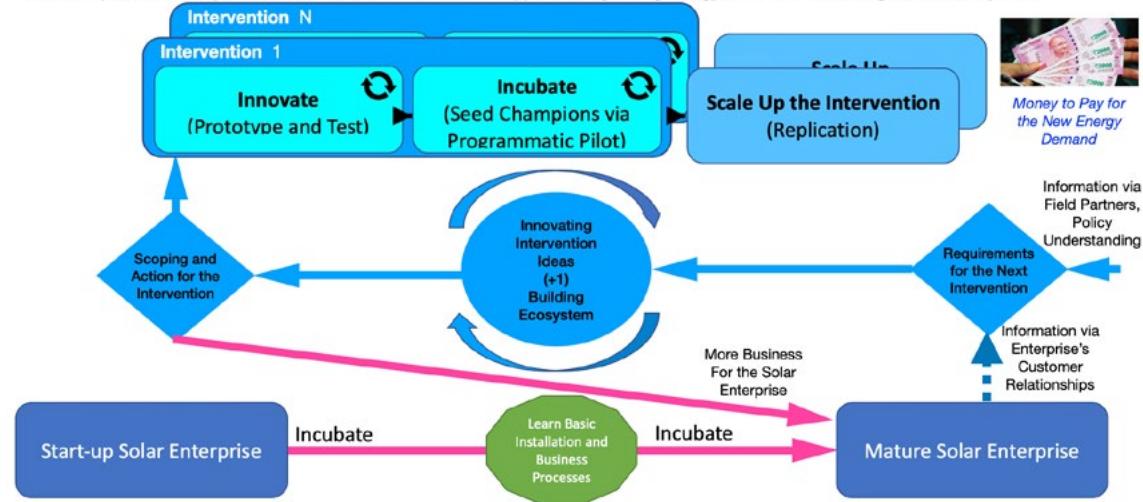
∞ (Every individual instance requires a fresh approach, capability building, constant uncertainty, searching, customization), α (With each instance, the time to finish decreases), α/∞ (Mix of both)

	End-consumer	Buyer (and other intermediaries)	Entrepreneur	Enterprise	Finance Provider	Scheme Providing Government Agencies	Solar Materials Provider	Mechanical Solution Manufacturer	SELCO Foundation	Loan Guarantor, Gap Support	Entrepreneur Linkage and Support	Training Provider
End-consumer	Customer	$\leftrightarrow \alpha$	$\leftrightarrow \alpha$	X	X	X	X	X	X	X	X	X
Buyer (and other intermediaries)	$\leftrightarrow \alpha$	Wholesale Buyer	$\leftrightarrow \alpha$	X	X	X	X	X	X	X	X	X
Entrepreneur	$\leftrightarrow \alpha$	\leftrightarrow	Mansha	α	α/∞	X	X	X	X	X	X	$\leftrightarrow \alpha$ Money
Enterprise (Solar solution provider)	∞ Sometimes, depending on vulnerability	∞ Sometimes, depending on vulnerability	$\alpha/\infty \rightarrow$	Technovillage, Suraj Enterprises	α/∞ Unlocking finance	α/∞ Unlocking schemes	$\rightarrow \alpha$ Push to supply to North-East	$\rightarrow \alpha$ Push to supply to North-East	X	X	$\leftrightarrow \alpha$ Reliable servicing to beneficiaries	$\rightarrow \infty$ Demos, connection to entrepreneurs
Finance Provider	X	X	α/∞	X	North East Grameen Vikas Bank	X	X	X	X	X	X	X
Scheme Providing Government Agencies	X	?	α/∞ Schemes for women, physically handicapped, tribes	α Might try for tenders	∞ Various schemes such as PMEGP	NABARD	α Certification	α Certification	X	X	X	X
Solar Materials Provider	X	X	X	α Materials	X	X	Suppliers	X	X	X	X	X
Mechanical Solution Manufacturer	X	X	X	α Servicing	X	X	X	Swinger, USHA	X	X	X	X
SELCO Foundation	X	X	X	∞ All the knowledge to run the business	∞ Banker training	?	α Facilitation with Enterprise	α Facilitation with Enterprise	SELCO Foundation	X	X	X
Loan Guarantor, Gap Support	X	X	∞ Shock-proofing	∞ Gap support money	∞ Loan Guarantee	X	X	X	X	SELCO Foundation, Diya Foundation	X	X
Entrepreneur Linkage and Support	∞ Potential leads	∞ Potential leads	∞ Conviction to try solar (access to training, subsidy, finance)	$\leftrightarrow \infty$ Potential leads	α/∞ Unlocking finance for beneficiaries	X	X	X	X	X	Diya Foundation	α Demos
Training Provider	X	X	$\leftrightarrow \infty$ Training	∞ Clients	X	X	X	X	X	X	X	USHA Tailoring School

A Depiction of the Theory of Change behind the Work of Selco Foundation

Ecosystem Theory of Change

Incubate Enterprise as a the Ecosystem Anchor; on top of it, innovate continuously to introduce New Applications, incubating with each the Entrepreneurs with profitable business models that can support their growing energy demand as there is greater development





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