Strengthening Supply Chains:

A HANDBOOK FOR COOKING FUEL ENTERPRISES

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

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ABOUT THE HANDBOOK

This handbook is meant to be used as a guide for enterprises interested in strengthening their fuel supply chains. Companies that produce and/or distribute cooking fuel can use the information to compare their development stage and their model to that of the companies highlighted in this handbook and use the experiences to inform their own scale-up strategies. While this guide is oriented towards cooking fuel enterprises, the overall objectives and results are applicable to a broader set of stakeholder audiences.

GLOBAL ALLIANCE FOR CLEAN COOKSTOVES

This effort is an initiative of the Global Alliance for Clean Cookstoves, a public-private partnership with a mission to save lives, improve livelihoods, empower women, and protect the environment by creating a thriving global market for clean and efficient household cooking solutions. Key components of the Alliance's strategy are to strengthen the supply of clean cooking solutions, both stoves and fuels, and to support the development of commercially viable and scalable enterprises.

The Alliance works with partners and sector experts to improve the utilization of biomass and to strengthen supply chains and markets for cleaner fuels over time. The foundation of the Alliance's fuels strategy is an understanding of the challenges, benefits, and impacts of different fuel types. This foundation supports work to improve processing, distribution, end use, and consumer awareness in order to create a sustainable and thriving market for fuels.

The Alliance partnered with ENEA to provide capacity building support to fuel enterprises focusing on efficient biomass fuel supply chains. Supporting greater capacity, more efficient production, and distribution of optimized biomass fuel sources will help fuel enterprises overcome market barriers to scale, strengthen their business models, as well as influence government and investor support for more efficient and cleaner cooking fuels. It will also enable local populations to access cleaner fuels for household energy use, helping to reduce the devastating health, gender, livelihood, and environmental impacts that result from cooking over open fires, burning solid and unprocessed biomass, and using traditional cookstoves.

ENEA CONSULTING

ENEA Consulting is an independent strategy consultancy specialized in the energy transition and sustainability, with offices in Paris, Melbourne and Hong Kong. ENEA works with a wide range of actors in the energy value chain, from global energy majors to major investors, from entrepreneurs to international institutions. ENEA Consulting is committed to supporting and accelerating energy access. The firm has provided consultancy services to more than 60 companies, social enterprises, NGOs and public institutions to help them increase access to energy in developing countries. These missions are carried out both on a commission, and, where necessary, through ENEA Consulting unique pro bono support to early-stage entrepreneurs and NGOs selected for their high impact potential.

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Introduction

1.1 Objective of Enterprise Capacity Building

As part of its overall fuel strategy, the Global Alliance for Clean Cookstoves (Alliance) supports the scale-up of promising, cleaner and more efficient fuel supply chains. To identify these, the Alliance evaluates the benefits, challenges, and impacts of all viable fuel options within a given context, ranging from processed solid biomass to liquid and gas fuels. The results of these evaluations are applied across global, country, and enterprise levels.

- At the global level, the results of these efforts are strategically disseminated in order to inform other stakeholders on best practices for identifying and addressing value chain inefficiencies, improving and replicating business models, and attracting partners and investors.
- At the country level, this global evaluation helps the Alliance identify opportunities where advocacy and policy interventions can strengthen a country's enabling environment for clean fuel supply chains.
- At the enterprise level, the Alliance provides innovation support, grant funding, and capacity building programs to fuel companies at different stages of development, while also tailoring support to address the specific barriers faced by alternative fuel companies.

This strategic approach aims to highlight opportunities to improve the production, distribution, and utilization of fuels. The ultimate objective is to increase the availability and affordability of higher quality fuel products that have the potential to reduce environmental and health impacts associated with traditional cooking practices with inefficient fuels.

The Alliance released a Call for Projects in June 2016 to support biomass enterprises performing at Tier 2 or better for efficiency, indoor emissions, and total emissions.[1] "Efficient biomass" in this context includes processed solid biomass and biomass-based ethanol. Three enterprises were selected at different levels of development, from early pilot phase, with only a few dozen customers, to companies with several hundred customers and planning for further expansion. The capacity building support was designed to help these fuel enterprises by providing a set of tailored decision-making tools and recommendations as they developed their scale-up strategies. Scale-up refers to the transition from a local company focused on validating the feasibility of its project to a regionwide or nationwide company providing its solutions to the mass market.

1 http://cleancookstoves.org/technology-and-fuels/standards/iwa-tiers-of-performance.html

1.2 Purpose of the Document: Objectives and Target Audience

Each of the three selected fuel enterprises had unique needs, but also a set of shared challenges that are common amongst most enterprises, including:[2]

- Reorientation of business models to adapt to evolving scale-up plans
- Availability of supply and sustainability of feedstock at scale
- Understanding new market potential before planning for expansion
- Overall environmental impacts across the fuel supply chain

With this in mind, this document was designed to share key information and insights illuminated by the tools and methodologies developed for the three grantees. Other fuel enterprises can benefit and learn from their experiences and use them to support decision-making and strategic planning. The document is not meant to be a step-by-step guide but rather to frame fuel enterprises' business and market considerations in a more structured and strategic fashion and strengthen short-, medium- and long-term decision-making. Where relevant, the sections use the experiences from the three fuel enterprise consultancies to provide context to illustrate why the tools and methodologies are useful and how they are used, and to demonstrate the results and recommendations that each approach can yield.

The three selected fuel enterprises were:

- **Leocome** in Kenya—sources ethanol from a local sugar company and sells the fuel along with ethanol stoves.
- **Dazin** in Bhutan—works with rural households to provide stoves for lease and free fuel cookies in exchange for wood waste and is planning to expand to the Indian market.
- **Inyenyeri** in Rwanda—provides locally manufactured biomass fuel pellets and gasifier stoves to rural and urban households.

An illustration of the business models of each can be seen in Figure 1.1 on page 4.

ENEA Consulting, one of Alliance's partners, worked with the enterprises to identify their fuel production potential and help them set strategic business targets. The scope of the three consultancies was also guided by the results of another Alliance-commissioned resource—FACIT, or the Fuel Analysis, Comparison & Integration Tool. The study used a life cycle modeling approach to quantify the environmental impacts of cooking fuel procurement, production, distribution, and use, and identified opportunities to improve environmental impacts in fuel supply chains. The results from FACIT highlighted fuel value chains, such as ethanol and pellets, which demonstrated positive environmental footprints while also revealing efficiency improvements that could have impactful outcomes. The Alliance used this information to define the call for projects, to guide decision-making process when selecting the three finalists, and when defining the scopes of work for the enterprises. The data and results from FACIT were also used as inputs for the methodologies during three consultancies.

To access the full report online, visit: **cleancookstoves.org/facit** under the Resources tab.

The document is organized by the common enterprise challenges listed above. Each chapter describes key insights that resulted from using the tools and/or methodologies that were developed for the three enterprises. A number of the tools were designed as interactive Word or Excel

2 This list is not representative of all challenges faced by fuel companies, only the most common identified through these consultancies.

FIGURE 1.1: OVERVIEW OF THE THREE ENTERPRISE BUSINESS MODELS

	INYENYERI		DAZIN		LEOCOME	
	BIOMASS PELLETS currently made of tree waste (branches and fallen trees), urubingo (local grass), and sawdust **+ STOVES** imported from abroad		**BIOMASS BRIQUETTES CALLED "COOKIES"** currently made of tree waste (branches and fallen trees), bushes, and sawdust **+ STOVES** imported from abroad		**ETHANOL** currently supplied by Kenyan sugar companies **+ STOVES** imported from abroad	
1 SUPPLY	**TREE WASTE & URUBINGO** **SOURCE:** Rural households' collection **TRANSACTION:** Households exchange tree waste and urubingo for processed pellets and stove lease membership.	**SAWDUST** **SOURCE:** Sawmills **TRANSACTION:** Sawdust purchased from sawmill.	**TREE WASTE & BUSHES** **SOURCE:** Rural households' collection **TRANSACTION:** Households exchange tree waste and bushes for processed pellets and stove lease membership.	**SAWDUST** **SOURCE:** Sawmills **TRANSACTION:** Sawdust purchased from sawmill.	(CURRENT MODEL) **ETHANOL** **SOURCE:** Purchased ethanol directly from ethanol producers (Kenyan sugar companies).	(POTENTIAL MODEL) **CROP WASTE** **SOURCE:** Purchase raw material like sugarcane waste from providers, and pay farmers to grow additional crops for a longer term supply.
2 PRODUCTION	**INTERIM, DECENTRALIZED PROCESSING:** Large pieces of tree waste are shredded in decentralized wood chippers local to rural collection areas, then transported to centralized processing. **CENTRALIZED PROCESSING:** Wood chips and sawdust processed into pellets at centralized pellet factory.		**CENTRALIZED PROCESSING:** Large pieces of wood shredded with wood chippers located at centralized briquette factory. Wood chips and sawdust processed into pellets at factory.		(POTENTIAL MODEL) **COMPANY-OWNED PROCESSING:** Build a microdistillery/factory to turn raw material into ethanol.	
3 SALES AND DISTRIBUTION	**DISTRIBUTION TO URBAN MARKETS:** Urban households purchase pellets and stoves in local stores, at prices that allow subsidation of stoves for rural markets.		**DISTRIBUTION TO URBAN MARKETS:** Schools purchase fuel cookies and use leased stoves providing revenue to subsidize the stoves for rural markets.		(CURRENT AND POTENTIAL MODELS) **STORAGE:** Ethanol fuel and stoves are stored in a facility owned by Leocome. **DISTRIBUTION VIA WOMEN'S GROUPS:** Women's groups sell ethanol fuel and stoves to urban markets and urban customers.	

documents that can be accessed on the Alliance's website and easily understood and used by other fuel enterprises. Appendices provide more detail on how to use each tool.

- **Section 2 – Reorienting Business Model Priorities:** This section focuses on using a strategic visualization tool to understand, prioritize and re-focus the building blocks of a business model as fuel entrepreneurs plan their scale-up strategies.
- **Section 3 – Modeling Available Supply**: This section focuses on using simple supply curves as a tool to assess local feedstock availability and to forecast short-, medium- and long-term supply options.
- **Section 4 – Prioritizing New Markets**: This section examines a process and tool developed to assess a business model's (specific to bartering models) economic viability when considering expansion to a new geography.
- **Section 5 – Assessing Value Chain Sustainability**: This section focuses on a methodology to assess the environmental impacts of the value chain of the three enterprises.

1.3 Limitations

While this guide provides insights, recommendations and tools that are applicable to a broad range of fuel entrepreneurs, it is important to note that these methodologies and tools were tailored to the *specific* context and stage of development of these entrepreneurs and caution is recommended when transferring their use and/or conclusions to other cases. The tools should not be used to make absolute determinations about the business, but instead, as a guide and framework for stronger decision-making. Moreover, one should keep in mind that these consultancies did not cover all the challenges an entrepreneur will face while planning for scale-up.

Throughout the different sections, readers will be provided with a brief background of a given company to understand the need for each tool, what each tool does, and what type of results would be expected. The background also shares some key findings for other fuel companies looking to these to address similar challenges. Supplemental appendices provide more detail on each tool.

PART TWO

Reorienting Business Model Priorities

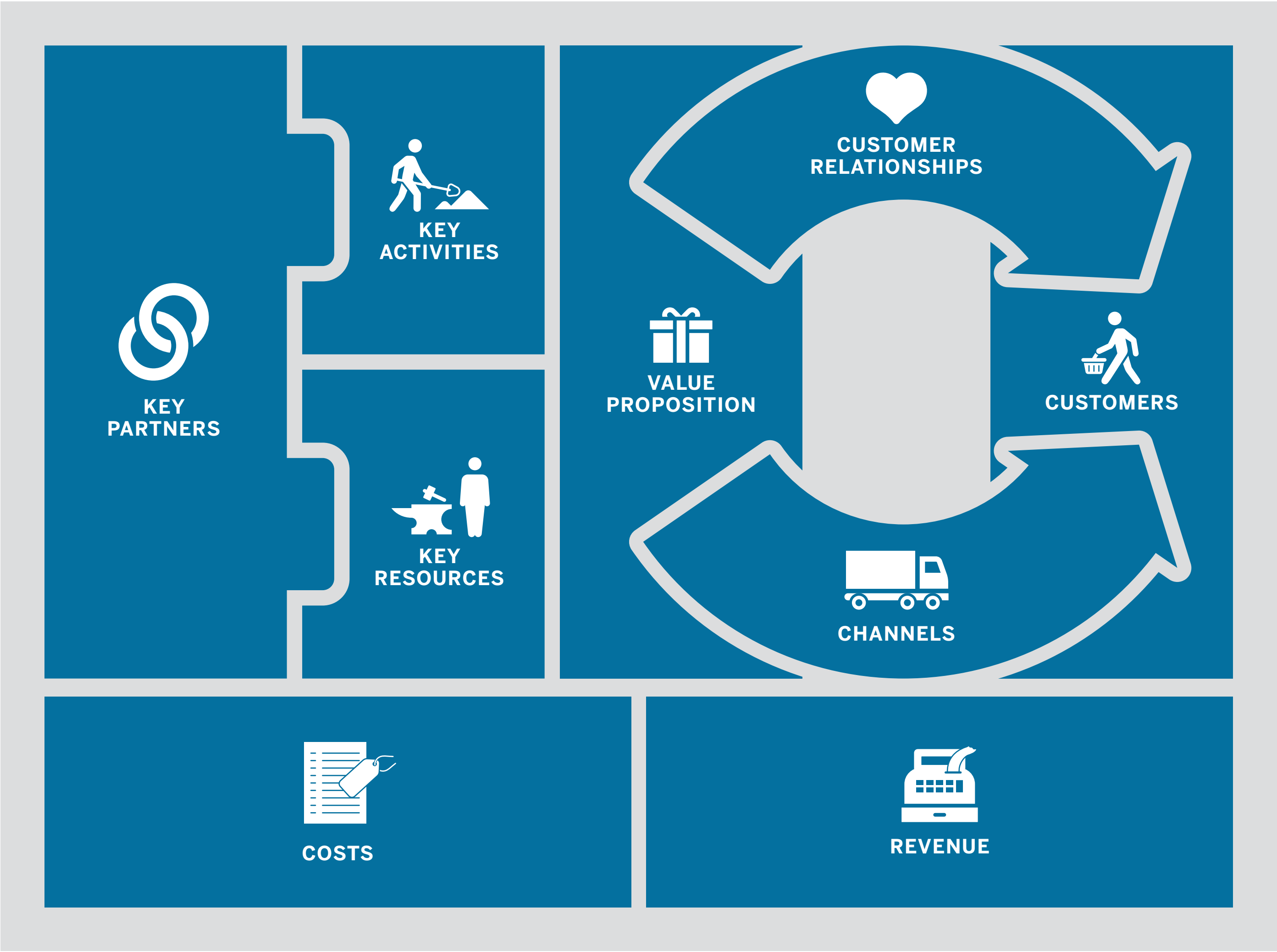
Businesses often struggle to describe, frame and organize their business models and to adapt their models under changing conditions and evolving scale-up strategies. This issue spans across sectors, including the cookstove and fuel sector. A Business Model Canvas (Canvas), shown in Figure 2.1 below, is a strategic management tool that helps entrepreneurs to visualize all of the building blocks of a business as individual segments. It is a simple way to give structure to the elements of a business plan and help the entrepreneur understand the key drivers of their business. Ultimately, it is meant to help businesses recognize and act on areas that can be improved or updated as external market and internal structural conditions shift. In the context of fuel enterprises, the Canvas can highlight areas that need a stronger focus in the near term vs. longer term and help to prioritize strategic planning steps.

The Canvas, which is a downloadable template,[3] categorizes the processes and internal activities of a business into nine separate categories, each representing a building block in the creation of a product or service.

- **Customer Segment** – These are all of the people and organizations for which a product or service is creating value. The features of the business model and its product or service should align with each segment's characteristics and needs.
- **Value Proposition** – This is the combination of products and services that create value for the customers and are both quantitative and qualitative in nature. For each segment, there should be a specific value proposition related to price and efficiency of the product or service and the experience and results that the product and its use produce.
- **Channels** – The channels describe the touch points through which a business is interacting with customers and delivering value. The ideal channels are ones that are the quickest and most efficient with the least amount of investment required.
- **Customer Relationships** – This outlines the type of relationship to be established with customers.
- **Revenue** – This makes clear how (the method uses to get customer segments to purchase the product or service) and through which pricing mechanisms the business model is capturing value.
- **Key Resources** – These represent the assets of the company that are fundamental to how it provides value to its customers.
- **Key Activities** – This identifies the activities that are absolutely needed to produce, market and deliver a company's value proposition.

3 The Canvas was developed by Alexander Osterwalder and Yves Pigneur in 2009. It has become a recognized reference to easily display the different components of the business model of a company or a project. The template is publicly accessible on the dedicated website: https://strategyzer.com/canvas/business-model-canvas

FIGURE 2.1: NINE BUILDING BLOCKS OF THE BUSINESS MODEL CANVAS



- **Key Partners** – This provides an understanding of which partners and suppliers can leverage the model. It can help to identify what key activities and resources a partner can take on so that the company can focus on its value proposition.
- **Cost Structure** – This defines how key activities drive costs and if these costs are aligned with the value proposition.

The core of the company's offer—its value proposition linked to a given market segment—is usually the first priority of an entrepreneur. The company's resources, activities and its distribution channels are the means to achieving the value proposition and are especially relevant for scale-up plans. Focusing on key partners, customer relationships, and economic profitability will help build a successful company in the long term. One of the key value-adds of this business canvas approach is being able to understand how the nine building blocks relate to each other and the different ways the relationships can be changed to increase efficiency and effectiveness. Aligning all of the components in this canvas is key to preparing a scale-up plan.

ENEA utilized the Canvas to categorize the processes and activities of the three fuel enterprises and develop targeted scopes of work for each based on each company's prioritized challenges. The canvas was used to further categorize issues and elements related to the market (external-facing) and those focused on internal business activities as seen in Figure 2.2. A number of those challenges were identified as common amongst enterprises working in the cookstove and fuel space and are highlighted in the next few sections of this guide to share relevant experiences, insights and methods to strengthen decision-making and business planning. More detail on the Business Model Canvas is in Appendix A.

FIGURE 2.2: MARKET-RELATED VS. INTERNAL BUSINESS MODEL ISSUES

Modeling Available Supply

The feasibility of biomass-related fuel projects largely depends on the economic viability, which is a factor of physical quantity of biomass resources available and total delivered price. As enterprises that produce or distribute cooking fuels attempt to scale, challenges related to the raw material supply become even more critical. For example:

- **To know whether the available feedstock will be sufficient for larger-scale operations** – As demand for a fuel product increases, limited supply can limit the scaling of activities if enough of the resource is not available or can subsequently increase the price of raw materials in local markets. This negatively impacts profitability and cost, and reduces consumer confidence.

- **To know how to invest in the appropriate production/processing facilities** – It might be necessary for a fuel company to adopt technology that can process multiple types of raw materials so that they are adaptable to diverse sources and variable supply.

- **To know which feedstock is available when entering or expanding into a new geography** – Market entry or expansion decisions should be determined in part by the availability of raw materials.

Therefore, modeling available supply of raw material is an important step for an enterprise to not only ensure sufficient and affordable raw material supply in the short term, but to forecast the medium- to long-term availability, pricing, and reliability of several potential sources.

To provide insightful analysis to answer these questions, entrepreneurs need tools that can explain feedstock availability in a simple, but impactful way. This section highlights one such tool and shares some key findings from the application of the tool used for an ethanol distributor in Kenya.

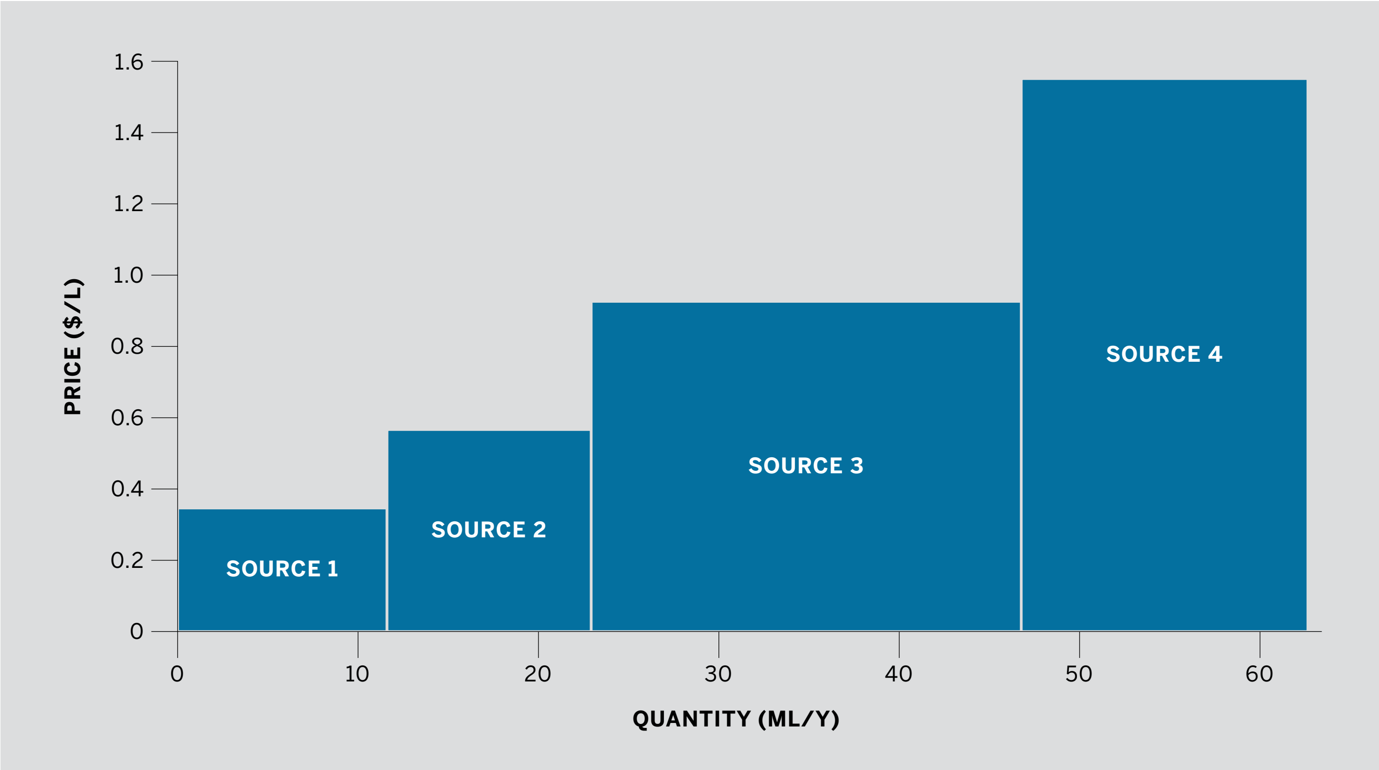
3.1 Tools to Address the Issue and How to Use Them

There are a variety tools and methods that can be used by companies to assess supply. One such simple, yet effective tool is a supply curve. A supply curve is a basic economic tool used to express and predict the price of a resource at a given quantity of demand. On a fuel supply curve, each possible source of biomass is associated with an available quantity and a cost (either market price or a complete cost that includes all costs up to factory processing, similar to an LCOE[4]).

Figure 3.1 on page 10 displays a sample supply curve that shows potential capacity in a hypothetical region for selected fuels or raw materials. Each source of supply is visualized as a rectangular box characterized by the volume available (width of the block) and its price (height of the block). The blocks are then sorted by ascending prices showing the cheapest available sources on the left. For instance, Source 1 in the Figure is cheap (US$ 0.36/L) but not plentiful (only 12 ML/year), whereas Source 3 is more expensive (US$ 0.9 /L) but more plentiful (30 ML/

4 LCOE, meaning levelized cost of energy, is an economic assessment of the average total cost to build and operate an energy-generating asset over its lifetime divided by the total energy output of the asset over that lifetime. Average total cost is equal to total cost divided by the number of goods produced.

FIGURE 3.1: EXAMPLE OF A SIMPLIFIED SUPPLY CURVE



year). What this tells us is that more biomass can be acquired in the form of Sources 2, 3, or 4, though at a higher cost. If enough biomass can be delivered sustainably at a low enough price while still ensuring a margin for the business, then enough biomass is available to supply that business with their resource needs.

More complex versions of supply curves would take into account that delivered costs vary by the type of biomass and distance or travel time and therefore transportation costs. With this approach, more costly resources that are closer in proximity may be more economically viable than cheaper resources that are further away or vice versa. As demand increases, a business may have to make the choice to purchase more expensive and distant resources.

To utilize a supply curve tool, fuel companies should follow several key preliminary steps outlined in Table 3.1 on page 11.

Once these steps are taken, they are ready to be used as inputs into a supply curve tool such as the one located on the Alliance website.

TABLE 3.1: STEPS FOR USING A SUPPLY CURVE METHODOLOGY

STEPS	SCOPE	POTENTIAL SOURCES OF DATA
1. IDENTIFY ALL SUPPLY SOURCES		
NON-PROCESSED FUELS	If the fuel enterprise is involved or plans to get involved in the conversion of the raw material (crops, residues, etc.) into a fuel product, it needs to identify the different supply sources of raw material.	Often found through national registries or statistics or direct contact with suppliers (biomass suppliers such as forest concession owners, farmers, landowners, mill owners, etc.).
PROCESSED FUELS	If the fuel enterprise directly purchases or procures the final fuel product from another supplier/distributor (ethanol, pellets, etc.), it needs to rigorously identify all the stakeholders in the market.	Often found through national registries or statistics or direct contact with suppliers.
2. QUANTIFY THE CAPACITY FOR EACH SOURCE		
NON-PROCESSED FUELS	Assessing the supply of each crop includes an assessment of the agricultural potential of the region for different crops.	National statistics or direct contact with suppliers* may be able to provide information.
PROCESSED FUELS	Assessing the supply of the fuel in a territory requires quantifying the existing supply capacity. It starts with investigating current production levels, collected at a national level or for each supplier independently, but can also require accounting for the level of unused capacities, or production margins.**	National statistics can be relevant for CAPEX*** intensive and concentrated sectors, where the number of factories is limited. Direct contact with suppliers may be necessary for more detailed information.
3. QUANTIFY THE PRICE OF EACH SOURCE		
NON-PROCESSED FUELS	When comparing several crops that require different processing, it is necessary to integrate all processing costs into the cost of the supply and to build a techno-economic model† for each crop.	Potential biomass suppliers, such as forest concession owners, farmers, landowners, and mill owners, may be able provide information. For processing costs, it is necessary to combine literature data and operational feedback to get realistic figures.
PROCESSED FUELS	This price can be a direct market price for fuels already available on the market.	NA

CAUTIONS/RECOMMENDATIONS: Gathering this information will be time-consuming but highly beneficial in order to have a robust analysis. There will be uncertainty as quantities and prices of biomass fluctuate with agricultural and forestry practices and market conditions. A good practice is to identify a range of possible values for each resource so that you can assess "worst case," "most likely," and "best case" scenarios. To be able to compare different sources in the same supply curve, it will also be important to convert to consistent units.

* This type of analysis is sometimes already available for large countries. This was the case for Kenya where national statistics were a reliable source of this data. If the market is limited to a few suppliers, the data can come from direct contact with these raw material suppliers.

** The difference between current production levels and installed capacity.

*** CAPEX, or capital expenditure, refers to expenses a business incurs to create benefit in the future, i.e. machinery or buildings.

† A techno-economic model would take into account all the CAPEX and OPEX (operational expenditure) of the facility and model its output to calculate the complete costs of the product.

3.2 What Results to Expect

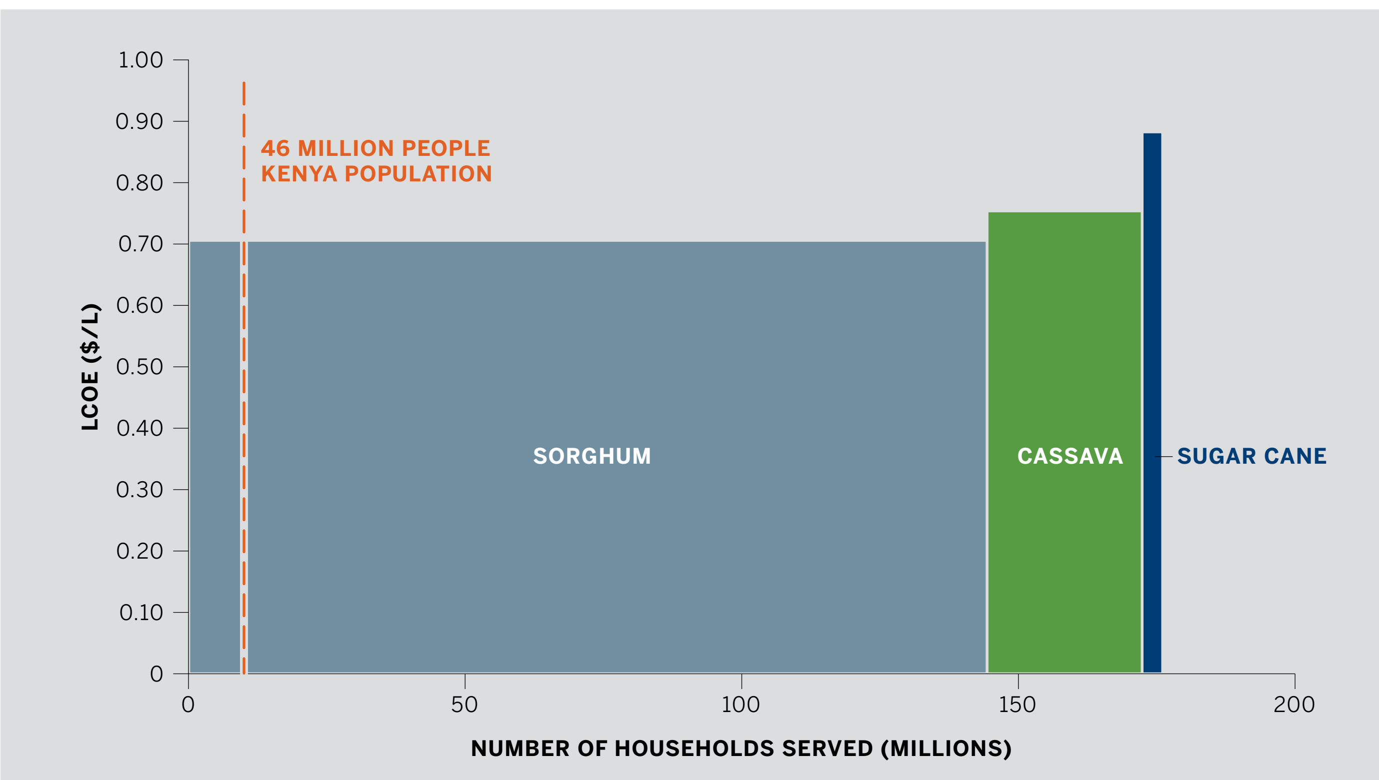
Supply is a strategic concern for fuel companies. It impacts key decisions of a company regarding its economic balance (cost of sustainable supply vs. public price), the activities of the company (when raw material production must be internalized), and its technology choices (which depend on the type of supply sustainably available).

Alliance grantee, Leocome, sources low grade ethanol from a local Kenyan sugar company for a low price. Their strategic plans involved shifting from this model to in-house ethanol production via micro-distilleries that Leocome would install. The rationale behind this potential strategy shift was to be able to diversify their ethanol supply, create positive local development through the micro-distillery, and ability to control the whole ethanol value chain. Making this transition to a model where Leocome would procure and process the raw materials directly would be a significant and demanding step, both financially and technically, and they had not yet assessed the feasibility of such an approach. ENEA's support was designed to help Leocome assess the risks and opportunities of their potential strategic decisions based on an assessment of the supply landscape in Kenya.

To utilize the supply curve method for Leocome, accurate data on costs and quantities for each potential supply source was required. Some data was available on ethanol production and prices in the country, but given the complexity of a potential distillery model, an additional step was taken to design a financial model to project the production costs of Leocome's potential micro-distilleries using various raw materials. This more complex supply curve analysis helped draw out a number of important conclusions:

- One of Leocome's motivations to develop a micro-distillery was to diversify their supply since they believed their current ethanol supply was limited. However, the supply curved helped reveal that within their current supplier, Leocome was only tapping into a small share of the supplier's annual production of low (technical) grade ethanol. It was also determined that a more common version of ethanol (extra neutral grade) was an available alternative but at a higher price, comparable or lower than in-house production.

FIGURE 3.2: ETHANOL SUPPLY CURVE INCORPORATING ADDITIONAL PRODUCTION CAPACITY BASED ON MAXIMUM RAW MATERIAL SUPPLIES AVAILABLE IN KENYA



Producing their own ethanol would be an added expense and use of resources when untapped ethanol sources were readily available at a similar or slightly higher price than current sourcing options.

- Producing fuel directly from raw materials is a demanding activity for start-up companies such as Leocome, both financially and technically. Looking towards its long-term customer targets, Leocome would require additional feedstock sources. Based on the data collected on the available land for each alternative crop identified (sorghum, cassava, sugar cane, maize) and the levelized cost (LCOE) of ethanol, Figure 3.2 on page 12 highlights the potential for sorghum as a long term secure source of supply.[5]

Utilizing the supply curve provides a company with view of potential opportunities within their current model that might not otherwise be apparent. Applying this tool to the ethanol market in Kenya helped Leocome build a supply chain roadmap and contribute to more effective business planning. The overall supply curve assessment concluded that:

- **In the short term**, the company should focus their efforts and resources on customer acquisition. Current levels of existing ethanol production in Kenya would provide enough ethanol supply to Leocome to meet their current demand and immediate business objectives, so short-term concerns about their ethanol supply did not need to be a priority.
- **In the medium term**, the company should develop a strategy for alternative raw material sources such as sorghum, which was observed to have good long-term supply potential (see Figure 3.2 on page 12) This could be initiated by working with existing actors in the agricultural sector to encourage or incentivize crop development and overcome future supply shortages.
- **For the long-term**, Leocome should continue researching the implementation of micro-distillery technology in order to determine how best to process feedstock such as sorghum in the future or if outsourcing production is a viable option.

This analysis demonstrated that a better understanding of fuel supply can highlight opportunities as well as limitations and additional factors to consider. The immediate use of supply curves is to be able to choose among several suppliers, each providing different feedstocks. However, for entrepreneurs willing to process feedstocks themselves, the knowledge of available options, in what volume, and at what price over time can have a strong impact on the technology selected to process those feedstocks into fuel.[6] Supply curves can also be used as a way to demonstrate to investors that the company is incorporating short and long term thinking into their strategies.

5 Sugarcane and maize were not deemed as viable alternatives mainly due to higher crop cost, lower availability of suitable land and high risk of competition with food crops.

6 In cases where entrepreneurs want to process fuel in-house, anticipating biomass availability is key to selecting and investing in production technologies that can be easily adapted to different types of biomass, and can reduce overall CAPEX on production plants. This might also increase the use of production facility, as local production of ethanol from crops depends on crop seasonality, which varies significantly by country.

PART FOUR

Prioritizing New Markets

Companies that have successfully piloted their ideas in one region often look to replicate their models in new geographies. Replication refers to the transfer of a tested concept, a pilot project, or a small enterprise, to a different location in order to repeat success elsewhere. Successful replication is dependent on a variety of internal and external factors. Before a company can bring their product(s) to a new area, it must first have a clear understanding of the opportunities and barriers that exist in a new region. Then it can use these factors as inputs to a "go" or "no go" decision and to determine which elements of the strategy should be fixed, and which should be adapted or re-worked for the for the new location. For fuel enterprises, this means taking additional steps to understand the local fuel supply in addition to general market characteristics.

A few key factors must be assessed in the new market:

- Interest and willingness of the local population to adopt the proposed cooking solution
- Volume of potential consumers
- Consumer behavior related to cooking and fuel purchasing habits
- Feedstock availability
- Characteristics of the distribution networks
- Existing policy environment

This section explains a) the basic steps needed to carry out a preliminary market assessment, and b) how to use a decision-making tool to assess the economic viability of an existing bartering model[7] in new market conditions. The case of a biomass fuel company, Dazin, expanding from Bhutan to Assam, India is used to illustrate how such a tool can be used to make informed decisions regarding potential expansion of a company to a new area.

4.1 Tools to Address the Issue and How to Use Them

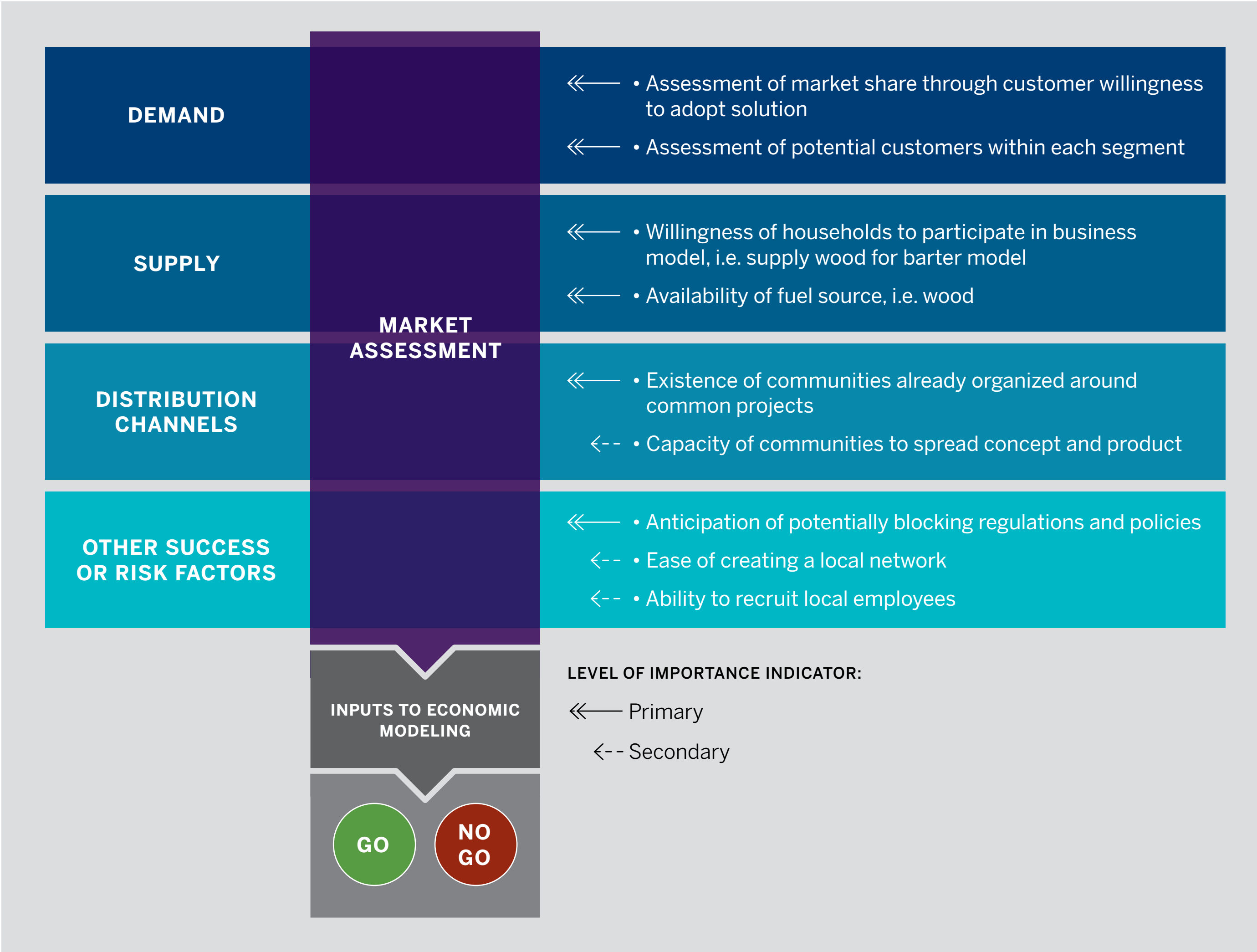
A multi-pronged approach is needed to make "go" or "no go" decisions regarding market replication. In addition to desk research, in-person investigation is necessary to gauge local challenges with respect to customer needs, available raw material, and supplier and distributor networks. The results of this research can then be used as inputs to a Market Replication Tool designed to test different parameters and assess the impacts on the business' economic viability.

4.1.1. PRELIMINARY MARKET ASSESSMENT STEPS

The first step of a market assessment is to take stock of the structure and key elements of the company's existing model in the current region. This will become the starting point to collect comparable data points in the new region. As information is gathered for the new region, it should be refined progressively as market knowledge increases. This approach is inspired by the *Discov-*

7 The tool was designed specifically for the context of a barter model in which there is an exchange of products to receive other products/services. The tool would be applied to other enterprises also using a similar model but the overall methodology can be used as a guide for other models.

FIGURE 4.1: MARKET ASSESSMENT CONSIDERATIONS



ery-driven planning method,[8] a planning technique that assumes that when operating in areas with significant amounts of uncertainty, parameters may change as new information is revealed. It is therefore key to identify critical parameters up front and then to check and validate the values in the new region. Figure 4.1 illustrates the key parameters to consider for this methodology.

The steps include:

1. Identify and consolidate all information about business activities in the country of origin to identify all key parameters of that specific market.

2. Then, for each of the parameters identified, collect the comparable data points in the new region during field visits since they will have different values. Four main data points should be prioritized:

   - **Demand quantification**: the willingness of the customers to adopt the solution, volumes of potential customers in eachtype of consumer segment

   - **Supply quantification:**[9] the availability of feedstock and willingness of target households to adopt the business model;

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8 R. McGrath et I. McMillan, Discovery-driven planning, Philadelphia: Wharton School, Snider Entrepreneurial Center, 1995.

9 The Supply Curve described in Section 3 can be useful for this step.

- **Distribution channels**: the identification of distribution channels with similar characteristics to the original model;
- **Other success or risk factors**: more qualitative in nature, the identification of success factors that can be complementary to new market entry, or barriers that can slow down or prevent new market entry.

This market information then becomes the input to a tool that was developed through the capacity building conducted by ENEA.

- Modeling the Economic Viability of Market Replication

A dedicated Market Replication Excel Tool was designed[10] to develop financial projections and to assess the economic viability[11] of a business model entering a new region. The tool takes into account information such as raw material supply and fuel production, and the characteristics of the new market to be addressed. It also incorporates inputs such as current and planned investments, operational costs, and stove and fuel sales. The more detailed information that is included into the tool, the more rigorous and meaningful the outputs will be to provide results such as:

- **Critical parameters:** Elements of the business model that most directly influence economic viability.
- **Company profitability:** Fuel company's net present value[12] (NPV) and breakeven point in the new market, and the fuel product market price, given a defined profitability target.
- **Customer financial return:** Customer payback time[13] and net present value compared to current cooking solution, for each consumer segment.

A more detailed explanation of how to use the Market Replication Tool is outlined in Appendix C.

4.2 What Results to Expect

The goal of market replication is not to copy the business model exactly—but to replicate key components of the model while adapting to the new target market and environment. The combination of the market assessment and the Market Replication Tool provide a framework to reveal the most critical aspects that a fuel enterprise should keep in mind when making a decision to replicate in a new market.

Alliance grantee, Dazin, utilizes a model based on sourcing raw materials from rural households to manufacture fuel cookies. In exchange, Dazin supplies both a gasifier stove (with a small deposit) and a free supply of cookies. Surplus cookies are then sold to urban markets, and stoves are provided to these markets in exchange for a deposit. The revenue from urban markets is used to subsidize cookie production and allow Dazin to provide a free supply of cookies to rural households. Dazin's solution entered the Bhutanese market in 2014, and its strategy is to replicate this model in India to target a much larger market. The company selected the state of Assam in India to test a market replication strategy, due to its short distance from Bhutan, high population density and availability of local forestry waste. ENEA's objective was to confirm the potential of Assam, specifically the Bongaigaon District, and provide recommendations for developing a roadmap.

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10 Note that the Market Replication Tool was designed for the case of a fuel enterprise like Dazin that utilizes a bartering model to obtain their wood supply but can be used as a starting point for other clean cooking companies to evaluate their economic viability.

11 Economic viability means that the revenues provided by the solution will at some point be higher than or equal to all made and planned expenditures.

12 The company net present value compares the initial company investment (working capital, workshops etc.) with the free cash flows produced by the activities during the next 5 or 10 years.

13 The customer payback time refers to the duration after which the initial investment (stove deposit) is compensated by the savings on fuel expenses.

4.2.1. MARKET ASSESSMENT RESULTS AND RECOMMENDATIONS

The market assessment phase highlighted a number of insights and recommendations as displayed in Table 4.1.

TABLE 4.1: MARKET ASSESSMENT OUTCOMES

FINDINGS	NEEDS FURTHER INVESTIGATION	RECOMMENDATIONS
DEMAND		
• School headmasters, restaurant and tea stall owners are paying customers able to opt for the solution. • Both men, as budget managers, and women, as future users of the solution, are involved in financial decision-making in households. • For households, stove deposits can represent a large amount of money and be a serious barrier. • Public organizations, such as schools, have varying levels of independence in policy decisions, which can limit their adoption speed due to long decision-making processes.	• Willingness to participate in the initiative should still be confirmed with practical implementation. • All potential market segments, e.g. pottery manufacturing, food/tea processing, schools, etc., require a systematic assessment.	• Interacting with decision-makers is invaluable. Once the key decision makers are identified, stove and fuel demos should be targeted to that audience and highlight the benefits of the new solution as well as the pitfalls of existing solutions. • Independent organizations (i.e. tea stalls and restaurants) do not face the same cost issue around stove deposits as households and could be strong short-term targets. Schools and industries should be secondary targets. • Lowering cookstoves deposits for rural households while raising fuel cookie sales price should be considered to foster adoption by rural households. However, availability of fuel cookies at multiple prices can create reseller issues so options should be carefully considered and communicated.
SUPPLY		
• The supply potential from rural households, focusing on wood from their own land or waste wood from community forests, the company's requirements for supplying urban and rural markets. • Communities visited expressed willingness to participate in Dazin's initiative. • The model's focus on community leaders is adapted to foster community adoption.	• Additional biomass supply potential from forest bushes and dust from saw mills requires further investigation. • Strategy to cope with seasonality of supply needs to be clarified and documented. • Efficiency gains with the model's cooking solutions compared to traditional solutions needs to be better documented. The overall model is dependent on raw material-cookie exchange rates, share of cookies production sold to urban market, etc.	• There is no need to build and own biomass collection centers within rural communities. Single collection points should be agreed upon with communities. • The company should keep control of the exchange of raw materials against cookies by having trusted employees weighing the exchanged products and validating these transactions.

TABLE 4.1 CONTINUED →

TABLE 4.1 CONTINUED

FINDINGS	NEEDS FURTHER INVESTIGATION	RECOMMENDATIONS
DISTRIBUTION CHANNELS		
• As in Bhutan, rural households form informal communities and these communities can be a strong ally to disseminate the solution through word of mouth to create interest and trust. • Some communities in Assam are already organizing themselves around other topics (i.e. self-help groups* and JFMCs**). They form particularly relevant targets for this cooking solution, which requires minimum group organization to supply households.	• Willingness to disseminate the solution should still be confirmed with practical implementation.	• Local structures and communities that are already in place, such as women-focused Self Help Groups, should be leveraged to foster participation and dissemination of the solution.
OTHER SUCCESS OR RISK FACTORS		
• Different forestry officers as well as NGOs are involved in forest protection which increases the lines of communication that need to be opened and sustained. • Current collection practices seem to be in line with forestry department rules.	• Influential local forestry officers and community leaders who could support the initiative need to be identified. • Strong relationships should be maintained with all local forestry officers.	• It is beneficial to engage early with local forestry officers and first build a local network with key community leaders in Bongaigaon district in order to build local support. • The company should engage further with Assam administration after concrete steps have been completed and in conjunction with central government in order to alleviate corruption issues. • Local supply and market development heads should be recruited due to the knowledge of local contexts required to successfully start the business. • Location of the production facility close to local highways (with good road infrastructure, reliable electricity and far from flooding risks) should be favored.

* Self-help groups are usually village-based communities proposing financial support to other people of the community or village.

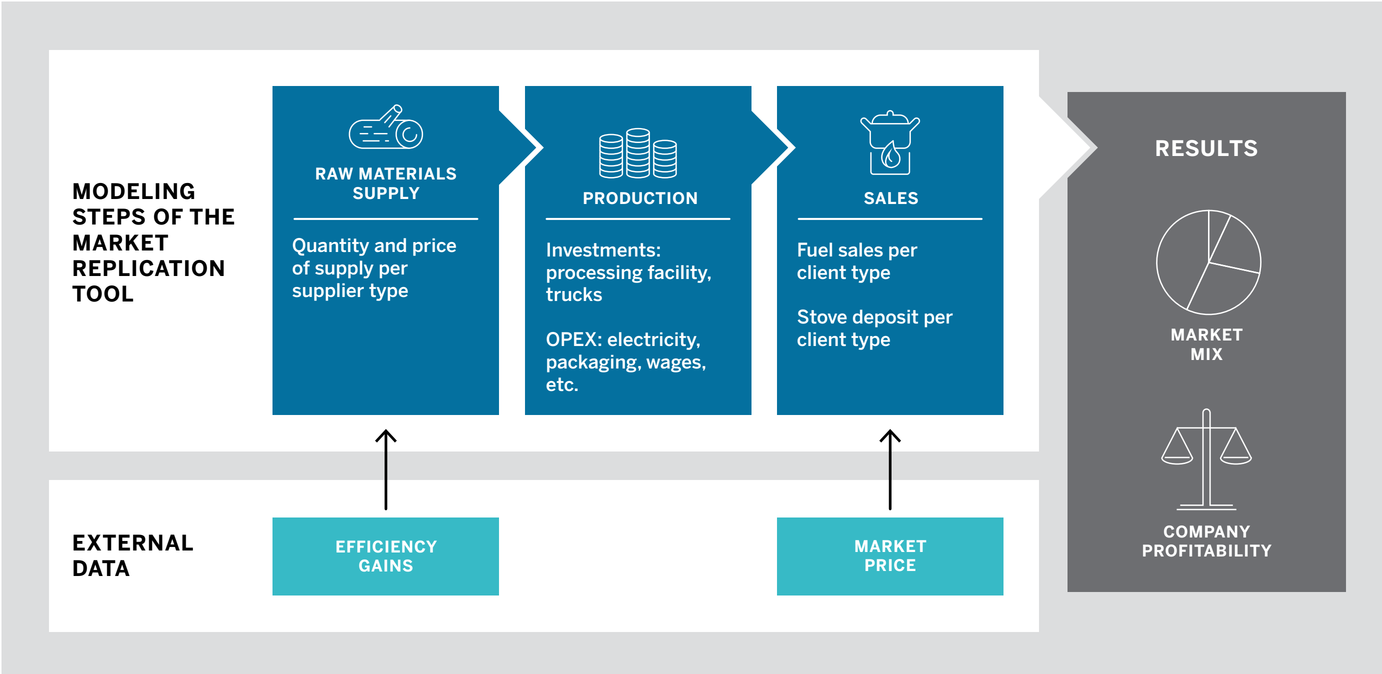
** Joint Forest Management Communities are communities involved in partnerships with the state forest departments in order to safeguard forest resources in exchange for forest products

4.2.2. MARKET REPLICATION TOOL RESULTS AND RECOMMENDATIONS

The second objective of the capacity building support was to assess the economic viability of Dazin's solution in the Assamese context using the Market Replication Tool. It is important to note here that the tool was designed specifically for a bartering model such as Dazin's. In this case, the value proposition is closely linked to the bundled stove and fuel solution and its ability to provide efficiency gains by delivering the same cooking service as current solutions but with less fuel, and hence provide fuel cost savings.

In order to perform this assessment, the structure and key characteristics of Dazin's model needed to be explored at a deeper level and included a number of current and planned cost, investment, and revenue estimations as highlighted at the top half of Figure 4.2 on page 19.

FIGURE 4.2: STRUCTURE OF DAZIN'S MODEL INPUT INTO THE MARKET REPLICATION TOOL AND RESULTING OUTPUTS



As mentioned in section 4.1.2, in addition to estimating Dazin's profitability and customer financial return, the tool identifies the elements of the business that most directly influence its economic viability. In the case of Dazin, the key parameters are:

- **Fuel pricing**: a financial analysis demonstrated that the initial pricing chosen by Dazin confirms its economic viability and provides savings to Dazin's customers, as well as being in line with the competition. This analysis was based on initial estimates of efficiency gains given influenced by Dazin's stove/fuel solution (see next bullet point).

- **Energy efficiency**: the analysis highlighted that the overall viability of the model highly depends on finding the balance between the free supply of cookies to rural households and amount sold to urban markets and the exchange between the free supply of fuel cookies and the biomass provided by the rural households. The ratio is linked to the energy efficiency of the solution at the household level as it determines the amount of cookies available for sale to paying customers. The energy efficiency originates from three sources:

  1. The higher calorific value of fuel cookies than wood currently used by households.

  2. The higher efficiency of the gasifier stoves (currently Philips gasifier stoves, but to be replaced with Mimi Moto stoves).

  3. The standardized characteristics (uniform pieces) of the fuel cookies which leads to more even and efficient combustion therefore less fuel cookies used than traditional wood.

- **Stove acquisition**: the study highlighted the barriers to the households that originates from the initial cost of the stove deposits.

- **Market size**: the analysis set targets regarding households (paying customers and raw material suppliers) and the other market segments (tea stalls, schools etc.) to reach the sustainability of the model through economies of scale.

In addition to some of the overall outcomes outlined in Table 4.1, the following recommendations were made to Dazin:

- To rapidly implement the solution in rural areas in order to create the supply to sell to cash customers (tea stalls/restaurants). This implementation will enable Dazin to test the fuel and stove pricing strategy.

- To lower cookstove deposits for rural households while raising fuel cookie sales prices as a means of fostering adoption by rural households.
- To develop a network of prescribers through informal communities identified in Assam to quickly reach potential customers.
- To validate the efficiency ratio of Dazin's solution (cookies + cookstove) through rigorous testing in Assamese homes.

Dazin's case embodies the main challenges of barter models. The balance of this type of model relies on the accurate assessment of the cookstove/fuel combination efficiency gains compared to the solution currently used by potential customers. These efficiency gains are both technical and behavioral in nature. It is dependent both on the stove and fuel efficiency as well as how the customers collect, purchase and/or use and adopt the fuel cookie/stove solution. These gains should be confirmed for each customer segment in each new region. It also highlights the importance of customizing the strategy of the company to the new region, using results of modeling and field data to reveal and validate key parameters that will affect the economic viability of replication.

PART FIVE

Assessing Value Chain Sustainability

When fuel companies are preparing to grow and scale, they must prioritize decisions about where and how to allocate resources to improve their business. Reducing environmental impacts across the supply chain may not be a priority at this stage of development. However, understanding these impacts across a business' processes can reveal opportunities for efficiency improvements that can contribute to short- and long-term economic viability, as well as avoid long-term negative environmental effects.

Life cycle assessments (LCA) have emerged as a valuable decision-support tool as they systematically quantify and evaluate the potential environmental impacts[14] that are caused by a product or process along each phase of product development. Environmental impacts include the materials and energy resources required to create the product, as well as the wastes and emissions generated throughout the process. Figure 5.1 illustrates the type of inputs and outputs that result from modeling the production of cooking fuels. By examining the entire life cycle of cooking fuels, it gives a complete picture of the individual and total environmental impacts beyond combustion. When deciding between two or more alternatives, LCAs can help decision-makers compare environmental impacts caused by multiple products and processes.

Since LCAs consider steps that occur prior to use of a product, e.g., material extraction and processing, cooking fuel enterprises that are or are considering sourcing raw materials and producing fuels can directly benefit from the methodology. Cooking fuel enterprises can use LCAs to:

- Identify opportunities to reduce the environmental impacts at various stages of the fuel's lifecycle by implementing steps that increase efficiency, innovation, and potentially cost savings
- Analyze the environmental trade-offs associated with traditional fuels to help gain stakeholder acceptance for cleaner options
- Optimize raw material procurement processes
- Integrate environmental management into core business decision-making and actions
- Improve return on investment
- Promote demand for fuels that have fewer adverse environmental impacts
- Communicate an environmental value proposition to potential donors and investors
- Strengthen discussions with policy makers to help broaden the range of environmental issues considered in developing regulations or setting policies.

As part of the capacity building, ENEA used an LCA modeling approach to assess the potential environmental impacts for all three grantee's existing or planned fuel value chains. They then

14 LCAs quantify potential impacts based on previous studies and impact factors and use proxies when emission factors are not available. They are not a measure of actual impacts.

Rigorous LCAs require technical expertise, software, adherence to the International Organization of Standardization (ISO) regulations and the inclusion of a critical review committee when the results are to be used for external communication purposes. However, there are simplified, or "light" LCA modeling methods that can help a company get a sense of a product's potential environmental impacts and be used for internal planning and decision-making. It is important to note that uncertainty and assumptions exist within all LCAs. The results reveal insights, highlight general trends, and shed light on primary drivers of impacts to inform where additional research could be beneficial. However, the findings should not be used in isolation to make absolute determinations but rather as one component of a more comprehensive decision process complemented with other resources, research, economic analyses, and contextual factors.

compared each grantee's cooking solution to traditional solutions within the region. Section 5 highlights the general considerations needed to conduct a simplified LCA. Fuel companies working on similar models to these companies can use the insights from these three LCAs to better understand key areas of environmental impact—and thus opportunities for improvements and further dedicated studies—across the value chain.

5.1 Tools to Address the Issue and How to Use Them

Fuel enterprises that are directly involved in fuel production have complex supply chains. Raw materials may come from many different sources, and obtaining each one of those materials involves a different series of inputs, processes, and outputs, each of which has impacts on the environment and is influenced by the country context. The life cycle approach (Figure 5.1 on page 23) models the environmental impacts that could be generated when raw materials are extracted, as well as the energy used to extract them. It evaluates the potential pollution that results from manufacturing and distributing the product. Finally, it considers the environmental impacts that occur at point-of-use.

The general steps of conducting an LCA involve:

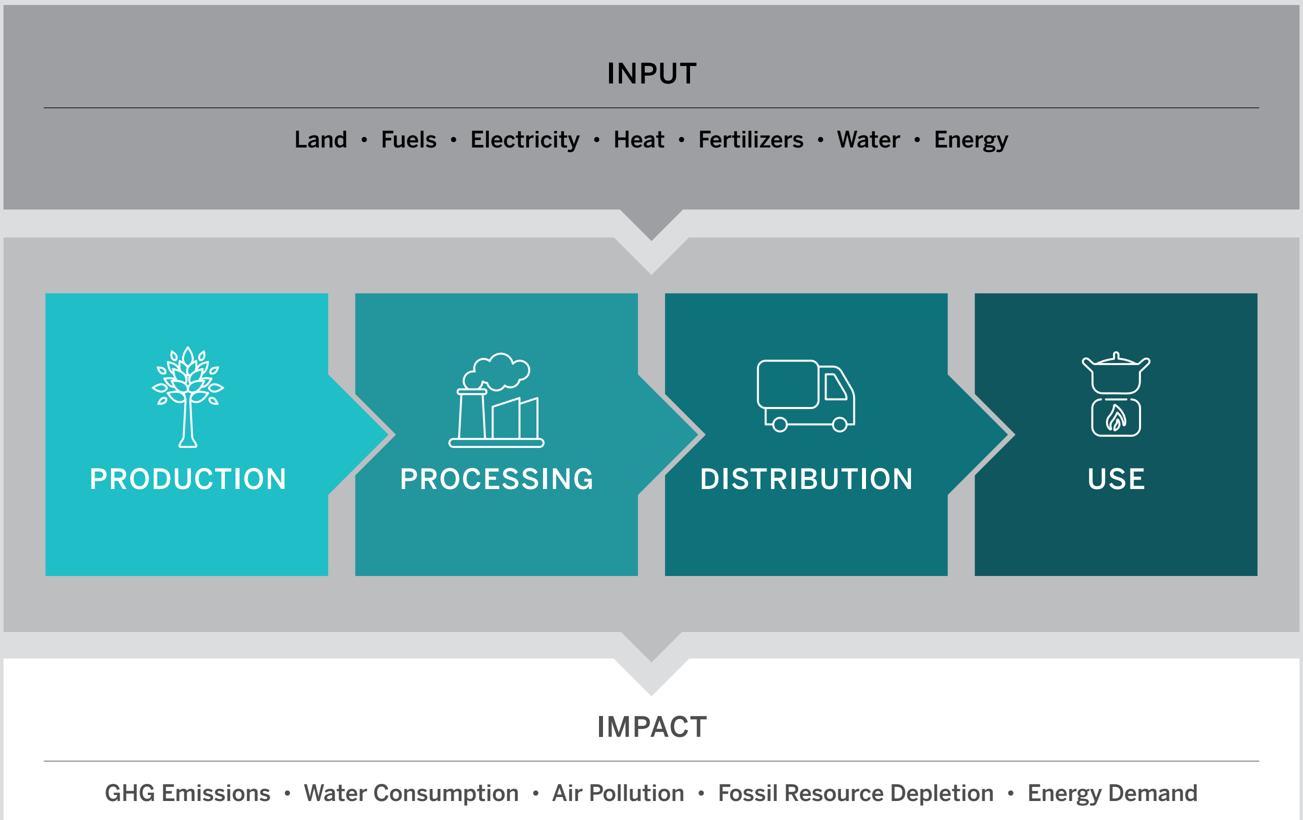
- **Determining the goal and scope**—This establishes the context of the assessment by defining the motivation for conducting the LCA, outlining the questions that need to be answered, and setting up its key elements.
  - **The system boundaries**—This defines what elements will and will not be analyzed, for example, whether or not to include upstream and downstream processes.
  - **A functional unit**—This provides a reference unit to which the inputs and outputs can be related, for example, megajoules (MJ) of energy delivered to the stove.
  - **The impacts to be studied**[15]—This determines the set of indicators to be evaluated that are most relevant to the goal and scope. For example, for clean cooking systems, the indicators selected for the consultancies are highlighted in Appendix D.
- **Conducting the inventory analysis**—The inventory step begins the process of identifying and quantifying the inputs and outputs from all parts of the product system defined in the system boundaries. Inputs include materials, energy, chemicals, etc. that go into the processes and outputs include air emissions, water emissions and solid waste that come out of the processes.
- **Conducting the impact assessment**—The assessment takes the inventory data and converts it to indicators for the impact categories defined in the scoping and inventory phases.
- **Interpreting the results**—This step evaluates the results of the inventory analysis and impact assessment with a clear understanding of the uncertainty and assumptions used to generate the results and compiles the findings and recommendations within the guidelines of the goal and scope.

The data collection phase is key whether conducting a formal LCA or a "light" LCA. A critical step is to systematically gather accurate and current data specific to a company's context. Data can be collected through field interviews and available literature and should be focused on fuel production processes (efficiency of the process, additives such as water or chemicals), the equipment used by the company (machinery, packaging, transportation modes, etc.) to produce and distribute the fuel, and the customers' use of the fuel (combustion in stoves). Once collected, the data can be used as inputs to model the environmental impacts across the fuel

15 Hundreds of indicators exist, some with a narrow scope (water ecotoxicity for example), and some with a broad scope. For this activity, the indicators were chosen based on the discussions with the Alliance on key indicators of interest to the cooking sector.

value chain for a set of defined environmental indicators. In the case of an LCA that would be formally shared with the public, it is recommended that a company work with an LCA expert. Fuel entrepreneurs interested in conducting a generalized assessment of their fuel value chain can insert available data into an Excel file developed by ENEA and its LCA partner, Quantis. The simplified LCA tool is accessible on the Alliance's website.

FIGURE 5.1: EXAMPLE OF THE LIFE CYCLE INPUTS AND IMPACTS, INCLUDING NOTEWORTHY IMPACTS AT EACH PHASE AND GENERAL RECOMMENDATIONS



PRODUCTION

NOTEWORTHY IMPACTS

GHG emissions, water consumption, fossil fuel depletion

RECOMMENDATIONS

Sourcing and verifying renewability of raw material

Sourcing raw material from near the processing facility

Using more energy efficient transportation

PROCESSING

NOTEWORTHY IMPACTS

Air pollution, energy demand, fossil fuel depletion, water consumption

RECOMMENDATIONS

Verifying and improving process efficiencies

Selecting renewable or recycled materials for processing and packaging

Including renewables in electricity generation mix when possible

DISTRIBUTION

NOTEWORTHY IMPACTS

Air pollution, energy demand, fossil fuel depletion

RECOMMENDATIONS

Transport of high energy density fuels, especially on long distances

Using more energy efficient transportation

USE

NOTEWORTHY IMPACTS

Air pollution, GHG emissions, energy demand

RECOMMENDATIONS

Working with energy dense fuels and high efficiency stoves

5.2 What Results to Expect

Each grantee's model has unique geographical differences in feedstock, processes, efficiencies, data availability and assumptions used. Each model was evaluated independently, using similar scopes, but with data specific to each model's supply chain and country context. A few results from each are highlighted below to illustrate the type of insights an LCA modeling methodology can yield. Each featured example showcases key areas where each enterprise can take steps to increase their efficiency and reduce their impacts. For all three enterprises, the system boundaries covered the full fuel value chain:

- **Land transformation:** impacts from land conversion from forest to non-forest, considering the share of non-renewable biomass from each country that can lead to land transformation at the end of the value chain. These impacts are minimal in this analysis.
- **Sourcing and processing:** impacts from raw material sourcing (i.e. harvesting, fossil fuel withdrawal, materials including transportation) and impacts from raw material processing into fuel (i.e. carbonization, fermentation and distillation).
- **Packaging:** impacts from the bottles or bags used to transport and retail fuels.
- **Transport:** impacts from transport (only after processing).
- **Cooking device:** impacts of materials and processes used to manufacture the cookstoves.
- **Combustion:** impacts of fuel combustion based on average stove efficiencies. (For LPG, CO_2 emissions from combustion are accounted in the "sourcing and processing" phase[16]).

The functional unit used to interpret and compare all results was megajoules of heat transmitted to the cooking pot. For each enterprise, the relevant processes were identified at each step and their material flows were modeled. The impacts of each process were characterized by the impact indicators displayed in Figure 5.1.

5.2.1. INYENYERI – MODELED IMPACTS AND OPPORTUNITIES

To produce densified pellets, Inyenyeri sources woody biomass collected by rural customers, uses energy to power a shredder to process the wood into smaller pieces, transports this material to its processing plant, then uses various equipment to further process the wood into pellets. In the same factory location, the pellets are packaged and then transported to their distribution hubs and eventually to customers to be combusted in gasifier stoves. The LCA modeling results for Inyenyeri's impact on black carbon and short-lived climate pollutants[17] are presented in Figure 5.2 which shows the impacts as compared to traditional and alternative fuel options available in Rwanda.

The results show that the impacts from charcoal are quite high compared to other fuels. The majority of impacts from charcoal occur at the sourcing and processing phase stemming from the use of inefficient kilning processes which release large quantities of BC and SCLPs. A switch from traditional charcoal to alternative fuels, such as pellets, demonstrates a significant reduction in BC and SLCPs. The impacts from firewood are also significant but are overshadowed in Figure 5.2 by the more polluting steps of charcoal production. The view of impacts below the main graph more clearly highlights the overall reduction of BC and SLCP emissions that can result from switching from firewood to pellets. The majority of the impacts stem from the combustion phase but show less impact from pellets due to the uniformity of pellet fuel, creating a more efficient combustion when paired with highly efficient gasifier stoves.

These results highlight an opportunity for Inyenyeri to work more closely with stove manufacturers to further improve stove efficiencies and use to reduce the emissions occurring at the

16 In LCA methodology, fossil fuel CO_2 emissions are accounted for as soon as fuel is extracted from underground fossil reserves.

17 The Black Carbon and Short-Lived Climate Pollutants indicator takes into account agents (mainly black carbon, methane and tropospheric ozone) that have a relatively short lifetime in the atmosphere (a few days to a few decades) and a warming influence on climate.

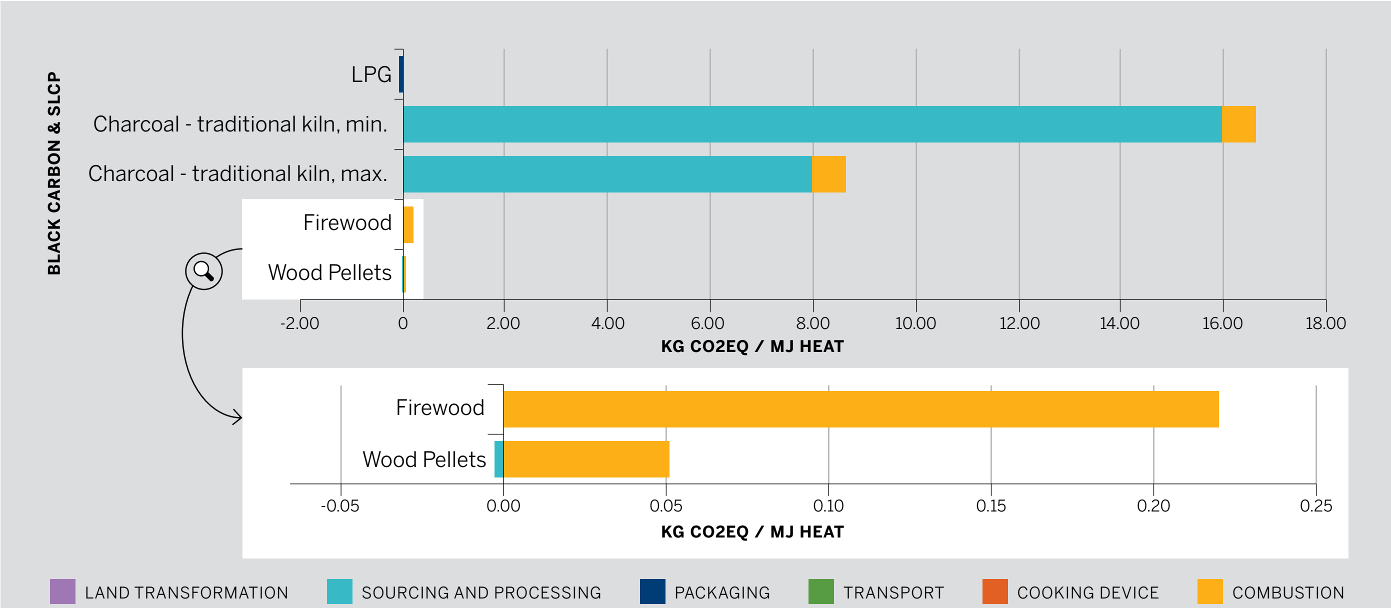
combustion phase. Another recommendation is for Inyenyeri to put a process in place to verify or certify the sources of biomass being supplied to them so as to officially validate its renewability. Taking this step could lead to further decreases in environmental impacts across their value chain.

5.2.2. DAZIN – MODELED IMPACTS AND OPPORTUNITIES

Dazin's model is similar to Inyenyeri's, but the end product is a biomass cookie (a small type of compressed briquette) and the pre-processing and processing phase occur in the same location. Figure 5.3 represents the modeled impacts of each life cycle stage on particulate matter[18] emit-

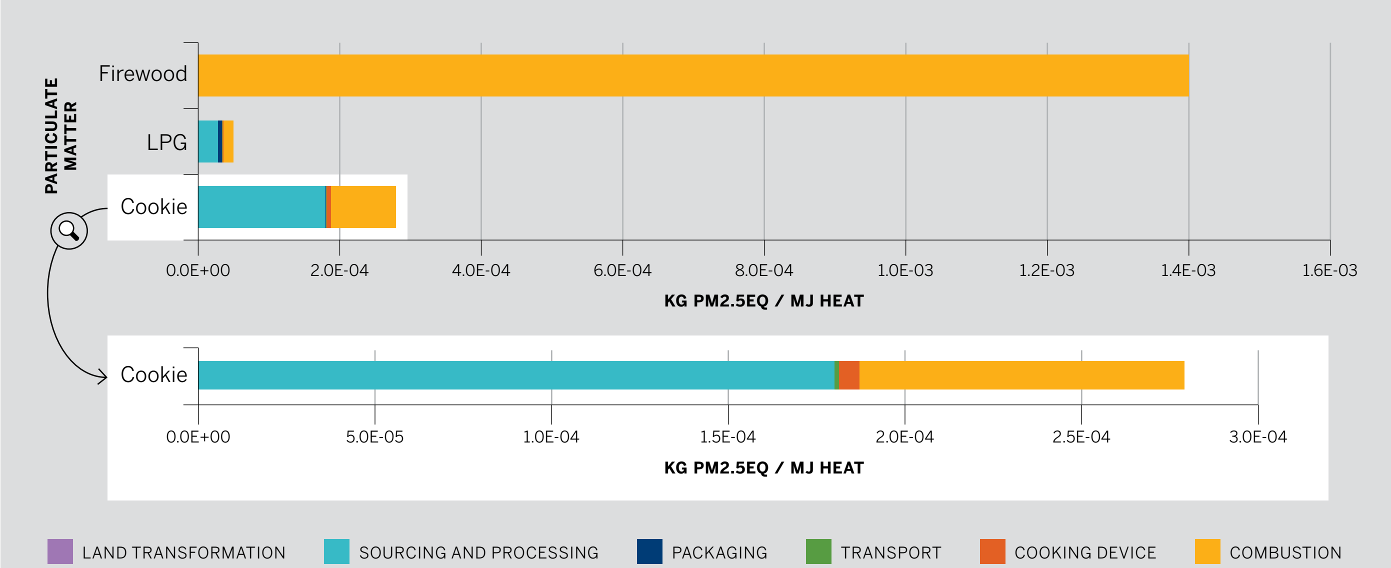
18 The Particulate Matter indicator represents emissions of PM2.5, air pollutants detrimental to human health.

FIGURE 5.2: BC AND SLCP REDUCTION POTENTIAL OF INYENYERI WOOD PELLETS COMPARED TO OTHER FUELS *



* Charcoal min and max refers to two different scenarios of charcoal production : charcoal produced from traditional kilns with an estimated efficiency of 22% for "minimum" (resulting in higher impacts) and 44% for maximum (resulting in lower impacts) and estimating combustion in conventional charcoal stoves (stove efficiency: 22.2%).

FIGURE 5.3: PM EMISSIONS OF DAZIN'S WOOD COOKIES COMPARED TO TRADITIONAL FUELS



ted by different fuels compared against Dazin's fuel. A majority of Dazin's impacts on PM occur at the sourcing and processing phase reflecting the use of electricity for compressing, drying and shredding during cookie production. The electricity mix in India is mostly comprised of power produced from coal power plants which emit significant amounts of particulate matter. For Dazin, and other entrepreneurs operating in countries with similar electricity mixes, alternative sources of electricity such as solar or local hydropower should be considered. Taking steps to source power from alternative resources can lead to decreased PM impacts at the sourcing and processing phase and overall reduced impacts. In Dazin's case, it was also noted that a fuel source with a higher calorific value, such as fuel cookies, contributes to lower PM emissions at the combustion phase in comparison to traditional fuels such as firewood.

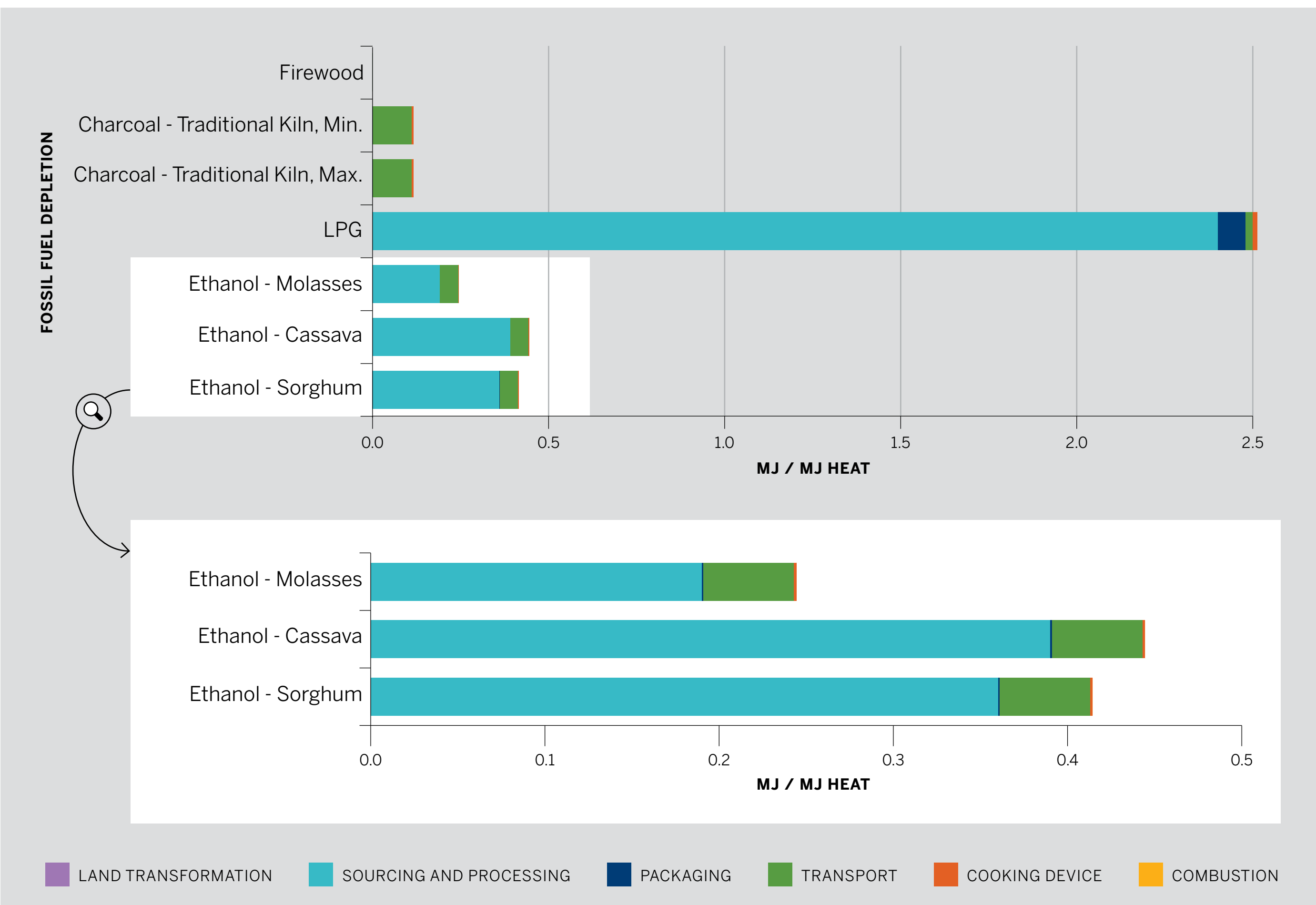
5.2.3. LEOCOME - MODELED IMPACTS AND OPPORTUNITIES

The fuel used by Leocome is liquid ethanol that is currently purchased from sugar distilleries. However, the process that was modeled for Leocome was for a future planned micro-distillery and accounts for steps such as harvesting agriculture feedstock, transportation, production processes in a micro-distillery, packaging, and combustion in an ethanol stove.

Figure 5.4 represents the modeled impacts of each life cycle stage on fossil fuel depletion.[19] Ethanol has a higher impact on fossil fuel depletion compared to charcoal mainly stemming from the sourcing and processing step. This step accounts for the impacts from the transportation modes used to transfer the feedstock to the distillery as well as the electricity needed

19 The fossil fuel depletion indicator represents the consumption of fossil resources during the production process which are nonrenewable (natural gas, oil, etc.). It excludes mineral resources.

FIGURE 5.4: FOSSIL FUEL DEPLETION IMPACTS OF ETHANOL MICRO-DISTILLERY PRODUCTION FROM VARIOUS FEEDSTOCKS IN KENYA



to power the distillery,[20] both of which are mainly powered by fossil fuel-based sources. The transportation steps related to distribution (after processing and represented by the "transport" bar) of more modern fuels, such as LPG and ethanol, are less impacting than transportation of charcoal due to the higher energy density of liquid and gaseous fuels and the assumed use of higher efficiency of the stoves.[21]

The second view in Figure 5.4 reveals interesting insights around feedstock sourcing. The fossil fuel depletion impacts of ethanol derived from molasses (a byproduct of sugarcane production; not a primary agricultural product) is lower than agricultural products such as cassava and sorghum which require more production and processing steps and hence more fossil-fuel based energy.

For Leocome, a few key lessons can be discerned. The main impactful factors for a potential micro-distillery are raw material sourcing, transport to the micro-distillery, and electricity sourcing. Therefore, a key recommendation for Leocome was to carefully consider the location of a micro-distillery to reduce the distance from the feedstock source as well as considering alternative power generation sources such as off-grid renewable sources. It is also worth noting that one of the overall recommendations made to Leocome, given its early stage of development and the volume of currently available and affordable ethanol sources, was to validate ethanol supplies and focus on customer acquisition and cost reduction before considering developing their own production unit. While the LCA modeling results demonstrated that the type of feedstock influences the level of environmental impact, these type of insights must be balanced with other assessments such as supply forecasting and economic analyses (as described in Section 3).

The Global Alliance previously used the life cycle assessment methodology to evaluate different cooking fuels including a range of biomass fuels as well as liquid and gas options. This analysis was done at the country level. The evaluation was designed as a part of a suite of decision-making tools developed by the Alliance for the cookstoves and fuels sector. The results are meant to inform and strengthen decisions for local and national governments, researchers, program implementers, as well as enterprises. The results and a complementary interactive tool are available on the Alliance's website: **www.cleancookstoves.org/facit**

5.2.4. Overall Insights

Meeting the diverse consumers demands for cooking energy in a sustainable and affordable way will require a combination of factors and sources. The results revealed opportunities for each business to make adjustments to their operations that could yield both environmental and economic improvements. The overall takeaways were:

- Sourcing and verifying renewable biomass is key both for long-term economic sustainability, and to reduce the impacts on the environment.
- Getting a better understanding of energy consumption and energy type (electricity mix or origin of electricity) in factory operations can inform future business decisions. Using renewable sources for power generation can be explored as a way to reduce impacts, especially when the national energy mix is highly dependent on fossil resources (coal, oil, etc.).
- The energy efficiency of the processing step is a primary opportunity for overall environment impact reductions.
- Similarly, the energy efficiency of the cooking device is key to reduce overall impacts and is key to ensure profitability in bartering business models as demonstrated in Section 4.
- The impact of the cooking device can be reduced through improved consumer usage and adoption rates to ensure that the ratio of overall impacts on overall energy delivered by the stove is reduced.

Other fuel enterprises can use the LCA approach and the simplified LCA excel tool to deepen the understanding of their business model's environmental footprint and also take additional steps to look at the costs associated with each phase. By discovering what is driving environmental impacts, companies can focus sustainability investments on the areas of highest potential impact. The information can then be used to inform strategic business decisions around resource management and company costs as it did for the three grantees.

20 Fossil fuels represent a third of Kenya's energy mix.

21 Transport impacts are scaled to the functional unit of MJ of energy delivered. The higher the energy density of the fuel being transported and the higher the stove efficiency, the lower the impact per energy delivered because you need to transport less fuel for a same "result."

PART SIX

Conclusion

Every fuel alternative has unique circumstances, challenges, and tradeoffs. This handbook, and the methodologies and conclusions derived from working with each fuel grantee, is meant to be used as a guide for enterprises interested in strengthening their fuel supply chains. Companies that produce and/or distribute cooking fuel can use the information to compare their development stage and their model to that of the selected grantees and use the experiences presented here to inform their scale-up strategies.

While this guide is oriented towards cooking fuel enterprises, the overall objectives and results are applicable to a broader set of stakeholder audiences. Stove companies can use the results to understand the impact of their stoves (efficiency, costs, etc.) on the development of a fuel company. NGOs or programs can use the information to better assist small and medium-sized enterprises (SMEs) and plan future projects. Investors can use it to understand the unique challenges of fuel companies and identify where further investment may be beneficial. Policy makers can use it as part of the basis for decisions on legislative and economic policy instruments, strategic planning, and procurement. Finally, those with an interest in starting an alternative fuel company will find tools and methodologies to test the theoretical feasibility of entering the market and understanding the opportunities and constraints of such a decision.

This handbook can be used by many different stakeholders who are interested in refining and rethinking their business models, evaluating feedstock supply options, adapting a business model to a new region, or understanding environmental impacts. While the examples provided are derived from three specific cases, the lessons learned can be applied broadly to other actors working in the cooking fuel sector. However, it is important to keep in mind that the tools, while adapted for use by a broader audience, are meant to be supplemented with other strategic decision-making resources and data validation methods.

PHOTOGRAPHY: Seema Patel/Dazin/Leocome/Inyenyeri

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