



accenture



**FUELING
CHANGE:**

**Building the case for
a Charcoal Price Index**

Each year,
four million
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prematurely from
illnesses associated
with exposure
to smoke from
polluting open fires

CONTENTS

02 EXECUTIVE SUMMARY

05 AN INTRODUCTION
TO CHARCOAL

10 BROKEN MARKET OR
BROKEN POLICY?

12 IMPROVING PRICE
TRANSPARENCY VIA
INDICES

14 OUTCOMES AND
IMPACT

16 USING DIGITAL TO
OVERCOME DATA
BARRIERS TO PRICE
TRANSPARENCY

24 SOLUTION ROADMAP

29 CONCLUSION

30 CONTACT
THE AUTHORS

EXECUTIVE SUMMARY

THE VISION

Each year, four million people die prematurely from illnesses associated with exposure to smoke from polluting open fires.¹ What this means is, two people died in the time it took you to read this opening paragraph, simply because they cooked using charcoal, wood, dried animal dung, coal or kerosene for fuel. Up to three billion people cook using open fires fueled by biomass and charcoal. Work is underway to help them to transition towards fuels that are cleaner or more sustainable, but a lack of data hampers these interventions.

Fuel choice is a multi-faceted issue. Perceptions of reliability, safety and familiarity, for instance, are important determinants of choice. However, people do not readily switch to cleaner fuels because of their longer-term health benefits—cost motivations make relative fuel prices an important factor in determining fuel choice. Due to the quantitative nature of prices, this paper focuses on fuel price data and the opportunities that their discovery can help to unlock.

Charcoal is produced from wood and typically sold outside of the formal economy. While the International Energy Agency (IEA) estimates that the global charcoal market will grow to \$70 billion by 2040, with little data available, nobody knows the current or future market size for sure. This paper focuses on a way to create price transparency for charcoal, due to its use by millions of the world's poorest people and its associations with negative environmental and health effects.

DATA WILL HELP DEFINE THE PATH

Our hypothesis is that more transparent charcoal prices will provide those outside of the informal charcoal sector with better data, which will help guide more informed interventions in markets dominated by the informal charcoal trade. Pricing cleaner, sustainably produced fuels at parity to informally sourced charcoal will help enable customers to switch to cleaner or more sustainable fuels.

Today, no means of readily accessing charcoal prices from around the world exists; it is a tool currently missing from the toolbox. Price “indices” are indicative price benchmarks that reflect local, current market dynamics. In other commodity markets, they allow accurate comparisons to be made between different locations or time periods. A ‘Charcoal Price Index’ has no impact as a stand-alone tool; much of its value comes from priming international actors, that hitherto have had limited visibility into informal charcoal prices, with better data to act on.

This paper asserts that better visibility of charcoal prices would help those outside of the informal charcoal value chain. Clean fuel companies and sustainable charcoal producers will be able to use the data to inform local pricing and assess new market entries. Researchers will have more useful data for studies and policy recommendations. Investors will have better data to evaluate clean fuel companies as potential investees; potentially helping them to scale or enter new markets. Governments and policy makers will have better insights to inform regional, national and international fuel policies and more information to tailor subsidies.

Technology appears poised to enable greater price transparency in charcoal markets, underpinned by the increasing penetration of mobile phones. Today, two in three people around the world already have access to mobile services. A simple mobile solution, using Short Message Service (SMS) and Interactive Voice Response (IVR), could be developed to let charcoal users send the price they paid in a given locale and receive local fuel pricing insights in return, helping them to choose from local fuel vendors based on price and fuel quality.

Clearly, stakeholders along the charcoal value chain will only submit charcoal price data if there is sustained value in it for them. Fortunately, there is. Customers could use their phones to search for, and find, the local vendor with the best price of charcoal for a specified grade of quality; helping them to save money on a day-by-day basis. The search feature will also show the prices of any local, cleaner fuels;

increasing awareness and familiarity of the cleaner alternatives and nudging them to switch to other cleaner or more sustainable fuels that are at price parity with local charcoal prices. Charcoal vendors also stand to benefit from this innovation, as evidence of regular trades could help them build a financial profile; bringing them into the formal economy and potentially getting them access to credit from local banks. Rural charcoal producers could see what prices are being paid by urban customers, increasing their bargaining potential with distributors.



THE CALL TO ACTION

A significant opportunity exists to prime stakeholders with data-driven insights, helping inform actions that will improve the accessibility of cleaner or sustainably produced cooking fuels to millions of people.

There are several ways for stakeholders to contribute to the development of the Charcoal Price Index:

Governance:

- **Advocacy:** one or more stakeholders will be needed to champion the Index and see its application to drive effective policy.
- **Data custodian:** a stakeholder will need to be appointed as guardian of the charcoal price data that is generated.
- **Operations and maintenance:** one or more stakeholders can be on point for determining system upgrades and ensuring sustained operability of the system, including scheduling any necessary maintenance.

Resources:

- **Investment:** stakeholders can provide funding for solution development, user testing and technical deployment.
- **Human Resources:** stakeholders can bring their people, knowledge, experience and networks to inform the design of the first indices.

Technology:

- **Technology development:** stakeholders can bring knowledge on the back-end technical architecture and analytics required for the solution.
- **Infrastructure Enablement:** given the centrality of mobile phone use to the Index, Mobile Network Operators (MNOs) would be a key stakeholder to inform the design and sustained usability of the solution.

Location:

- **Trusted enterprises:** can contribute their expertise and experience of local barriers to inform the design and utility of the solution.
- **Government:** to use the insights arising from local indices, inform and update policies and guide the sequencing of the global roll-out of the Index.

Transparent charcoal prices are a stepping stone to helping cleaner and more sustainable fuels to be more price competitive with unsustainably sourced charcoal, which has implications for customer accessibility and their fuel choice. Charcoal is mainly an urban fuel, so current trends of rapid urbanization in developing countries across the world would suggest that future charcoal demand is set to boom. If this demand is met through an increase in unsustainably sourced charcoal, it will be to the detriment of people's health, to local ecosystems and to the global climate. Creating a way to accurately reveal charcoal prices is a necessary initial stepping stone to support and inform targeted actions in the sector.

AN INTRODUCTION TO CHARCOAL

IMPACTS FROM SOLID BIOMASS FUELS

Charcoal and wood combined are the primary cooking fuel for three billion people around the world². Data from the World Health Organization shows that four million premature deaths a year are attributable to exposure to smoke from cooking with solid fuels in open fires³, the health burden of which is borne largely by the poor, women and children in low-income countries⁴.

Household Air Pollution has been linked to some of the major preventable causes of death in children, including low birth weight and respiratory infections, and to some of the most significant contributors of non-communicable diseases, morbidity and mortality around the world, including: stroke, chronic pulmonary disease, lung cancer and eye disease. Sustainable Development Goal 3 calls for major reductions in illness and early deaths due to air pollution. Household Air Pollution is estimated to account for 18 percent of all ischemic heart disease and 33 percent of lower respiratory infections globally⁵.

The burning of these solid fuels is also a significant contributor to climate change: up to 58 percent of global black carbon emissions, a significant cause of climate change, come from household cooking, heating, and lighting⁶.

These externalities are caused by solid biomass fuels, of which charcoal is a part, but a lack of data and the phenomena of 'fuel stacking'—where people switch between different cooking fuels—makes it difficult to specifically apportion charcoal's impacts on health and the environment, compared with other solid biomass fuels.

THE SIZE OF THE CHARCOAL MARKET

Such is the paucity of data on charcoal, nobody can definitively say how much charcoal is made, bought or burned around the world each day. Industry practitioners refer to the charcoal market as being worth \$40 billion per year, but the scarcity of robust data on the volumes consumed and the prices paid make it difficult to accurately quantify the value, size and trajectory of the true market size with confidence. The IEA forecasts the charcoal market to grow to almost \$70 billion by 2040, due to increasing levels of consumption, higher prices and a rising urban population. The United Nations Environment Program has predicted a doubling, or even a tripling in charcoal demand, by 2050⁷; fueled by population growth and urbanization.



THE CHARCOAL VALUE CHAIN

Despite the human, social and environmental shortcomings of unsustainably produced charcoal, charcoal is a critical livelihood activity for many people living below the poverty line. Charcoal's ubiquity is underpinned

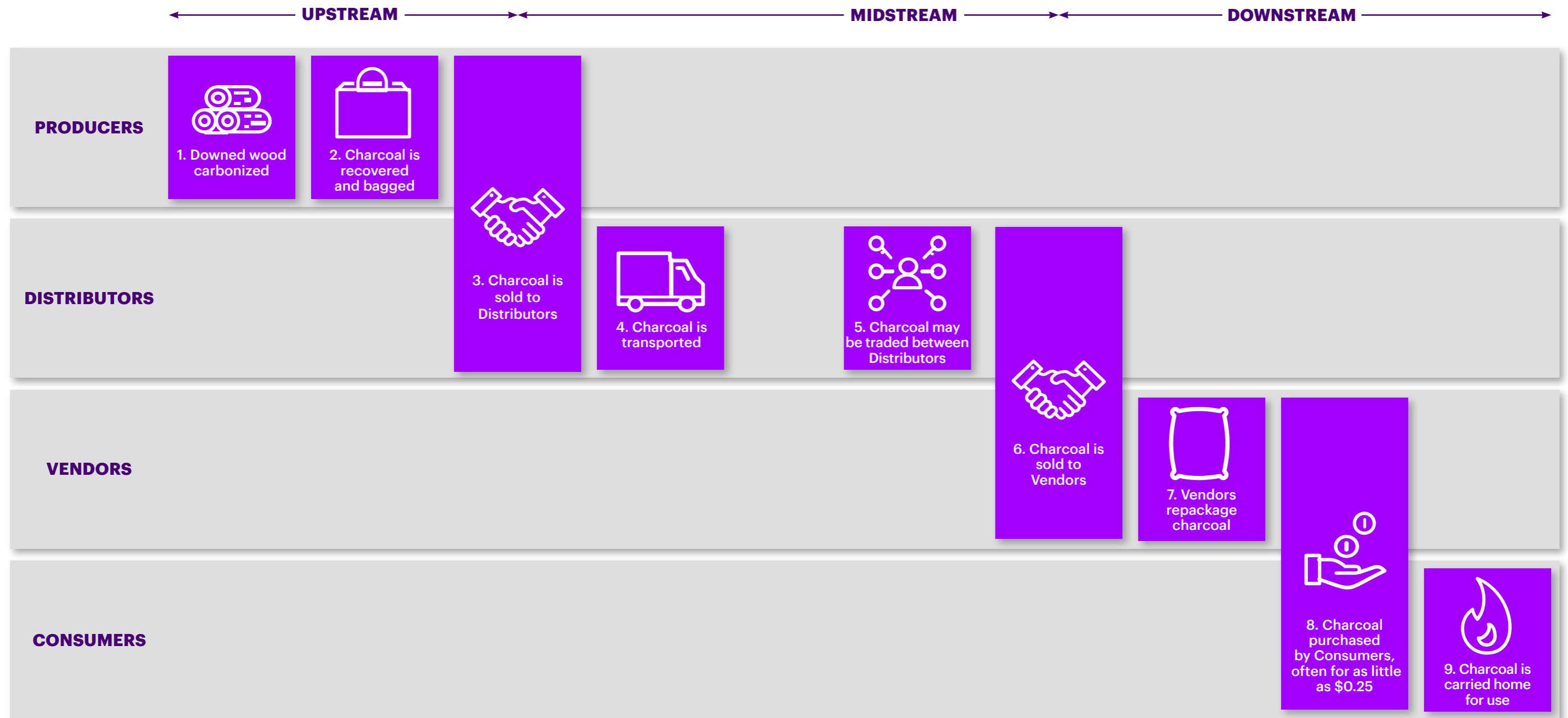
by its simple value chain, relative ease of manufacture compared to substitute fuels and the volume of demand for it, primarily as a cooking fuel. The structure of the charcoal value chain has a variety of actors with clearly defined roles, as shown in figure 1

The upstream production of charcoal requires minimal investment and relies on raw materials that are widely and freely available. The manufacture of charcoal is a very cheap and easy process; a patient workforce oversees the burning of wood in a low oxygen environment for five to ten days to remove moisture and volatile compounds such as methane, hydrogen and tar, to produce small, easily combustible and

heat efficient pieces of carbonized wood. This simple but labor-intensive production process makes the market a significant employment sector and a generator of income, particularly in impoverished, rural communities.

On the consumption side of the value chain, charcoal is an appealing fuel to end users for a variety of reasons: The higher energy density of

FIGURE 1: THE CHARCOAL VALUE CHAIN



charcoal over wood means it burns hotter and for longer, which suits certain culinary styles or heating requirements. Also, charcoal has a higher calorific value than wood; its higher energy content per unit mass means that more energy can be delivered per unit transported. Furthermore, many consumers cite the enhanced taste, especially of meat, as a reason to continue to use charcoal over other alternatives. Consumers also like that charcoal can be easily stored over extended periods of time with no loss in potency, no risk of rotting or degradation by insects and fewer safety risks compared with more combustible fuels like kerosene.

THE DARK SIDE OF UNSUSTAINABLY PRODUCED CHARCOAL

There will always be a demand for charcoal, not least because its utility is broader than just a cooking fuel. It is not the intention of this paper to see charcoal eradicated, rather, this paper hopes that price data enables actors to increase the availability of sustainable charcoal and cleaner fuels, such that charcoal consumption can become a choice for some, rather than a necessity for so many.

Consumption of unsustainably sourced charcoal has significant negative implications for human health and local ecosystems from which the raw wood is sourced, but the human, environmental and social impacts are not being priced into the informal charcoal markets. This means that negative externalities associated with charcoal are not reflected in the price of the commodity, making it cheaper than other fuels, including sustainably produced charcoal, that do not carry these negative externalities.

Charcoal and wood-fuel account for 90 percent of wood consumption in Africa⁸, so with the continent's unprecedented population growth, its rising demand for charcoal is set to compound the degradation of African woodlands and rainforests. The world's largest wood-fuel hotspot, where more than 50 percent of the wood harvested for firewood and charcoal production is unsustainable, is in East Africa.⁹

Because the price of charcoal traded on the informal market does not adequately reflect the cost of reforestation, if at all, charcoal produced in a more sustainable way is often priced out of the market. However, there are communities and governments across sub-Saharan Africa exploring sustainably produced charcoal, from managed woodlots and improved kilning.

The UN Environment Program and Interpol estimate that \$1.9 billion of government revenue is lost in Africa each year from unregulated charcoal trade. The charcoal sector operates largely outside the formal economy, meaning that policymakers have few levers to promote more sustainable forestry. Many players operate illegally throughout the charcoal value chain; smuggling charcoal across borders. The UN Environment Program estimates that charcoal raises up to \$289 million per year of revenue for criminal enterprises, vastly dwarfing the \$12 million of proceeds estimated for the illegal trade in ivory¹⁰.

THE CHARCOAL COST CONUNDRUM

Charcoal prices in Goma, Democratic Republic of the Congo are often four times that of prices in the neighboring Rubavu district, Rwanda (two contiguous cities separated by a relatively free flowing border). Pricing distortions like this one are likely to get worse as the continent's demand for charcoal grows.



BROKEN MARKET OR BROKEN POLICY?

An opportunity for action exists in revealing local charcoal prices to those outside of informal charcoal value chains. Reliable data on local charcoal prices would be a useful dataset; a tool to help inform a broader set of stakeholders. Governments, for instance, could use the data to create locally targeted policy actions. On a national level, regulation and political intervention have been limited in some countries, almost non-existent in other markets, and poorly coordinated in others.

Bans on charcoal production have been introduced in a handful of countries across sub-Saharan Africa, including Somalia, Chad, Kenya and Tanzania, with the intent of arresting the degradation of local forests. However, prohibition will not end demand for, or use of, charcoal; as many households lack access to an affordable alternative source of cooking and heating energy. Tanzania's ban on charcoal in 2006 lasted just two weeks, following unprecedented price spikes and a surge in illegal trading. Similarly, Kenya's ban on charcoal trading in 2018 led to significant price rises and a lowering of charcoal quality; pushing many further into fuel poverty and exacerbating health risks.

SUSTAINABLY PRODUCED CHARCOAL

There have been some successes from policy initiatives looking to address some of the core flaws and weaknesses in charcoal markets. In Cameroon, harvesting intensity decreased by 11 percent in some areas following the introduction of legal management initiatives, whilst Kenya introduced a wood-fuel permit and charcoal production licensing system via charcoal producer associations. In Tanzania, a designated area of forest, owned by villagers,

has been reserved for charcoal production with all remaining areas set aside for conservation. The charcoal production area is divided into 24 distinct sections, with one being harvested each year on a rotating basis. The government program advocates environmentally sustainable harvesting measures and royalty payments to villagers for every bag of charcoal produced. A system for tracking payments and exchanges between midstream and downstream players could help the government set or adjust the royalty payments. Being able to track the movement of price points across regions could be a useful tool to help forewarn of areas where high prices could tempt illegal wood harvesting.

Bans on charcoal often fail to achieve the intended results.
Local charcoal prices will help policymakers take more informed, data-driven actions

IMPROVING PRICE TRANSPARENCY VIA INDICES

Better transparency on charcoal prices could be achieved by the development of charcoal pricing indices. Indices in this context refer to indicative price benchmarks based on prevailing market dynamics that accurately and objectively measure the current fair market value of a given commodity. Indices allow relative comparisons to be accurately made across different locations and time periods.

A localized set of charcoal indices would be useful and feasible, but no organization has ever been the authority on charcoal prices. Data discovery and data accuracy are key issues facing improved price transparency and index creation. Any worthwhile index of charcoal prices must capture a representative volume of field transactions and ensure a way of excluding inaccurate data, to prevent any undue market manipulation or the creation of misleading outputs that form a poor basis for strategic decision making. Charcoal transactions are common events across Lower-Middle-Income countries, but the number of transactions is presently unknowable. However, given that many end-customers buy their charcoal in small, daily bundles equivalent to 25 US cents due to affordability constraints, it is probable that globally there are billions of individual charcoal transactions over the course of a year. These transactions tend to be made in cash, with no auditable record. Capturing accurate samples of market prices from some of society's poorest people, living deep in the last mile, is a challenge that has not yet been attempted using technologies available today.

Local indices would reflect local pricing dynamics. Each urban neighborhood would have its own index and in rural areas, 'provinces' would be defined, each with its own pricing

point. Whilst more established energy commodities are traded globally and have an impact on market sentiment in other parts of the world, this is not true of charcoal, so a single, global index for charcoal is undesirable.

The Index would be piloted in one location, which would inform the design of the Index and how the average charcoal price for that location would be calculated and disseminated. The pilot will be key in shaping and refining the approach before a global roll-out. In terms of calculating individual indices, a pilot will help to inform the number of transactions and the length of the rolling time window needed, to ensure that prices accurately reflect local conditions. Clearly, the more data points entered in a locale; the more accurate the index in that locale. In terms of disseminating the index, it will be important for the information to be accessed readily by national and international organizations, as well as by the stakeholders supplying the raw price information. For the national and international organizations, this information will be made available via an online portal. For the data provider, the same SMS, app, or IVR interface used to enter data will be the means of receiving the information they seek; such as fuel prices within a two kilometer radius of their location.

COMMODITY PRICE INDICES

Energy price indices exist for much more sophisticated and well-established markets such as oil, natural gas and electricity, where billions of dollars' worth of contracts are traded with reference to published indices every day on international commodity markets. Clearly this is very far removed from the informal charcoal market. As such, any suggestion of improving price visibility and easing or removing

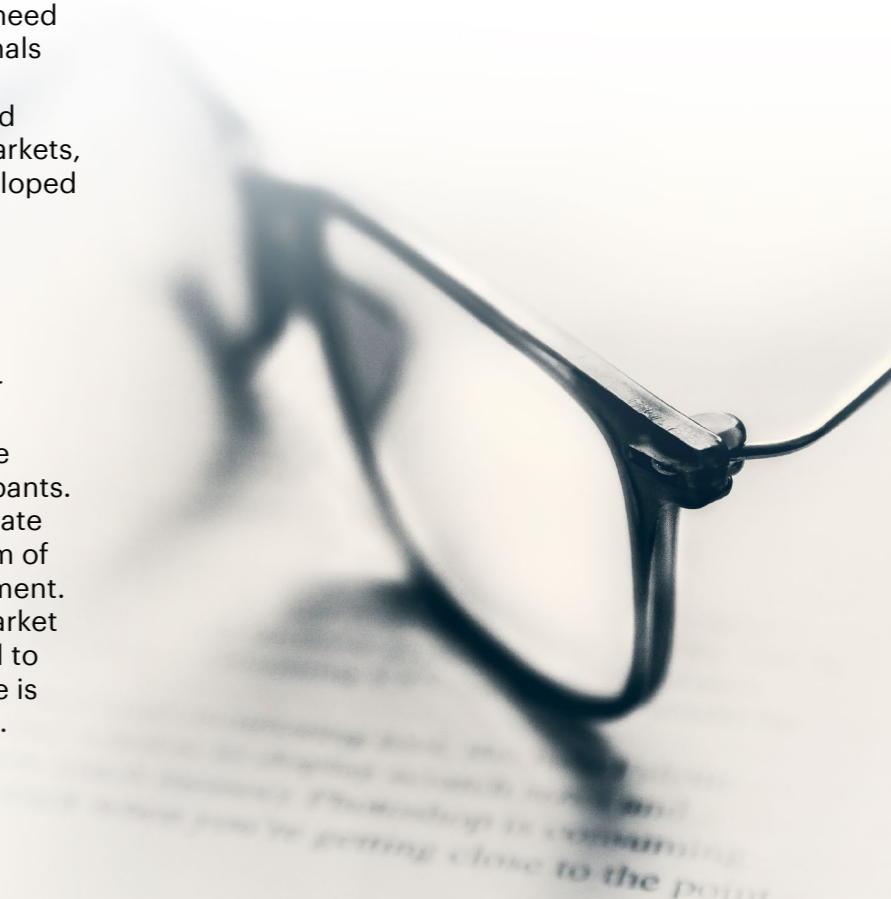
market inefficiency via the use of such indices, might at first appear to be illogical. However, the core principles of indexation remain true; the need for market reflective pricing, price transparency and for consumers to be informed of these accurate price signals, are key tenets of economic efficiency and the smooth functioning of any market, regardless of the commodity, market size, maturity or sophistication of the market in question.

Indices in the highly developed commodities markets have become established and widely accepted as the default pricing benchmark mechanism, given that their use facilitates fair and efficient pricing; precisely what is needed in the charcoal markets of Lower-Middle-Income countries. The lack of sophistication in the charcoal markets in no way diminishes the need for, or the benefits of, improved pricing signals and price transparency. By looking at what has been achieved in price transparency and discovery in the developed commodities markets, we are more able to see the flaws in undeveloped market commodities, such as charcoal.

SOURCES OF PRICE INDICES

A primary source of price transparency in the established commodities market are Price Reporting Agencies, who publish their assessments of market prices for a given commodity based on their knowledge of the market and discussions with market participants. Whilst every effort is made to provide accurate and market-reflective assessments, this form of price discovery is only an indicative assessment. It can be influenced by the availability of market participants or other factors that might lead to debate about whether the final quoted price is too high or too low from the "perfect" value.

Another source of price transparency often used in the established commodities market is the Deal Based Price Index. Here Price Reporting Agencies and other data and information providers, such as brokers, provide a mathematical average of all deals transacted or reported either during the trading day or in a specific time window. Different indices use slightly different methodologies for dealing with inaccurate data, or for situations where a minimum threshold of data inputs have not been reached.



OUTCOMES AND IMPACT

A Charcoal Price Index would bring global visibility to charcoal prices being paid in regional markets, helping to open these markets up to a new sector of stakeholders outside of the immediate charcoal value chain. The Charcoal Price Index will not have a positive impact on human health or on the environment as a standalone tool; the impact on climate, environmental preservation and on peoples' health will be as a result of how the data is used by local and international market actors. The short-term outcomes described below, arising directly from the operation of the Charcoal Price Index, should be seen after 12 months of operation. Longer-term impacts, based on actions informed by the Charcoal Price Index, should start to materialize after three years of continuous operation.

SHORT-TERM OUTCOMES

It is envisaged that an operational Charcoal Price Index will help consumers to access better prices. Customers can access these insights by sending an SMS query on their phones to find out the current prices of charcoal vendors within, say, a two kilometer radius of them. Upon receiving this information, they can select the vendor with the best price offering a desired quality or quantity of charcoal or use this data to negotiate with other vendors.

Clean fuel enterprises and sustainable charcoal producers will be able to use this source of market intelligence to assess the viability of entering new regional markets, or to revisit pricing strategies in current markets.

Impact Investors will have more market information available to assist with investment screening decisions and assess high priority local markets.

Researchers and academics will have more information on local charcoal prices, including the degree to which they move between seasons and vary between rural and urban populations.

Governments will have more accurate data to inform their policies. Seasonal fluctuations in charcoal prices will make alternative fuels more, or less, competitive. There could be a role for government subsidy in ensuring that clean fuels, or sustainably produced charcoal, are price competitive with informal charcoal. The design of these subsidies could be tailored using data from the Charcoal Price Index.

An example from the brewing industry can be found in Kenya, where the government partnered with an international producer of alcoholic beverages to find a solution to reduce the harm caused by consumption of illicit alcohol. The partnership created a beer called Senator Keg, which was price competitive with illicit alcohol¹¹. By using locally sourced ingredients and manufacturing locally, new formal jobs were created and customer demand was optimized. Similarly, another international producer of alcoholic beverages has had success in several African countries with Eagle, a cheaper beer made from locally grown sorghum, rather than imported malt. An international producer of alcoholic beverages can price this beer at levels below those of other beers in Uganda, Zambia and Zimbabwe, partly because it obtained a reduction in excise duties from the governments involved¹².

LONGER-TERM IMPACT

The Charcoal Price Index is a stepping stone for market actors to use, so the longer-term positive impacts are contingent on the actions it informs and the outcomes that arise from these actions.

It is envisaged that increased visibility of charcoal prices would give policymakers new levers to target the unregulated charcoal trade and help clean fuel social enterprises to access more impact capital and successfully enter new markets. The potential impact from these possible outcomes could be to protect some of the world's poorest people from price extortion, save trees from illegal harvesting and reduce household air pollution; positively impacting human health and the global climate.



USING DIGITAL TO OVERCOME DATA BARRIERS TO PRICE TRANSPARENCY

The ubiquity of mobile phones means that people are now more accessible than ever. Given the trend of increasing mobile phone penetration, it is conceivable that there may soon be the opportunity to start a two-way dialogue with every person on the planet. By the end of 2018, 5.1 billion people around the world subscribed to mobile services, accounting for 67 percent of the global population. Over the next seven years, 710 million people are expected to subscribe to mobile services for the first time.¹³

In today's increasingly connected, mobile-enabled world, a simple mobile application, supported by a strong analytics back-end, could hold the key to unlocking greater price transparency in charcoal markets.

BRINGING QUALITY DATA IN...

A simple mobile interface for smartphones—and accompanying SMS and IVR protocol for feature phones—could be developed to allow end users in a given market area to send the prevailing charcoal price in that market on a daily or weekly basis via SMS, IVR or app. At the downstream end of the charcoal value chain, data contributors to the Index would be local buyers and sellers of charcoal, inputting data for a given quality and quantity of charcoal. The quality of charcoal is dependent on many factors, including the type of tree used, and the degree of carbonization during its making.

At the upstream end of the charcoal value chain, data contributors would be charcoal producers (people who cut trees, construct kilns and make charcoal; including small-holder farmers and

cooperatives of charcoal producers). Given the growth of mobile micropayments across Lower-Middle-Income countries, a simple mobile solution could end up facilitating digital payments for charcoal or clean-fuel alternatives, replacing cash transactions for some users. Charcoal price data contributors would receive access to the collated price data; equipping them with better market information which would ease price distortions in the market. Additional user incentives, like free mobile network airtime microcredits, could also be considered to maintain data contributions. Charcoal sellers could be incentivized, through instruments such as government-issued subsidies or authenticity certifications, to participate in verification activities that promote sustainable harvesting and production practices from forest to fire.

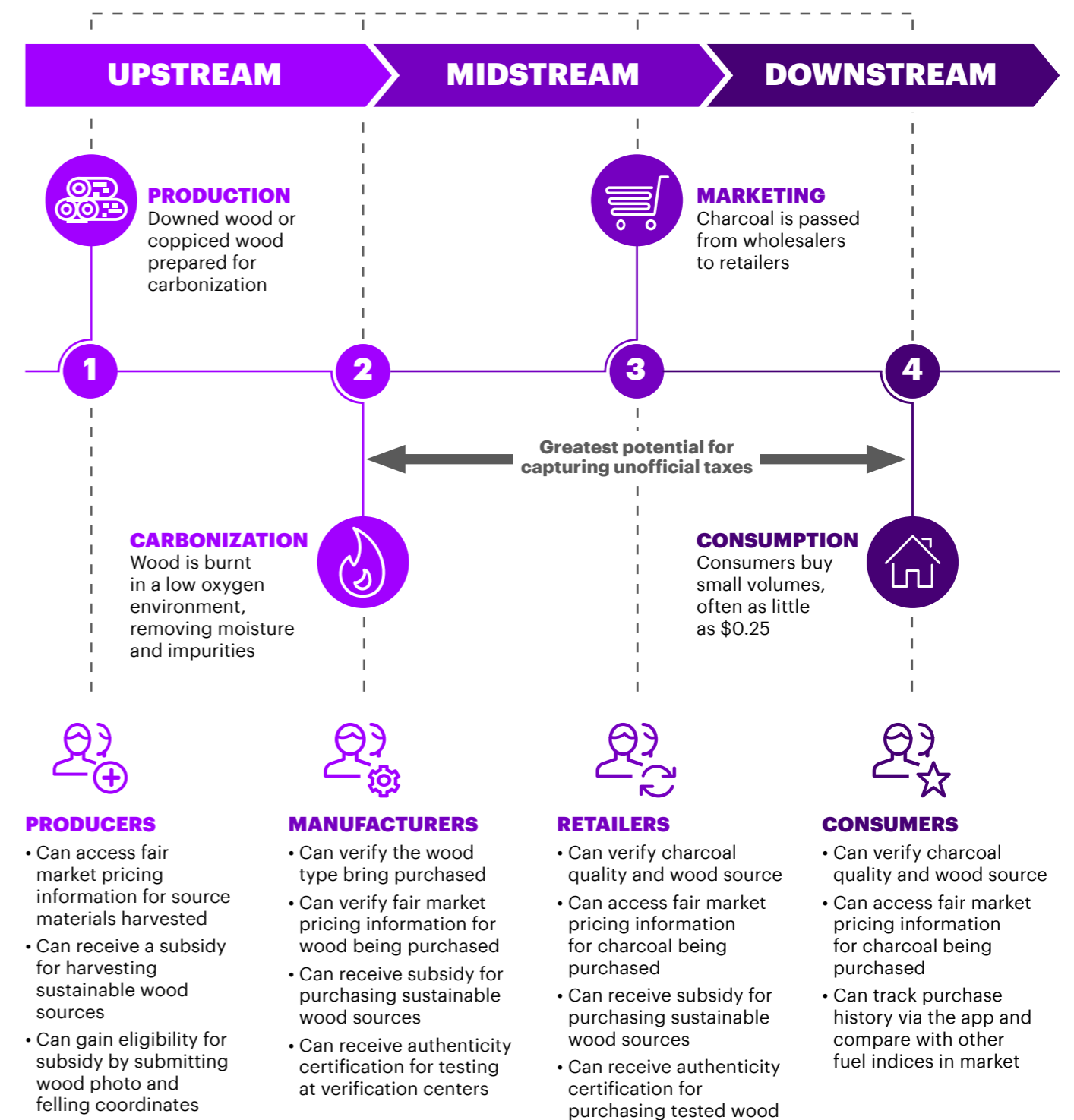
... AND GENERATING MARKET INSIGHTS

A cloud-based data lake—a storage repository that holds a vast amount of raw data in its native format until it is needed—could be set up to collate the data coming in from the charcoal value chain, with analytics checking individual transactions for anomalies and removing any statistical outliers according to a pre-defined and mutually agreed methodology criteria, such as the highest five percent and lowest five percent of data points at a specific charcoal vendor location, to overcome the data integrity barrier. Use of the centralized data lake would also allow data to be collated and represented geographically; creating de facto market hubs with data for specific areas.

THE INDEXING APP




Consolidates local data collected from across the charcoal value chain, which are then used to calculate and publish localized charcoal price indices back out to the market.




FIGURE 2: HOW STAKEHOLDERS ACROSS THE CHARCOAL VALUE CHAIN COULD SOURCE CHARCOAL PRICE DATA






BARRIERS TO PRICE TRANSPARENCY AND SOLUTIONS TO OVERCOME THEM




Key to the solution’s success is its adoption by actors from across the charcoal value chain. Second to the value the solution delivers to its users, adoption will be driven by its accessibility across the last mile, which can be enabled by a range of technology innovations that address common barriers to accessibility in the last mile.




| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
|--|--|--|
| <p>TECHNOLOGICAL BARRIER: COST-PROHIBITIVE DATA PROVISION: For a phone-based solution to work, the act of providing data to a central aggregator needs to have a clear value case to the person providing the data; if they are charged to provide data, or if this is seen as a means to track and penalize the behaviors of those in the value chain, the solution will fail.</p> | <p>FREWARE PLATFORMS USING VOIP: Building the solution on a freeware messaging platform makes it possible for large numbers of users to use the Index’s outputs for free.</p> | <p>AMREF: In partnership with Amref and Safaricom, Accenture deployed Leap, a mobile health training app for community health workers in Kenya. It is free to end users, but Amref incurs the data, SMS and voice costs. However, Safaricom gives preferential rates to Amref to enable social impact outcomes.</p> <p>FACEBOOK LITE: Facebook Lite, a version of Facebook’s core app which consumes less data and is suitable for networks in emerging markets, the app hit 200 million users just 20 months after launching.</p> |

| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
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| | | <p>WHATSAPP: In Zimbabwe, WhatsApp accounted for 44 percent of all mobile internet usage in the country in 2017.</p> <p>WhatsApp was found to be the most effective way to track charcoal transportation in Haiti.</p> <p>MomConnect, in South Africa, switched from using SMS to WhatsApp as their primary outreach tool. The change substantially reduced costs and allowed them to generate new insights on the individuals they interact with.</p> |
| <p>TECHNOLOGICAL BARRIER: PATCHY NETWORK CONNECTIVITY: Vast swathes of Lower-Middle-Income countries are not covered by mobile and internet service; posing challenges for price realization amongst charcoal consumers in these areas.</p> | <p>MESH: Extending the range of a mobile network out beyond its normal operational limits is possible by strategically deploying mobile hotspot “nodes”.</p> | <p>PROJECT LANTERN: Project Lantern is designed to keep citizens and first-responders online during response and recovery, even if traditional connectivity is down. By connecting to the keychain-sized Lantern device, users gain access to a network where applications (local maps, supply locations, etc.) and data are pushed to Lanterns via long-range radio and Wi-Fi, which are then saved offline to browsers for continued use.</p> |

| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
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| <p>TECHNOLOGICAL BARRIER: GRADING FUEL QUALITY AND QUANTITY: Identifying the charcoal source is important for determining charcoal quality (higher quality hardwoods versus lower quality softwoods). Protocol would need to be put in place to combat fraud in a way that is universally repeatable.</p> | <p>CROWDSOURCING IMAGES FOR AI ASSESSMENT: Machine learning could be used to train a computer to assess the quality of the charcoal being bought. A library of charcoal images could be sourced by on-the-ground contributions, with these crowdsourced images from the field being assessed by charcoal experts for perceived quality and used to train the initial algorithm.</p> | <p>PREMISE: Premise is a data and analytics platform that empowers decision makers with real-time, actionable intelligence by combining a global network of on-the-ground contributors with machine learning. Contributors are local contractors tasked to collect images and data via mobile phones for specific areas of interest and are generating an estimated 1.5 million observations per month. People apply to be contributors through the mobile app, responding to advertisements, or through referrals. Contributors are then paid for images based on quality of, and demand for, the image type. Clients then pay for access to this data and for the predictive analytics services.</p> |

| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
|---|---|--|
| <p>HUMAN BARRIER: USERS' ILLITERACY AND INNUMERACY: Stakeholders across the value chain are key to getting accurate data, but not all will be numerate, literate, or speak the language used in the mobile solution; Illiteracy rates and the 160 SMS character limit can pose issues for data collection.</p> | <p>INTERACTIVE VOICE RESPONSE (IVR): IVR is one way to reach large numbers of people living in very remote areas via telephone and to generate highly reliable data.</p> | <p>HUMAN NETWORK INTERNATIONAL AND VIAMO: Developed an innovative approach to connect anyone in a country, even those without smartphones, with the information they need on the topic of their choice. Partnering with Airtel and the Government of Madagascar, the "3-2-1 Service", a toll-free, automated hotline powered by IVR technology, was launched; delivering information on a wide range of development topics in local language. Today, Viamo powers the 3-2-1 Service, which is accessible to more than 70 million mobile subscribers in 14 countries. More than three million unique users used the service in 2016.</p> <p>MVAM World Food Program's mobile Vulnerability Analysis and Mapping project uses mobile technology and IVR to remotely monitor household food security and nutrition and food market-related trends in real-time; providing high-frequency, gender-disaggregated and operationally relevant data to support humanitarian decision-making.</p> |

| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
|---|---|---|
| <p>HUMAN BARRIER: SUSTAINING USER INTEREST: For the solution to succeed, tens of thousands of users will need to supply price information by mobile technology, but the average app loses 77 percent of its active users within the first three days after install. Within 30 days, this rises to 90 percent of active users.¹⁴</p> | <p>SUPER-USERS: Some users could be employed (or incentivized) as ‘Super Users’. These users would act as price reporters by receiving incentives or payments to track prices for charcoal exchanges at specific points in the value chain.</p> | <p>YEGO MOTO: Since launching in 2017, the motor taxi hailing and cashless payment app has facilitated 1.5 million trips in Kigali. Roadside facilitators are on hand to book trips and coordinate payments for those without phones, looking to pay in cash.</p> |
| <p>HUMAN BARRIER: PEOPLE SUBMITTING PRICE DATA: Users in the value chain must clearly and directly benefit from sending in charcoal price data to the Index. If they do not see the benefit, the behavior will stop. Of particular importance to the Charcoal Price Index is the ability to gather price data at the start and end of the charcoal value chain (steps 3 and 8 in figure 1); if prices can be generated at source and at the point of sale to customers, the margins of the midstream retailers will be revealed.</p> | <p>SHOW THEM THE SAVINGS: Tracking a user’s transactions could show the user an estimate on the amount of savings they have made by consulting the Index when buying their charcoal.</p> <p>DATA BUNDLES: Offering data bundles to users could be an additional way of getting users to enter their data to the system. MNOs looking to grow their user base for mobile money might be interested in shaping the nature of the offer.</p> | <p>WAZE: Waze—a road travel app—added gas station prices as one of the crowd sourced features it offers to its millions of “Wazers” around the world. Fellow “Wazers” send in the prices of petrol at their local gas stations.</p> <p>OPTIMETRIKS: Managing large distribution networks in the traditional trade in Africa is a real challenge. Optimetriks provide a platform that enables African consumer goods brands to be directly in touch with the retailers to improve their stock availability and get real time market insights. Anyone with a smartphone can be a data collector for Optimetriks, which provides users additional income to crowdsource real-time and mobile-based data.</p> |

| BARRIERS  | BREAKTHROUGH SOLUTIONS TO BARRIERS  | USE CASES FROM MARKET  |
|--|---|---|
| <p>HUMAN BARRIER: AVERTING PRICE FIXING: One problem with asking market participants to submit accurate data is that vendors have an incentive to say that prices are high, whilst buyers have an incentive to talk the market down. Legally binding legislation of the type set out in the European Union’s REMIT legislation is unfeasible for charcoal markets, so data integrity needs to be a consideration that is built into the data gathering process.</p> | <p>CROWDSOURCING DATA: Making a platform accessible for thousands of users to input information to, drives up the quality of the platform’s content.</p> | <p>WIKIPEDIA On average, more than 130,000 registered contributors contribute to site content monthly, meaning that a Wikipedia page is edited every 38 seconds.</p> |



SOLUTION ROADMAP

To set up an improved system of price transparency, a pilot study is needed to validate the barriers to improved price discovery and to identify any unintended consequences of trying to bring greater visibility of prices to the charcoal value chain. The pilot should engage local charcoal suppliers and distributors to generate and sustain an accurate charcoal price index for a defined local geography. The local data contributors should be able to send price data through a mobile phone to a centralized database, which calculates and publishes the Index.

STEP 1: CREATE A PILOT COALITION

The pilot will require funding to set up the tools and processes needed to gather, calculate and disseminate the indexation service. Once established, the costs of setting up and running the indexation would be minimal. During the early days of the European energy market deregulation initiatives, when the (now multi-million-dollar) Price Reporting Agencies were first established, they were run by a handful of people using rudimentary technologies, at a low overall cost. A charcoal price index could be set up in a similarly scalable manner, starting in one region, expanding over time to others and across countries.

Interested parties could include NGOs or sector advocates with interests in human health, environmental degradation or the informal economy and governments looking to shape their charcoal policies based on price data. The potential roles, interests and pay-offs of various stakeholder groups are considered in the next table.

STEP 2: DEFINE THE METHODOLOGY

Defining the basic tenets of the methodology, for example the agreed mode of data collection, the basis of price calculation, dealing with data outliers and other necessary principles, would need to be established and documented. This, and other tasks such as technology development, pilot testing and the subsequent day-to-day running of the indices, would need to be coordinated by a centralized body, either specially created for the purpose, or under the auspices of a suitable organization.

Defining a standardized commodity specification

Firstly, a standardized unit of quantity and energy quality will be needed, in the same way that oil is traded and priced in dollars per barrel, or natural gas in dollars per million British Thermal Units.

When a commodity deal is priced, the basic premise is to ensure that the overall index is not distorted because of a lower quality of product. This is important in the case of charcoal where hardwood yields a superior product to that derived from lower quality softwood or mangrove wood, which is less heat efficient. This is a relatively simple barrier to be overcome, either by having a higher quality and a lower quality charcoal index, or by pricing lower quality charcoal at a discount to the higher quality variety. The standardized quantity unit issue can be overcome by use of a generally accepted unit of weight such as a “marmite” (a coffee-sized can), a “bundle”, “sack” or a wholesale quantity in several kilogram bags.

| STAKEHOLDERS | ROLE IN A PILOT | VALUE TO THEM |
|--|---|--|
| MULTILATERALS OR FOUNDATIONS | <ul style="list-style-type: none"> Bring their expertise to shape and design the solution. Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> Ownership of aggregated data insights on international charcoal markets. |
| MOBILE NETWORK OPERATORS (MNO) | <ul style="list-style-type: none"> Provide subsidized access to SMS and IVR for users to provide data to the Index. | <ul style="list-style-type: none"> Introducing more people onto their network, ultimately increasing data package purchases and potentially introducing new users to mobile money. |
| GOVERNMENT MINISTRIES | <ul style="list-style-type: none"> Champion the launch of the Index in their cities, peri-urban and urban regions. | <ul style="list-style-type: none"> A tool to help inform local policy. Visibility of social utility data. Decreased funding going to criminal organizations. |
| ADVOCATES OF THE CLEAN COOKING, ENERGY AND HEALTH SECTORS | <ul style="list-style-type: none"> Bring expertise to shape and design the solution. Contribute to financing of the solution design and build. Coordinate the day-to-day running of the Index. | <ul style="list-style-type: none"> A tool to help guide policy to bring in new cleaner fuel technologies, ultimately allowing end customers to switch away from charcoal consumption. |
| UNIVERSITIES, RESEARCHERS AND BEHAVIORAL ECONOMISTS | <ul style="list-style-type: none"> Bring expertise to shape how the data from the Index can be used to measure, and ultimately change, human behaviors. | <ul style="list-style-type: none"> Access to data to inform research and recommendations. |
| ENTERPRISES SELLING CLEAN COOKING FUELS | <ul style="list-style-type: none"> Inform the design and build of the end-to-end solution. | <ul style="list-style-type: none"> Ability to make strategic market entry or new product offering decisions based on data. Assistance in helping to objectively quantify the market value of displacing charcoal use in a given market to potential investors. Advertising of clean energy services to last mile users. |

| STAKEHOLDERS | ROLE IN A PILOT | VALUE TO THEM |
|---|---|--|
| IMPACT INVESTORS | <ul style="list-style-type: none"> Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> Ease of cleantech opportunity market screening. |
| ENVIRONMENTAL NGOS | <ul style="list-style-type: none"> Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> A tool to help evaluate internal strategies. A tool to help evaluate local government policies. Preemptive view into areas at risk of illegal logging due to price responses from suppliers. |
| LOCAL FINANCIAL INSTITUTIONS | <ul style="list-style-type: none"> Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> Visibility on regular trades of charcoal vendors; helping them to build credit files for new potential customers (charcoal vendors). |
| FULL-STACK DIGITAL TECHNOLOGY AND USER DESIGN SPECIALIST | <ul style="list-style-type: none"> End-to-end Index design, including front end user experience and back-end data cleaning, machine learning, data storage and data analytics functions. | <ul style="list-style-type: none"> Fees for design and build of the service architecture. Revenues from shipping new features and service updates. |
| CONSUMER GOODS COMPANIES | <ul style="list-style-type: none"> Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> Advertising on the app platform, potentially reaching millions of new users. |
| ENERGY OPERATOR | <ul style="list-style-type: none"> Contribute to financing of the solution design and build. | <ul style="list-style-type: none"> Access to consumer energy data in untapped downstream markets. Positive public relations locally and globally. |

Defining the Pricing Point

Second, it is critical to define exactly where in the value chain the indices should be placed. An initial study of price points across the value chain in several key markets might be needed as a first step, to make a more informed starting point for the pilot. Establishing an index at the end of the charcoal value chain has the advantage of being where the largest data sample could be sourced from. Establishing an index earlier on in the charcoal value chain, where producers hand the finished product over to non-producing intermediaries will also be key, as it appears that this is where the small independent producers lose most income generation potential, due to profiteering by intermediaries. Ultimately, both price points will be needed in a functioning index.

STEP 3: IDENTIFY THE PILOT LOCATION

An appropriate pilot geography, with at least 25,000 households, a thriving formal and informal charcoal market and a mobile phone penetration rate of at least 50 percent of households should be selected. It should also be relatively easy to perform price “spot audits” on foot, to help validate the accuracy of the index during the pilot.

STEP 4: FACILITATE ACCESS TO MARKET INFORMATION

Getting accurate data from market participants is key to making the pilot work, as without them a price index will not be created or sustained. If the population of data contributors is sufficiently large, several trial populations could be created to help the pilot assess and identify the most effective incentives to keep data contributors involved over time. It is likely that data participants could be incentivized with a small financial remuneration, or if they are given small bundles of phone data for participation.

With a large enough number of data contributors, rigging the market would present a considerable challenge for any party wishing to do so. Inevitably some spurious or inaccurate data might leak into the system, however if a sufficiently large number of data

contributors were contributing to the data sample, the impact of the spurious data would be heavily diluted. There may be a role for a central “regulatory role” to monitor, review and cleanse the data by identifying anomalies. In the long term, such a role could eventually be transitioned to a machine learning algorithm.

The importance of using ‘Super Users’, people paid to ground-truth the prices paid for charcoal on the ground within the pilot location, will be key to determining the veracity of the pricing insights generated by the Index.

If one or more clean fuel enterprises enter a market because of pricing data generated by the Charcoal Price Index, it would be useful to arrange an on-the-ground pre and post survey of households’ fuel consumption at the start and end of the pilot, to help quantify the extent to which the amount of charcoal consumed by a typical household shifts as a result of the entry of the clean fuel enterprise(s).

STEP 5: SCALE

The methodology outlined in steps one through four seek to prove the key tenet of the Charcoal Price Index; that more transparent charcoal prices will help market actors to make cleaner or more sustainable fuels available to those with no other option but to cook with informally sourced charcoal. It will confirm that the Index generates price data that is accurate and reflective of true prices and that the data creates insights that are usable and useful to the stakeholders mentioned throughout this paper. It will prove the extent to which people are willing to participate and provide data for the Index and indicate ways to encourage continued future participation. It will also indicate how best to determine the quality and quantity of charcoal bought and sold. Finally, the pilot will provide insights into the potential impacts on livelihoods, particularly of those currently supported by the informal charcoal sector.

Understanding these issues more deeply is key to informing changes to the Index as it is rolled out to other regions and countries. It will be important to monitor for, and understand

the nature of, any negative consequences arising from the Charcoal Price Index, for instance, on the thousands currently employed within the informal charcoal value chain.

Looking ahead to the international expansion of the Index, a logical progression would be to pick three new countries to launch the Index in, where further learnings and refinements can be made, before a coordinated and systematic approach is taken to a phase of international expansion.

IN THE LONGER TERM...

Whilst more sustainable and safer alternatives to charcoal as a cooking fuel are gaining ground, their global impact will be minimal in the next couple of years. New innovations such as the development of organic briquettes made from harvested waste matter and a new generation of efficient biomass gasification stoves are gaining traction in the market, but it will take time and investment for these solutions to markedly impact the charcoal market. Some alternatives to charcoal, such as Liquid Petroleum Gas (LPG), are often too expensive for many customers living below the poverty line, whilst the further penetration of natural gas and electricity for cooking are hampered by the costs associated with building the required infrastructure.

Customers can falsely perceive charcoal to be much lower cost than other cooking and heating fuels¹⁵. Getting transparency in the charcoal market is a first step to driving economic gains at the last mile. The next step is to leverage charcoal price data to enable highly localized comparative pricing on fuels sources, enabling people to make informed decisions on the fuels they buy; supporting adoption of cleantech when prices reach parity. With increased price transparency on local charcoal markets, a new set of targeted micro-interventions could eventually be developed to nudge people on the margins into using cleaner fuels.

The long-term possibilities of a price-tracking index are broader than just charcoal price discovery. Once the Charcoal Price Index is established, it could be adapted to track the prices of other commodities in the last mile, such as grain or rice.

CONCLUSION

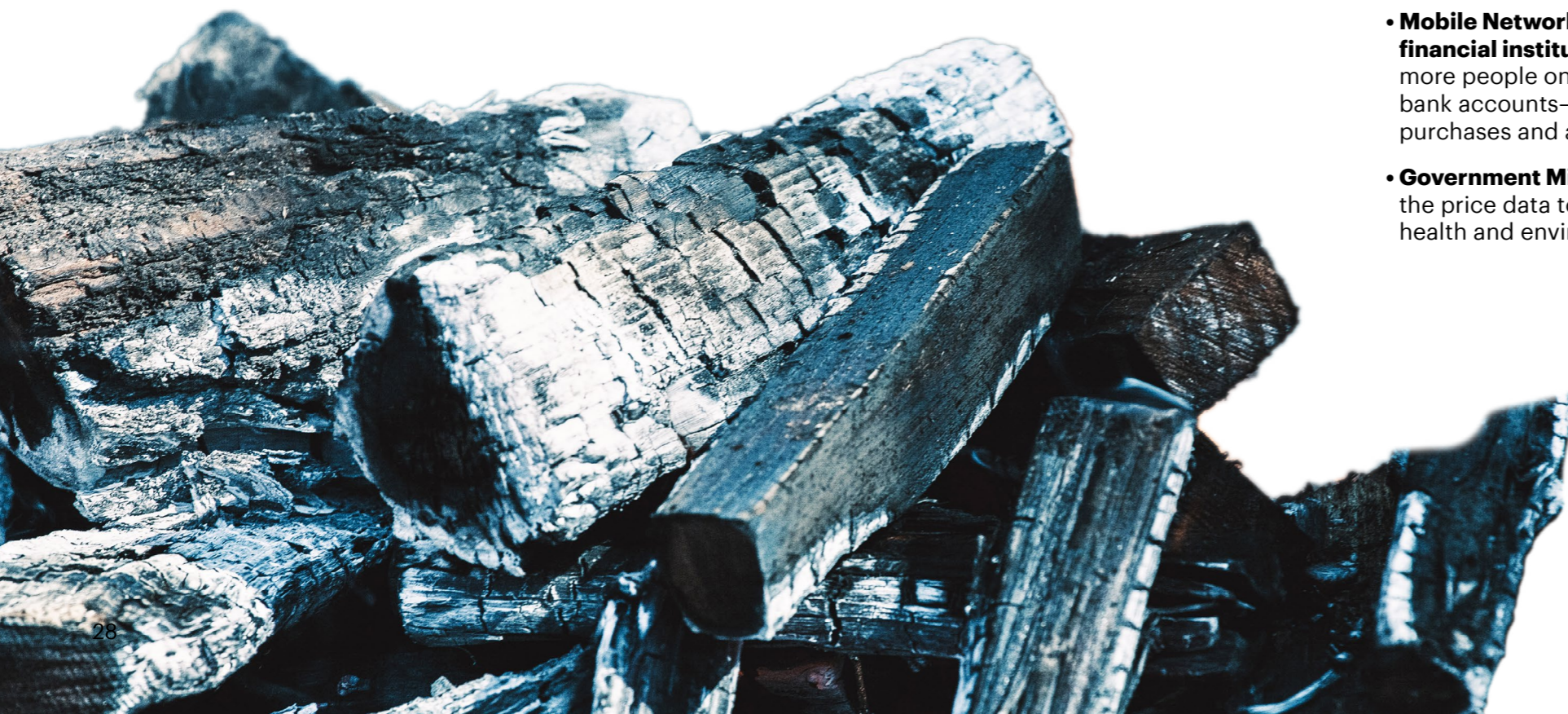
Price transparency would increase economic efficiency in charcoal markets, which would not only benefit end users, but facilitate improved policy making around the externalities associated with informal charcoal production; including the negative impacts for human health, environmental preservation and for financing informal activity. This in turn can be used as a decision-making input to policy creation, which can be bolted onto existing policy initiatives aimed at other policy areas, such as tackling environmental degradation and deforestation.

To further develop this initiative, a pilot is needed to set up and run the necessary infrastructure in a specific location. This is a worthwhile endeavor for many stakeholders, including:

- **Multilaterals or Foundations**, who could own aggregated data insights on international charcoal markets;
- **Mobile Network Operators and local financial institutions**, who could bring more people onto their networks and bank accounts—increasing data package purchases and affordable borrowing;
- **Government Ministries**, who could use the price data to guide national energy, health and environmental policies;

- **Sector Advocates**, who could use the pricing data to guide policy to help bring in new cleaner fuel technologies, ultimately allowing end customers to switch away from charcoal consumption and towards cleaner fuels;
- **Social Enterprises**, who could use the index to make the investment case for driving greater adoption of cleaner fuels—with a charcoal baseline, a path appears to compare financial, social and environmental pros and cons of adopting other clean fuels alternatives;
- **Impact Investors**, who could assess clean energy ventures with more objectivity and with less effort spent on primary research for geographic market assessments;
- **Health and Environmental NGOs**, who could use the data to shape policies and strategies for arboriculture, health or energy use.

An opportunity exists to facilitate the transition towards cleaner and sustainably sourced fuels; to guide and inform national energy policies; to increase the visibility of investment opportunities for impact investors interested in supporting cleantech enterprises and to help millions of the world's poorest to choose cleaner, more sustainably sourced cooking fuels.



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