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Strengthening the Nigerian Clean-Cooking Business Ecosystem

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Contents

List of Acronyms

BoI	Bank of Industry
CNG	Compressed Natural Gas
DFI	Development Finance Institution
FMENV	Federal Ministry of Environment
GACC	Global Alliance for Clean Cooking
ICS	Improved [biomass] Cookstove(s)
LPG	Liquified Petroleum Gas
MSMEs	Micro, Small and Medium Enterprises
NACC	Nigerian Alliance for Clean Cooking
NDC	Nationally Determined Contribution
NESP	Nigerian Energy Support Programme
NGEP	National Gas Expansion Programme
NICCAS	Nigerian Institutional Clean Cookstove Acceleration Scheme
NLPGEP	National LPG Expansion Plan

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Summary

This research paper describes the current business ecosystem for clean and conventional cooking fuels and technologies in Nigeria. Drawing on the knowledge of private-sector actors as well as a number of key market-enablers and experts, the study examines recent trends, drivers and barriers influencing the clean-cooking market and estimates its potential growth in the future under different scenarios.

The key findings are that there is currently momentum in the liquefied petroleum gas (LPG) value chain and that some market players in the improved cookstove (ICS) space have become established and attracted important investments. Firms fall into different typologies according to their size and the extent of their reliance on imports, and each typology presents different needs for scaling up. Nevertheless, the business ecosystem for clean cooking remains weak and, as a result, Nigeria is likely to fall short of its national clean-cooking target of 60% of the population having access to clean cooking by 2030.

Key knowledge gaps include limited or no cookstove sales data and an inadequate understanding of the value chain for cooking energy in the manufacturing and agri-chain sectors. Recommendations for high-priority interventions that could support the private sector to scale up include the strengthening of private-sector representation in intervention design, the availability of credit facilities for both importers and local manufacturers and the strengthening of incubation, seed-funding and capacity-building support for early-stage firms.

Key Messages

1. The LPG value chain is still developing but has an appropriate policy framework and a platform for engagement with government. Opportunities for intervention include targeted support to retailer-centred cylinder distribution models, innovations to increase affordability for consumers and the strengthening of publicly available market data to aid monitoring and decision making.

2. The ICS value chain has not scaled up despite a growing range of manufacturers, importers and distributors with proven products and business models. Interventions for strengthening the ICS value chain could include an appropriate financing ecosystem (credit lines, subsidies, tax incentives, etc.), incubation of new businesses in the sector, support for broadening the distribution channels of established players and support to industry associations.

3. While many challenges remain within the household ICS value chain, the productive use/institutional sector – micro, small and medium enterprises (MSMEs) – is even further behind and deserves urgent attention.

4. Very little is known about the woodfuel and charcoal value chains, the potential resistance of value-chain actors, and opportunities for intervention. Moreover, a map of the demand and supply areas for these fuels is urgently needed.

5. Under a best-case and relatively disruptive scenario, there could be a rapid scale-up of LPG penetration by 2030. Penetration of ICS would remain modest but be firmly positioned for scale-up.

6. A number of technology and business-model innovations have the potential to address key market needs: e.g. smart metering, geospatial mapping and planning tools, electricity as cooking fuel.

7. Women-led enterprises have a growing role in last-mile distribution, but greater attention should be paid to the development of women-led firms in the import/manufacture and wholesale distribution segments.

8. The design of interventions should take into account the significant differences in the urban/peri-urban and rural value chains. Differences that directly affect the profitability of private players in these value chains include the cost and accessibility of different fuels, the demand for uniform products vs. tailor-made solutions and transportation costs.

1. INTRODUCTION

The cooking-energy market in Nigeria is dominated by the wood, charcoal and traditional-stoves value chains. However, a growing number of private-sector actors operate in Nigeria's clean-cooking space. LPG, improved biomass cookstoves (ICS) and renewable-fuel value chains are emerging nationwide. The LPG sector is almost entirely financed by the private sector and its policy and enabling environment has greatly improved. The ICS sector, though still strongly reliant on carbon finance, public funds or donor grants, has made important progress in developing and testing appropriate solutions and business models. Firms are also operating in larger numbers and reaching more households each year. While the rate of market growth is still far from able to support a scale-up phase, it is estimated that several tens of thousands of Nigerian households are shifting to cleaner fuels or efficient stoves yearly.

The goal of this study is to provide a knowledge base for the design of supply-side-focused interventions that would strengthen the "business ecosystem" (as defined in Box 1) for clean cooking and ultimately contribute to the scale-up of cleancooking adoption in Nigeria.

The specific objectives are to:

- outline the current market structure and key trends in the clean and conventional
- cooking fuels and technologies value chains;
- assess the potential for the market under different scenarios;
- put forward recommendations for supply-side-focused interventions.

Five key fuel and technology value chains are considered in this study: LPG, ICS, woodfuel and charcoal, kerosene, and other solid biomass. The scope of the study is national. The document is organised as follows: the approach to the analysis of the business ecosystem is presented (Section 1), followed by key findings for each major value chain (Section 2). Future scenarios for the market are then outlined (Section 3). Finally, key knowledge gaps and recommendations are put forward (Section 4). Several case studies are highlighted across the report.

Box 1.

What do we mean by business ecosystem?

We propose the term "business ecosystem" rather than "value chain" because there is a variety of value chains for different fuels and cooking technologies. The term "ecosystem" also allows for dynamic interactions among these different value chains as well as a co-evolution of the players and technologies. Moreover, it encompasses key enablers beyond the traditional private-sector players. This may include government agencies, business incubators, financiers or industry associations.

2. THE NIGERIAN COOKING BUSINESS-ECOSYSTEM

2.1 Approach

The approach of this study is based on the "Energy Market System Assessment Framework" (Franz et al., 2015). This framework supports the systematic analysis of decentralised energy-service markets and the development of effective interventions for supporting energy-market development. It has been applied, among others, in the context of improved biomass cookstove and fuel markets as well as to LPG stove markets.

In the first stage of this methodological framework, a mapping is made at three levels: the "market chain", the "inputs, services and finance" that feed it and the "enabling environment", which includes political, social and economic factors. Figure 1 depicts the three levels. Different factors and inputs can be linked to different stages of the value chain. Possible interventions are proposed for specific segments of the value chain and linked to specific influencing factors and inputs.

This methodological framework guided the data collection and was applied to analyse the LPG and ICS value chains. Data collection took place in the form of 10 semi-structured expert interviews, complemented with literature and published data where available.

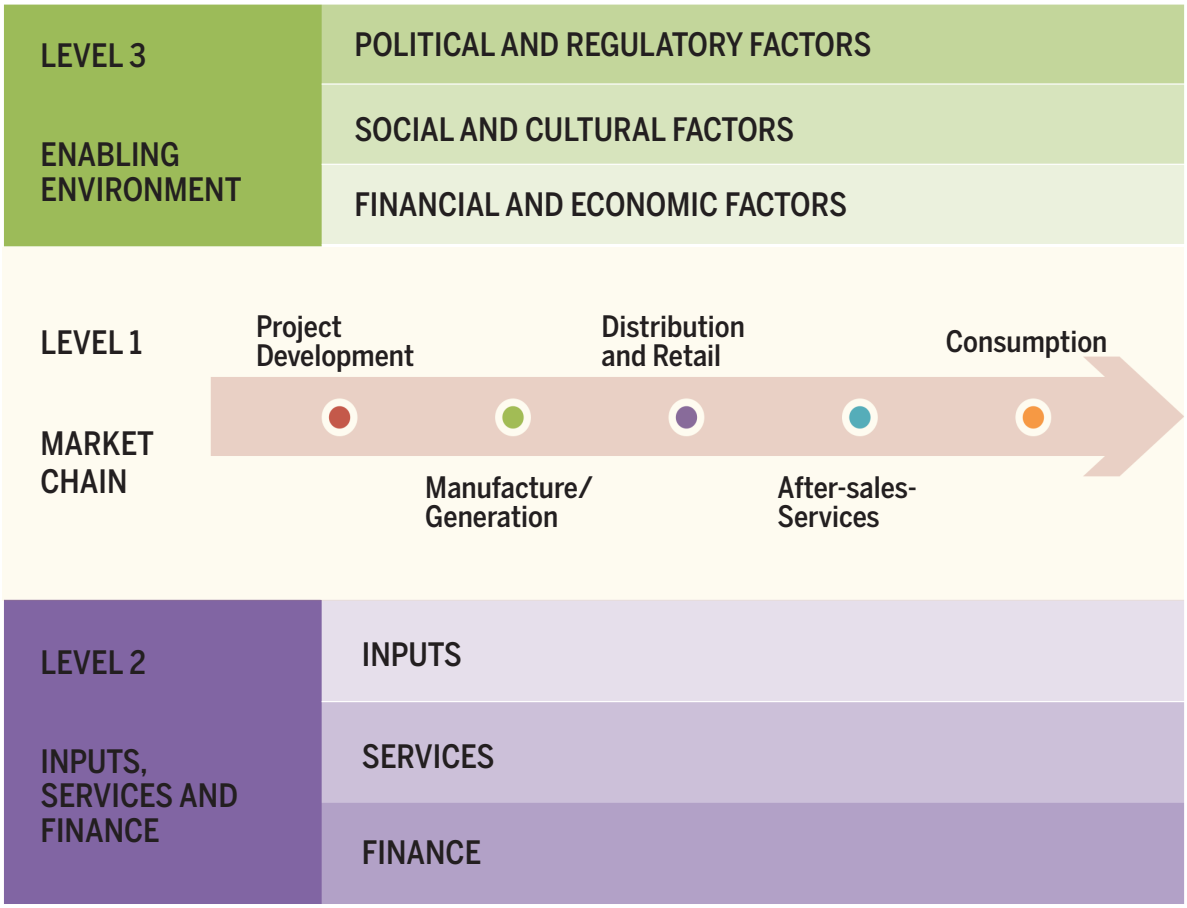


Figure 1. Market map based on Energy Market System Assessment Framework
Source: adapted from Franz et al., 2015

2.2 Liquified petroleum gas

With a current penetration of over 20% in urban households,[1] the liquified petroleum gas (LPG) value chain is quickly becoming firmly rooted in the Nigerian market. Expert interviews also indicated that LPG is the fuel-and-stove value chain that has the greatest potential for growth in the short term, in particular in urban and peri-urban households. Thanks to a number of key policy initiatives (National Gas Policy, National Gas Expansion Programme (NGEP), National LPG Expansion Plan (NLPGEP), Economic Sustainability Plan 2020), the market has grown very rapidly, particularly in some areas, such as Lagos state. There are, however, important characteristics of the value chain worth noting.

Currently, the key dynamics in the LPG value chain are playing out at the distribution level. Both private and government experts agree that, despite the current buoyant demand and distribution market, the model is not sustainable. The majority of cylinders currently in circulation in Nigeria are owned by customers and most LPG distributors do not have the means to invest in purchasing cylinders. There is a significant number of small companies in the segment, including informal last-mile distributors. One expert pointed out that this is characteristic of early-stage LPG markets and that other economies, such as Brazil, show the path for a transition from this early stage to a fully mature market.

[1] For details on current penetration of different fuels, see Section 3.1 Base-year assumptions.

The customer-owned cylinder model poses severe safety risks and, with them, public-acceptance risks. Each explosion jeopardises public perception in what is still a small market in urban areas and a nascent market in rural areas. The safety advantages of a retailer-centred model include: (a) it facilitates the regular safety checks required over the lifetime of the cylinder as well as the removal at the end of the lifetime; (b) it ensures safe filling of cylinders and a "cylinder exchange" model that avoids unsafe filling in residential areas; (c) it allows for centralised distribution planning (facilitated by new tracking technologies).

A retailer-centred cylinder ownership model is also more profitable. However, it has a high entry barrier. Investing in a gas-distribution plant is generally affordable in the current business climate but a larger investment that includes plant, warehousing/import facilities, cylinders and transport logistics is not. Building a vertically integrated distribution model is expensive and only affordable to larger companies. Despite there being a strong "first mover" opportunity, these larger players are still not present in the Nigerian market in sufficient numbers.

To address this financial barrier and facilitate access to capital, a credit facility of NGN250 billion targeting the LPG and compressed natural gas (CNG) sectors (5% rate loan, 1–2 years' moratorium) was proposed in 2020 as part of the National Gas Expansion Programme (Adekoya, 2020). A variety of other finance sources, including development finance institutions and carbon credit markets, are currently under discussion. Waivers of 5% VAT on the domestic production of LPG and 5% import duty on LPG equipment and accessories are in place. Other proposed interventions include five-year tax holidays for firms in the sector.

The distribution bottlenecks require interventions beyond finance. The other key element to expand cylinder numbers is regulation and standards. Both the national and Lagos state governments are currently strongly focused on developing standards for LPG distribution and dispensing that will support the market.

It is estimated that there are currently fewer than 3 million LPG cylinders in circulation in Nigeria. Expanding the distribution segment of the value chain, growing the number of cylinders in circulation and encouraging the production of cylinders domestically are key goals of government initiatives. There is, however, a fine balance to be struck: small distributors have been and are still very important to help grow the market, and restricting them could jeopardise the gains made.

Until recently, the upstream imports and domestic production were a significant challenge in the LPG value chain. Following strong interventions (import duty exemptions, increased import terminals), it appears that there are fewer risks of supply shortages and shocks, at least for current levels of demand. It would be important to understand whether supply could become a bottleneck in certain areas in the case of a very rapid acceleration of the market. A map of existing and planned LPG terminals could shed light on the prospects for future supply growth.

The focus of supply-side interventions has shifted towards resuscitating local LPG production and encouraging local content with a view to supporting the local industry and the security of supply. A key goal of the NLPGEP is to have 70–80% of fuel supplied from national sources by 2023. This is to be done mainly by engaging with the export-oriented gas industry. Some of the barriers to getting gas companies involved include the unfavourable investment environment, their previous negative experience in the power sector, the lack of transport infrastructure (physical and virtual pipelines, warehousing terminals), as well as regulatory barriers.

Another aim is to reach beyond core urban areas. Lagos, the Southwest and Federal Capital Territory are seeing rapid LPG penetration. Expert interviews indicated that transport costs are not a key barrier to reaching other regions, although some work is going into storage terminals that facilitate transport via inland waterways and roads to reduce the costs of transport.

Finally, relatively little attention has been given to date to interventions on the consumption end of the value chain, which remains key to building demand. Reducing the upfront investment cost of the stove has been a target of some LPG distribution companies, such as Oando, which recently introduced "all in one" products (smaller volume cylinders with in-built burners). A variety of other affordable small burners are available, as well as full stoves intended for urban households. While the market is adapting well to user needs, some experts indicated that there are still untapped opportunities for local manufacturing of tailor-made solutions, as well as for improvements in quality and safety. One example of a market innovation that would allow low-income households to shift to LPG is smart LPG metering (see Box 2).

In conclusion, key policy initiatives currently supporting the sector (e.g. NLPGEP, NGEP, Gas Master Plan, Lagos state policies) are, by and large, effectively supporting an already dynamic value chain and have shown a capacity to adapt to different priorities of the value chain as they progressed. In contrast to the ICS space (Section 2.3), private-sector players in the LPG sector are already the target of a comprehensive policy support programme and have a platform for continuous engagement with government. Specific challenges and opportunities that remain include a more developed financing ecosystem for LPG distributors and retailers, innovations to increase affordability for consumers and the strengthening of publicly available market data that aids monitoring and decision-making.

Figure 2 maps the potential intervention areas analysed above onto the Energy Market System Assessment Framework for both the LPG fuel and stoves value chains. This is only a preliminary map to be developed in consultation with stakeholders and could be complemented with other key interventions such as capacity building, subsidies, removal of import duties, etc.

While the ethanol and methanol value chains are not covered in detail in this report, it is worth noting that there have been several projects in this field. A recent project in Lagos piloted 2,500 stoves and 15,000 alcohol-fuel canisters and there were plans to roll out a commercial start-up in 2018–19 (BAMG, 2018; Ozier et al., 2018).

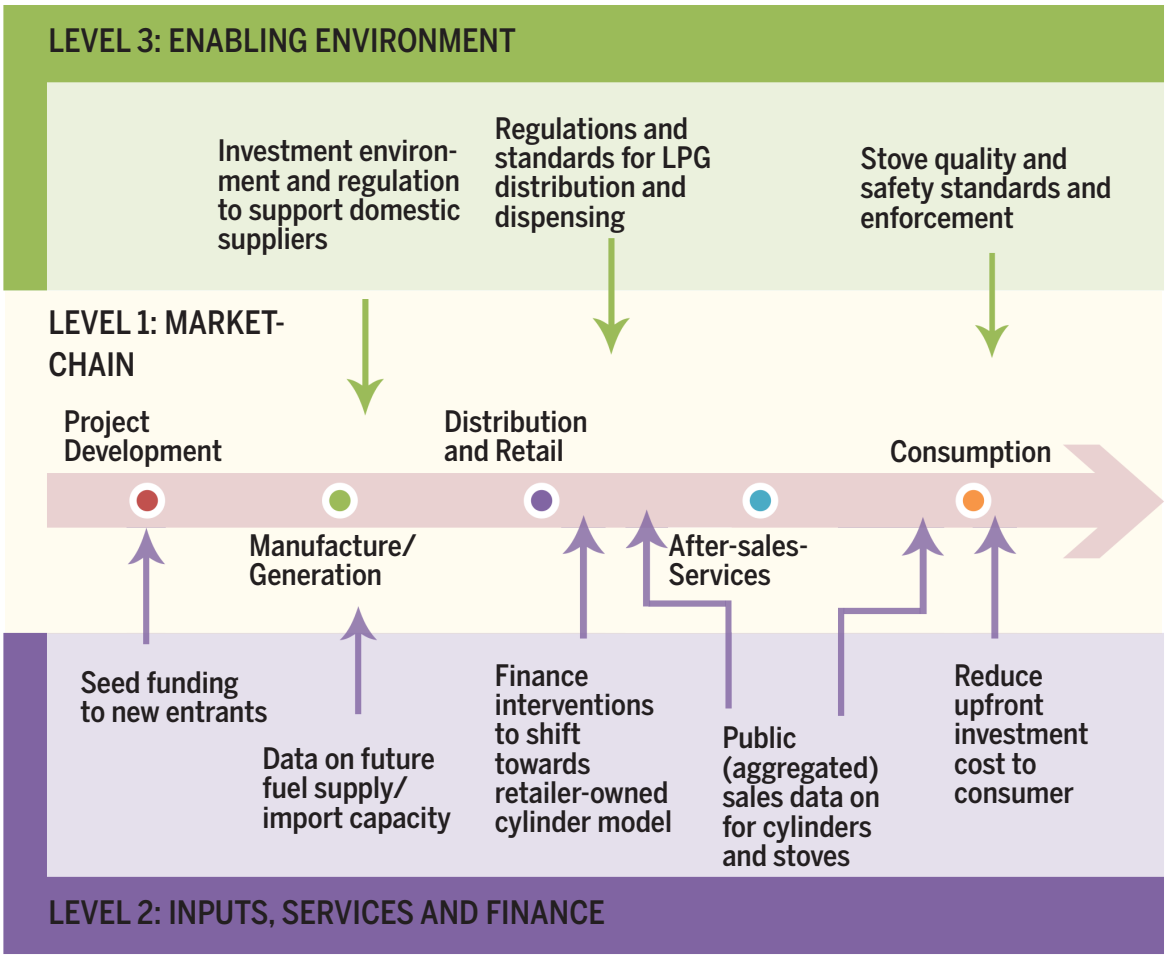


Figure 2. Mapping of potential interventions in LPG value chain

Box 2.

Case Study: Pay-as-you-cook business model innovation to increase LPG affordability at consumer level

Envirofit's SmartGas programme was one of the first pay-as-you-cook meter services. It integrates mobile money and an innovative valve that allows consumers to pre-pay for LPG in small increments and get access to gas on credit. The technology was piloted in Nairobi and Accra with support from the Shell Foundation. Based on the lessons learnt, the firm has been able to scale-up marketing across low-income segments in Kenya and Ghana and plans to pilot the solution in Nigeria. Similar to other pay-as-you-go business models in off-grid electricity or sanitation, this approach can align the earning and consumption patterns of consumers at the base of the economic pyramid (Alderman, 2019).

Source: Envriofit

2.3 Improved biomass cookstoves

While LPG is generally perceived to have the greatest potential for growth in urban and peri-urban areas, ICSs are seen to have particular potential in rural areas, where fuelwood has greater affordability and accessibility. There is, however, no national-level data regarding the level of penetration of improved wood and charcoal stoves in Nigeria. The present study estimates that ICSs are currently used in around 0.5% of households in Nigeria (see Section 3.1 for further details on this estimate). Figures on the use of improved cookstoves in MSMEs and industry are not available.

Furthermore, it is difficult to assert whether there has been a growing number of firms in the value chain in recent years. While all are relatively young companies, they have clearly become more established, with proven business models and agent networks. In any case, the market remains very small and there is much potential for the entry of more players.

Three different models can be identified in the import and manufacture segments of the ICS value chain:

- **Internationally manufactured stoves:** imported by both international and national firms. Some firms import components and assemble in Nigeria, or at least have tested this model at times. While most stoves are imported from China or the EU, a relatively new player (Burn) manufactures stoves in Kenya. Internationally manufactured stove firms are all able to reduce the cost of their stoves to consumers through carbon finance, which also entails close tracking of the use of their products.

- **Nationally manufactured stoves with centralised distribution through agents and retailers,** though they may also sell directly to users. These companies trade in smaller numbers than those importing and focus on more limited geographical areas, given the significant transportation costs. The stoves are usually more affordable and tailored to the preferences of customers in the target communities, and their design is adapted to use the raw materials available locally. Funding from development or humanitarian agencies or NGOs (e.g. WFP, MEDA, DFID) is still the basis for commercial operations of many of these firms.

- **Nationally manufactured stoves with decentralised distribution through direct sales.** Companies can be very small and include informal stove manufacturers. This model was not considered in depth in this study.[2]

Distributors play a key role in the value chain. Around thirty ICS producers and suppliers are currently listed in the Nigerian Alliance for Clean Cooking (NACC) private-sector database; the majority of these are distributors at the wholesale or retail level. They warehouse and distribute different brands of internationally and nationally manufactured stoves and are vital partners for importers and local manufacturers. Distributors, retailers and sales agents play a key role in ensuring affordability for consumers as they negotiate payment plans and make collections. Moreover, they facilitate after-sales service and implement data-monitoring. They have an in-depth understanding of local contexts and customer preferences, which is particularly important in the ICS value chain.

Nigeria's **last-mile distribution models** in the ICS value chain rely primarily on engaging local entrepreneurs (often women) through various incentives to distribute selected products within their communities. While this is an effective strategy, other models have been used in other countries, often in combination, such as piggy-backing on fast-moving consumer goods to attract consumers and ensure more stable income (SNV, 2015).

Many firms in the ICS value chain provide other services, such as advisory and training, and most are not solely devoted to ICS. For example, firms also operate in the LPG (e.g. Envirofit), off-grid electricity (e.g. Sosai, Creeds, Solar Sister) or other solid-fuel value chains (e.g. briquette production from agricultural waste). Sosai also designs in-built stoves in rural communities and provides training in building them. Integrating clean cooking within a wider portfolio of products and services is common in other countries (e.g. India) and holds much promise for strengthening the cooking value chain as companies are able to provide consumers with a variety of complementary energy solutions and use the same distribution channels for different products.

A number of experts interviewed indicated that, while many challenges remain within the household ICS value chain, the productive-use sector is even further behind and deserves urgent attention (this possibly applies as well to the LPG value chain). Productive use of cookstoves – more often called "institutional clean cookstoves" (ICCs) in this context – include rice parboiling, cassava fermentation, palm kernel oil production, fish smoking and bakeries. Rice parboiling seems to receive the most attention, with two programmes currently targeting the sector: the Competitive African Rice Initiative (CARI)

[2] Annex 1 contains a list of cookstove prices valid in 2017 to illustrate the differences in price among the different import and manufacture segments.

and the recently awarded Nigerian Institutional Clean Cookstove Acceleration Scheme (NICCAS) (see Box 3).

Box 3.

Case Study: Nigerian Institutional Clean Cookstove Acceleration Scheme (NICCAS)

NICCAS was designed to support the development of a market for improved institutional clean cookstoves (ICC) for agro-processing through the provision of support to local specialised companies. It will target the provision of ICCs to 600 agro-processing groups in two conditional steps: piloting and replicating. This will be followed by a third step, capitalisation, during which a bankable project proposal to provide 2,000 agro-processing groups with access to ICCs will be developed and presented to interested investors. Sosai won the bid through a competitive process and will receive technical assistance and financial support to pilot, replicate and scale the improved rice-parboiling stoves. The foreseen outputs comprise refined technical designs and a viable business plan that will facilitate access to finance. The design of this intervention aims to support the development of the value chain without subsidising the price of the stove directly. NICCAS is managed by the Federal Ministry of Environment (FMEnv), with support from the European Union (EU) and the German government through the Nigerian Energy Support Programme (NESP) and implemented by Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ).

Source: Sosai

Economic factors that affect all manufacturers in Nigeria hinder the growth of the Nigerian ICS value chain. These include high costs of self-generation, high transport costs, high investment risks, etc., and are compounded by industry-specific challenges such as the very low price of fuelwood, limited awareness among consumers and social norms.

Carbon finance and donor funds remain the only sources of finance in the value chain and continue to be very scarce. No national-level credit facility is available for ICS firms, in contrast to the LPG or solar off-grid sectors where various facilities have emerged in recent years. Finance from the Bank of Industry (BoI) is available for importers of machinery related to clean cooking (such as pellet/briquette machines) but not for importing stoves or stove components. Moreover, there is a complete lack of awareness about the sector among commercial banks and very limited experience within microfinance institutions, although the Clean Cooking Alliance has brokered links between suppliers and microfinance institutions in recent years. One recommended intervention is awareness-raising and capacity-building in financial institutions and at BoI similar to recent interventions in the off-grid electricity sector.

There is an even starker lack of financing options to allow early-stage companies to grow. When asked about possible interventions for financing the market and attracting investors, expert interviews indicated that business incubation and support mechanisms for early-stage firms are a crucial next step. Nigerian ICS firms have in recent years received targeted funding support through development funds such as the Catalytic Small Grant, Spark Fund and Women's Empowerment Fund (CCA, n.d.). The Clean Cooking Alliance has also assisted in matchmaking firms and investors (Clean Cooking Investment Series 2020, n.d.). However, this remains negligible compared to the emergence of business-incubation initiatives in the off-grid renewable electricity space, including from impact investors.

There are several business skills training programmes currently available in Nigeria that ICS entrepreneurs are making use of. Increased access to business skills training and peer-to-peer knowledge-exchange interventions are seen as one way for many manufacturers to expand their businesses and for more women entrepreneurs to enter the value chain.

Providing a gender perspective to finance, business incubation and skills programmes in the ICS sector is important for the design of future interventions. In Nigeria, women-led enterprises are currently far more represented in the distribution, retail/last-mile segment than in manufacture and there are currently no women-led importing firms. This is analogous to the findings of researchers looking at the ICS value chain in East Africa (Sesan et al., 2019) and seems to be the case in traditional fuel value chains as well, as suggested by a recent study of the Kenyan charcoal value chain (Ndegwa et al., 2020). Value chain positioning affects profitability as it influences access to mass markets and finance for business expansion. The clean cooking value chain is set to gain from encouraging women's involvement at higher levels and not only in last-mile operations. Some examples of recent interventions internationally include the Women in Clean Cooking mentorship programme (CCA, 2020). Women's cooperatives and women-led MSMEs are also important targets for interventions aimed at the adoption of clean cooking in the productive-use sector.

In terms of enabling policies, there is currently no overarching national government programme that targets ICS private firms, though public finance has been directed through several interventions to test the viability of concepts or to subsidise ICS. Interventions by government and donor agencies prioritise local manufacturers. None yet has aimed to attract more international players to enter the market and scale-up supply in terms of stoves and locations.

One further policy-related barrier in the ICS value chain is the lack of standards. The range of ICS models available in the Nigerian market typically reduce fuel consumption by 20% or more (ASI, 2014) and reduce emissions of indoor air pollutants such as particulate matter and carbon monoxide. However, the quality of ICS ranges from stoves with limited efficiency and emission gains to those with better performance but also higher prices. It is often unknown how well the stoves perform as there is no quality assurance programme in place. A quality standard was approved in 2017 but is yet to be enforced (CCA, 2017).

Lastly, the ICS value chain is lacking an industry association in which firms could join efforts to lobby government.

In summary, recommendations for strengthening the ICS value chain include:

- a shift of attention to productive end-use sectors;
- an appropriate financing ecosystem, for both consumers and entrepreneurs;
- awareness and capacity-building in the finance sector;
- incubation of new businesses in the sector;
- support for broadening distribution channels of established players, e.g.through favourable financing of new, commercially viable production and are housing locations;
- training in business skills;
- support to industry associations.

Figure 3 below maps the potential intervention areas analysed above for improved cookstoves onto the Energy Market System Assessment Framework. This is only a preliminary map to be developed in consultation with stakeholders and could be complemented with other key interventions.

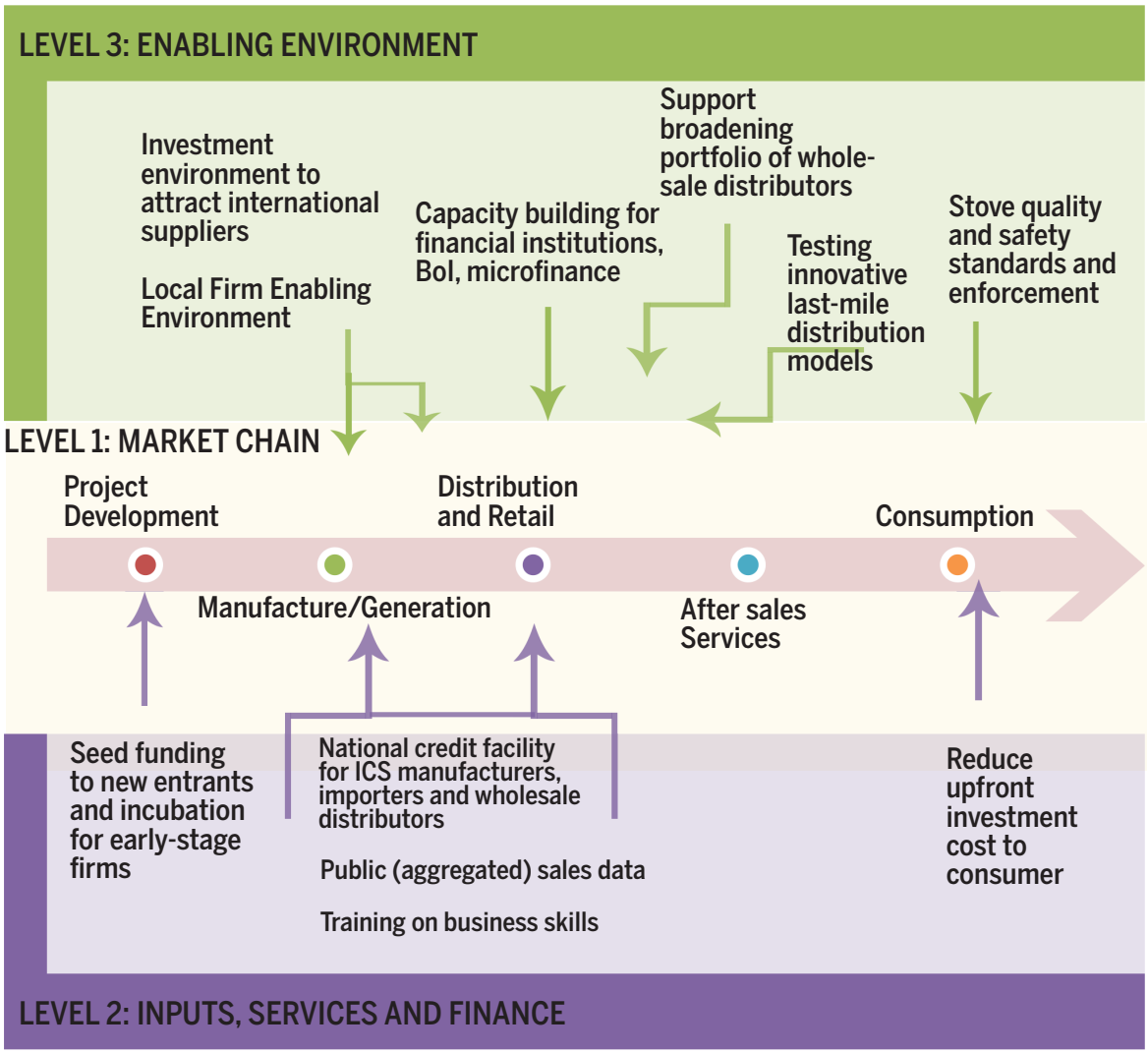


Figure 3. Mapping of potential interventions in the ICS value chain

2.4 Wood and charcoal

Wood and charcoal are the main fuels used in two-thirds of Nigerian households (wood 62.3%, charcoal 4.4%; see Section 3.1). Despite their major role as energy sources in the country, there are significant knowledge gaps as to the structure of the value chains and their socio-economic impacts (e.g. employment created, impact on deforestation). A map of woodfuel demand and supply areas is currently not available at the national level, though global studies have attempted this based on geospatial data.[3] A review of the Nationally Appropriate Mitigation Actions database reveals that several studies of the charcoal value chain have been carried out in other African countries, with the aim of attracting climate finance to the sector. Studies have looked at neighbours such as Ghana and Côte d'Ivoire, but none have yet been commissioned for Nigeria, despite the fact that Nigeria is the world's second-largest charcoal-producing country after Brazil (Van Dam et al., 2017).

This undocumented and largely unregulated sector nevertheless brings great rents to certain actors. Local woodfuel industry associations can have strong political influence. As such, any intervention aiming to reduce demand for the fuels via efficient stoves or to shift to cleaner fuels is likely to meet resistance from those "losing out" and will require dialogue with industry representatives.

The lack of information on demand and supply patterns, governance, ownership and the role of the private sector impedes an assessment of what would be the most appropriate interventions to address the green and just transition in the woodfuel and charcoal value chains in Nigeria. Examples of policies and interventions implemented in sub-Saharan Africa to support sustainable woodfuel value chains and regulate charcoal trade include:

- bans on woodfuel production or transportation (which is the case in some states of Nigeria). These are typically difficult to enforce, encourage corruption and promote a shift to lower-quality fuels;
- land-tenure and forest management reforms. These are common to all examples of successful woodfuel value-chain development, but insufficient on their own to ensure success;
- licenses, quotas and permits. These require formalising a highly informal sector; moreover, complicated or costly permit systems can act as de facto bans;
- subsidies and taxes, e.g. differential taxation, has been implemented with some success in Chad and Niger;
- cooperatives and producer associations. These allow for monitoring who produces woodfuels and create clear pathways for communication and revenue. Moreover, members are able to pool resources and increase bargaining power in some market conditions;
- for charcoal: commercial utilisation rights, legislated licensing. (UNEP, 2019)

[3]Forestry research institutions have developed tools and programmes to estimate woodfuel demand and supply at a global level through satellite data. The key ones are WISDOM (Woodfuel Integrated Supply/Demand Overview Mapping; www.wisdomprojects.net/global/), MoFuSS (Modeling Fuelwood Savings Scenarios; https://www.mofuss.unam.mx) and Global Forest Watch (https://www.globalforestwatch.org/). An interview with World Resources Institute elicited that some energy-access geospatial planning tools are starting to incorporate spatial data on cooking demand and forest cover.

The Sustainable Fuelwood Management project implemented by UNDP with Global Environment Facility (GEF) funds is an example of an intervention in the Nigerian woodfuel value chain (UNDP, n.d.). The project supported baseline studies to assess fuelwood availability and consumption rates in selected rural communities in the Cross River, Delta and Kaduna states. Over the lifetime of the project, it has secured woodlots for sustainable wood plantations and set up tree nurseries in the three states. The project engaged fuelwood value-chain actors in the states, trained them in sustainable fuelwood management best practices and sensitised them to its benefits.

At a micro-level, ICS entrepreneurs also engage with the fuelwood value chain. One entrepreneur engages local fuelwood sellers and their children (who often help in the trade) and trains them in the building of improved cookstoves as an additional source of income.

The charcoal value chain is more traceable and there are several studies of it in Africa (Kazimoto, 2015; Ndegwa et al., 2020), though none were found for Nigeria. Importantly, but not in terms of national cooking energy, Nigeria produces 8% of the world's exported charcoal (Hilse, 2017).

2.5 Kerosene

Despite a decrease in demand in recent years, kerosene remains the main cooking fuel for 20% of Nigerian households (in the case of urban households, up to 40%).

The kerosene value chain is highly organised and starts at the marketer's tanker on the shore, which is then discharged into trucks and transported to roadside tanks, from where it is sold to jerry-can retailers and ultimately to bottle retailers.

The supply chain suffers from price fluctuations, supply shortages, black-market activity, smuggling, hoarding and the adulteration of kerosene with gasoline, which causes explosions and other safety incidents (ADP, 2011; Ogundari et al., 2018). Following recent subsidy removals, prices have become prohibitive for many Nigerians and the industry is seeing very low margins, many importers and distributors (as well as oil companies operating the downstream segment) are shifting their focus towards their LPG business, which is closely tied to the upstream segment of the kerosene supply chain. It is important to note that, despite there being a shift from kerosene to LPG, the high prices of kerosene may have led many urban poor to "move down the energy ladder" to biomass fuels (see Work Package 1 report).

Kerosene stoves are relatively affordable and are mostly imported, though some local manufacturers exist. The quality of stoves can be poor and lead to safety problems.

The main intervention in the kerosene value chain (apart from the removal of subsidy) is the LPG Expansion Plan described in Section 2.2. The plan aims, among other things, to displace kerosene demand by lowering barriers to LPG adoption. In this context, the Kerosene to LPG Conversion Programme in Indonesia is widely cited as an example of best practice for large-scale interventions.

2.6 Other solid biomass fuels

According to the 2016–17 Multiple Indicator Cluster Survey (NBS, 2018), 7% of Nigerian households use agricultural crop residue (e.g. rice husk), animal dung and other solid biomass (e.g. straw and grass) for cooking. Agricultural production will continue to increase in Nigeria, so the availability of these by-products is not likely to be an issue. However, the challenge lies in the aggregation of residues in significant quantities as well as the management of its allocation between fuel, fodder for animals and other uses.

A number of private players are operating in this space, but there is no database or directory that facilitates access to them. ICS manufacturers are also present in the value chain, as entering the fuel/briquette value chain complements their portfolio and may offer a more stable source of cash flow.

Recommendations for strengthening the local value chain include providing incentives to feedstock aggregators, increasing access to finance for mechanised production (e.g. briquettes), public procurement policies and research to better understand the availability of feedstock. Moreover, there is no clear picture of which technologies are best suited for which fuels from agricultural waste. Lastly, there is a lack of standards and certification.

This section has reviewed the main value chains for cooking fuels and technologies in Nigeria. Box 4 addresses one further technology yet to arrive in the Nigerian market.

Box 4.

Case Study: Solar Electric Pressure Cookers and the MECS Programme

Though not yet present in the Nigerian clean-cooking ecosystem, solar electric cooking is a potentially transformative addition to the technology landscape. Recent price drops in battery technology are opening the door for the use of solar PV panels to charge a battery which can then be used for cooking. The Modern Energy Cooking Services (MECS) Programme is working to overcome social and cultural barriers to the adoption of solar electric cooking. It has developed recipes and cookbooks in a participatory manner, designed consumer-awareness interventions and is supporting the development of distribution channels and supply chains in several countries in East Africa as well as in Ghana. Key barriers to market penetration of solar electric pressure cookers in Nigeria include cost, consumer awareness and social norms.

Source: MECS

3. FUTURE SCENARIOS

A number of different policy targets exist in relation to clean cooking in Nigeria. In 2015, the Federal Government set out the target of providing 60% of the population with access to clean cooking by 2030 (FMPWH, 2016). At its inauguration in 2011, the NACC aimed to introduce 10 million fuel-efficient stoves to Nigerian homes and institutions by 2021. A similar figure is currently the target of the Federal Ministry of Environment, which aims to launch a programme to reach 10 million households (or 21% of the population) with clean-cooking solutions by 2025. Lastly, the latest Economic Sustainability Plan targets the "conversion of 30 million homes from dirty fuels (kerosene, charcoal and diesel) to LPG" in the short term (ESC, 2020).

The evidence used to build these quantitative policy targets is not publicly available. No literature could be found regarding scenario assessments of Nigeria's clean-cooking targets, except for the latest IEA Africa Energy Outlook, which sees 80 million Nigerians gaining access to clean-cooking solutions by 2040 under an optimistic scenario (IEA, 2019).

It is important to note that Nigeria's 2015 Nationally Determined Contribution (NDC) contains no emission goals associated with cooking energy nor any mention of goals relating to access to clean cooking (FRN, 2015). It is, however, foreseen that the 2020 revision of the NDC will integrate cooking energy in the goals and modelling.

Drawing from recent survey data on household cooking energy consumption, and on our assessment of current trends, we explore feasible pathways for the sector and compare them to government targets. For this, three scenarios for the growth of different segments of the market over the next decade were built. Their underlying assumptions and storylines are presented here in turn, followed by the key findings.

It is important to note that this is only a preliminary set of scenarios to be developed in consultation with stakeholders.

3.1 Base-year assumptions

All of the base-year (2018) assumptions for the scenarios draw from the draft IRENA Energy Balance, except the assumption for the improved biomass cookstoves (ICS) segment.

Draft Energy Balance base-year assumptions: the draft sums up data available from three national surveys conducted since 2016 (LSMS (NBS, 2019), DHS (NBS, 2018) and MICS (NPC, 2018)). The three data sources provide a picture of the percentage of households using different fuels for cooking. The use of this data in the base year of our exploratory scenarios is made with two important assumptions. First, "percentage of households" figures are considered equivalent to "percentage of population". Second, we assume that fuel shares in non-household cooking (services, institutional cooking) are equivalent to those of households and do not disaggregate the two. This differs from the approach in the IRENA Energy Balance, which does disaggregate the two types of consumption.

As stated in the draft Energy Balance, there is a knowledge gap regarding the use of cooking energy outside of households, especially in services and MSMEs, and a survey of energy use in businesses is urgently needed.

ICS base-year assumptions: the use of ICS is not reported in recent national surveys and no public data is yet available on current sales of ICS in Nigeria. However, expert interviews indicated that total yearly sales, including imported and locally manufactured stoves, could be in the range of 50,000 stoves in 2020. Assuming the market has been growing slowly but steadily at a 10% yearly growth rate over the last 5 years and providing for average lifetime of stoves, it could be assumed that around 180,000 households currently use an ICS. This represents 0.5% of households in Nigeria in 2018. Given the higher prevalence of wood and charcoal as fuels in rural households, it is safe to assume that ICS use is also more prevalent in this segment than in urban households.

3.2 Scenario storylines

The three scenarios have the following storylines.

Business-as-Usual (BAU): a pessimistic scenario where sector transformation is slow, national plans are weakly implemented and development continues along historical trends. Specific fuels follow these trajectories between 2018 and 2030:

- **LPG:** doubles its current share on both the urban and rural segments, displacing mainly kerosene. This implies an average yearly growth rate of 6%, therefore staying abreast of population growth;
- **Woodfuel/charcoal ICS:** triples its current share, based on an assumed annual growth rate of 10% (see Figure 4);
- **Woodfuel with traditional stove:** stays largely stable;
- **Charcoal with traditional stove:** stays largely stable;
- **Kerosene:** halves, displaced by LPG;
- **Other clean biomass:** remains stable;
- **Electricity:** increases by 50%.

Transition: a relatively disruptive scenario where there is a substantial transformation of the sector. It assumes there is a more rapid shift to LPG, with a ten-fold growth in the sales of ICS by 2030. Specific fuels follow these trajectories between 2018 and 2030:

- **LPG:** triples its current share on both the urban and rural segments, displacing mainly kerosene. This implies an average yearly growth rate of just under 10%;
- **Woodfuel/charcoal ICS:** sees a ten-fold increase in its share, based on a 33% yearly market growth rate. (see Figure 4);
- **Woodfuel with traditional stove:** stays largely stable, displaced by LPG as well as by the amount that the ICS market grows. In urban areas, the displacement by LPG is greater than in rural areas;
- **Charcoal with traditional stove:** halves;
- **Kerosene:** drops to one-third of current use, mainly displaced by LPG;
- **Other clean biomass:** more than doubles;
- **Electricity:** doubles in urban areas and grows overall by 75%.

Ambition: a fully disruptive scenario where there is a dramatic increase in sales of ICS (adding over 8 million units by 2030, or an average of 750,000 per year over the next 10 years) and just under half of the country's population shifts to LPG. Kerosene is fully phased out. Other technologies follow the same path as in the Transition scenario.

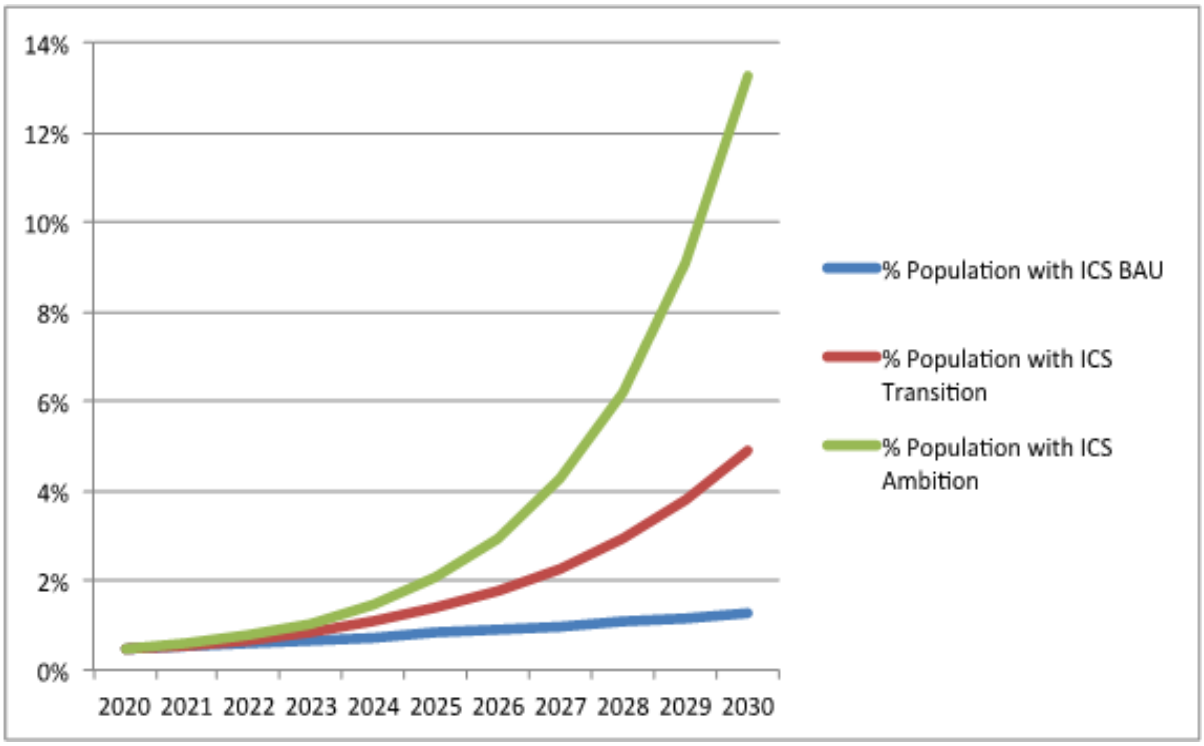


Figure 4. Market growth assumptions for improved biomass cookstoves (ICS) in BAU, Transition and Ambition scenarios

3.3 Results

The results of this exploratory scenario exercise are shown in Figures 4 and 5 and in detail in Figure 6. A summary of the (rounded) number of households that would have access to either LPG or ICS is shown in Table 1. It is important to note that these are only preliminary scenarios that are to be complemented with expert views from stakeholders.

The Business-as-Usual scenario sees only 26% of the population, or 68 million Nigerians, having access to LPG, ICS and other clean-cooking solutions in 2030.

The Transition scenario sees around 44% of the population, or 115 million Nigerians, using clean fuels (LPG 28%, other biomass 7%, ICS 5%, electricity 2%) in 2030. While this would be an extremely positive scenario, it falls short of Nigeria's national clean-cooking target set by the Federal Government in 2015 (60% of the population with access to clean cooking by 2030). This relatively disruptive – but still possible – scenario takes into account the fact that the ICS value chain is currently weak and, as a result, penetration rates of ICS in 2030 are at best 5% (or 10 times the current penetration).

The Ambition scenario, which is based on extremely positive developments, sees almost 65% of the population, or 181 million Nigerians, having access to clean cooking fuels and technologies (LPG 45%, ICS 12%, other biomass 5%, electricity 2%) in 2030.

Households with access to:	Base-year (2018)	BAU (2030)	Transition (2030)	Ambition (2030)
LPG	3,760,000	10,140,000	15,210,000	25,350,000
Improved Biomass Cookstove	200,000	660,000	2,600,000	6,990,000

Table 1. Rounded number of households with access to LPG or ICS in each scenario

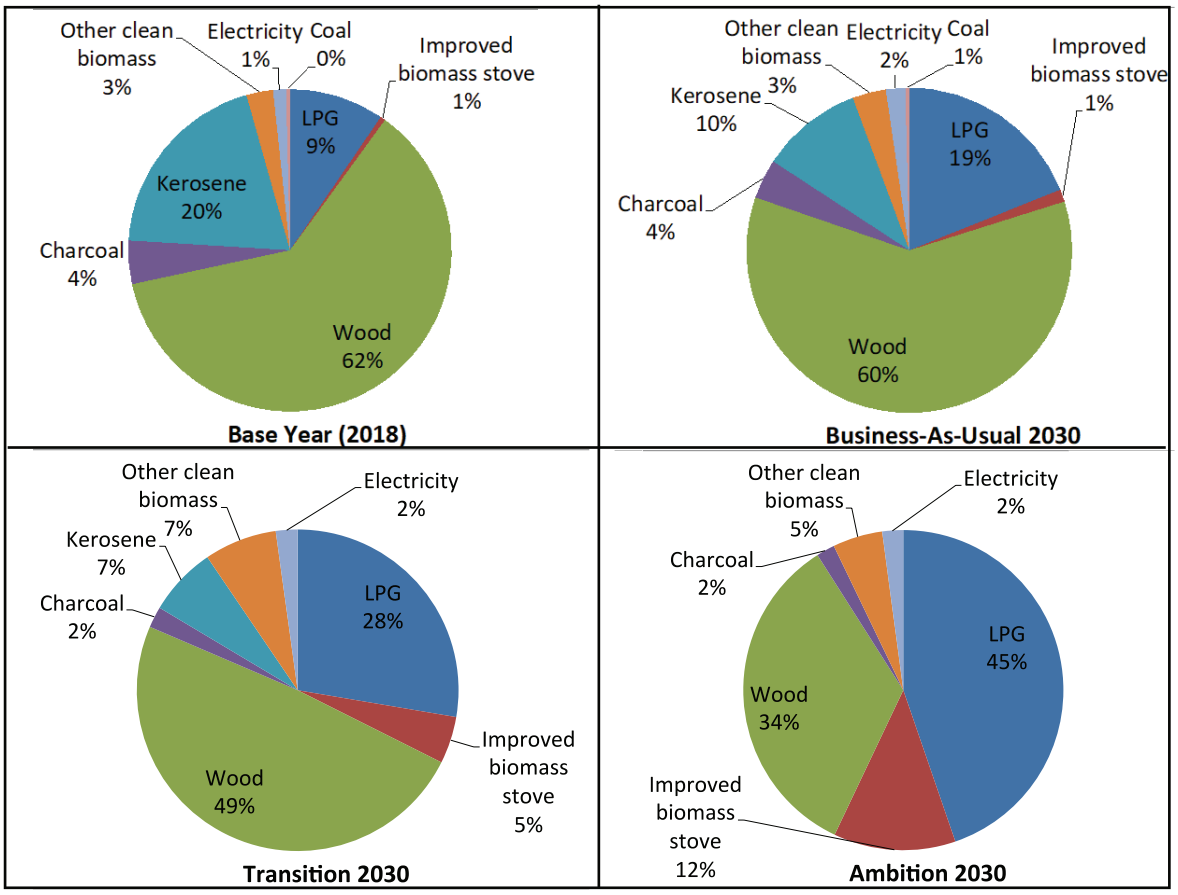
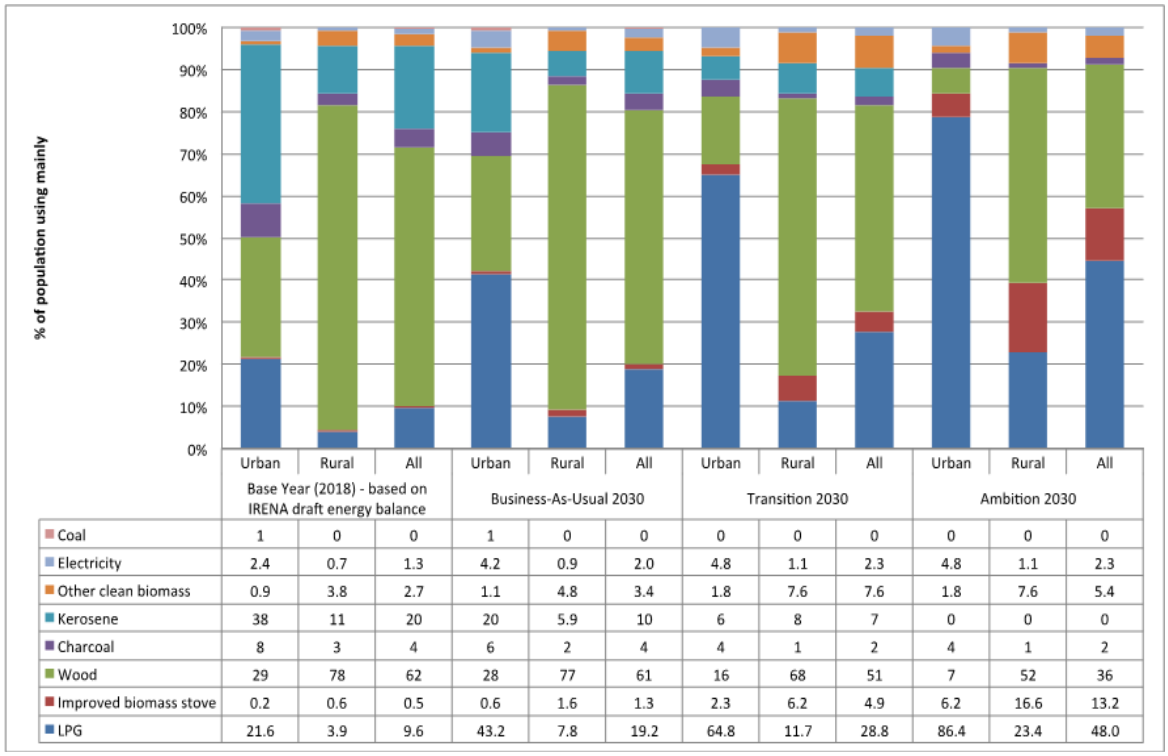


Figure 5. Summary of results: Percentage of population using different cooking fuels in 2018 and in 2030 under different scenarios



	Base Year (2018) - based on IRENA draft energy balance			Business-As-Usual 2030			Transition 2030			Ambition 2030		
	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All
Coal	1	0	0	1	0	0	0	0	0	0	0	0
Electricity	2.4	0.7	1.3	4.2	0.9	2.0	4.8	1.1	2.3	4.8	1.1	2.3
Other clean biomass	0.9	3.8	2.7	1.1	4.8	3.4	1.8	7.6	7.6	1.8	7.6	5.4
Kerosene	38	11	20	20	5.9	10	6	8	7	0	0	0
Charcoal	8	3	4	6	2	4	4	1	2	4	1	2
Wood	29	78	62	28	77	61	16	68	51	7	52	36
Improved biomass stove	0.2	0.6	0.5	0.6	1.6	1.3	2.3	6.2	4.9	6.2	16.6	13.2
LPG	21.6	3.9	9.6	43.2	7.8	19.2	64.8	11.7	28.8	86.4	23.4	48.0

Figure 6. Percentage of population using different cooking fuels in 2018 and in 2030, under different scenarios
Source: Base-year data from IRENA (2020), which in turn uses data from the LSMS (NBS, 2019) and DHS surveys (NPC, 2019)

4. RECOMMENDATIONS

This research paper outlines the current business ecosystem for both clean and conventional cooking fuels and technologies in Nigeria. Drawing on the knowledge of private-sector actors as well as a number of key market enablers and experts, the study examines recent trends, drivers and barriers influencing the different value chains, and estimates their growth in the future under different scenarios. As well as its key messages, the study puts forward the following recommendations for priority action in policy and research.

4.1 Policy

1. The National LPG Expansion Plan cannot cover the entire market: there is room for simultaneous initiatives, and a national government programme that targets private ICS firms is urgently needed.

2. Donor funding has been key to seeding the ICS value chain but the next steps in the financing model call for attracting commercial investors and financiers.

3. Opportunities for intervention in the LPG market include targeted support for a retailer-centred cylinder distribution model and innovations to increase affordability for low-income consumers.

4. Lagos is proving to be an important testing ground for the build-up of the LPG value chain in other parts of the country. The knowledge gained should be transferred by means of peer-to-peer exchanges among state officials and intervention teams.

5. Recommendations for high-priority interventions that would support the private sector to scale up include the strengthening of private-sector representation intervention design; the creation of an appropriate financing ecosystem, including credit lines, subsidies, tax incentives, that is targeted at both importers and manufacturers; and the provision of incubation, seed funding and capacity-building for early-stage firms.

4.2 Research

Priority knowledge gaps include:

1. standardised metrics of the LPG and ICS market: in particular, production, sales and revenues of different ICS types and market shares of different segments. (One model could be the metrics developed by GOGLA, the global off-grid solar energy association, and published in aggregated manner semi-annually (GOGLA, 2020);

2. thermal efficiency and emission data of products to monitor policies and allow quantification of savings;

3. cooking energy demand in the manufacturing and agri-chain sectors;

4. mapping of the woodfuel and charcoal value chains;

5. whether, and how, the National LPG Expansion Plan or other state and local governments are engaging with the woodfuel and charcoal industry as part of their strategies.

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Annex 1: 2017 data for retail prices of ICS from key manufacturers and distributors in Nigeria

Manufacturer/Distributor	Retail Price (NGN)	Import Status
Envirofit	Old model: 6,500 New model: 15,000	Import all cookstove parts from overseas and assemble locally in Nigeria
Toyola	Small size: 3,000 Medium size: 5,000 Large size: 10,000	Import metal cladding and doors from China and clay liner from Ghana
Sosai ER (EcoZoom)	15,000	Import EcoZoom cookstoves from overseas
D.A.R.E (Safe80)	15,000	Import cookstove parts from China and assemble locally in Nigeria
Zagos	Single hob: 3,000 Double hob: 6,000	Import ethanol stoves from China
SMEFUNDS-GEB	Single hob: 5,000 Double hob: 8,500 Maami stove: 1,500 Converter component for kerosene stoves: 750	Import ethanol stove parts from China and assemble locally in Nigeria
Musa Raymond	5,000 for a bundle which includes a stove, firelighter and 2kg bag of charcoal briquettes	Cookstoves are manufactured locally, but firelighters (made of sawdust) are imported from Belgium
Nenu Engineering	4,000–4,500	Locally manufactured

Source: Extracted from CLASP, 2017

Author's Bio

Maria Yetano Roche is an international consultant and researcher with two distinct fields of expertise: sustainable energy access and climate policy. She has fifteen years' experience in energy and sustainability, of which five in Nigeria, with active involvement in the country's energy access, off-grid, e-waste and NDC spaces. Maria has an MSc in Energy Policy from Imperial College, London.

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