Benin

eCooking Market Assessment

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The MECS/EnDev eCooking Market Assessments

This study is one of a series of publications produced jointly by Energising Development (EnDev) and the Modern Energy Cooking Services (MECS) Programme. This series of market assessments offer strategic insight on the current state of electricity access and clean cooking in eight countries across sub-Saharan Africa and South Asia. These studies identify the key opportunities and challenges to the scale up of electric cooking in the coming decade and conclude with a series of recommendations for targeted interventions that could support the development of emerging eCooking sectors. The market assessments are structured according to the MECS transition theory of change (TToC), which consists of three interrelated dimensions: the enabling environment, consumer demand and the supply chain.

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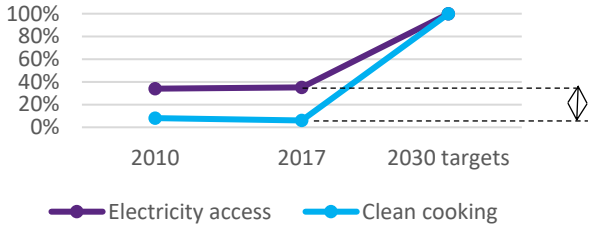
Executive Summary

Benin has an electrification rate of around 41% and clean cooking access rate of around 6%, meaning that 35% of the population now have access to electricity, but are still cooking with polluting fuels. Clean cooking has been addressed by a few programmes in the past, but they were all focused on improved biomass cookstoves (ICS). Benin shows significant potential for the uptake of eCooking especially among urban, middle-class households as the uptake of eCooking in these segments is still very low despite now having access. Beninese customers seem to be very interested in modern energy cooking including eCooking and the many dishes of the Beninese cuisine seem to be compatible with eCooking solutions such as EPCs. The eCooking supply-chain and market distribution is at a very nascent stage. The support of local supply-chain management and business-model development for small- and medium-sized businesses flanked by a consumer awareness campaign, especially in urban areas, could significantly support the uptake of eCooking in these areas.

Benin data snapshot from MECS eCooking Global Market Assessment:



35% now connected to electricity, but still primarily cooking with polluting fuels

Cooking energy

Primary fuel use:

0% cook primarily with electricity

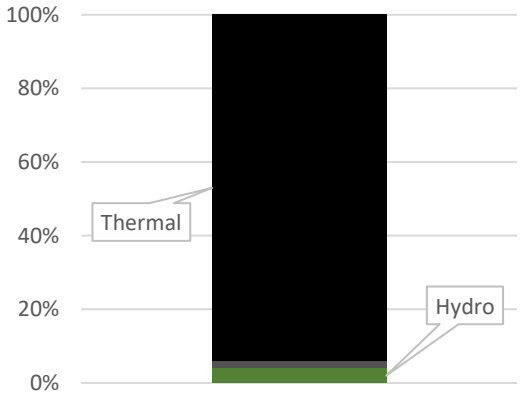
95% cook primarily with polluting fuels

26% cook primarily with commercialised polluting fuels (charcoal)

Electricity generation

On-grid:

94% fossil fuels; over 90% is imported (fossil fuels)



0% surplus power generation

Low reliability: on average 28 power cuts per month

Off-grid:

Sector emerging; around 2-3 mini-grids have been established but accurate data is missing

eCooking GMA viability scores/rankings

Overall:	On-grid eCooking:	Mini-grid eCooking:	Off-grid eCooking:
109th/130	**0.390 – 110th/130**	**0.315 – 111th/130**	**0.372 - 87th/130**

Key opportunities:

- Rising charcoal prices and limited supply of firewood especially in urban areas;
- Forest-Protection efforts by the government supported by the World Bank increase sustainable charcoal & firewood supply;
- Infrastructure investment has been leading to less power cuts/increased &more stabilised power supply especially in urban areas;
- The cuisine includes many main foods that are boiled leaving good potential for eCooking appliances
- Consumer priorities for selecting cooking method according to survey: cooking speed (32%), affordability (18%), no indoor pollution (13%) which 'selling' arguments for MEC
- Annual GDP growth rates (5-6% annually) in Benin are above SSA average
- Rising awareness of companies to focus on consumer needs and awareness; some companies have started campaigning for eCooking
- Established PAYGO models in the off-grid/SHS sector

Key challenges:

- High electricity tariffs and low income: Benin's energy tariffs are comparatively high (0.262 USD per kWh[1]/average monthly income 60-200 USD[2]) which establishes a pricing disadvantage of eCooking towards charcoal use.
- High import levels for electricity which makes the country vulnerable to external shocks and supply problems;
- Low access to electricity (40% overall; 17% rural; 65% urban)
- Power reliability (Most the electricity in the on-grid sector is imported (75-95%) – Benin is dependent on external suppliers; voltage variations & power-cuts are frequent)
- Limited availability of modern energy cooking fuels and appliances including an underdeveloped supply-chain and business models (low number of MEC manufacturers & specialised distributors); the simple retail-model for MEC appliances in household-appliance shops prevails
- Perceived higher durability/longevity of biomass stoves (after 9 years replacement rates for gas cookers/electric cookers were between 25-85% with biomass stoves 13-17% according to GIZ survey); new appliances are a significant investment for households (affordability issues) and there are currently no quality standards/quality control mechanisms for eCooking/MEC devices yet which leads to poor quality of (imported) devices

Potential impacts of scaled uptake within most viable market segment

If 40% of Benin's urban charcoal users (5.2m ppl, 1.04m HHs) switched to eCooking, the WHO's BAR-HAP tool suggests that:

- 777 DALYs/yr avoided
- 1.8m tonnes/yr CO2eq emissions increased
- 10,300 tonnes/yr reduction in unsustainable wood harvest
- 69m hrs/yr of women's time saved (397hrs/HH/yr)
- No payback for eCooking appliances ($80/HH upfront cost, $45/HH/yr additional expenditure on fuel energy costs)
- 236 GWh demand for electricity stimulated

For further detail, please see *Appendix A: Impact of scaled uptake*.

[1] https://www.mcc.gov/content/uploads/benin-case-study-for-mcc-advisory-council.pdf
[2] https://worldpopulationreview.com/country-rankings/median-income-by-country

1. Introduction

Clean cooking and electricity access in Benin

Benin has an electrification rate of around 41% and clean cooking access rate of around 6% which leaves 6.5 million without electricity access and more than 10 million people without clean cooking access. Clean cooking has been addressed by a few programmes in the past, but they were all focused on improved biomass cookstoves (ICS). EnDev Benin, for example, currently promotes improved cookstoves (ICS) for households and small restaurants in rural and (peri) urban areas and works on a results-based financing approach that focuses on the setup of a market for pico PV systems and solar pumps. It is aimed at households in rural areas without access to electricity as well as (semi-) urban households interested in solar products, particularly for use in case of blackouts.[3]

Benin has a high poverty rate (46.4%/2018), with a poverty line of $1.90 a day in purchasing power parity (World Bank, 2019). Growth is mainly driven by two sectors: agriculture and services accounting for 23% and 56% of GDP. Cotton and pineapple are the main export products of the agricultural sector. Core activities of the service sector are formal or informal import/export of goods to Nigeria. Consequently, Benin's economy is heavily dependent on Nigerian economic cycles.[4]

Benin shows significant potential for the uptake of eCooking especially among urban, middle-class households as the uptake of eCooking in these segments is yet very low.

[3] Source: EnDev: https://endev.info/countries/benin/
[4] https://www.sarpublication.com/media/articles/SARJPS_26_94-102.pdf

2. Enabling environment

eCooking policy outlook: The National Renewable Energy Development Policy document (PONADER) 2019 and the National Energy Management Policy document (PONAME), 2020 focus on the expansion of RE & energy efficiency; clean cooking is found in this context through the energy saving factor in the management of electric and solar cooking equipment but there is currently no national policy that integrates clean cooking into the energy access targets. The National Clean Cooking Action Plan (PANCP) commissioned by EnDev is under development.

Key policy stakeholders: Ministry of Energy, The Directorate General of Energy Resources (DGRE); Beninese Rural Electrification and Energy Management Agency (ABERME); Interior Electrical Installation Control Agency (CONTRELEC); Unit in charge of Renewable Energy Development Policies in Benin (UC / PDER) (Technical Assistance Unit); The National Agency for Standardization, Metrology and Quality Control (ANM); Benin Consumers Association

RISE (Regulatory Indicators for Sustainable Energy) scores:

41%	5%	49%	31%
Electricity Access	Clean Cooking	Renewable Energy	Energy Efficiency

Targets:

Electricity access	Clean cooking
100% electricity access by 2030 (grid/off-grid) 100% renewable grid electricity by 2030	No targets/under development

Potential drivers for eCooking:

- Rising charcoal prices and limited supply of firewood especially in urban areas;
- Forest-Protection efforts by the government supported by the World Bank increase sustainable charcoal & firewood supply;
- Infrastructure investment has been leading to less power cuts/increased &more stabilised power supply especially in urban areas;
- The cuisine includes many main foods that are boiled leaving good potential for eCooking appliances
- Consumer priorities for selecting cooking method according to survey: cooking speed (32%), affordability (18%), no indoor pollution (13%) which 'selling' arguments for MEC
- Annual GDP growth rates (5-6% annually) in Benin are above SSA average
- Rising awareness of companies to focus on consumer needs and awareness; some companies have started campaigning for eCooking
- Established PAYGO models in the off-grid/SHS sector

Potential barriers for eCooking:

- Tax exemption from customs duties exists on equipment for producing electricity from renewable energies such as solar energy – hence, any direct-solar cooking equipment benefits from tax relief but equipment including electric cookstoves are subject to taxes/customs
- Currently there are no specific policies and regulations in place that focus on eCooking specifically, this includes technical- and quality standards
- The electrical grid infrastructure is underdeveloped, and outages are frequent due to the state of the grid itself but also due to the dependency of Benin on power-imports

- The electricity prices are comparatively high and due to the overall power-shortages the national utility does not have an immediate interest in promoting eCooking; the potential to increase the efficiency of existing eCooking devices (e.g. energy-intensive hot-plates) is limited due to the very low current uptake of eCooking

For further detail, please see **Error! Reference source not found.**.

3. Consumer demand

What's on the menu?

In an average week, a typical Beninese cook might prepare:

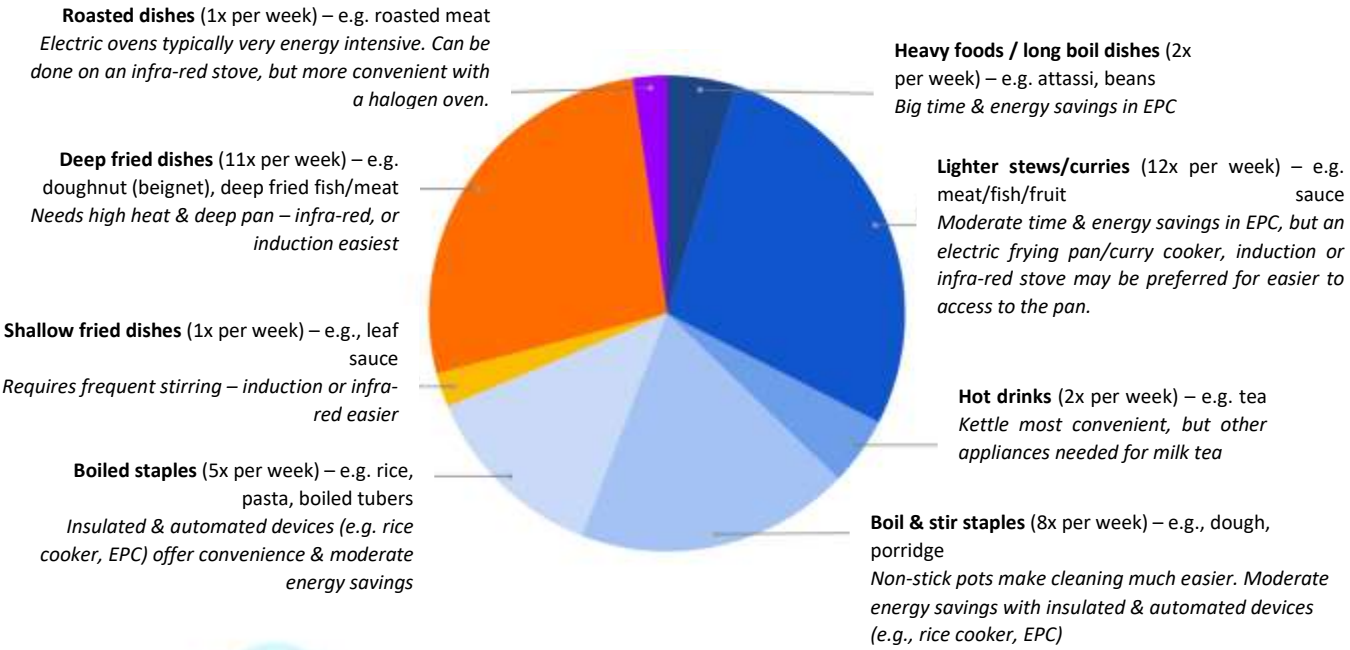


Figure 1: Visualisation of the results of a culinary analysis carried out during this market assessment by asking local team members to map out the dishes that a typical Beninese household might prepare in an average week and assessing their compatibility with modern energy-efficient appliances.

Beninese cuisine has high proportions of stews/heavy foods/long boiled dishes on the regular menu. These dishes can easily be prepared with modern eCooking appliances including EPCs, with big savings available on energy, cost, time and convenience. However, market awareness of Beninese consumers for the applicability of these appliances is currently very low.

Most viable energy-efficient appliances: **EPCs, kettles, electric-oven, microwaves**

Key marketing messages: **energy-efficient appliances offer substantial time and cost savings and enable multi-tasking. EPCs are the most convenient way to cook heavy foods.**

Key demand side barriers/drivers:

1. **Consumer preferences:** Speed of cooking, cleanliness of fuels, ease of ignition and price are on top of the consumer preferences which present key opportunities for the promotion of eCooking appliances incl. EPCs.
2. **Gender:** Research has shown that the selection of particular cooking fuels is significantly associated with the gender of the household heads. Traditional fuels are less likely to be chosen by households headed by women compared to households headed by men headed counterparts and women are more likely to choose transition- and modern fuels compared to the male-headed households. [5] This indicates a greater

[5] Lokonon, Boris Odilon Kounagbè. "Household cooking fuel choice: Evidence from the Republic of Benin." African Development Review 32.4 (2020): 686-698.

awareness for modern fuels among women than men (probably because women are typically responsible for cooking).

3. **Education**: research has shown a strong correlation between education levels and the choice of transition-/modern cooking fuels **and households headed by someone** with a least secondary education level are more likely to choose modern energy cooking fuels than households headed by a person with no formal education level indicating that formal education is of key importance in adopting modern cooking[6]
4. The culinary survey revealed that out of the 21 most common dishes and drinks in Benin, 19 involve boiling which allows the application of the most efficient eCooking devices (e.g. EPC)
5. Demand-side barriers are low market-penetration/availability/awareness of eCooking devices and frequent power cuts.
6. **Geographical location**: research indicates that the adoption of cooking fuels depends on the departments – respondents in the Littoral department which also hosts the capital Cotonou are more likely to choose transition and modern cooking fuels compared to those living in the 11 other departments. Therefore, the adoption of cooking fuels is associated to regional availability of the fuels.[7]
7. **Marketing/Adoption behaviour:** To acquire equipment, households are informed from several sources and surveys show that 78% of households are informed by informal sources including 'word of mouth' (46%) and observation with neighbours (32%). Formal sources, including the mass media (radio (6%), television (14%), internet(1%)) and local awareness raising (1%) only account for 22%. It emerges that investment in the promotion of cooking equipment through the mass media and local awareness raising is low and deserves to be reinforced.[8]
8. **Market focus:** The distribution of eCooking appliances is generally on a low level and is mainly focused on the capital.
9. **Fuel stacking**: in urban areas, an average household uses around 2 different appliances
10. Current target markets are LPG: there seems to be significant potential for LPG In a survey 42% of respondents claimed to use gas for cooking but 'official statistics' suggest only 2%. A large LPG production & distribution facility has been opened in Benin in 2019[9]

Key demand creation programmes:

- LEMA / EPAC laboratory which carries out research in the field of clean cooking technologies and ensures the capacity building of actors (mainly ICS & solar cooking equipment)
- OFEDI (NGO) aims to create awareness for the use of clean and efficient cooking equipment ((mainly ICS & solar cooking equipment))
- EnDev support to semi-industrial units production of cooking equipment and expansion of the range of cooking equipment (mainly focused on ICS still)
- Overall, there are no specific programmes focusing on eCooking to a significant extent yet and such activities are often singular activities from clean cooking companies without larger outreach.

Relative costs:

- The current charcoal prices are comparatively low, while electricity prices are relatively high. This hampers a cost benefit of eCooking over cooking with charcoal currently.

[6] Ibid.
[7] Ibid.
[8] Programme Energising Development (EnDev): Etude de marché des équipements de cuisson électriqe solaire au Bénin; Rapport final, 09/2021
[9] https://www.nipc.gov.ng/2019/04/29/nnpc-to-unveil-largest-cooking-gas-facility-in-benin/

For further detail, please see *Appendix D: Results of National Culinary Surveys*.

4. Supply chain

- The GIZ/EnDev Report of 2021 currently lists around 9 companies that are distributing electric cooking devices; these are small to medium local distributors:

Table 1: Cooking equipment provided by some companies in Benin

Denomination of the company	Cooking equipment according to fuel				Total/ business
	Electric	Solar		Charcoal Gas or firewood	
ETS SUNNY BEST	1	1	1		3
Obiking		1			1
IT BENIN	1		1		2
OLOUWAFOMI			1	1	2
SAMSUNG	1		1	1	3
HUAHUI SARL	1		1		2
SOLATEC Electric Benin		1			1
New Land Electro	1		1		2
Benign	1		1	1	3
Electro-Plus	1				1
Fenix Power		1			1

- The service delivery models in the eCooking sector are mainly based on distribution via. household stores or similar shops. The industry is very nascent with only a few players in the market (around 4-5) offering eCooking equipment (wholesale). Table 2 illustrates a few marketing/distribution approaches for eCooking solutions undertaken by the market players.
- Almost all companies offer after-sales services to their customers but on different scales: over 90% of companies surveyed (clean cooking - & RE companies) offer installation service; 71% maintenance (offered by 71% of companies) which are the most common after- sales services.

Table 2: Actions taken to interest more social categories in the use of electric and solar cooking equipment[10]

Actions made	Frequency of action with sales companies
Promotion / advertising (warm welcome, gifts for purchasing a product)	33%
Raising public awareness of the advantages of this equipment	29%
Reduction of selling prices from a certain level of purchase	21%
Promotion of several sources of renewable energy	8%
Popularization of equipment in rural areas Emphasis on the	4%
sale of good quality equipment	4%
TOTAL	**100%**

Grid electricity tariffs:
Regular: 125 CFA/kWh (0.262 USD/kWh)
Mini-grid tariffs:
Cost-reflective/unknown

Innovative eCooking (clean-cooking) pilot projects & scaling initiatives:

- EnDev support to semi-industrial units of production of cooking equipment and expansion of the range of cooking equipment
- PASE Project which finances actions on cooking equipment
- OFEDI (NGO) support of awareness for the use of clean and efficient cooking equipment.
- LEMA / EPAC laboratory which carries out research for clean cooking technologies and performs capacity building

[10] Source: Programme Energising Development (EnDev): Etude de marché des équipements de cuisson électriqe solaire au Bénin; Rapport final, 09/2021

Key supply side barriers/drivers:

- The availability of appliances seems to be limited to local traders/distributors that are selling household appliances and the use of electric cooking appliances is mainly concentrated around the urban areas/the capital
- **Income situation/ Affordability/Likelihood to change fuels**: Formal credit access is low (access rate around 4%); average expenditures per capita/per year are around CFA 301,335.8 (about $509.49), with significant deviations among households; Households face several types of shocks: e.g. 24% of the households reported to have been subject to biophysical shocks (floods, heavy rainfalls, droughts, late onsets, etc.), 19% to economic shocks (rise in prices, job- lessness, income reduction, etc.), 13% to social shocks (diseases, accident, death of a household member, etc.), and 1% to other shocks; Households affected by social shocks are more likely to adopt modern fuels compared to those that were not subject to any shock; households that encountered economic shocks are more likely to choose traditional and modern fuels relative to their counterparts that have not been affected by any shocks, while economic shocks decrease the likelihood of adopting transition fuels relative to no shocks.[11]
- Current perceived strengths of the market for eCooking are: Existence of outlets (Households and centres food production and social institutions); Relative effectiveness of communication informal (word of mouth, observation of neighbours) in the popularization of cooking equipment.
- Due to low charcoal prices and high electricity prices, e-cooking currently does not have a financial benefit compared to charcoal and firewood but has a cost benefit compared to LPG and Kerosene.

For further detail, please see *Appendix B: Relative costs of cooking and willingness/ability to pay for appliances*.

[11] Lokonon, Boris Odilon Kounagbè. "Household cooking fuel choice: Evidence from the Republic of Benin." African Development Review 32.4 (2020): 686-698.

5. Recommendations for interventions

Table 3: Decision matrix/board highlighting key factors and viability of specific interventions.

		Current status (inc. summary of key opportunities & challenges)	Recommended interventions (highlight most important in bold)
Market segments	**On-grid**	*Grid-connection levels are still low, power-cuts are frequent but the situation seems to be improving.* *Poverty & low income is a major barrier – not only in terms of appliance-affordability but also modern fuels/electricity.*	*Pilot battery-supported eCooking devices to mitigate unreliability.* *Strengthen the availability and permanence of the SBEE electricity supply in large cities to facilitate the adoption of electric cooking equipment.* *Explore subsidizing energy tariffs – especially for eCooking might be a viable solution*
	Mini-grid	*Development of off-grid access projects through various programmes including EnDev but electricity access in rural areas is still very low*	*Make use of the PASE to increase SBEE's access to energy to agro-food production companies which will be oriented towards electric cooking equipment*
	Off-grid (SHS)	*There is currently the promotion of direct solar cooking appliances*	*Lobbying government to reduce import tariffs on eCooking equipment*
TToC dimensions	**Supply chain**	*Existence of facilities granted to small and medium-sized enterprises and industries to get grid-connection & receive tariff subsidies from SBEE but not yet widely used* *Insufficient funding for businesses to increase their range of cooking equipment / Difficulties in the recovery of debts for the sale of equipment on credit* *No structural specialization in strengthening the technical and entrepreneurial capacities of eCooking companies* *Low production & distribution capacity of national eCooking companies*	*Capacity building among eCooking companies* *Use the improvement of access to electrical energy for the SBEE to motivate the demand for electric cooking equipment* *Improve the profitability of eCooking companies manufacturing eCooking equipment by taking advantage of the subsidies granted through SBEE* .
	Consumer demand	*Growing scarcity of firewood & charcoal and increasing prices which makes biomass cooking more expensive/less attractive but limited awareness & usage of eCooking;* *Misuse of eCooking equipment by customers despite advice and instructions from companies* *Weak technical and financial capacity of key stakeholders incl. companies for communication and promotion of equipment through the mass media* *Low demand for eCooking by potential customers/limited awareness/prejudice/Reluctance of some households to adopt eCooking* *Existing women distribution groups for ICS in the south but no focus on eCooking* *Challenges in terms of affordability; limited access to credit and financing*	*Awareness campaigns that target male-headed households: sensitization regarding the need of giving-up traditional fuels to achieve positive health- & environmental impacts* *Develop the e-commerce of electric and solar cooking equipment to facilitate their access to potential customers.* *Improve demand for electric and solar cooking equipment through formal (through mass media) and informal (word of mouth and neighbour observation) communication; live cooking demonstrations, Involve the media for communication around e-cooking (TV and social media.*

			Focus on women's groups as enablers for eCooking[12] *Create attractive purchasing conditions/consumer financing models for e- cooking*
	Enabling environment	*Development of the National Action Plan underway for Clean Cooking (PANCP) under the lead of EnDev* *Growing awareness among public stakeholders but limited alignment and strategic planning among Ministries* *Development of the preliminary draft standards for "improved stoves" and strategy underway but overall lack of policy/regulations/ standards for e-cooking equipment*	*Develop draft standards for electric and solar cooking equipment based on the approach used for the preliminary draft standards on improved stoves* *Support the implementation and validation of the National Clean Cooking Action Plan (PANCP).Involve NGOs / Cabinets to sensitize potential customers for the adoption of electric and solar cooking equipment* *Advocate with the Ministry of Finance to obtain an exemption from customs taxes on imports of electric cooking equipment & components for the local manufacture of this equipment* *Make use of projects / programs in the sector for the structuring and organization of players in the electric and solar cooking equipment sector*

[12]Learning lesson from ICS FABEN: "It has been discovered that particularly in the South, there is already an established structure of retailers (particularly women) who buy stoves in bulk and sell them to customers in different areas of Benin. By channeling some of the "anfani stoves" through these structures, the sustainability of supply-demand systems is already improved.(https://endev.info/wp-content/uploads/2020/12/EnDev-Annual-Planning-2014.pdf)

6. Appendices

Appendix A: Impact of scaled uptake

Overview of opportunities

The use of biomass cooking fuels contributes significantly to indoor- and outdoor air pollution in Benin. In accordance with the World Health Organization's guidelines, the air quality in Benin is considered unsafe. The most recent data indicates the country's annual mean concentration of PM2.5 is 39 µg/m3 which exceeds the recommended maximum of 10 µg/m3.[13] Contributors to poor air quality in Benin include the textile industry, **food processing**, and car and motorcycle emissions. Available data indicates that Cotonou has consistently high levels of air pollution.[14] According to the CDC, respiratory diseases are no. 3 cause of death in Benin after neonatal disorders and malaria. Air pollution is considered the second highest health risk factor in Benin.[15]

The biggest potential for scaled-uptake lies in the on-grid sector. Since the off-grid sector is dominated by SHS, direct-solar cooking appliances and low voltage eCooking appliances (e.g. DC pressure cookers) could be an interesting opportunity but need to be coupled with electricity access approaches and supported by a HH affordability study.

Table 4 Scenario for eCooking (projections)[16]

	rural	urban	total
Population in mio	6.1	5.7	11.8
% of population cooking with biomass (charcoal/firewood)	98.0	91.0	95.0
# of people exposed to polluting cooking fuels in mio.	6.0	5,2	11,2
People with access to electricity 2020 in %	4,9	41,0	29,0
People with access to electricity 2020 in mio	0,3	3,4	3,7
People with access to electricity 2030 in mio based on current access growth rate of 2% pA (excl. population growth 2.6% pA)	0,9	2,9	3,8
People with access to electricity 2030 in % based on current access growth rate of 2% pA (excl. population growth 2.6% pA)	14,9	51,0	49,0
% of people that use eCooking currently (estimation based on GIZ survey)	1,0	9,0	7,0
Electrified households in mio (average 5 ppl per household)	0,060	0,674	0,733

[13] https://www.iamat.org/country/benin/risk/air-pollution
[14] https://www.cdc.gov/globalhealth/countries/benin/default.htm
[15] http://www.healthdata.org/benin
[16] Source: MECS/Susann Stritzke

People that could use eCooking in total (70% urban/30% rural of electrified households - estimation) = total impact potential	0,090	2,358	2,448
Households that could use eCooking in total (70% urban/30% rural estimation) = total impact potential	0,018	0,472	0,490
Current growth potential for eCooking in people (eligible HH minus current users)	**0,089**	**2,146**	**2,235**
Number of eligible target households as of 2020/21 in Mio	0,018	0,429	0,447
Estimated RBF investment requirement for 50 USD subsidy per electric appliance (e.g. EPC) excl. TA/admin in mio USD	**0,886**	**21,460**	**22,346**
Growth perspective until 2030 based on current electrification growth (on-grid only) & 70% affordability levels (people that can use eCooking in 2030)	0,106	2,575	2,682

Scale-up cost-benefit analysis

This section explores the likely costs and benefits for one simple illustrative scenario of scale-up of eCooking in selected key segments. The World Health Organisation (WHO) revised "Benefits of Action to Reduce Household Air Pollution" (BAR-HAP) tool[17] has been applied to quantify the expected financial costs, health and environmental benefits of the scale-up.

The scenario modelled is chosen to reflect the first part of the MECS programme's suggested "40, 60, by 2030" goals: a target of 40% for all households connected to grid or off-grid electricity in Low and Middle Income Countries to be using it for cooking by 2030, and a target of 60% of households utilising modern energy for cooking to be utilising energy generated from low carbon sources by 2030 (low carbon interpreted here to include electricity coming from relatively low carbon fuel mix, and excluding fossil-derived LPG). For this illustrative analysis of costs and benefits, the focus is just on urban households that are grid connected, but currently cooking with charcoal. While specific data are not available for this demographic, an estimate was made based on the evidence earlier in the report about different categories of users, suggesting approximately 430,000 households. Consistent with the MECS 40% goal, the scenario models transition of 40% of those, so 174,000 households. Details are in the first part of the table. BAR-HAP models a ramp-up of transitioning households over the first 5 years to 2025 and then a further 5 years operation.

BAR-HAP has been implemented here using its policy option of a ban on charcoal use, which comes in gradually from 2020 to 2030. This is clearly not a realistic policy and is simply used here to effect the transition wanted for this illustration, with clarity about the impacts and where costs fall; it can be regarded as a proxy for other specific actions used to mobilise a major transition from charcoal to eCooking. The assumption is that transitioning households are fuel stacking, with 20% of cooking still delivered using charcoal. The full costs of the new MECS devices have been assumed to be paid for by the Government, as a convenient simplification for this illustration. Other policy options that could have been modelled would see a different distribution of stove and fuel costs and savings between parties. eCook devices are assumed to cost $80 and to have an average efficiency of 75% (MJ input to MJ useful heat output). eCooking is assumed to save 30% of the typical 4 hours cooking per day. Benin's grid electricity generation mix is dominated by fossil fuels (65% natural gas and 32% oil), and hence the emissions factors associated with

[17] https://www.who.int/tools/benefits-of-action-to-reduce-household-air-pollution-tool

use of electricity are high. The government aims to increase the share of renewables significantly, to 25% by 2025 and 30% by 2035. The analysis below has thus been undertaken assuming a lower carbon mix of electricity, with approximately 27% renewables.

The lower part of the table shows the outputs of BAR-HAP for the modelled scenario. The figure shows the structure of costs and benefits.

The table below shows that the private and public financial impacts of the transition would all be negative, with cost to government of some $110 per household for equipment and programme costs, and higher costs to households for purchasing electricity rather than charcoal. Despite cooking energy savings from use of more efficient electric devices, electricity tariffs are high at around £0.262/kWh and charcoal is relatively inexpensive at $0.195/kg.

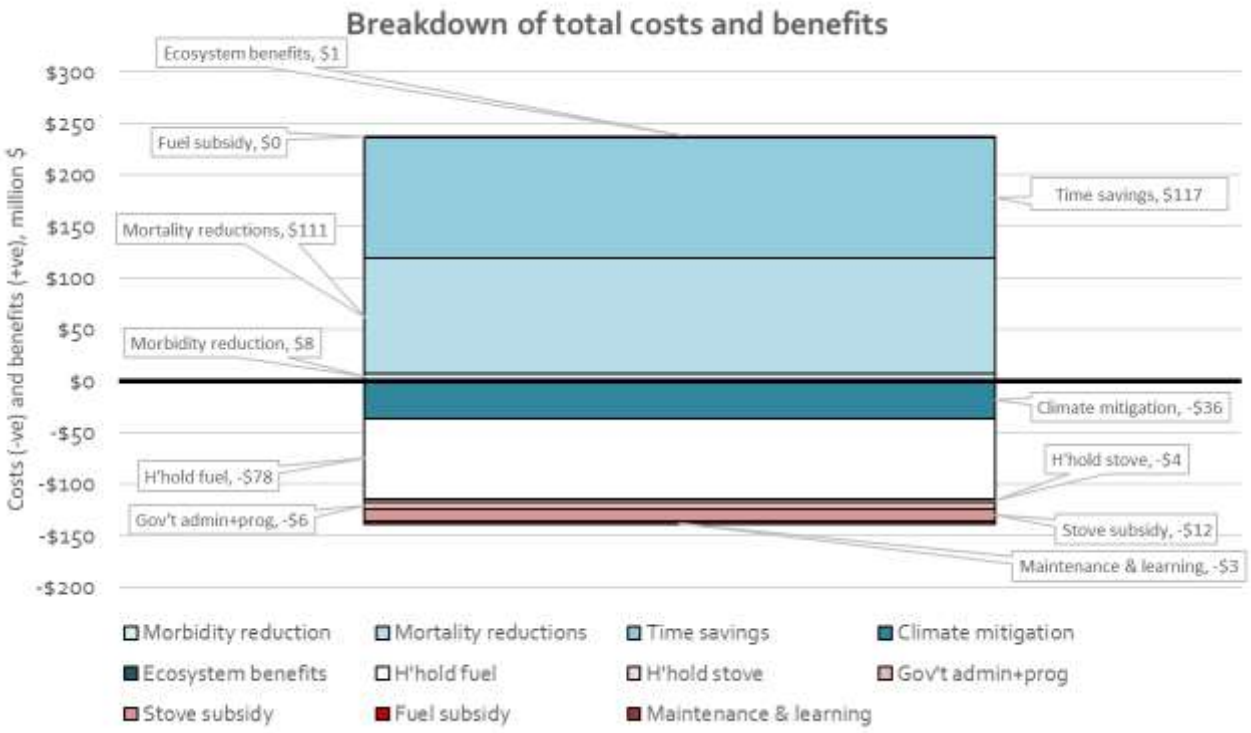
Since grid electricity is dominated by fossil fuels, the transition also leads to higher GHG emissions, adding approximately 7% to the emissions from cooking in the whole country. This is despite the assumed shift towards more renewables in the generation mix; with the current mix the increase would be more than twice as large. However, the health benefits would include more than 40 lives saved per year, and some 3% of current unsustainable wood harvesting would be avoided. Overall the social impacts are positive, with net benefits of more than $50/household per year. These impacts may seem modest, but this scenario is targeting less than 8% of the total population. The transition from charcoal to electric cooking would however increase greenhouse gas emissions,

The chart summarises the various physical and financial impacts of the transition in monetary terms. The social benefits from avoided time spent cooking are large, reflecting mainly time savings using an EPC, and the opportunity cost for peoples' time, as used in BAR-HAP. Health benefits are also considerable, mainly associated with the lives saved. The largest element of cost is from the cost of carbon equivalent applied to the increase in greenhouse gas emissions. The purchase cost of modern stoves by government is also evident.

This is an impact analysis for one simple scenario for just one segment (grid connected charcoal users) of Benin's population. Whilst with the near- and medium-term power generation mix eCook would not bring climate benefits, the scenario has very significant net social benefit overall, based on the WHO's physical impact and impact monetisation methodologies.

Grid connections projections and eCook target		Population (millions)	households (millions)	% grid connected			
National population, 2020		12.10	2.33				
Grid connections, 2020		5.00	0.96	41%			
Of which, using charcoal		2.25	0.43				
Scenario modelled		Population (millions)	households (millions)				
MECS "40%" target for eCooking by those connected		0.90	0.174	18%			
Costing (costs are -ve, benefits are +ve)				$/yr	$/yr per household transitioning	$M total	$total per household
Total present value (ie net social benefits of the transition)				9,839,070	56	98	564
Total costs of transition, government+private				-10,240,085	-59	-102	-587
Private cost to housholds: total				-8,406,211	-48	-84	-482
Stove				-350,487	-2	-4	-20
Fuel				-7,800,702	-45	-78	-447
Maintenance				-255,022	-1	-3	-15
Costs to government: total				-1,833,874	-11	-18	-105
Stove				-1,226,705	-7	-12	-70
Fuel				0	0		
Admin+Programme				-607,169	-3	-6	-35
Health, Time, and Environmental Benefits: total		Physical: change/yr	Physical: % of national cooking total	20,079,156	115	201	1151
Health impacts total: DALYs avoided	DALYs	777		11,893,688	68	119	682
Mortality reduction	*YLL*	*509*	0.1%	*11,135,019*	64	*111*	638
Mortality reduction	*Lives*	*44*	0.3%				
Morbidity reduction	*YLD*	*268*	0.7%	*758,670*	4	*8*	43
Morbidity reduction	*Cases*	*1,345*	0.7%				
Time savings	Hours	69,332,726	5.8%	11,736,181	67	117	673
Time savings per adopting household	*Hours/HH*	*397*					
Electricity use	*MWh*	*152,605*					
CO2-eq reduction (CO2,CH4,N2O)	Tonnes	-238,138	-6.9%	-3,636,048	-21	-36	-208
Unsustainable wood harvest reduction	Tonnes	10,300	3.8%	85,335	0	1	5
Note: costs are discounted across programme period.							
Totals are Net Present values; costs/year are NPV divided by the ten years of the programme							

Figure 2 Breakdown of total costs and benefits.



Appendix B: Relative costs of cooking and willingness/ability to pay for appliances

- The majority of households in Benin rely on traditional- or transitional cooking fuels as Table 5 illustrates. Less than 1 % of the households is currently using electricity for cooking. Recent household surveys in urban areas reveal also a high frequency of the usage of gas (LPG) for cooking.
- In terms of household-income, surveys revealed that around 76% of the urban households classify themselves as 'average' income households with 10% above average and 14 poor households.
- The average income has been estimated with 38 500 CFA (around 66 USD) per month with significant variations between and among urban and rural households
- On average 4% of income is spent on fuels; Table 8 illustrates average costs for different cooking types and shows a relative advantage/potential for eCooking (water-heater)

Table 5: Cooking fuels used by the households[18]

	Percent		
Cooking fuels	Urban	Rural	Total
Modern fuels	8.17	1.09	4.47
Electricity	0.16	0.04	0.10
LPG	4.78	0.88	2.74
Natural gas	2.57	0.16	1.31
Biogas	0.66	0.01	0.32
Transition fuels	46.30	9.88	27.25
Kerosene or petrol	0.54	0.13	0.32
Coal lignite	0.37	0.12	0.24
Charcoal	45.39	9.63	26.69
Traditional fuels	45.52	89.04	68.28
Firewood	44.77	86.12	66.39
Straw/branches/herbs	0.24	1.63	0.97
Crop residues	0.14	1.21	0.70
Animal waste	0.02	0.05	0.04
Others	0.35	0.03	0.18
Total	100	100	100

Table 6: Frequency (in%) of cooking equipment currently used in households according to fuel type

Cooking equipment depending on the fuel	Relative frequency (%) of equipment for	Number of equipments 100 households
Gas	44.5%	0.90
Charcoal	42.5%	0.80
Electric power	5.7%	0.11
Firewood	5.7%	0.11
Oil	1.4%	0.03
Solar energy	0.1%	0.003
TOTAL	100%	2.0

Table 7 Average prices of some cooking equipment and usage in Benin[19]

Technology	Average price CFA per unit	USD	Equipment share used in hh
Electric stove(stainless steel)	300,000	537	0%
Electric cooker (ceran)	167,555	300	1%
Gas stove with oven & timer	45,250	81	0%
Gast stove with 4 outlets	41,667	75	1%
Electric rice cooker	27,917	50	1%
Gas cooker (without oven)	27,500	49	2%
Table-top gas cooker	25,555	46	22%
Electric oven	25,000	45	1%
Portable gas-stove (LPG cartridge)	24,317	44	6%
Single-flame gas cooker	17,425	31	13%
Electric kettle	13,985	25	2%
Kerosene cooker	8,833	16	1%
Improved cookstove charcoal	4,125	7	41%

Table 8 Average consumption of electric-, biomass and gas cookers[20]

Cooking equipment	Costs for energy for cooking per year (CFA)	Costs for energy for cooking per year (USD)	Cost of repairs (CFA)	Cost of repairs (USD)	Annual amortization charge (CFA)	Annual amortization charge in USD	Average expenditure year (CFA)	Average expenditure year (USD)	Number of hours of use per year	Cost per hour of use (CFA)	Cost per hour of use (USD)
Electric water heater	15050	27	0	0	2000	4	17050	31	528	32	0,06
Gas heater	53153	95	5564	10	6286	11	65003	116	1639	40	0,07

[18] Lokonon, Boris Odilon Kounagbè. "Household cooking fuel choice: Evidence from the Republic of Benin." African Development Review 32.4 (2020): 686-698.

[19] Source: Programme Energising Development (EnDev): Etude de marché des équipements de cuisson électriqe solaire au Bénin; Rapport final, 09/2021

[20] Programme Energising Development (EnDev): Etude de marché des équipements de cuisson électriqe solaire au Bénin; Rapport final, 09/2021 & MECS

Firewood stove	110656	198	1000	2	1488	3	113144	203	2360	48	0,09
Charcoal stove	102513	183	1838	3	2770	5	107121	192	2015	53	0,10
Gas stove	88837	159	2239	4	4840	9	95916	172	1425	67	0,12
Table-top gas cooker	141862	254	10679	19	1087	2	153628	275	1398	110	0,20
Average	85345	153	3553	6	3079	6	551862	988	1561	58	0,10

Appendix C: Clean cooking and electrification policy

- Benin is an ECOWAS member and, with the rest of the region, adopted a concerted approach to the implementation of the SEforALL Country Action, with the development of the Action Agenda alongside the Renewable Energy and Energy Efficiency Action Plans, and their formal adoption.
- Tax exemption from customs duties exists on equipment for producing electricity from renewable energies such as solar energy – hence, any direct-solar cooking equipment benefits from tax relief. But equipment including electric cookstoves are subject to taxes/customs
- Currently there are no specific policies and regulations in place that focus on eCooking specifically, this includes technical- and quality standards
- Overall, five laws and / or policies govern the clean cooking sub-sector:

1. **Law No. 2020 - 05 of April 1, 2020** on the Electricity Code in Benin – this law allows independent power generation & -sale and sets tariff exemptions for solar energy products but this law does not have a remarkable influence on electric cooking equipment
2. **The Finance Law 2021** supported by the General Tax Code in its article 224 stipulates that solar devices are exempt from VAT – so solar cooking equipment will be able to benefit from the VAT exemption but not eCooking appliances;
3. **The Off-Grid Electrification Master Plan (PDEHR):** is a tool for implementing the Off-Grid Electrification Policy (EHR) and inventorying investment opportunities for off-grid electrification; is a 10-year off-grid electrification policy implementation plan, a decision-making tool relating to EHR, he PDHER offers (i) geographic groupings of “power plant / mini-grid” systems for shared management, in order to reduce operating costs and facilitate the mobilization of qualified stakeholders and (ii) concession areas intended for Decentralized Electrical Services Companies (SSED) for the installation, management, maintenance and development of a fleet of pico-power plants (power less than 10Wp) and solar kits
4. **Law No. 98-030 of February 12, 1999 establishing the framework law on the environment in the Republic of Benin:** his law, which does not deal specifically with clean cooking, addresses the issue from the angle of environmental protection. She speaks in a subtle way about the promotion of materials and equipment resulting from clean technologies and thus less energy consuming and insists on these advantages in the protection of the environment.
5. **Law 2016 - 24 of June 28, 2017 on the Legal Framework of the Public - Private Partnership in Benin** - It sets the conditions for partnership between the State and the private sector and constitutes a guarantee of quality and efficiency for all actors wishing to invest in the energy sector in Benin. It is therefore a legal framework which gives confidence to private companies which will be able to invest in the acquisition of modern materials and equipment which do not consume energy.
6. **Beninese Investment Code**: promotes incentives for private investment in the energy sector including simplification of approval processes in the clean cooking sub-sector through the acquisition of electrical equipment; RE companies operating are exempt from the first year of tax on equipment.

National Policies:

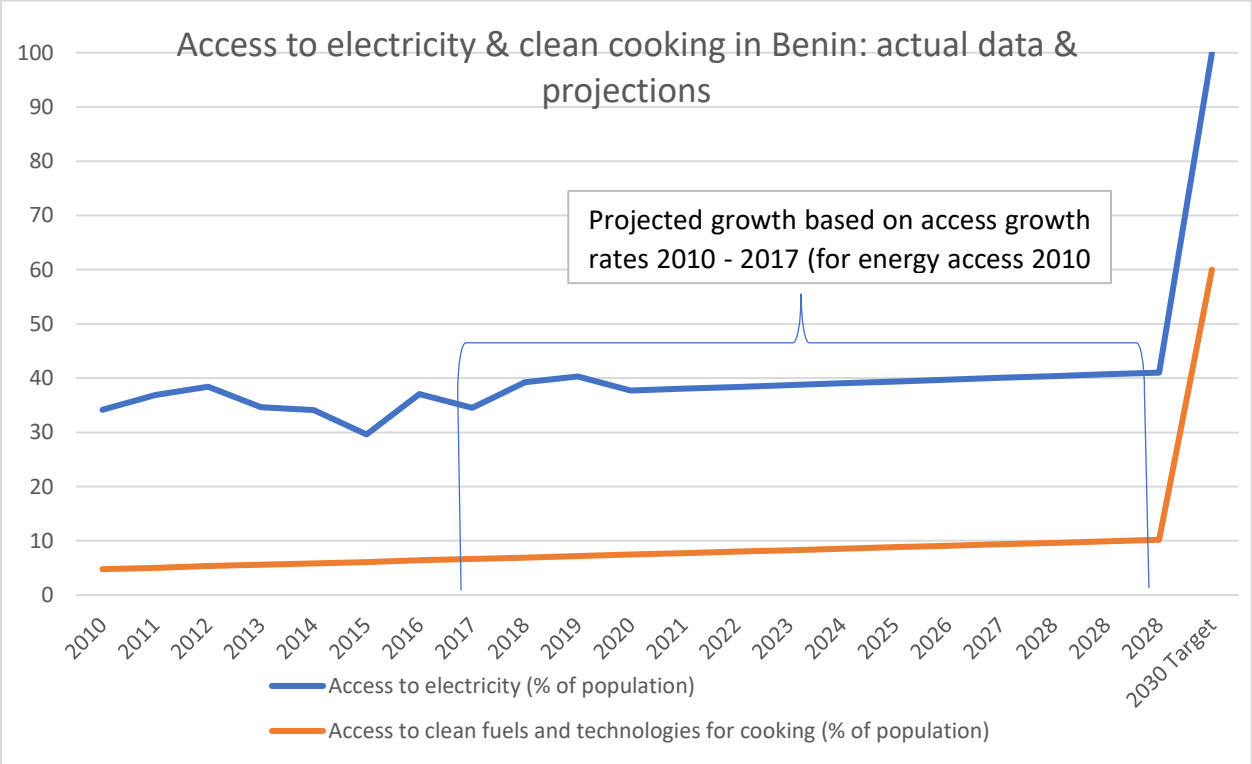
- National Renewable Energy Development Policy document (PONADER) 2019 & the National Energy Management Policy document (PONAME), 2020.: focuses on expansion of RE & energy efficiency; clean cooking is found in this context through the energy saving factor in the management of electric and solar cooking equipment.
- The National Clean Cooking Action Plan (PANCP): commissioned by EnDev; under development; aims to: Increase the sustainable production of wood fuels; Increase the availability of alternative fuels for cooking; Reduce deforestation in target areas; Reduce CO emissions through regeneration, protection, sustainable management of forests and clean cooking;

1.1.1 2030 targets (or nearest equivalent)

- In terms of electricity access, the objective is to achieve urban and rural electrification rates of 95% and 65% by 2025, and regarding renewable energy target the objective is to achieve 24.6 % renewable energy in the energy mix of Benin in 2025.[21] And 30% of renewable energies (RE) in the electricity mix by 2035 through the introduction of at least 25% of the total solar photovoltaic capacity.
- Through a $375 million compact with the U.S. Millennium Challenge Corporation, combined with an additional $700 million in other donor financing (mainly concessional debt), the Government of Benin (GoB) is building generation assets, pursuing IPP transactions, expanding transmission capacity, and modernizing its distribution network, while expanding access through grid and off-grid connections. The GoB has demonstrated commitment to power sector reform by installing a management contract to run its national electricity distribution utility, SBEE (Société Béninoise d'Energie Electrique), as well as enacting a new energy code that supports IPP investments. The GoB has adopted tariff reforms but rate increases are pending."[22]
- Information on specific clean cooking targets could not be retrieved.

Figure 3 Actual and projected growth: access to energy & clean cooking (based on World Bank data)

[21] https://www.se4all-africa.org/seforall-in-africa/country-data/benin/
[22] https://www.usaid.gov/powerafrica/benin


Access to electricity & clean cooking in Benin: actual data & projections
Projected growth based on access growth rates 2010 - 2017 (for energy access 2010
100
90
80
70
60
50
40
30
20
10
0
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
2021
2022
2023
2024
2025
2026
2027
2028
2028
2028
2030 Target
Access to electricity (% of population)
Access to clean fuels and technologies for cooking (% of population)

Appendix D: Results of National Culinary Surveys

Day of the week	Meal	Dish/food/hot drink 1	Dish/food/hot drink 2	Dish/food/hot drink 3
Day 1	Morning meal	Porridge	Left over meal	Doughnut (Beignet)
	Midday meal	Boiled tubers or roots	Fried chilli and onion	Fried meat or fish
	Evening meal	Meat sauce	Dough	Okra sauce or similar
Day 2	Morning meal	Left over meal	Porridge	Hot drink
	Midday meal	Beans	Fried chilli and onion	Fried meat or fish
	Evening meal	Meat sauce	Pounded yam	
Day 3	Morning meal	Porridge	Left over meal	Doughnut (Beignet)
	Midday meal	Rice	Fruit sauce (tomato, oini	Fried bananas (Aloko)
	Evening meal	Fish sauce	Dough	Okra sauce or similar
Day 4	Morning meal	Porridge	Left over meal	Doughnut (Beignet)
	Midday meal	Rice + beans (Attassi)	Fried chilli and onion	Fried fish or boiled egg
	Evening meal	Okra sauce or similar	Dough	
Day 5	Morning meal	Porridge	Left over meal	Doughnut (Beignet)
	Midday meal	Rice	Sauce	Pasta
	Evening meal	Dough	Leaf sauce (man)	
Day 6	Morning meal	Hot drink	Left over meal	Omelettes
	Midday meal	Fatty dough	Fruit sauce (tomato, oini	Roast meat
	Evening meal	Dough	Okra sauce or similar	
Day 7	Morning meal	Porridge	Left over meal	Doughnut (Beignet)
	Midday meal	Fatty rice or pasta	Fruit sauce (tomato, oini	Fried meat or fish
	Evening meal	Dough	Meat or fish sauce	Okra sauce or similar

Please add any further information that is not captured in the table above:
We have many kind of dough and sauce with differents cooking process. Also sauces are cooked with meats, fishs or chees

Dish/food/hot drink name	How long does it typically take to cook?	When eaten at home, is it usually cooked at home or purchased?	What is the main cooking process in this recipe?						Which cooking device/s and/or pans/pots are usually used?	Other interchangeable dishes with similar preparation techniques	Any other important information about this dish, e.g. regional variations/substitutions or specific preparation techniques
			Boil	Steam	Shallow Fry	Deep Fry	Roast/ grill	Bake			
Porridge	Quick (<20 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☐	Three stones stove with round	Hot drink	
Left over meal	Quick (<20 mins)	Usually cooked at h	☑	☐	☐	☐	☐	☐	All stoves and pans		
Hot drink	Quick (<20 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☐	LPG or metal/ceramic stove w	Porridge	
Boiled tubers or roots	Medium (20-60 mins)	Usually cooked at h	☑	☐	☐	☐	☐	☑	Three stones stove with round bottom pot		
Dough	Long (>1 hr)	Usually cooked at h	☑	☐	☐	☐	☐	☑	Three stones stove with round bottom pot		
Rice	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☑	LPG or metal/ceramic stove with flat bottom pan		
Fatty rice or pasta	Long (>1 hr)	Sometimes cooked	☑	☐	☐	☑	☐	☑	Three stones stove with round bottom pot		
Pasta	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☑	LPG or metal/ceramic stove with flat bottom pan		
Beans	Long (>1 hr)	Usually cooked at h	☑	☐	☐	☐	☐	☑	Three stones stove with round bottom pot		
Rice + Beans (Attassi	Long (>1 hr)	Sometimes cooked	☑	☐	☐	☐	☐	☑	Three stones stove with round bottom pot		
Boiled eggs	Quick (<20 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☐	LPG or metal/ceramic stove w	Cheese	
Pounded yam	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☐	☐	☑	Three stones stove with round bottom pot		
Meat sauce	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☑	☐	☑	LPG or metal/ceramic stove with flat bottom pan		
Fish sauce	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☑	☐	☑	LPG or metal/ceramic stove with flat bottom pan		
Fruit sauce	Quick (<20 mins)	Sometimes cooked	☑	☐	☑	☐	☐	☐	LPG or metal/ceramic stove with flat bottom pan		
Leaf sauce	Medium (20-60 mins)	Sometimes cooked	☑	☐	☑	☐	☐	☑	LPG or metal/ceramic stove with flat bottom pan		
Okra sauce or similar	Quick (<20 mins)	Usually cooked at h	☑	☐	☐	☐	☐	☑	LPG or metal/ceramic stove with round bottom pot		
Roast meat	Medium (20-60 mins)	Sometimes cooked	☑	☐	☐	☐	☑	☐	Three stones or metal stoves		
Doughnut (Beignet)	Quick (<20 mins)	Usually purchased	☐	☐	☐	☑	☑	☐	LPG or metal/ceramic stove with flat bottom pan		
Fried chili and onion	Quick (<20 mins)	Usually cooked at h	☐	☐	☐	☑	☐	☐	LPG or metal/ceramic stove with flat bottom pan		
Fried fish or meat	Quick (<20 mins)	Sometimes cooked	☑	☐	☐	☑	☐	☐	LPG or metal/ceramic stove with flat bottom pan		

Please add any further information that is not captured in the table above:

Generally, in rurals areas, households use open fires stoves (three stones stoves) and wood as fuel. In urbans areas most households use charcoal stoves (metal or ceramic) and some use LPG
Very few households use electric stoves. In general there are two types of pans that are used in Benin for cooking. Round-bottomed pans are used for stirring dough and cooking rice and beans, and flat-bottomed pans are used for prepari