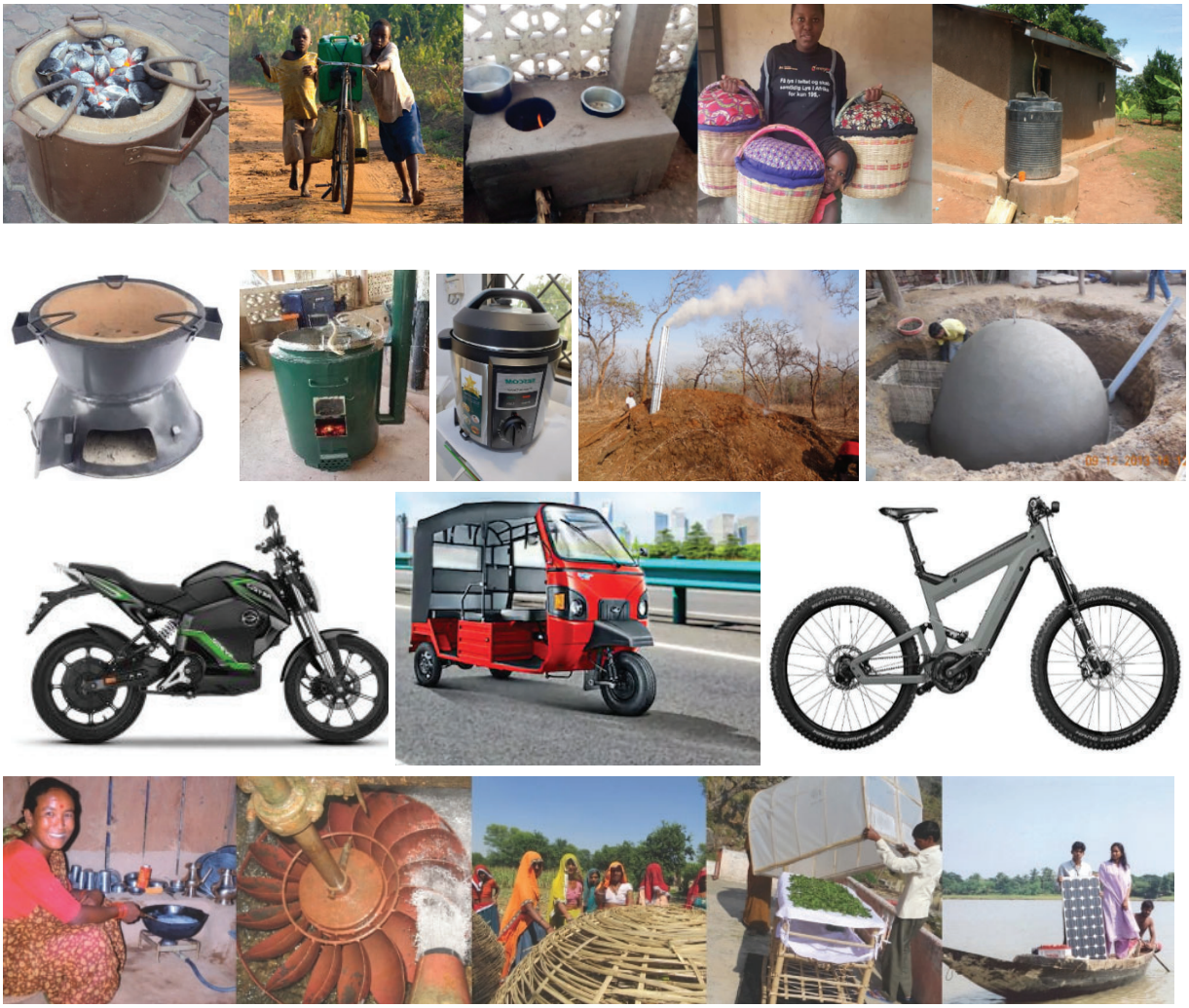
Local Solutions Proposed for Climate Action & Development
and
Policies to Promote & Scale-up Local Sustainable Energy Solutions

30.08.2023 - v2



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Introduction

This publication consists of two sections. Section-1 is a collection of best practices local sustainable energy and climate solutions from South Asia, Latin America, East Africa, West Africa, and Europe. The solutions were identified by the INFORSE coordinators as the most important local solutions that are important as climate solutions and also as development solutions to reduce poverty in sustainable ways. The purpose of this publication of Local Sustainable Solutions is to popularize local solutions in support of sustainable energy and development, specifically, best practices in technical solutions, policies and proven financing models. The publication includes 12 sustainable solutions.

Section-2 of this publication is a collection of policies, including best practice policies, in promotion of local sustainable energy solutions. The focus is on local solutions that can increase access to clean and affordable sustainable energy, but that are also forgotten in national energy policies, where central solutions are often the main focus.

This publication contains established examples of successful tried-and-tested local solutions that can help to address challenges related to energy for lighting, cooking and productive use of energy, water, and other essential human needs in climate-friendly and (as much as possible) affordable ways. It is useful for people, who need cleaner and better energy and other needs for their life and for local development, as well as community leaders, change agents, media, development workers and planners. Some of the cases feature well known solutions in some areas, while others are undocumented or may be unfamiliar. The publication is bridging the knowledge gap as well. The focus is on local solutions that can address energy access but have been omitted from national energy policies, where central solutions are often the main solutions.
The publication was developed in the framework of the Project *"Synergies across the continents - strengthening CSOs in climate action and reducing poverty with local, sustainable solutions"* with implementation period of December 2021 August 2023. It is a civil society cooperation project among members of INFORSE.

We hope with this publication to show how national policies can also promote the local solutions that are both key to reach climate targets that are not achievable with central solutions and indispensable for sustainable development.

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Read more about the project, and download this publication: www.inforse.org/synergies.php

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About INFORSE

The International Network for Sustainable Energy (INFORSE) was established at the Global Forum parallel to the "Earth Summit" /UNCED in Rio in 1992. INFORSE has got consultative status to the UN ECOSOC (1998) and UNFCCC (2002). The structure of INFORSE includes a secretariat and regional coordinators. Under this intervention, the partners included were the secretariat and the regional coordinators in Africa (one in East Africa, one in West Africa), in South Asia, and in Latin America.

The registered INFORSE members in the areas of the intervention are 32 in South Asia, 18 in East Africa, 25 in West Africa, 15 in Latin America, in total around 90. In addition, there are informal sustainable energy coalitions of CSOs in several countries in all the regions. The CSOs in these coalitions will also be invited to the events etc. of the intervention.

The **INFORSE secretariat** is hosted by **INFORSE-Europe** in Aarhus, Denmark, the European part of the INFORSE network and which is registered as a non-profit CSO in Aarhus, Denmark and has members throughout Europe. The INFORSE Secretariat contributed with its experience in coordinating the network, outreach with newsletters, website and social media, organising webinars etc. The INFORSE Secretariat has the capacity and resources in network coordination and outreach with an online database with more than 1000 sustainable energy contacts, a popular website (0.4 million annual visitors including many from the intervention countries), social media (Facebook and Twitter), and the publication "Sustainable Energy News", where themes are used to highlight specific results. Further, it has the capacity and resources to be involved in and coordinate international advocacy on climate and energy. With the intervention, the network's outreach and ability to involve CSOs working on sustainable energy was strengthened as well as its ability to strengthen the capacities of CSOs to disseminate and promote. From the INFORSE Secretariat Mr. Gunnar Boye Olesen and Ms. Judit Szoleczky were involved in the project.

INFORSE Regional coordinators

INFORSE South Asia is coordinated by Integrated Sustainable Energy and Ecological Development Association (INSEDA), India. INSEDA is an Indian organization, registered as a non-profit national NGO since 1995 which at present has over 30 NGOs and individual members. INSEDA has more than 25 years of experience on sustainable energy (household biogas, improved cookstoves, solar dryers, and use of bamboo) and been driving promotion and implementation of renewable energy based, community oriented, sustainable eco-village development programmes in India since 2002. INSEDA is cooperating with DIB on the eco-village development intervention with support from CISU. Dr. Raymond Myles, one of the founder members of INFORSE is the Regional Coordinator, INFORSE South Asia since 1992, and is founder President and Chief Executive of INSEDA since 1995. Mr. Sanjiv Nathan, Deputy Regional Coordinator, INFORSE and Mr. Ashok Zutshi, Deputy Regional Coordinator, INFORSE were involved in the project activities along with Dr Raymond Myles.

INFORSE East Africa is coordinated by Centre for Sustainable Energy Services (TaTEDO-SESO), Tanzania. TaTEDO, was founded in 1990 in Tanzania, and has a long-standing experience in capacity building and advocacy targeting poor and underrepresented groups. TaTEDO is currently cooperating with the Danish NGO Nordic Folkecenter for Renewable Energy on the CISU supported project "East African Civil Society for Sustainable Energy & Climate Action (EASE-CA)". The existing partnership and knowledge contributed to the success of the proposed intervention. The outreach is facilitated with social media. The coordinator of the activities is the Chief Executive Officer of TaTEDO, Mr. Estomih N. Sawe together with Ms. Mary Swai.

INFORSE West Africa is coordinated by ENDA Energie Environnement Développement (ENDA), Senegal. ENDA Energie has 30 years' experience in promoting and implementing local, sustainable energy solutions and other climate action locally, nationally, and regionally. The network and its members collaborate on a number of projects and have also cooperated with a Danish NGO (SustainableEnergy) on promotion of sustainable energy solutions nationally and regionally with support from CISU. Mr. Djimingue Nanasta, coordinated the work with support from the communication officer Mrs. Affoué Nathalie Koffi, director Mr. Secou Sarr, and the ENDA team.

INFORSE Latin America is coordinated by Roque Pedace in cooperation with Centro REDES, Argentina, (project partner), Laboratório Interdisciplinar de Meio Ambiente (LIMA) and others. Centro REDES is an independent center for research, technical cooperation and higher education created in 2002 by CSO "Grupo REDES" in Argentina. Since its formation, it has been involved in a number of activities and projects with civil society organisations on science, energy transition, development and gender issues. Centro REDES are new to the INFORSE Latin America network, but the coordination is done by Roque Pedace, who has been coordinating INFORSE Latin America since 1995 in cooperation with other CSOs. The other CSOs include the INFORSE coordinator in Brazil, LIMA, a new and active CSO called The Brazilian Climate Center (CBC), and the Uruguayan CSO CEUTA. LIMA is an independent Brazilian institute working on environmental issues. It has been involved in networking for climate and sustainable energy for over 20 years, and has been providing expertise and has represented INFORSE and CSOs in a number of cases, including the World Commission of Dams. The Brazilian Climate Center (CBC) is an independent think tank and CEUTA has been active for sustainable energy since the formation of INFORSE in 1992. Together, these cooperating organisations have substantial experience in development of opportunities for local sustainable energy solutions in Latin America. Mr. Roque Pedace has been coordinating INFORSE Latin America since 1995. He is also affiliated with the University of Buenos Aires as a senior researcher.

Section 1 - The Local Solutions Proposed for Climate Action and Development

1.1. Improved Cookstoves for Firewood and Charcoal by ENDA - INFORSE West Africa

Description of the solution

An improved cook stove (ICS) is a food cooking device built to use wood energy or charcoal just like the traditional open stoves and fires, but more economical in wood energy and less polluting. Its thermal efficiency is much higher than that of the traditional fireplace[1].
In Senegal as in other parts of the developing world, there are different types of improved stoves. They vary in form and size. Among the most popular and well known that consume less charcoal or firewood than traditional stoves, there are: the Jambar stove, the Sakkanal stove, the banco stove, as well as larger institutional stoves. The Jambar stove, also known as the Kenya Ceramic Jiko (KCJ), will be considered hereby as the standard improved stove.
The metal-ceramic Jambar improved cookstove consists of a metal fireplace with a ceramic part inside that allows it to conserve heat as much as possible. This stove is manufactured in workshops and has an energy efficiency of about 30 to 50% higher than the traditional stoves. It has a lifespan of 3 to 5 years (IFDD)[2].

What the solution provides?

Improved cook stoves offer reduced use of wood or charcoal. Being thermally and ecologically more efficient than the traditional cook stoves, they allow a significant saving of wood energy, with the consequence of preserving woodlands. The improved cook stoves make it possible to reduce the consumption of domestic cooking fuels, to contribute to the reduction of expenses related to the purchase of the fuels, and the improvement of sanitary conditions during the cooking of food (less smoke). It improves the quality of the air inside homes, and reduces the time spent collecting wood, for those who collect it themselves.

Why is it successful, from a user-perspective

The use of improved cookstoves brings great satisfaction to consumers. Improved cookstoves are convenient, make it easier to cook food, adapt to cooking habits and save money. Indeed, according to testimonies, expenses of 4000 CFA Franc every 7 days to ensure the supply of butane gas are reduced to only 6000 FCFA (9 euros) (a bag of charcoal) for a month. The use of Jambar stove saves 10,000 FCFA (15 euros) each month compared with LPG. Compared with

[1] Kitoto, Patrick Arnold Ombiono .- Facteurs d'adoption des foyers améliorés en milieux urbains sahéliens camerounais / *Adoption factors of improved stoves in Cameroon urban Sahelian environment*
https://doi.org/10.4000/developpementdurable.12182
[2] https://ifdd.francophonie.org/media/docs/publications/519_Fi_foyers_ameliores_7.pdf

traditional stoves, the savings is around 6000 FCFA (9 euros) each month Financial profit is the first motivation for users[3].

Energy savings or energy production

The energy efficiency of the Jambar cookstove is around 30 to 50% compared to the traditional one.

Climate effects

In terms of the environment and climate, the activities have generated the following results:

1. A reduction in CO_2 emissions of approximately 86,000 tons each year (for a total of around 40,000 stoves/year);
2. Protection of 2,800 hectares of forest each year (uncleared area);
3. An annual saving of approximately 57,000 tons of firewood[4].

Costs and time to construct

In a workshop with a dozen staff, production can reach 50 units of ICS per day, or 250 per 5-day week.

Prices for different sizes :

Jeeg (4 to 7 kg pots) : 6,000 CFA Franc (9 euros) to 8,000 CFA Franc (12 euros)
Jaabot (7 - 10 kg pots) : 7,000 CFA Franc (10 euros) to 9,000 CFA Franc (14 euros)
Jongoma (10 - 15kg pots) : 10,000 CFA Franc (15 euros) – 15,000 CFA Franc (23 euros)

Lifetime

The estimated lifespan of Jambar cookstoves is 3 to 5 years.

What policies and strategies helped the success?

The dissemination of improved cookstoves through the 'FASEN' project in Senegal was done through the consideration of the multidimensional aspect of the problem of improved cookstoves within the framework of a market approach.

These dimensions include:

- Technical: to put on the market a proven, efficient technology at an affordable price obeying well-regulated and modernized standards and manufacturing methods.
- Social and cultural: implementation of innovative systems taking advantage of traditional networks of savings and credit, formal and informal trade.
- Ecological, by campaigning for the use of improved stoves.

[3] PERACOD.- Vulgarisation des foyers améliorés au Sénégal : Les acquis du projet FASEN du PERACOD. La vulgarisation des Foyers améliorés au Sénégal.
[4] PERACOD, Idem.Senegal

- Economic, with the creation of jobs and income, providing affordable and reliable equipment.
- Politics, by basing the problem on socio-economic development policy.

The strategy was based on the establishment of organizational systems adapted to the different levels: macro and micro. The macro-organizational level is the political dimension. Several ministries, in charge of issues related to energy, environment, women, etc. are involved through capacity building to ensure the sustainability of actions. This involvement took into account the areas of competence of the structures concerned: supply of raw materials (energy and environment), household production (trade), marketing (research, control of standards and micro-finance) and finally consumption (ministry in charge of crafts).

The micro-organizational level concerns the operational level. It focuses on the technical, economic, environmental and social dimensions. The project was based on the dissemination of improved stoves adapted to the environment (rural and urban) and at socially acceptable prices. This strategy allows each stakeholder in the sector, from the producer to the consumer through the distributor, to find an economic and social interest in getting involved. The sustainability of the sector is based on the economic benefits that each actor can derive.

How widespread is it, where is it popular

The following results were obtained (estimates):
- 200,000 (Senegal) improved stoves released from 2007 to April 2012 (for a total of around 40,000 stoves/year).
- ~57,000 tons of firewood saved each year.
- ~2 million € saved by households each year.
- More than 81 blacksmiths and 40 distributors (women's promotion groups, shops, associations).
- 11 ceramics production centres, 5 of which are managed by men and 6 by women.

Example, description

There are two models of the Jambar ICS, one uses charcoal as fuel and the other uses wood-fuel. The most adopted is the first one that uses charcoal. Its hourglass shape is made of metal in the exterior and ceramic in the internal liner. This ceramic liner has a hole in its base to let ash fall through and be collected in a box located at the bottom of the stove.

Features and components:-
- Metal lining: a mild steel sheet.
- Ceramic insert with a grid at the base with small holes, the number of which varies according to the size of the stove.
- Kettle supports made of mild steel bars on which the kettle rests.
- Insulating bonding material between the metal sheet and the ceramic insert obtained from several mixtures of materials to prevent cracking during use[5].

The following artisans are needed to manufacture :
- Ceramists potters: they provide the ceramic inserts necessary for the production of the stoves
- Blacksmiths / metal welders: produce the different models of stoves.

[5] PERACOD.- Fiche technique de fabrication des foyers améliorés « Jambar » à bois et charbon de bois. https://energypedia.info/images/4/44/GUIDE_DE_FABRICATION_DU_FOYER_AMELIORE_JAMBAR.pdf

Examples, links

Ciza, Angélique Neema; Ngezirabona, Stany Vwima; Mardochée Ngandu; Mubasi, Clérisse Casinga.- Etude comparative de performance d'utilisation des foyers améliorés et leurs effets sur les niveaux de vie des ménages de Bukavu

https://doi.org/10.4000/vertigo.24496

Improved Cook Stoves, https://www.ctc-n.org/technologies/improved-cook-stoves

Kitoto, Patrick Arnold Ombiono .- Facteurs d'adoption des foyers améliorés en milieux urbains sahéliens camerounais/

Adoption factors of improved stoves in Cameroon urban Sahelian environment

https://doi.org/10.4000/developpementdurable.12182

PERACOD. Vulgarisation des foyers améliorés au Sénégal: Les acquis du projet FASEN du PERACOD. https://d-nb.info/1127680684/34

PERACOD. Fiche technique de fabrication des foyers améliorés « Jambar » à bois et charbon de bois.
https://energypedia.info/images/4/44/GUIDE_DE_FABRICATION_DU_FOYER_AMELIORE_JAMBAR.pdf

1.2. High-efficiency Improved Cookstoves for Firewood by TaTEDO - INFORSE East Africa

Description of the solution

Cooking on traditional biomass stoves is mostly related to very low levels of energy efficiency. The most basic type of cooking with biomass is the so-called "three-stone fire", which is made by arranging three stones in such a way that it is possible to place a pot for cooking above it. Although this type of biomass cooking is most inefficient and bears serious risks to human health and the environment, it has been around for thousands of years and is still the most prevalent way of cooking in the world. About 1.5 billion people in the world use traditional stoves for cooking (and heating)[6]. Many efforts have been made in order to improve the energy efficiency and reduce risks for human beings and to the environment related to cooking using a traditional stove. These efforts have resulted in a large number of improved cooking stoves (ICS) which vary in design, performance and costs. Improved stoves come in different forms and sizes, can be designed and built in various ways, depending on the local conditions. Especially in developing countries, stoves occupy a central place in the health, environmental, economic and social domains of life. By improving the efficiency of wood burning stoves, the amount of toxic smoke produced can be reduced and health risks to the family be minimised. In view of these and other concerns, a good cooking stove is defined as one that meets technical, scientific and safety standards, and has high combustion quality, technical efficiency, minimal smoke emission, ergonomics and structural stability.

What the solution provides?

Compared to a basic three-stone fire with 10-15% thermal efficiency, improved cooking stoves can easily halve the fuel requirements of the cooking process achieved by providing an insulated combustion chamber, improving the air supply, and other measures. New designs of improved cooking stoves can reach efficiencies over 50%, being four times as efficient as the three-stone fire. If a chimney is added to an indoor biomass stove, indoor air pollution drops to almost zero[7]. One of the new, efficient cooking stoves is the SeTa-IIFC firewood stove designed by the Tanzanian company, SEECO for institutions as well as for small and medium enterprises (SMEs) such as schools, colleges, prisons, hotels, restaurants, and any other mass cooking places.

[6]Improved Cook Stoves, https://www.ctc-n.org/technologies/improved-cook-stoves

[7] Test Results of Cook Stove Performance", Partnership for Clean Indoor Air, 2012. See Appendix C for the University of California Berkeley (UCB) Water Boiling Test (WBT) protocols.

Why is it successful, from a user-perspective?

SETA-IIFC succeeds because the stoves have high efficiency due to good design for heat transfer, increased surface area for heat exchange, high efficiency of the combustion chamber for reduction of harmful emissions and heat loss by application of ceramic fibre blanket to areas where heat exchange takes place. According to evidence from stove users, the SETA-IIFC has the ability to save more than 70 % of fuel. For example, Mnolela Secondary school in Lindi Region (Tanzania), before it started using SETA-IIFC, required about 430 pieces of firewood each day for preparation of students' meals. Switching to the SETA-IIFC dropped that amount to 57 pieces per day. It means that if trees of 16 inches' diameter at breast height (DBH) are harvested for firewood, this one institution reduces forest-harvesting from 2 trees to 0.25 trees per day.

Energy savings or energy production

A three-stone fire, thermal efficiency is stated to be as low as 10 to 15%[8]. In other words, 85 to 90% of the energy content in the wood is lost as heat to the environment outside the cooking pot. The thermal efficiency of different improved stoves (of the rocket stove types) varies between 23 and 54%. The SETA institutional cook stove manufactured by SEECO with rocket stove features has a thermal efficiency of 54.8 %, which means it has the ability to reduce fuel consumption by around ¾ (75%) compared to three-stone fireplaces with efficiencies 10-15%. The reduction of fuel consumption also implies that the stove contributes to a reduction of the institution's cooking-energy budgets, allowing less time to be spent in cooking and contributing to environmental conservation.

Climate Effects

Improved stoves use less firewood and produce less smoke, and they have been touted as a way to reduce greenhouse gas emissions and health effects from indoor air pollution, as well as to improve forest conservation[9]. The emissions from stoves are dependent on various parameters involved in the combustion process, such as the type of fuel, the type and design of the stove and the operating conditions. Therefore, it is not possible to set a definitive value. The SeTA Improved Institutional Stove contributes to forest conservation. It reduces greenhouse-gas emissions, since the amount of firewood used for cooking is reduced. If the wood used is the result of deforestation and other cutting of trees without replanting, each reduced kg of wood reduces CO_2 emissions with 0,39 kg CO_2/kWh wood, equal to around 1.2 kg CO_2/kg wood. For a larger school that uses 1 ton of firewood per day, 200 days per year of unsustainable firewood, the four times improvement with change to a high-efficient stove from cooking on three stove fires will save ¾ of 1.2 tons = 900 kg CO_2/day, equal to 180 tons CO_2/year. If only half the used wood is unsustainable, reductions with the high-efficiency stove will be "only" 90 tons CO_2/year in this example. If it is possible to reduce wood use to the volume that it is possible to grow sustainably, it can make the fuel use at the school sustainable. In addition to CO_2, the improved stoves also reduce emission of black carbon that is also a driver of climate change.

Costs and time to construct

[8] What users can save with energy-efficient stoves and ovens, Microsoft Word - Appliance__Residential_CookingStoves__User_Savings__20140220__8.doc (bigee.net)

[9] https://openknowledge.worldbank.org/handle/10986/29972

The SeTA-IIFC is available in different sizes. According to the SEECO company price list of 2020, the stove of 25 liters costs TSh 1,200,000 (USD 550), the 50 liters stove is TSh 1,600,000 (USD 730), a stove of 100 litres costs TSh 2,300,000 (USD 1045), and a stove of 200 liters costs TSh 3,500,000 (USD 1,600). The prices also include a stainless-steel pot. The fabrication of SeTA-IIFC stove and its pot takes about 5 days. Installation of the chimney outside the roof normally takes two hours.

Lifetime

The durability of SeTA-IIFC is more than 10 years.

What policies and strategies helped the success?

Globally 2.8 billion people do not have access to clean cooking fuels and technologies, according to the 2020 *Tracking Sustainable Development Goal (SDG) 7: The Energy Progress Report.* The world falls short on its progress towards the Sustainable Development Goal 7, achieving universal access to affordable, reliable, and modern energy services. Globally, clean cooking is increasingly viewed as an urgent development issue with significant benefits for public health, gender equality, the local environment, and the global climate.

The Tanzania national Energy policy emphasises the promotion of efficient biomass energy conversion technologies to save resources; reduce deforestation and minimise threats of climate change. The Tanzania Biomass Energy Strategy (BEST) and SE4All Action Agenda support the production, business, and utilization of efficient biomass stoves.

There have been a number of small projects on improved cook stoves initiated by the government through ministries (e.g., Vice President's Office) and agencies (such as Rural Energy Agency) supporting the private sector to disseminate ICS in specific areas in the country.

- Also, carbon financing and social subsidies have helped to enhance incentives to adopt.
- In 2015 Kenya enacted the Energy (Improved Biomass Cookstoves) Regulations
- Development of standards - for instance the Tanzania Bureau of Standards (TBS) has developed a standard for only charcoal stove (TZS 473:2010) but due to the informality of the sector there is no enforcement mechanism on the products and in the interim, there is no mechanism or framework in place to protect customers from sub-standard cookstoves in the market.

How widespread is it, where it is popular?

Of the more than 2.85 billion people who rely primarily on solid fuels globally, less than one-third use improved cookstoves. In sub-Saharan Africa and Asia, the lack of access to clean cookstoves is especially acute.

Problems and Challenges

It requires a special pot, which means the pot has to be fabricated together with the stove. The bottom of the stainless-steel pot has to be 3 mm thick to ensure its longevity.

1.3. High-efficiency Electric Pressure Cookers (EPC, E-cookers) by TaTEDO - INFORSE East Africa

Description of the solution

Pressure cookers existed first as a stove-top version that required manual monitoring of pressure. A pressure cooker works on a simple principle: steam pressure. Electric pressure cookers arose to help streamline and simplify the process. They have digital or analogue timer controls and are generally easy to use. The quick cooking time and ability to electronically set time also increase their consumer appeal. In addition, the cooker is a closed system which helps retain moisture, nutrients and flavor.

Additionally, well-insulated electric pressure cookers are more energy efficient than stove top or oven cooking. The insulation prevents energy from being lost in the cooking process. Every pressure cooker model is different. Older, less insulated models tend to use more energy than newer models. An upgrade to a newer energy-efficient model can save you money. In addition to energy efficiency, the biggest advantage of an electric pressure cooker is its features. You can schedule your cooking with the in-built timer. They come with safety features too to protect you from explosions. Some of these features are pressure sensors and warning for high temperatures with the help of temperature sensors. Unfortunately, not all pressure cooker models are energy efficient. Thoroughly check the manufacturer's description before buying a pressure cooker.

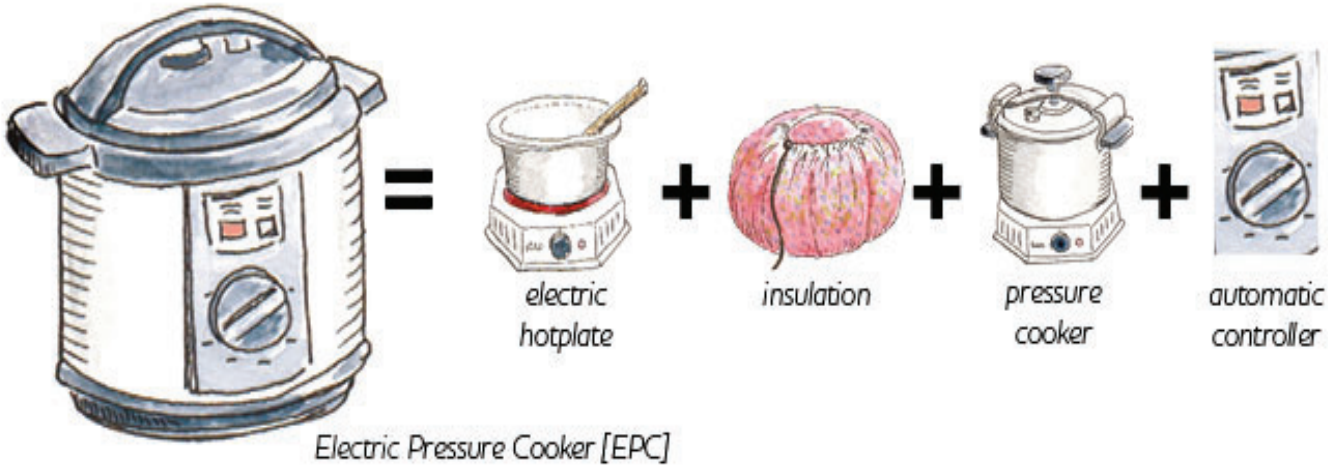


Fig 1: Fundamental components of Electric Pressure Cooker

What the solution provides?

It's a genuinely useful device that can save you both time and money in the kitchen. Pressure cookers speed cooking in two ways. First, the higher heat inside the pot cooks food faster than you can with ordinary boiling water or steam, often reducing cooking times to ⅓. Second, the high pressure forces the moisture into the food, so it heats through quickly. Pressure cooking has other advantages, too. The high-pressure cooking preserves the flavor of food in a way that

ordinary steaming can't. And the high temperatures inside the pressure cooker can even allow some food types to brown and caramelize, producing rich, complex flavors that you normally can't get when cooking with water. A pressure cooker doesn't just save you time in the kitchen; it also saves you money. Cooking with a pressure cooker saves energy and opens up a whole new range of cheaper food options for busy cooks. Because pressure cookers cook faster, it also uses less energy.

Why is it successful, from a user perspective?

The pressure cooker is highly efficient — it uses far less energy than many other appliances, since it cooks so quickly and leverages the pressure powers of steam. A pressure cooker cook food about 30 percent faster than conventional methods like steaming, boiling, and braising using the same power. According to the American Council for an Energy-Efficient Economy, pressure cookers also use 50 to 75 percent less energy due to shorter cooking times than normal electric cooking. Pressure-cooked foods retain more vitamins (except vitamin C) and minerals (as well as flavor) than boiled foods because there is less water into which nutrients can dissolve.

Energy savings or energy production

Pressure cookers use less electricity than other electric cooking appliances, more energy efficient than ovens or stoves, pressure cookers are more versatile and cook more efficiently—especially today's versions. Pressure cookers cut energy use in two ways. First, they cook food faster than a slow cooker because they can slash cooking time by 70%. Secondly, they are well insulated, retaining heat that is transferred to cooking so you don't waste energy radiating heat into your kitchen. So, you don't have to turn on the fan or air conditioning. You save energy this way too! Compared to other cooking methods with the same power, pressure cookers are 2-10 times faster. They save energy instead, cutting down electricity costs. However, it depends on what kind of pressure cooker you have and how often you use it. On average, it can use 700 to 1,000 watts of electricity. For example, if you use it for around 3 hours a day, your pressure cooker might use 700 watts. It varies from home to home. By cooking using a pressure cooker, you can save 65 to 70 percent of energy.

The cost saving depends on the price of the electricity. In Tanzania, cooking using the EPC was approximately 7 times cheaper than kerosene, 10 times cheaper than LPG, and 13 times cheaper than charcoal for boiling heavy foods, based on 2020 market prices of the electricity. The device also limits the temperature of the food inside during cooking: when a specific temperature (typically 130'C) is reached, the heating element automatically turns off. Because it is insulated, it maintains that optimal cooking temperature while reducing cooking time to 60%.

Table 1: Daily, Monthly, Annual Costs per Person of Cooking within a Mini-grid Context

Appliance Type	Daily Cost Range per Person, in EUR	Monthly Cost Range per Person, in EUR	Annual Cost Range per Person, in EUR
Electric Hot Plate (2000W)	0.127 – 0.211	3.81 – 6.33	46.25 – 77.09
Induction Hot Plate (1500W)	0.106 – 0.176	3.18 – 5.28	38.54 – 64.24
Slow Cooker (190W)	0.038 – 0.063	1.14 – 1.89	13.73 – 22.88
Pressure Cooker (700W)	0.023 – 0.039	0.69 – 1.17	8.55 - 14.26

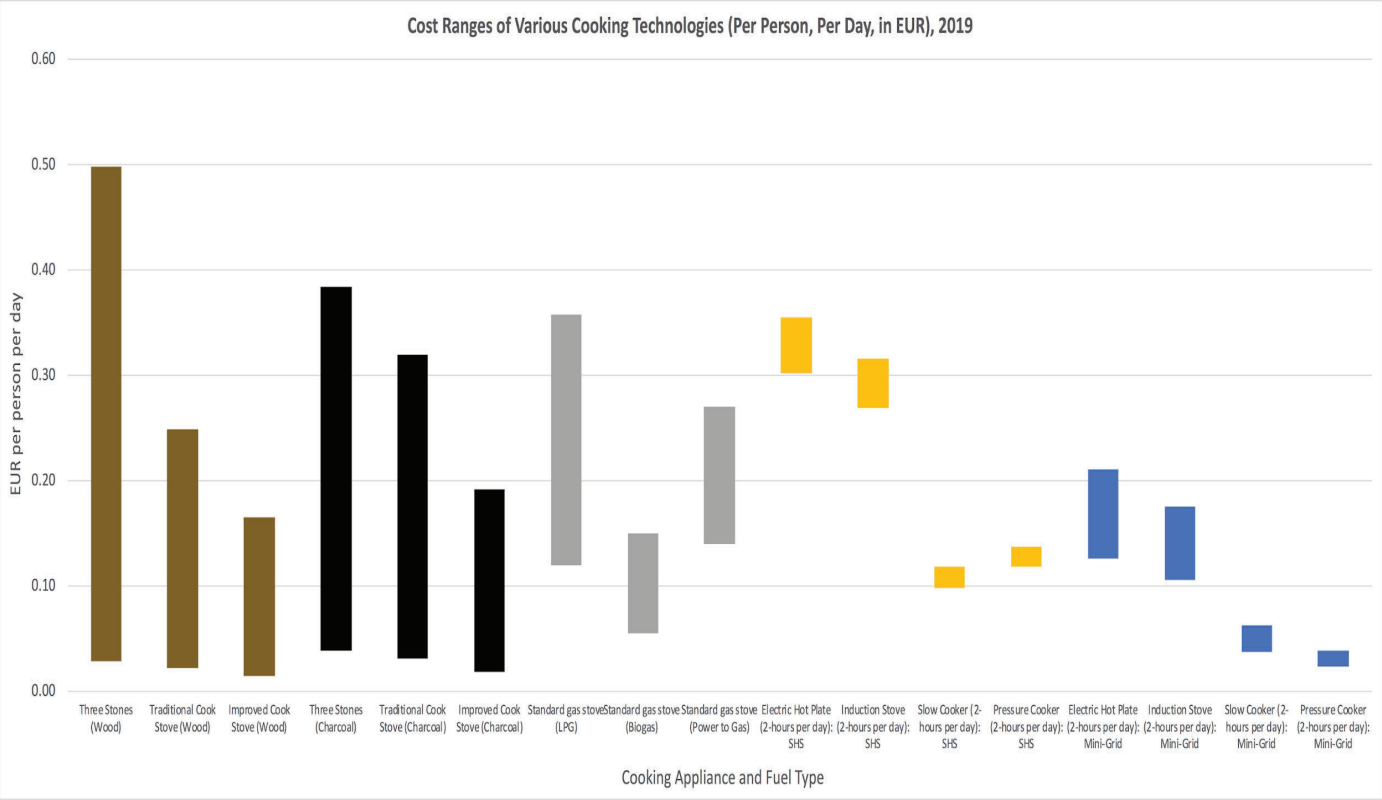
Cost range of **EUR 0.53/kWh to EUR 0.88/kWh** (USD $0.60 - $1.00/kWh; see RMI 2018) is assumed.

Table 2: Daily, Monthly, Annual Costs per Household (average of 5 people) of Cooking within a Grid Context in Tanzania using Pressure Cooker

Appliance Type	Daily Cost Range per Person, in Tsh	Monthly Cost Range per Person, in Tsh	Annual Cost Range per Person, in Tsh
Pressure Cooker (1000W)	200 – 700	6,000 – 21,000	73,200 – 256,200

Cost range of **Tsh 100/kWh to Tsh 350/kWh** (USD $0.04 - $0.15/kWh) is assumed.

Figure 2: Cost Ranges of Various Cooking Technologies (Per Person, Per Day in Tanzania, in EUR), 2019



Legend:

h	= Firewood		= Charcoal		= Gas-based Fuels		= SHS (Electric)		= Mini-grids (Electric)

Sources: Authors' elaboration, based partly on RMI 2018; BNEF 2018; Leach and Oduro, 2015; Goodwin et al. 2014; GACC 2015; Adkins 2010; Smith et al. 2013; FNR 2016.

Table 3: Electricity Consumption of Sample Cookware

Electricity Consumption of Sample Cookware Bringing 1.5 Litres of Water to a Boil (energy savings for pressure cookers are even greater when actually cooking food)	
Cookware	**Energy Use in Watt-hours (Wh)**
Pressure Cooker	60
Warped Bottom Pot	290
Flat Bottom Pot	190

Source: https://fastcooking.ca/pressure_cookers/energy_savings_pressure_cooker.php

Climate effects

Electric pressure cooking provides a wide range of benefits, from reducing carbon emissions and personal exposure to harmful pollutants to lowering the burden of disease associated with household air pollution.

The reduction of energy consumed by using an automatic electric pressure cooker also results in less greenhouse gas emissions from the power plant used to generate the electricity for your electric stove and also lesser smoggy air, depending on power sources of the country.

Electric Pressure Cookers generate less heat, cook your meal quickly and you also don't have to turn on your fan or air conditioning. This reduces pressure on your air conditioner as the amount of heat generated now is far less than before. Normally an air conditioner consumes one unit of energy to remove three units of heat from your home or apartment which is not very efficient. Thus, using an electric pressure cooker can result in a decrease in your electricity bill by reducing the amount of time your air conditioning is on.

Electric Pressure Cookers save forests by providing an alternative clean cooking solution and avoid emissions from combustion of biomass. Exposure to household air pollution from burning wood, charcoal, coal and kerosene is a leading risk factor for diseases. Furthermore, emissions from household cooking are a significant source of ambient air pollution and a contributor to climate change.

Researchers have found that the contribution of indoor emission to atmospheric air pollution is 37%. And almost 90% of that comes from the kitchen. 90% of 37% is 33.3% and it is the contribution from the kitchen.

The new generation pressure cookers help cut pollution and minimise the greenhouse gas emissions from your gas stove, and reduce electric power consumption when using electric stoves, and that means electric plants use less energy to generate power.

If around 4.5 billion people or close to 1 billion houses start cooking their food in pressure cookers, they will be saving huge amounts of fuel and ultimately the emission of greenhouse gases would be cut down by 21.64%.
https://www.linkedin.com/pulse/use-pressure-cooker-everyone-can-offset-global-warming-rajan-pandey.

Costs and time to construct

There are many online resources providing reviews and recipes for all the main brands of electric pressure cookers available. Prices of models range from $50 to $100. Market prices in Tanzania range from Tsh 180,000 to 250,000 (USD 77 to 107) for good quality EPCs with capacities of 4- to 6 liters. EPCs are manufactured in factories and special engineering knowledge is required. Training is required to be able to provide after-sale services.

Lifetime

For most regular users who maintain it properly, it will last for more than five years before replacement.
Most of the EPCs for residential use come with a 1 year to two years warranty; it is very common for EPC to last anything from 2 – 5 years. This shows that the product is expected to last at least that time of the warranty. In some cases, they can last longer if they are properly cared for and certain parts replaced.

For instance, the manufacturers of Instant Pot say that it can withstand more than 100,000 uses. This also extends to individuals who use the instant pot several times a day. Although it is dependent on the maintenance culture of the user, proper cleaning after each use is ideal. The one component that a manufacturer specifies a long-life span for, is the heating element. The silicone ring that surrounds the lid and ensures it is closed is also a part that is expected to last. However, assuming regular usage, it should take a user two to three years before it needs to be replaced. The piece of the EPC that goes through the most wear and tear is the ring, which has a lifespan of 1 to 2 years. Since the delicate parts stand the test of time, through a few replacements, a pot that is properly cared for will last. The stainless-steel pot can withstand minor scratches over a long time.

Problem and challenges

Uses only one type of pot. Not suitable for some fried foods like nyama choma, chapati, and deep frying. If you want crispy fried chicken, then the EPC is not the right cooking appliance because it makes food moist and tender but not crispy.
EPC looks complicated at first.

What policies and strategies helped the success?

Modern Energy Cooking Services (MECS), the UK clean cooking funded programme. Modern Energy Cooking Services (MECS) is a five-year programme funded by UK Aid. The Modern Energy Cooking Services (MECS) programme aims to break out of this "business-as-usual" cycle by investigating how to rapidly accelerate a transition from biomass to genuinely 'clean' cooking on a global scale. Awareness raising campaigns are critically important to raise demand for the EPCs.

How widespread is it, where is it popular?

EPC are widespread all over the world and most popular in Netherlands, India, Asia,

Examples, links

SESCOM electric pressure cooker is among the best EPCs, for more information visit
https://storage.googleapis.com/e4a-website-assets/2020-Global-LEAP-EPC-Buyers-Guide.pdf
and https://sescom.co.tz/products

1.4. Efficient Charcoal Making by TaTEDO and Uganda Coalition for Sustainable Development (UCSD) - INFORSE East Africa

Description of the solution

Charcoal is produced from wood and other biomass types in a process called carbonisation. Carbonisation is the method of burning wood or other biomass in the absence of air after which it breaks down into liquids, gases and charcoal. In many towns in Africa, charcoal is the dominant cooking fuel, making it an important form of energy.

Charcoal is made using charcoal kilns or retort technologies. The most common type of kiln used in charcoal production in Tanzania and many other countries is the traditional (basic) earth mound kiln (BEK) with varying degrees of efficiency. The efficiency of the kiln depends on the construction of the kiln (arrangement of the fuel etc.), moisture content of wood and the monitoring of the carbonization process. There are also other different kiln technologies for production of charcoal, they include: Earth pits (low efficiency), improved Earth mound kilns (medium efficiency), Half orange brick kilns (better efficiency) and metal kilns (better efficiency). Retorts are used for carbonizing residues from Agro processing or sawmill residues, generally with good efficiency.

The Basic Earth Mound Kiln (BEK) is one of the oldest and most commonly used kilns in Tanzania and East Africa. BEK has average efficiency of 8-15%, so only 8-15% of the energy in the used wood is retained in the produced charcoal and wastage is 85%. Carbonization time is eight days, during which the kiln requires continuous attention, and cooling time is 24-48 hours on average. The quality of charcoal produced is rather low. The Improved Basic Earth Mound Kiln (IBEK) has efficiency up to 25% and carbonization takes only four days, cooling takes 24 hours, and the quality of charcoal produced is relatively high.

What the solution provides?

IBEK has an efficiency of about 20-25%. It requires half the time required by the traditional BEK to produce charcoal. IBEK yields large pieces of charcoal with no leftovers, requires only 4.5 kg of wood per 1kg of charcoal, and raises the calorific value of produced fuel to more than 31kJ/kg. For traditional EMK, in contrast, 7 kg of wood are required to produce 1 kg of low-quality charcoal of calorific value of 26kJ/kg.

Why is it successful, from a user-perspective?

Normally, most people prefer to use technologies which they are familiar with rather than new technologies. The Basic Earth Mound Kiln (BEK) has been selected for improvement so that it can be adapted to the improved basic earth mound kiln (IBEK). This is because this kiln is very popular in Tanzania since it is commonly used by most charcoal producers. Charcoal producers prefer to use IBEK because when compared, the quality of charcoal made from a traditional kiln and from the IBEK are significantly different in terms of time of carbonization and weight of charcoal. IBEK uses a relatively smaller quantity of wood, and less carbonization time (hence,

less monitoring time) to produce charcoal in the same quantity as the traditional method. Moreover, the IBEK yields large pieces of charcoal with no leftovers.

Energy savings or energy production

The conversion of wood to charcoal plays a small but crucial role in the charcoal value chain. In most instances, charcoal production takes place using traditional BEK or pit kilns, where wood is cut and stacked before being covered in earth and carbonized.

In most instances traditional kilns are used resulting in low conversion efficiencies of around 8 percent to 12 percent. Table 1 summarizes kiln technologies and their associated conversion factors and emission rates. It clearly shows that significant efficiency gains can be achieved by applying improved kiln technologies and that this aspect needs to be considered for designing appropriate policies for sustainable charcoal utilization.

Table 1: Efficiency of Alternative Kiln Technologies

Characteristics	Traditional Phase	Transition Phase	Semi-Industrial Phase	Industrial Phase
	Traditional Kilns	Improved Kilns	Semi-industrial Kilns	Industrial Kilns
Conversion Technology				
Efficiency	8-12%	12-18%	18-24%	>24%
Emissions (in g per kg charcoal produced	CO_2: 450 - 550 CH_4: ~700 CO: 450 - 650	→		CO_2: ~400 CH_4: ~50 CO: ~160

Source: Sepp (2008b) in World Bank 2009

In recognition of these potential challenges, there is an increasing body of experience in Tanzania (and other east African countries) relating to promoting low-cost improvements to the traditional earth kiln design. The Tanzania Traditional Energy Development and Environmental Organization (TaTEDO) has pioneered this approach with a range of simple adaptations to traditional designs that can achieve significant savings at a low cost. These include the introduction of a chimney, as well as ensuring that wood used in the kiln is adequately dried and cut into approximately similar sizes. Semi-industrial and industrial kilns (Table 1) have met with some success, but only under intensive production systems (such as in a plantation setting or with significant external investments by a private sector enterprise dedicated exclusively to charcoal production).

Climate effects

Each ton of charcoal produced and consumed in Tanzania using traditional methods generates nine tons of CO_2 emissions; IBEK reduces emissions considerably. With the increase in efficiency from around 12% to around 24%, emissions are reduced from around 9 kg CO_2/kg charcoal (2.4 kg/kWh) to around 1.2 kg CO_2/kWh charcoal. If the wood used is from deforestation or other not replanted trees, the total emissions contribute to climate change. For more sustainable wood sources, a smaller part of the CO_2 emissions contributes to climate change.

The IBEK is designed such that the chimney plays an important role in reducing air pollution by serving as a smoke filter. It works well, reducing the emission of harmful volatile substances into the atmosphere by as much as 75 %. Of these, both methane (CH_4) and black carbon contribute to global warming.

Costs and time to construct

Construction cost depends on the type of the kiln. IBEK is a temporary structure; the size of the kiln varies from a few cubic meters' capacity to over 100 cubic meters. One iron sheet to make the chimney is required, the price ranges from TSh 15,000 to 18,000 (USD 6.50 to 7.75). Another cost in time, effort, labour, to construct, to load, to monitor, and to clear away the kiln. Given the reductions in number of days required for carbonization and in the amount of wood needed, the IBEK is a vast improvement over the traditional BEK in terms of labour costs.

One corrugated-iron sheet is needed to make a chimney. Wood, grasses, and soil, all locally available, complete the building materials. The IBEK requires little capital investment once one possesses the necessary common hand tools.

Lifetime

In IBEK, carbonization takes four days and cooling takes 24 hours, then off-loading follows. IBEK is a temporary structure, as the kiln is offloaded, mark the end of the structure. However, it should be noted that the iron sheet can be used for more than three to five times depending on thickness of the sheet used and size of the kiln constructed.

What policies and strategies helped the success?

The Tanzania Forest Act (2002), Charcoal Regulations (2006), and Guidelines for Sustainable Harvesting and Trade in Forest Produce (2007) provide the legal basis for the production and trade of charcoal. The Charcoal Regulations and the Guidelines for Sustainable Harvesting require the establishment of a harvesting committee at the district level. This committee includes participation by village representatives for areas where charcoal production is occurring.

How widespread is it, where it is popular

The IBEK design is applied in Tanzania's coastal and southern areas, mainly used in Kilosa in the Morogoro region, Tanzania.

Problems and challenges

More time is consumed while preparing and organizing wood in the kiln to minimize void space. A large amount of small pieces of wood is required to make the apron. More grasses are required, as the more efficient design requires the entire piles of wood to be covered completely. Higher material costs, increased labor input, but also lack of knowledge all represent disincentives for charcoal burners to adapt improved technologies in situations where they are not rewarded with increased prices.

1.5. Briquettes from Biomass/Agri Waste and Charcoal Dust by ENDA - INFORSE West Africa and REDES - INFORSE Latin America

Description of the solution

Briquettes are blocks of combustion materials made of biomass, charcoal dust, etc. and obtained by die-casting and used instead of charcoal or wood-fuel. Charcoal briquettes are inexpensive solid fuels made from the charred biomass or charcoal dust[10]. They are obtained by compacting these biomass residues into a single solid block.

There are two types of briquettes on the market:

1. Non-carbonised briquettes. These are produced from non-carbonised waste such as sawdust, paper and cardboard waste, waste from the wood products industry, etc.;
2. Carbonised briquettes. They are made from waste that has undergone carbonisation such as powdered charcoal or by carbonising uncarbonised briquettes, invasive plants; residues from the processing of agricultural products – such as coffee husks, coconut shells, croton shells, shells, acacia bark residues, maize cobs, bagasse, groundnut husks, rice husks; as well as agricultural residues from the harvesting of maize, leaves, grasses, stalks and straw from agriculture (if not needed for soil improvement).

In African countries, thousands of tons of biomass residues are produced every year as a result of logging, farming, etc. and their use is generally not profitable. The transport and handling of charcoal, which is the main source of domestic energy in many towns, also produces a large quantity of residues in the form of dust that cannot be used for briquettes. In general, in each bag of charcoal, there is about 5 to 10% of dust depending on the weight. This huge amount of biomass residues and unused charcoal dust can be utilised, turning it into briquettes.

What the solution provides?

The use of charcoal dust for the production of briquettes avoids the waste of resources and protects the environment. The use of briquettes has ecological, economic and societal advantages. Economically, it seems to be more affordable than charcoal, since a kilo is sold at 150 CFA francs

[10] CARNAJE, Naomi P et al.- Development and characterisation of charcoal briquettes from water hyacinth (*Eichhornia crassipes*)-molasses blend
https://doi.org/10.1371/journal.pone.0207135

(0.25 USD) as against 300 CFA francs for charcoal (0.5 USD)[11]. Ecologically and environmentally, the recycling of the charcoal dust avoids pollution and congestion with piles of charcoal dust in sales outlets or on landfill sites. Finally, from a societal point of view, just like charcoal, the use of briquettes respects culinary habits, emits less smoke and does not blacken pots.

In Africa, the production and sale of briquettes provide income generation opportunities for entrepreneurs in the cooking and heating fuel supply market. Moreover, the production of biomass briquettes fits perfectly with waste management in the context of a circular economy[12].

Why is it successful, from a user-perspective?

The success of briquettes is due to their lower cost than charcoal (see above). Moreover, briquettes do not pollute and do not upset culinary habits. In addition, the use of fuel briquettes means less firewood to collect and less charcoal to buy; this saves time and money. Fewer trees will be cut down, which will help save the forests.

New employment can be made by selling dust for briquette making or by making and selling fuel briquettes yourself. Briquettes mean less rubbish on the streets and in dumpsites, which improves hygiene in the places where charcoal is sold.

Energy savings - up to 25% saving on charcoal cost. Not all residues will give briquettes of the same calorific value: briquettes produced from banana and cassava peels give a long and brisk cooking time whereas briquettes produced from paper and cereal stalks give less heat than charcoal.

In order to optimise the use of briquettes, specific stoves can be developed or improved cookstoves can be used. The specific stoves are more efficient than conventional stoves, generate less smoke, which has positive impacts on women's health, and the cooking time is reduced.

Climate effects

Using briquettes means less firewood to collect and less charcoal to buy. More importantly, fewer trees will be cut down, which will help to save the forests.

Costs and time to construct

To make briquettes, there are various types of pressings that can be used: manual or motorised screw pressing, manual piston or motorised pressing and lever pressing. The cost and construction time vary according to the pressings or briquette machines.

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[11] NEBEDAY.- Bio charbon : Fabriquer des briquettes de charbon à partir de déchets agricoles carbonisés. https://wiki.lowtechlab.org/wiki/Bio_Charbon

[12] RAMSEY, Deanna.- Cinq choses à connaitre les briquettes de biomasse et la bioénergie durable en Afrique.
https://forestsnews.cifor.org/72699/cinq-choses-a-connaitre-sur-les-briquettes-de-biomasse-et-la-bioenergie-durable-en-afrique?fnl=

What policies and strategies helped the success?

Business opportunities along the briquette value chain can help promote the successful adoption of briquettes:

- Collection and sale of raw materials to producers
- Production and wholesale of briquettes
- Purchase of briquettes from producers
- Retail or packaging of briquettes for the general public / supermarkets
- Production and sale of briquettes
- Production and sale of stoves
- Organisation of training courses on briquette production for people interested in interested in briquette production[13]

Examples, links

LA GUILDE.- Le Charbon vert, espoirs et réalités d'une alternative énergétique séduisante: Etude réalisée par Mathilde Laval
https://mediatheque.agencemicroprojets.org/wp-content/uploads/Le-charbon-vert-espoirs-et-r%C3%A9alit%C3%A9s-dune-alternative-%C3%A9nerg%C3%A9tique-s%C3%A9duisante1.pdf

Practical Action.- La fabrication des briquettes: fiche descriptive
La fabrication des briquettes - Practical Answers (practicalaction.org)

[13] Practical Action.- La fabrication des briquettes: fiche descriptive

Grameen Bandhu Biogas Plants

Description of the Solution Development:

The design framework for building a fixed dome biogas models using Bamboo Reinforced Cement Mortar (BRCM) was conceived in early 1993 by Dr Raymond Myles, the actual experimentation could only be initiated towards the mid of 1993 after collecting all the available information and details on civil construction based on BRCM.

Bamboo is preferred as construction material as it is widely grown the world over and the properties of bamboo as a building (civil construction) material are well documented.

Few crucial aspects related to the implementation of the biogas programme which needed to be looked into were:

- The Reinforced Cement Concrete (RCC) slab of the Outlet Displacement Chamber (ODC) was designed to be an integral part of Deenbandhu Biogas plant, however, in several cases, the ODC was not covered and posed a threat of accidents as small animals and children could fall inside the plant..
- Women masons trained in construction could not be involved at a large-scale construction of DBP in rural India because of:
  i. the socio-cultural reasons for not employing trained women masons in rural areas.
  ii. the reason that the trained women masons could not travel to distant places and stay for longer duration in the field due to family pressure.
  iii. difficulty in supervising men involved in construction..
  iv. additional drudgery as women masons had to perform their daily household chores along with masonry job.

Keeping the above in mind, the first prototype model of the new biogas plant was conceived by Dr. Raymond Myles and was built in March 1994. As about 45% of the cost of building this new model is the wages of labourers, therefore the designer gave the name "**Grameen Bandhu"** (friend of the rural people) plant.

A few family size plants of Grameen Bandhu plant (GBP) model are in operation for over one decade now and have been found to be working satisfactorily as a simple semi-continuous hydraulic digester biogas plant.

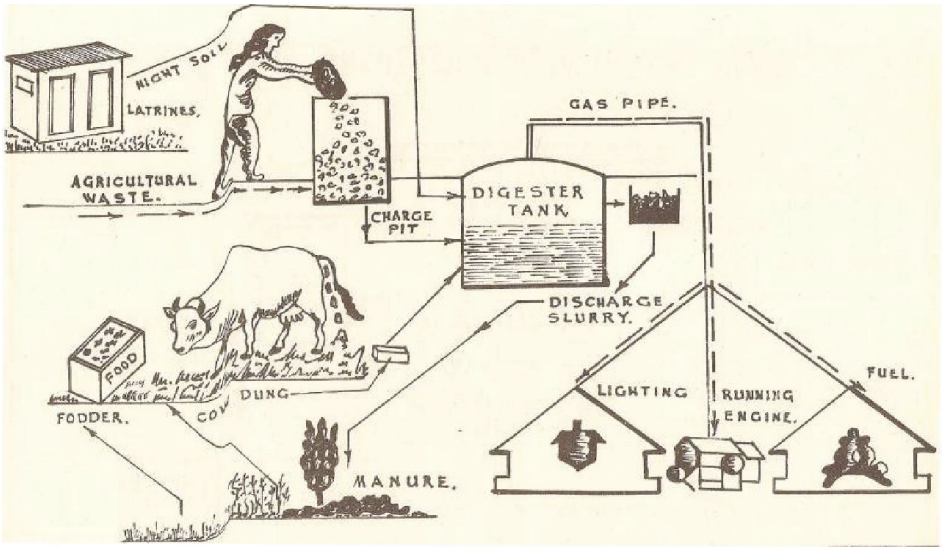
In this design, a large ellipsoidal shaped structure, called the "Main Unit of the Plant" (MUP) is woven with bamboo strips in two segments which are joined tightly using binding wires. The "MUP" of the Grameen Bandhu plant (GBP) is made by joining these two bamboo baskets (each

of which is segment of different spheres of two different diameters) at their open ends to form an ellipsoidal shaped structure.

The diameters of these two baskets-like structures at their peripherals (i.e. at their open-ended bases) are the same; therefore, they will perfectly match each other). When joined at their junction and properly tied using binding wire, the shape of MUP thus formed would look almost like an oval shaped football. However, only the top structure of the entire composite bamboo structure, placed inside the plant pit can be seen from outside, thus from outside the MUP would look like a hemi-spherical basket shaped shell structure.

Joining two fabricated or prefabricated woven bamboo shells in the shape of two baskets makes the Main Unit of the Plant (MUP) of GBP model. One of them, which comprise the bottom segment of the MUP, is shallower and looks like a big dish. The bottom segment (which constitutes the lower portion of the digester or fermentation chamber) also acts as the base of the MUP of GBP model and rests on the surface of the foundation of the appropriate size plant pit, as per the dimensional drawing. The bottom segment once cast becomes an integral part of the foundation of MUP and along with it also acts as the load bearing structure of the unit; as well as carries the weight of slurry inside the plant. Whereas the 'top segment' is a larger hemi-spherical shaped bamboo shell.

The structure, which looks like a very big and deeper basket, and is placed inverted on top of the dished shaped (looks like a shallow basket) bottom bamboo structure. The cement mortar in the appropriate ratios, is used for casting (both from outside and inside) the woven bamboo surface of the MUP. Two coats of plasters follow this, on the outer and inner cast surfaces, to form a continuous BRCM structure for MUP. In the same manner other components, sub-components and minor components of the GBP model are made of BRCM structures, as described in detail in the GBP manual.



The Grameen Bandhu plant (GBP) being made of Bamboo Reinforced Cement Mortar (BRCM), has substantial advantages especially for building it in remote and other areas where quality bricks, stones etc. are not easily available but bamboo is either available or its cultivation can be easily promoted. As the bamboo reinforced structures can be either fabricated or prefabricated at any place, the rural women, landless peasants, unemployed rural youth and other marginalized sections of the rural community can be trained to fabricate these woven structures from bamboo strips. This activity would promote regular income generating activities & opportunity of self-employment on a massive scale in rural areas.

Practical Pictorial Field Guide on Grameen Bandhu Biogas Plant

What the solution provides?

- Biogas Production Technology is an environmentally sound and Eco-friendly technology and a Carbon Neutral System. Biogas provides a smokeless, high efficiency fuel for domestic purposes (cooking and lighting), as well as heating and power generation at the village level.
- Biogas is a clean fuel and keeps, kitchen, household and the surroundings clean.
- The manure (slurry) from the biogas plant has higher nutritive value as compared to that of conventional Farmyard Manure (FYM) produced from the same amount of dung.
- Reduces environmental pollution and improves public health by preventing flies and mosquitoes which otherwise breed on the fresh dung heaps, especially during rainy seasons and also prevents foul odours as decomposition in open areas is avoided.
- Digested slurry can be applied directly along with the irrigation water to the crops and tree plantation to reduce nutrients lost from the slurry.
- Digested slurry is good for backyard horticulture and kitchen gardens and helps supply of nutrition from fresh fruits and vegetables to the families with additional income from sale of surplus.
- Biogas plants save time in cooking, cleaning utensils and reducing drudgery of women and girl children in fuelwood collection.
- Biogas is a very safe fuel for rural homes as it cannot explode easily due to presence of 35-40% CO_2 (Carbon dioxide) in the biogas mixture.

- The smokeless kitchen helps prevent eye and lung disease among women and children who are normally in the kitchen when food is cooked on firewood and dung cake.
- Manure prepared from digested biogas slurry has humus in addition to all the nutrients and trace elements that enrich and regenerate the soil thus contributing to better quality of crops and sustainable crop yields.
- Application of manure from biogas plants increases the water holding capacity of the soil, which makes it easily available to plants.
- The application of biogas manure changes texture and structure of the soil and makes it porous for better aeration, thus contributing to better crop yields.
- Biogas slurry can be used for seed treatment and is found to result in better germination.
- Biogas slurry can be used in the intensive composite pisciculture to give better returns to the farmers.
- The dried slurry can be used as feed for poultry and pigs.

Why is it successful, from a user-perspective?
The Grameen Bandhu plant (GBP) is simple to operate & handle by any plant owner or his/her family in rural areas. Being a simple technology based on the principle of a fixed dome rural household semi-continuous hydraulic digester biogas plants, which are very common in India e.g., Janata & Deenbandhu models, the maintenance and daily care needs to be done in the same way, which can be easily managed by the rural housewife or even the teenage children by devoting only 15 to 30 minutes each day.

Energy production
A 2 cubic meter (daily gas production) biogas plant fed daily with 50 kg cattle manure mixed with 50 liter of water produces enough gas for cooking for a family size of 6-8 persons.

Climate effects
Grameen Bandhu biogas plant would save approximately 4 tons of CO_2 equivalent/ year.

Costs and Size
A 2 cubic meter biogas plant which produces enough gas for cooking for a family size of 6-8 persons, and would cost about INR 40,000 to 45,000 (440-500 EUR)

Lifetime: If properly maintained, life could go easy to 25 to 30 years.

Examples, Links:
Grameen Bandhu Biogas Plant in the Catalogue of Local Solutions Eco-Village Development:
https://inforse.org/evd/presentation/present_solution.php?id=80
https://www.inseda.org/assets/documents/Grameen-BandhuBiogas-plant-A-Pictorial-Field-Guide.pdf

1.7. Solar Home Systems by INSEDA - INFORSE South Asia

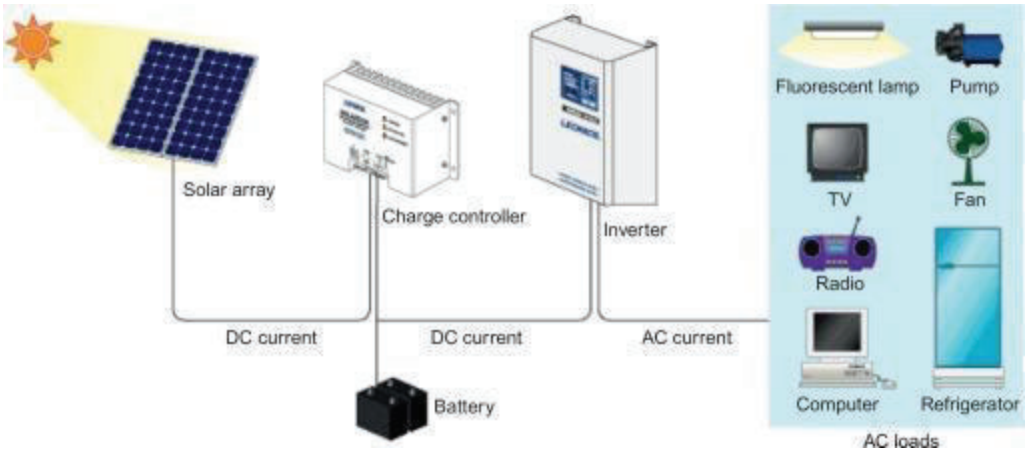
Description of the solution

Solar home systems (SHS) are stand-alone photovoltaic systems that offer a cost-effective mode of supplying amenity power for lighting and appliances to remote off-grid households. In rural areas that are not connected to the grid, SHS can be used to meet a household's energy demand fulfilling basic electric needs. Globally SHS provides power to hundreds of thousands of households in remote locations where electrification by the grid is not feasible. SHS usually operate at a rated voltage of 12 V direct current (DC) and provide power for low power DC appliances such as lights, radios and small TVs for about three to five hours a day. Furthermore, power conditioners/ inverters can be used to change 12/ 24 V power to 240VAC power for larger appliances. SHS are best used with efficient appliances to limit the size of the photovoltaic array.

A SHS typically includes one or more PV modules consisting of solar cells, a charge controller which distributes power and protects the batteries and appliances from damage and at least one battery to store energy for use when the sun is not shining.

What the solution provides?

A solar home system provides electric energy to fulfil the power requirements of a home. It is capable of providing AC power as traditionally all homes use AC power to operate lighting systems, gadgets, appliances and equipment such as computers, refrigerators, mixers, fans, air conditioners, TVs and music systems.



Why is it successful, from a user-perspective

They contribute to the improvement of the standard of living by:

- reducing indoor air pollution and therefore improving health as they replace kerosene lamps,
- providing lighting for home study,
- giving the possibility of working at night and
- facilitating the access to information and communication (radio, TV, mobile phone charging).

Stand-alone photovoltaic systems can also be used to provide electricity for health stations to operate lamps during night and a refrigerator for vaccines and medicines to better serve the community.

Energy savings or energy production

Solar home systems are available 100 W to 10 kW systems.

Climate effects

SHS avoids greenhouse gas emissions by reducing the use of conventional energy resources like kerosene, gas or dry cell batteries or replacing diesel generators for electricity generation.

Costs and time to construct

The benchmark cost of a typical 1 kW off-grid system generating 4-5 kWh/day of electric power can vary between Rs 1 lakh and 1.25 lakh INR (1000 - 1400 EUR).

An off-grid home solar system is an excellent cost-saving feature when planned properly and is capable of paying back the initial investment within the first 5 years of operation through savings in electricity bill.

Price List of Off-Grid Solar System in India 2022

Off-Grid Solar Model (kW)	Selling Price	Price Per Watt
1kW Solar System Price	Rs. 71,442	Rs. 71.442
2kW Solar System Price	Rs. 1,70,774	Rs. 85.38
3kW Solar System Price	Rs. 2,11,313	Rs. 70.44
5kW Solar System Price	Rs. 3,59,011	Rs. 71.81
6kW Solar System Price	Rs. 4,45,256	Rs. 74.20
7.5kW Solar System Price	Rs. 5,15,574	Rs. 68.74
10kW Solar System Price	Rs. 6,23,101	Rs. 62.32

(71,441 INR is equal to around 850 US$)

Lifetime

Solar panel systems are extremely durable and require little to no maintenance over their productive lifetime, which can span 25 years or more. Solar systems are also extremely easy to maintain. The main maintenance that these panels require is an occasional dusting to remove dirt, leaves, or any other fragments. One can always call a professional, to clean these panels once in a while. Batteries have typical lifetimes of 5 years and charge controllers can live 20 years, if they are not overheated.

What policies and strategies helped the success?

Clean Energy Cess in India, 2010
The Clean Energy Cess was introduced to levy the amount of INR 50 (0.60 USD) to every tonne of coal used in the country. The Cess created the National Clean Energy Fund (NCEF) that aims to fund clean energy projects. It provides up to 40 per cent of the total costs of renewable energy projects through the Indian Renewable Energy Development Agency (IREDA). The Cess has now grown to INR 400 (5 USD) per tonne of coal used.

Joint Liability Group (JLG) for off-grid installations

The purpose of Joint Liability Group (JLG) is to augment flow of credit to tenant farmers cultivating land either as oral lessees or sharecroppers and small farmers who do not have proper title of their land holding through formation and financing of JLGs and to extend collateral free loans to target clients through JLG mechanism. By synthesising business and social potential, a small group of 4–10 local entrepreneurs as JLG can help in making loans available for micro-grid installations.

Central Financial Assistance (CFA) from Ministry of New and Renewable Energy (MNRE) for grid connected rooftop solar projects in the residential sector in India (as percentage of benchmark cost or cost discovered through competitive process whichever is lower).

Type of residential sector	CFA
Residential sector (maximum up to 3 kW capacity)	40 % of benchmark cost**
Residential sector (above 3 kW capacity and up to 10 kW capacity)*	40 % up to 3 KW Plus 20% for RTS system above 3 kW and up to 10 kW
Group Housing Societies/Residential Welfare Associations (GHS/RWA) etc. for common facilities up to 500 kWp (@ 10 kWp per house), with the upper limit being inclusive of individual rooftop plants already installed by individual residents in that GHS/RWA at the time of installation of Roof Top Solar System (RTS) for common activity.	20 %

** The residential sector users may install RTS plant of even higher capacity as provisioned by respective State electricity regulations; however, the CFA will be limited up to 10 kWp capacity of RTS plant.*

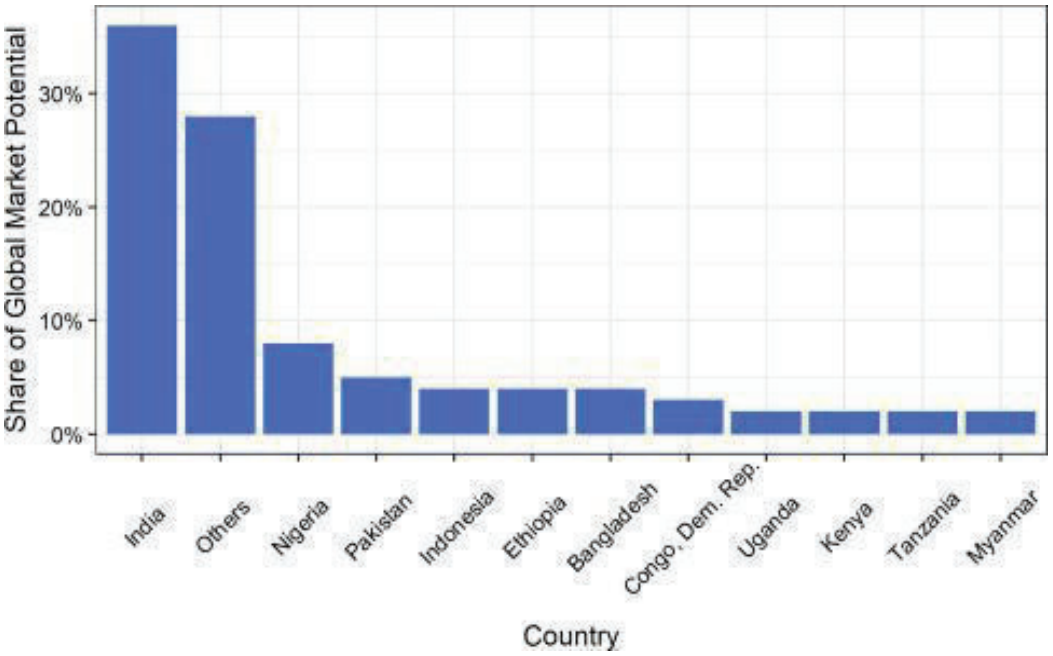
*** Benchmark cost may be different in General Category States/UTs and Special Category States/UTs i.e., North Eastern States including Sikkim, Uttarakhand, Himachal Pradesh, Jammu & Kashmir, Lakshadweep, and Andaman & Nicobar Islands. CFA shall be on benchmark cost of MNRE for the state/ UT or lowest of the costs discovered in the tenders for that state/ UT, whichever is lower*

How widespread is it, where it is popular

Currently, SHS business models have reached somewhere on the order of 2–4 million households (or 10–20 million citizens worldwide) with more installations in Bangladesh than in any other country.

When pico-solar products are added, over 300 million citizens worldwide have benefited from solar-powered lighting and electrification solutions. And yet, with an estimated global total of 1.1 billion without access, there is still much work to be done.

The IEA estimates in its new policy scenario



that under the expansion at current pace still more than 600 million people (or roughly 130 million households) will lack electricity access in 2030. This is despite average investments of 24 billion USD per year into energy access or roughly 1.5% of the global annual energy investment (IEA and World Bank, 2017).

Problems and challenges

More expensive due to additional battery cost. The cost of solar PV is usually a cost effective way to supply smaller quantities of electricity needed. Although the cost of solar PV electricity has been significantly decreasing, further decreasing is still necessary in order for this technology to be affordable to everyone.

Solar PV has challenges regarding the uncertainty of how much of the sun's rays it would receive, as weather can change from time to time. This can prove difficult in determining how much energy to store for future use. Sunlight is clearly unavailable during night hours while there is still demand for electricity. In addition, peak radiation availability may not match with the demand for peak electricity. A mechanism for effective energy storage is needed for this reason.

Location can be an issue. The availability of solar radiation can vary depending on location. Some places such as Southwest, have significantly more solar radiation than other locations. This would mean that solar energy generation of a specific system is dependent on the locations where the systems are installed.

Low quality products have been a big problem in several countries, where vendors sell PV panels and equipment with very short lifetime (below one year). This has given SHS a bad reputation in some countries, including some African countries. Quality control and standards as well as enforcement is needed to cope with this.

Examples, description

Case Study from Fosera - How Teddy's Tailoring Business Was Re-ignited by Solar Lighting, provided by Fosera's partner in Zambia VITALITE.

After more than two decades spent building up a loyal customer base, Teddy Hangandu, a tailor in Lusaka's Luangwa Compound, found himself falling into a slump. If you are living in a house without power, work comes to a standstill once the sun goes down. But Teddy's clientele wants their clothing when they want it, sunup or sundown.
With this in mind, Teddy tried using paraffin lamps at nighttime, but this ended up costing him K50 (about 2.80$) a week on fuel.

These lamps also pose serious hazards:

- The paraffin lamps give off poisonous fumes that badly affect the respiratory system.
- Paraffin is highly flammable, and if knocked over, the lamp can cause serious house fires.
- Impure paraffin has been known to explode without warning.

Aware of these dangers and unhappy about spending money on fuel instead of more valuable activities, Teddy vented his frustrations to a friend. Luckily, his friend, a VITALITE customer, introduced him to the **Lighting Plus Solar Kit** – a product that is particularly adapted to the needs of people with limited or no access to grid electricity in Zambia.

The Lighting Plus Kit, built on a Pay-As-You-Go basis, comes with three lamps that last six to eight hours when fully charged and three years warranty. Because of these extended hours, Teddy went from serving 10 to 15 customers a week to a booming business with 20 to 30 customers a week. He no longer turns away last minute clients and has increased his turnover.

Outside the long-term positive impact on the environment, the **FOSERA** solar system has helped Teddy save money. The increase in sales means he can better support and provide for his two orphaned grandchildren.

His advice for small business owners still reliant on candles and paraffin lamps is to make that switch to solar. He is no longer pressured to turn away clients or only work in daylight hours. He no longer worries that a clumsy grandchild might knock over an oil lamp and burn the house down. More importantly, the solar PV system will continue to save him money in the future.

Sharing SHS Electricity, Bangladesh

Grameen Shakti (INFORSE member in Bangladesh) partnering with ME SOLshare, was the winner of "Powering The Future We Want" initiative of United Nations Department of Economic and Social Affairs (UN DESA) in 2017, awarded to implement the project titled "Smart Peer-to-Peer Solar Grids for Rural Electrification & Empowerment". The project was developing a sustainable business model for peer-to-peer energy trading solar system by establishing 100 SMART grids in villages (15000 beneficiaries). Under this project, bi-directional energy meters are installed both in houses with SHS and without SHS, interconnected to create a decentralized, low voltage grid. These meters enabled the households to sell or purchase electricity through peer-to-peer solar energy trading facilities, backed by mobile wallets. The households which generate excess electricity can sell in the grid and make money. Also, the houses which require electricity can purchase it from the grid without expending on the upfront cost of an entire solar system. The entire operation is monitored and managed by a back office connected through a Wi-Fi tower.

Links:

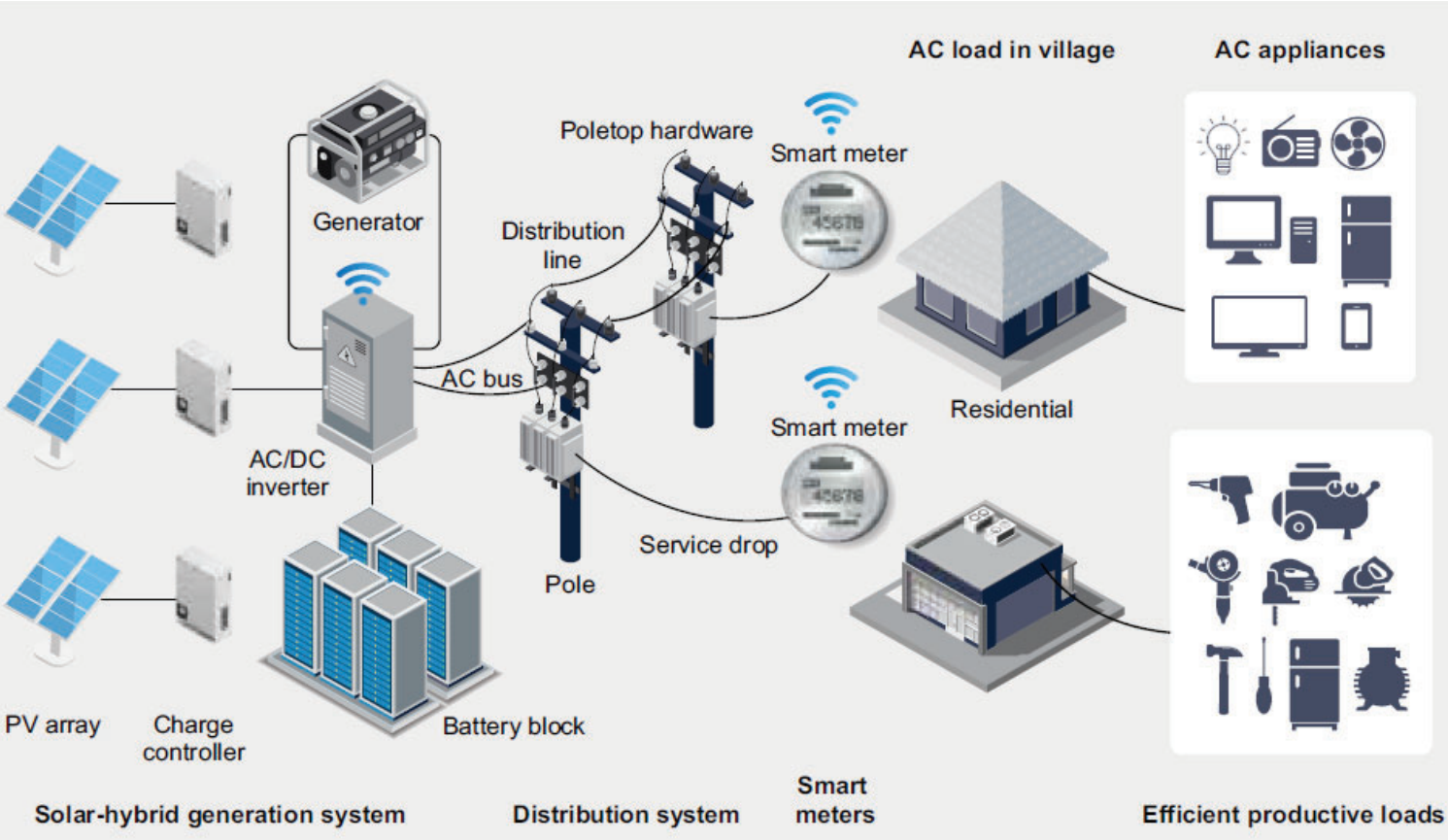
https://www.gshakti.org/pdfs/downloads/GS_Consultancy%20_%20Knowledge.pdf
https://poweringthefuture.un.org/recipients/2017/grameenshaktiandmesolshare.html

1.8. Mini-grids by REDES - INFORSE Latin America

Description of the solution

A typical third-generation mini grid consists of a hybrid generation system that includes solar panels, windmills or other renewable electricity sources, batteries, charge controllers, inverters, and may have diesel backup generators. It could be connected to a bigger grid at the time of installation or in the future. These mini grids typically use smart, remotely controlled electricity meters that allow customers to prepay for their electricity, for example in a pay-as-you-go (PAYG) model. They use remote monitoring systems to manage the status of the system in real time from a distance. They have also integrated partnership programs throughout the lifecycle of the mini grid that stimulate the local economic development of their clients and do this in collaboration with suppliers of energy-efficient appliances as well as microfinance providers. Research shows that the uptimes of third-generation mini grids often exceed 97 percent—less than 2 weeks of scheduled maintenance per year. This performance is significantly better than previous generations of mini grids and most utilities across Sub-Saharan Africa.

The combination of falling costs, new technologies, and favorable enabling environments has made third-generation mini grids an option to connect 490 million people, complementing grid extension and solar home systems to reach universal electrification by 2030.At the same time community energy systems within bigger already established grids are using similar Technologies taking advantage of distributed energy schemes and participatory policies holding the potential of serving an even greater population in urban and peri urban media.



What the solution provides.

Mini grids can be a low-cost and timely solution to supply electricity to people in areas that the main grid is unlikely to reach or deliver reliable electricity services in the medium term (five to ten years). In such regions, mini grids have an edge over main-grid expansion/ reinforcement in several ways.

Mini grids can be deployed more rapidly than the main grid. Their planning and implementation are more conducive to spontaneous entrepreneurial development, while grid expansion involves several institutions (ministries, utilities, rural electrification agencies) in a longer and more complex series of steps.

Mini grids are now more than ever price-competitive against traditional sources of off-grid energy (diesel self-generation, kerosene, and dry cell batteries) thanks to the significant improvements in the cost and performance of renewable and storage technologies, coupled with innovative business models. The latest generation of low-cost, rapidly deployable "solar hybrid" mini grids source their energy from solar photovoltaic (PV) systems coupled with battery storage and diesel backup. They make use of smart in-home meters and offer convenient payment options, such as mobile money.

Why is it successful, from a user-perspective?

High efficiency for lighting, fridges, TV, computers, and other information and telecommunication (ITC) equipment can be provided by relatively small appliances but still bigger than for solar home systems (SHS)*. Efficient productive loads can be added for AC or DC appliances (see graph) due to the increase in available power with considerable positive impact on job generation at a much lower cost.

Mini grids can access private financing and operate without subsidies when the regulatory framework allows them to charge full cost-recovery tariffs. Even at cost-recovery levels, users can save money in comparison with traditional sources of energy. For example, mini grids could save Nigeria's off-grid and underserved consumers up to $2.4 billion annually on diesel self-generation (REA 2017: 7).

Policymakers may view investing in mini grids as a waste of resources in the longer term if they are meant to be replaced by a cheaper, more cost-efficient main grid. But the arrival/reinforcement of the main grid does not necessarily mean that the investment in mini grids would be wasted. Indeed, mini grids' generation and distribution assets can be reused in an integrated system, either separately or together. Solar hybrid and small hydro mini grid systems can improve the stability and quality of the main grid by providing backup and frequency stability; and they can do so without significantly lowering efficiency, since their levelized costs are close to those of larger solar PV and hydro plants that would be built as independent power producers. Reusing mini grids' generation and distribution assets can enable developing countries to shape their power system into a centralized grid that integrates fractal systems.

Climate effects

The climate effects are dependent on the emission profile of the local power production and the extent of the substitution of diesel for the gensets and combustion of other fuels, e.g. GPL, kerosene etc.

What policies and strategies helped the success?

Information campaigns can help final users understand how much money they can save. Defining clear technical standards and commercial options for integration can address key concerns of mini grid developers and entice them to invest.

What happens when the main grid arrives is a major concern for mini grid developers. Investors face two risks: The first is that their assets will be stranded. This can occur when the main grid builds over the mini grid, pulling customers to the cheaper or better service the main grid offers. The second risk is expropriation of assets, which occurs if the utility or the government takes over the mini grid assets without adequate compensation. Governments that are serious about increasing electricity access will want to mitigate these risks to foster mini grid investments and hasten electrification.

Two sets of actions can reassure potential mini grid investors. The first set would define clear technical standards for mini grids, enabling them to connect to the main grid. The second would establish clear rules on commercial options available to mini grids when the main grid arrives. The two sets are intertwined, so they need to be dealt with together.

Setting clear technical standards is key to allowing future connection of mini grids to the main grid at minimal cost. Setting main-grid standards and granting a right to connect, subject to compliance with standards, may be useful where the main grid is likely to expand soon; light standards may be enough where the main grid is likely to expand later.

Technical standards for connection with the main grid should cover the following aspects:

- Equipment (distribution network poles, conductors, and insulators) that ensures the network can handle the quantities of electricity that flow when energized by the main grid

- Generation synchronization, to ensure the safe and reliable operation of the grid when connected to the mini grid generator.
- Interoperability, which refers to the capability of two or more networks, systems, devices, or components to interact, communicate, and exchange information securely and effectively.

Guaranteeing mini grids, the right to connect, subject to compliance with standards, can further reassure investors. Without a legal requirement, the operator of the main grid may be tempted to exert discretionary power and reject the connection of a mini grid.

Setting grid-compatible or main-grid standards can be useful when the grid is expected to be expanded within the lifetime of a mini grid's assets. At that point, a mini grid operator may well not have received the required return. Having the option to connect to the main grid may allow a mini grid operator to earn the expected revenue, preserving the value of the investment.

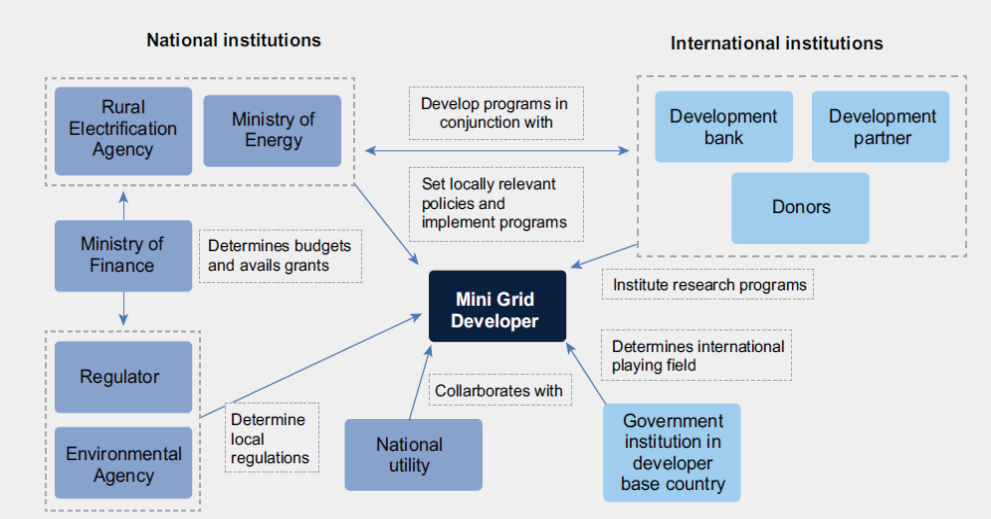
Grid-compatible or main-grid standards enable mini grids to integrate without jeopardizing the safety, stability, and reliability of the power system. Mandatory standards guarantee the stability of the power system and ensure higher equipment quality and safety. But stability of the power system can be preserved even with optional standards, while offering flexibility to mini grid operators. Operators can choose either to follow the standards to guarantee later connection or not to do so and risk being denied the right to connect if they are unable to upgrade their infrastructure when the main grid arrives.

Grid-compatible or main-grid standards entail relatively high costs both for developers and governments for several reasons:

- Equipment that meets these standards is typically more expensive. For example, in Bangladesh one developer reported that compliance with pole standards accounted for 25 percent of the total mini grid's capital expenditure, compared with 5 percent for an unregulated project in Nigeria. Grid-compatible or main-grid standards may also prevent innovation that could decrease costs.
- Governments may need to provide subsidies to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff. Subsidies can help users in the transition period. e.g., by providing Lifeline tariffs to avoid harming the poor.
- Designing and enforcing grid-compatible standards requires significant human resources from governments. For example, in Cambodia the regulator advises developers on how to build mini grid systems so that they can integrate with the main grid later (Tenenbaum 2018: 30).

A lighter approach to setting standards may be appropriate for areas where grid expansion is expected to occur *after* developers and investors have recouped their investments. A lighter approach includes options that range from safety standards only (and no technical standards), or technical standards specific to mini grids.

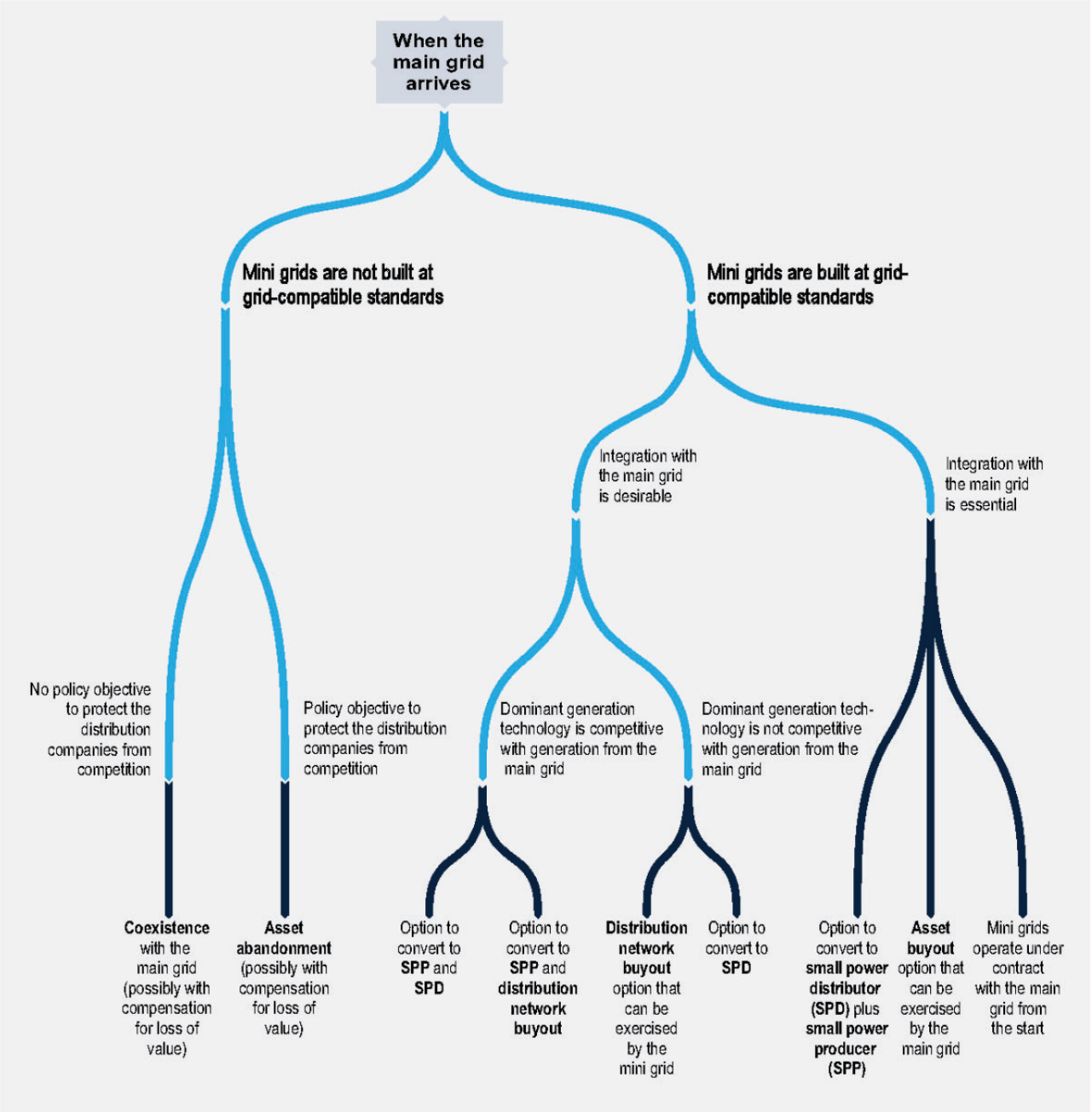
FIGURE ES.7 **Sample institutional framework affecting mini grid developers**



Setting lighter standards can save resources for both developers and governments:

- This option gives developers more flexibility to design mini grids with their target market and local conditions in mind—and it encourages innovation. For example, developers might design their mini grids to operate on direct current, which is cheaper than operating on alternating current.
- Governments may save on subsidies. No subsidy is generally required when there are no technical standards; safety standards require minimal subsidies. A lighter approach may foster the development of mini grids in communities where subsidies are limited, and where the ability to pay for the desired service level rules out the use of technology compatible with the main grid.

Decision tree for determining what happens to mini grids when the main grid arrives



Cost Analysis of mini-grids

TABLE ES.5 Current and projected tariffs, costs, and profits of mini grid operators, 2019 and 2030

Item	2019	2030
Average tariff/kWh	0.45	0.26
Cost of service/kWh	0.43	0.21
Profit on mini grids deployed this year (millions of US$)	28	608
Cumulative profit on all mini grids deployed (millions of US$)	153	3,343

Source: ESMAP analysis.
Note: kWh = kilowatt-hour.

This ESMAP study should be revised since costs of PV, batteries and inverters have reduced more than expected. The World Bank considers 15 000 U$ per system a reasonable threshold for mini-grids in Latin America, but the ESMAP study (see box above; Mini-grid evolution in a snapshot) arrives at much lower figures: 4000 U$ 2019, 3000 U$ 2030. Community energy based in renewables is providing final users within the grids with even lower upfront costs.

TABLE ES.4 Cost benchmarks and price projections for mini grid components[9]

Component	Unit	Percent of total capital cost	Median cost in ESMAP survey	Minimum cost in ESMAP survey	Mainstream industry benchmark in 2010	Mainstream industry benchmark in 2018 (percent change from 2010)	Cost estimate by 2020	Cost estimate by 2030 (percent change from 2018
PV module	$/kWp	11%	690	497	1,589	230 (–85%)	220	140 (–39%)
PV inverter	$/kWp	5%	264	176	320	115 (–64%)	80	58 (–50%)
Battery	$/kWh	15%	214	126	—	147 (n.a.)	127	118 (–20%)
Battery (Li-ion)	$/kWh	15%	598	461	1,160	176 (–85%)	139	62 (–64%)
Battery inverter	$/kVA	9%	649	311	565	203 (–64%)	142	102 (–50%)
Smart meters	$/client	4%	83	50	106	40 (–62%)	35	30 (–25%)

Sources: ESMAP analysis; Bloomberg New Energy Finance databases; Fu and others 2017. Full references are provided in Chapter 3 of the book.

Note: Median, minimum, and 2010 benchmark data are expressed in inflation-adjusted dollars. Future prices are as reported by the source. — = not available; kVA = kilovolt-ampere; kWp = kilowatts-peak; n.a. = not applicable; PV = photovoltaic.

How widespread is it, where is it popular?

According to the latest *Tracking SDG7: The Energy Progress Report*, progress toward achieving universal access to electricity has been promising (World Bank and others 2019)**.** In 2017, the global electrification rate reached 89 percent, with the number of people without access dropping to around 840 million—compared with around 1 billion people in 2016 and 1.2 billion in 2010. Despite this progress, under current policies, an estimated 650 million people—or 8 percent of the global population—will still lack access to electricity in 2030; 9 out of 10 of them will be in Sub-Saharan Africa.

Reaching the remaining unserved people, including those connected to frail and overburdened urban grids, as well as displaced people and those in hard-to-reach locations, will require strong policies, increased private financing, and comprehensive electrification planning. *Tracking SDG7: The Energy Progress Report* shows that countries with a comprehensive approach to planning—which consists of main grid extensions, mini grids, and solar home systems—have achieved the fastest results in electricity access (World Bank and others 2019). Countries with the fastest gains in electrification between 2010 and 2018 include Bangladesh, Cambodia, India, Kenya, Myanmar, Nepal, Rwanda, and Tanzania.

Compared with the main grid and solar home systems, mini grids are a more viable solution for off-grid areas with high population density and demand. Extending the main grid to serve remote communities consuming a limited number of kilowatt-hours (kWh) per month is prohibitively costly in most cases. Meanwhile, solar home systems are ideal for areas with low population density and low demand. Mini grids are generally the most economically viable option for servicing areas that are too expensive for the main grid to reach in a timely manner but have high enough demand and population density to support commercial viability.

At the same time, mini grids have grown from a niche solution to being deployed widely. The World Bank's Energy Sector Management Assistance Program (ESMAP) has developed a database of more than 26,000 installed and planned mini grid projects around the world. Globally, at least 19,000 mini grids are already installed in 134 countries and territories, representing a total investment of $28 billion, providing electricity to around 47 million people. Most of these mini grids are diesel-fueled, followed by hydro-powered and solar-hybrid systems. Between 2014 and 2018, twice as many solar-hybrid mini grids were built compared with the period between 2009 and 2013. In Africa and South Asia only, however, the investment figure drops to $5 billion for 11,000 mini grids covering 31 million people. Another 7,500+ mini grids are planned to go online over the next couple of years, mostly in Africa, connecting more than 27 million people for an investment cost of $12 billion. These planned systems show a significant shift from diesel to solar-hybrid systems using the latest technologies.

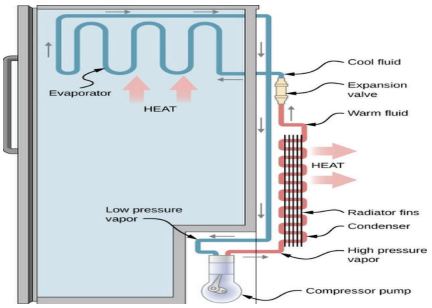
Asia has the most mini grids installed, but Africa has the largest share of planned mini grids. The ESMAP database of mini grid projects around the world indicates that Asia—including South Asia, East Asia, and the Pacific—has a combined total of more than 16,000 installed mini grids, representing 85 percent of the global total. The majority (61 percent) of the installed mini grids in Asia are in just three countries: Afghanistan (4,980), Myanmar (3,988), and India (2,800). Estimates show, however, that mini grid deployment will grow predominantly in Africa. Currently, more than 4,000 mini grids are being planned for development in Africa, representing more than half (54 percent) of the total 7,507 planned mini grids globally. More than half of the planned mini grids in Africa will be developed in Senegal (1,217) and Nigeria (879).

Sources:
Mini Grids For Half A Billion People: Market Outlook And Handbook For Decision Makers, ESMAP, The World Bank, September 2022.
https://www.esmap.org/sites/default/files/esmap-files/Mini%20Grids%20for%20Half%20a%20Billion%20People%20-%20OKR%20Download%20Version_compressed_MKA.pdf
Tracking SDG7, The Energy Progress Report 2022, ESMAP, The World Bank.
https://trackingsdg7.esmap.org/data/files/download-documents/sdg7-report2022-full_report.pdf
Mini Grids for Half a Billion People: Market Outlook and Handbook for Decision Makers, ESMAP, The World Bank, 2019.
https://openknowledge.worldbank.org/bitstreams/f3815820-92b6-5807-8e9f-d0bd98732b5a/download

1.9. Efficient Light and Electricity Use by INFORSE Secretariat

Gunnar Boye Olesen, INFORSE - Secretariat: Training material for advocacy for local sustainable energy solutions

Description of the solution: Efficiency Use of Electricity
Electric appliances have become much more efficient over the latest two-three decades. The development of efficient lamps is probably the most remarkable development, but energy efficiency is not limited to that. The most important electricity saving solutions are

 Wikimedia, photo by Geoffrey.landis	Lamps, where there is an increase in efficiency from incandescent lamps to LED of a factor 10. The increase in efficiency of good LEDs over halogen lamps is around 7 times and over fluorescent lamps around two times. In many countries, the inefficient incandescent and halogen lamps are still on the market.
 Wikimiedia, photo by Superbmust	Modern TV's and computers are now over 10 times as efficient as 20 years ago, but some of the less efficient types are still on the markets[14]
 Wikimedia, Illustration by DigitalNet99	Good refrigerators and freezers are around 5 times as efficient as 20 years ago. Today, the best models on the market are three times more efficient than the less efficient ones.[15]

[14] According to Topten.eu a 32" (81 cm TV) can consume only 24 kWh/year, if used 1000 hours/year. On the EU market are TV's with twice the consumption, while consumption over 240 kWh/year was normal before 2010 according to https://www.aceee.org/files/proceedings/2012/data/papers/0193-000292.pdf

[15] A high-efficient fridge uses 65-75 kWh/year (250 ltr) and a high-efficient fridge-freezer uses 110-120 kWh/year (250 ltr. fridge + 100 ltr freezer) according to topten.eu. On the EU market are fridges with three times this consumption. Before 2005, consumption above 600 kWh/year normal for a fridge according to https://www.osti.gov/servlets/purl/971432

 Wkimedia, photo: VEM motors GmbH	Pumps and electric motors can be used much more efficiently, when they are equipped with variable speed drives and controls that limit speed, adapting the speed to the needs.
 Photo: TaTEDO, Tanzania	High-efficient e-cookers are twice as efficient as cooking with normal electric stoves, and more if they are used in pressure cooking mode (see description of e-cookers).
 Photo: Wikimedia, en.wikipedia.org/wiki/User:Firstfreddy	Standby consumption. Older chargers and some equipment use a lot of power, when not in use, but the demand has been much reduced for new chargers. for an old charger, the consumption can be as much as 40 kWh/year, while for new chargers it is just 1 kWh/year[16].

What the solution provides?

In general, the efficient lamps and equipment make it possible to provide the electricity services for households and businesses with much less power than with the traditional, inefficient types. With the high efficiency, electricity for light, TV, computers, and other information and telecommunication (ITC) equipment can be provided by relatively small solar home systems (SHS), at least in tropical and subtropical areas (see description of SHS). Focusing of lamps: good LED lamps can both provide light with very little power demand and with much longer

[16] Modern small power supplies, such as mobile phone chargers use just 0.1 Watt in standby, which is equivalent to just below 1 kWh for a year. Chargers from before 2010 can use as much as 5 Watt, equal to 40 kWh/year, if left in the plug.

lifetime than incandescent lamps. LEDs are made for all voltages, both for low volt power systems for small solar home systems and for mains power.

Why is it successful, from a user-perspective?

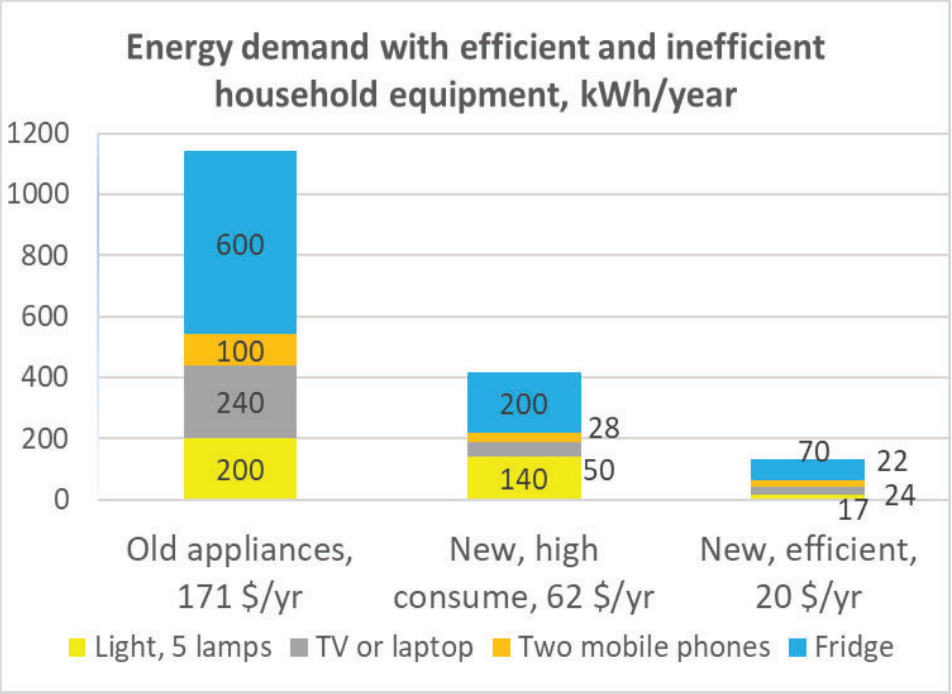
It is possible to light a house with minimal power, for instance 5 lamps for a household can together use just 17 Watt and per year 17 kWh while giving the same light as 5 incandescent lamps that use 200 Watt together and per year consume 200 kWh[17]. This saving will for instance save a household consumer in India 14 US$/year and in Uganda 35 US$/year with 2021 electricity prices[18]

The LED lamps have normal lifetimes of 15-50 years, if used 3 hours/day, opposite to incandescent lamps that have normal lifetimes of just one year. Thus, the user can benefit from them for a long time. It is also possible to have other power consumption with small energy consumption. In some countries with lifeline tariffs, where the first consumed kWh is cheaper (as South Africa, Tanzania, Uganda), it is possible to limit consumption to the cheaper power.

Energy savings or energy production

Savings with efficient lamps: The energy savings for an efficient LED that replaces a 40 Watt incandescent, used 3 hours per day is:

- Compared to a incandescent lamp it saves 92%, equal to 37 kWh/year
- Compared to a halogen lamp it saves 90% equal to 32 kWh/year
- Compared to a compact fluorescent lamp (CFL) it saves 60% equal to 5 kWh/year
- Compared to less efficient LEDs it saves 50% equal to 4 kWh/year[19]



[17] This example is based on replacing 40 watt incandescent lamps with a light of 470 lumen each with Philips MASTER Value LED bulb E27 A60 3.4W 927 matt

[18] With household electricity prices in June 2021 of 7.6 US-cent/kWh in India and 19.2 US cent/kWh i Uganda according to https://www.globalpetrolprices.com/Uganda/electricity_prices/

[19] The efficiency in light in lumen per watt of electric power are in this example: incandescent: 11.8 lm/W, halogen lamp 13.2 lm/w, CFL 53 lm/W, low efficiency LED 67 lm/W, Philips MASTER value LED 138 lm/W. All lamps in this example are available on the Danish market

Savings for a household: Hereby an example for a family with a basic set of modern electric appliances, showing how the power consumption can differ with different efficiencies of appliances.

Electricity in a household, data for above graph	Old appliances*	New, high consuming	New, efficient	
Light, 5 lamps	200	140	17	kWh/year
Fridge, 160 ltr.no freezer	600	200	70	kWh/year
TV or laptop	240	50	24	kWh/year
Two mobile phones	100	28	22	kWh/year
Total	1140	418	133	kWh/year
Costs/year	171	63	20	US$/yr @ 0.15 $/kWh

*** Including old chargers for mobile phones and laptops**

Climate effects

The climate effects are dependent on the sources of power production. In India with mainly coal power, each efficiency LED that replaces a 40 W incandescent lamp saves 34 kg CO_2/year, while in countries with a large proportion of renewable energy in power production, as Brazil and Uganda, the electricity savings reduce CO_2 emissions by 5 kg CO_2/year or less[20]. In the above example for a household, the CO_2 emissions can be reduced 120 kg/year with average electricity production in India.

Costs and time to construct

The LED lamp prices depend on the light they produce. For a LED that replaces a 40 W incandescent, the price can vary between 1 and 5 US$, depending on the shop, but also how efficient it is and the light it gives. Other appliances vary in price, but the extra price for the efficient equipment may not be much.

Lifetime

With normal use, 3 hours a day, the lifetime is normally above 15 years. Warranty for many lLED lamps is 5 years. In general, efficient appliances have the same lifetime as inefficient ones.

What policies and strategies helped the success?

Ban of incandescent lamps in several countries, including all the EU countries in Europe, has been the most important policy to drive the development.

Energy labelling of lamps has been an important policy to speed up the uptake of the most efficient types of lamps. Information campaigns can help people understand how they can save energy and how much they can save. Subsidies can help people buy new, efficient equipment,

[20] CO_2 emissions per kWh power consumed in India is around 0.93 kg according to https://www3.epa.gov/ttnchie1/conference/ei20/session5/mmittal.pdf, while in Brazil it is around 0,15 kg CO_2 according to https://link.springer.com/article/10.1007/s11356-021-14097-w. In Uganda it is lower, but it varies a lot with river flows to hydro power that determines the need for fossil fuel based power.

but it only saves electricity, if the old equipment is discarded. Lifeline tariffs can make the user's electricity savings pay better without harming the poor. Quality control is important to avoid counterfeit products and wrong labelling of products to make them appear energy efficient. Quality control is also important to ensure the long lifetime of products.

How widespread is it, where it is popular?

LED lamps are widespread all over the world, and in many countries, it is the most popular type of lamp. For energy efficient appliances, they are widely available in Europe, and in many countries around the world.

Problems and challenges

LED's can be ruined if there is an unstable power supply with periods of longer spikes with too high voltage.
The light spectrum of a LED lamp is not homogenous as it is for sunlight and for light from incandescent lamps. The best LED has a light spectrum better than 90% similar to a homogenous spectrum. This is specified with a RA number above 90. For cheaper LED, the light spectrum is less homogenous and the RA is 80 or even lower.
While state of the art LED has an efficiency of above 130 lm/W, older models have efficiencies well below 100 lm/W.

For energy efficient appliances, they are working similar to inefficient ones, no specific problems..

Example, description
A good examples of a modern LED lamp is the Philips LED
Lamp (Dimmable) bulb E27 5.9 Watt, Colour 822-927 matt. It has a high efficiency of 135 lm/W, a good colour rendering with CR(RA)-number of 90, cost around 3.5 € + VAT (a cheaper version with CR number of 80 and only 110 lm/W cost around 2.2 € + VAT) .

Example:
www.lighting.philips.co.uk/consumer/p/led-lamp--dimmable-/8719514323858/specifications

1.10. Electric Two-Wheelers (Bicycles, Scooters) by TaTEDO and UCSD - INFORSE East Africa

Description of the solution

Electric bicycles (e-bike) are very similar to regular bicycles, but with an electric motor. The only significant difference in appearance is the inclusion of the electrical drive system. This includes a motor, a battery, and sometimes a display screen. It makes it much easier to bicycle, in particular uphill. E-bikes use rechargeable batteries that can travel up to 25 to 45 km/h and can drive 40-80 km between charging, depending on battery size and how much you let the motor work for you.

E-scooter and e-motorcycles are like normal scooters and motorcycles, just driven with an electric motor and a battery instead of a petrol tank . They have the same speed as petrol versions, faster acceleration and can drive 50-200 km between charging depending on battery size.

E-Scooters / E-Motorcycles

Description of the solution

E-scooters/motorcycles use electricity to run. They have rechargeable batteries to store the electric energy and propel the two-wheeler. A two-wheeler that uses only electricity to run is called the E-2-wheeler, E-scooter, or E-Motorcycle. Instead of an internal combustion engine (ICE), an e-scooter gets its power from an electric motor.

There are more riding modes such as Eco, Power, and Sport for different types of performances. The battery range differs depending on the riding mode. For example, your e-scooter will go more miles in the Eco mode than the Sport mode. However, Eco mode will restrict the speed, while Sport mode will deliver maximum speed but lower mileage. The performance of an e-scooter mainly depends upon the power (wattage) rating of the electric motor. According to the industry experts, for better performance & carrying two passengers needs at least a 200 - 250 W electric motor, but some have over 10 kW motors.

Picture: Ampere Magnus Ex, E-scooter with 2.1 kW motor, see information below

What the solution provides?

In several East African countries two-wheelers dominate the fleet. In Uganda two wheelers make up for 46 per cent of the vehicle fleet. In Kigali, Rwanda, motorcycles are more than half of all vehicles on the road. In Kenya, motorcycles are set to more than triple to five million this decade compared with 2018. Motorcycles and utility vehicles of all types are also the fastest-growing segment of the African automotive market, transition to zero emissions technology can provide considerable benefits.

Why is it successful, from a user-perspective

The first factor to become apparent when jumping on an e-motorcycle/e-scooter is the noise and vibration, or more, the lack of it, when compared with a petrol-powered equivalent which makes for a smoother and more comfortable ride. Electric motorcycles are also exceptionally simple to operate. Just power it on, twist the throttle and you're moving. With an e-motorcycle, you can reach top speeds without any shifting or other complications that come with manual transmissions on petrol motorcycles. This makes them easier to ride, especially for beginners.

Energy savings or energy production

Removing the need for fuel dramatically reduces the cost of running. Charging e-motorcycle batteries usually costs considerably less than the use of gasoline. Further to this, there are fewer additional running costs such as servicing requirements for oil changes, ignition & clutch parts that petrol-powered two wheelers need that an electric powered one doesn't. The main additional costs on top of charging are for e-scooters battery replacement. Battery lifetime typically range from 3 to 10 years with regular use of the scooter.

Expanding market

UNEP, 2021 estimated 270 million motorcycles were on the road worldwide, a number expected to swell to 400 million by 2050. Running on fossil fuels, emissions from these vehicles drive climate change and are hazardous to people. UNEP's ground-breaking Emob calculator reveals that a global shift to electric motorcycles could prevent 11 billion tons of carbon dioxide emissions, more than double the annual energy-related emissions in the United States of America. It would also save global motorcycle owners a combined US$ 350 billion by 2050, largely because electric vehicles are cheaper to fuel and maintain.

While electric motorcycles do produce CO_2 emissions in countries where the electricity is predominantly produced by fossil fuel combustion, even then electric motorcycles still produce much less CO_2 emission per mile than gasoline driven ones. They're also more environmentally friendly than electric cars because of the smaller size and lower electricity demand.

Costs

In Kenya, e-scooters and e-motorcycles range between KSh 75,000 to KSh 1,000,000 (USD 500-7,000) depending on power capacity and brand. While you'll likely find a petrol-driven motorcycle cheaper than most electric ones, electric motorcycles are more cost-effective in the long run. Over the lifetime of the vehicle, these savings can be significant. While replacing the battery is expensive, electric motorcycles have effectively less maintenance than petrol driven

ones. No engine oil or filters to change, and it doesn't have parts exposed to high temperatures that may get damaged easily.

Lifetime

The average lifespan of an electric motorbike is around 8-10 years. Generally, the average lifespan of an electric motorcycle battery ranges from **3 to 10 years**, but some batteries can last even longer with proper care. Overcharging or fully de-charging the battery reduces battery lifetime considerably. While charging the motorbike, make sure to not use a cheap quality charger to prevent your battery from any short circuit. Battery chargers also play a vital role in the lifespan of electric motorbike batteries because any faultiness in the charger can destroy the battery permanently.

If you charge your motorbike battery overnight, you should go with a charger, which has an auto cut-off feature. You can use an auto voltage regulator charger, which manages the voltage irregularity giving your battery a constant and stable charging.

How widespread is it, where it is popular

The electric scooters and motorcycles market was valued at USD 2 billion globally in 2020, and it is anticipated to reach USD 3.5 billion by 2026," according to a study by Mordor Intelligence. The electric motorcycle market is seeing considerable growth due to increased interest and need for sustainable, environmentally friendly transportation coupled with favourable government initiatives. As fuel prices continue to rise, riders are also benefiting from the lower costs of using electricity than petrol fuel.

E-motorcycles/e-scooters are popular in many countries in Asia including China, India and in East African countries.

Problems and challenges

Despite the environmental benefits and cost savings, there are some obstacles which hinder the spread of electric motorcycles, including higher upfront costs than petrol driven scooters, charging times, lack of infrastructure, low awareness and understanding, and limited battery range.

While charging times are improving, it often takes at least six hours to fully charge a battery. With quick chargers and sufficient mains power, charging times can be shorter, but it still takes longer to fully charge a battery compared with filling a fuel tank.

Examples of e-scooters, e-motorcycles

Ninebot Q80c is an electric scooter that can go up to 115 km with a maximum speed of 45 km/h, price (2023) KSh 74528 (USD 513).

Ampere Magnus Ex is an electric scooter that can go up to 121 km/charge with a maximum speed of 50 mph (80 km/h), price (2023) 132,600 KSh (USD 912).

TVS X is an electric motorcycle than can go up to 140 km/charge with a maximum speed of 105 km/h, price (2023) 424,864 KSh (USD 2923).

E-Bicycles

What the solution provides?

The e-bike is one of the most environmentally friendly means of transportation. It makes you mobile in a sustainable way - flexible, emission-free, quiet and climate-friendly. E-bikes use a motor to assist the movement of the pedals, making riding the bicycle less taxing. The motor only assists when you pedal. You can ride electric bikes like a normal bicycle. The ability to ride it like a regular bike often saves riders when their bikes run out of battery power.

Photos by https://www.zigwheels.com

Norwegian researchers found electric bikes place less stress on the heart when compared to riding a regular bike. (see the paper)

Why is it successful, from a user-perspective

E-bikes are more efficient and less expensive than cars for short-to-medium-distance travel. An e-bike is often faster for urban trips, and the cost per mile is negligible compared to running a car. Importantly, cycling is non-polluting, so it is better for the environment.

You can charge your electric bicycle from a normal socket which costs pennies, unlike fuel which costs pounds.

An electric bike allows you to relax as you enjoy the natural surroundings, something you are likely to miss when driving a car because of the speed of the ride or the routes used.

Energy savings or energy production

Charging the battery is affordable. You can go 1000 miles for about USD 6. A single charge costs a few pennies. You will invest about USD 4 a month for charging, which comes to about USD50 per year for an e-bike..

Costs

The most common e-bikes in the market today range from USD 400 to USD 2000. Electric bikes are primarily expensive because they feature costly components, including a motor, controller, and rechargeable battery.

The e-bike market was valued at USD 27.22 billion in 2021, and it is expected to reach USD 54.48 billion by 2027, registering a CAGR of 12.26% during the forecast period (2022-2027).

Lifetime

On average, e-bikes last around 10 years. That number can be higher or lower depending on the type of bike and how you use it. If you are conscientious about caring for your e-bike, it can last well over a decade. However, various parts like motors and chains will need to be periodically replaced even with proper care. Batteries typically last 3-5 years, depending on use.

How widespread is it, where it is popular

E-bikes are popular in North America (United States, Canada, Rest of North America), Europe (Germany, United Kingdom, France, Italy, Rest of Europe), Asia-Pacific (China, Japan, India, South Korea, Rest of Asia-Pacific), Rest of the World (South America, Middle-East and Africa). E-scooters are gradually increasing popularity around the globe, including South Asia and several African countries.

Problems and challenges

While e-bikes are efficient in manoeuvring traffic, they cannot be used for specific situations. Because of the restricted speed limit, e-bikes can only cover a short range, similar to other bi-cycles. For this reason, they are only useful in urban settings and other places, where distances are relatively short. There are special models for rural areas. The fact that you have to charge the battery after every 20-40 miles or so means you need a place where you can easily access electricity.

You can use your electric bike to commute to work if you are living in the same town where you work. If you forget to charge your battery at home, you can charge it in the office or use the pedals.

E-bikes are made to be assisted by the driver, so you will not have a completely relaxing ride.

Bicycles need to be taken care of in order to last a long time. Apart from general upkeep such as greasing the chains, some services can be more expensive, such as replacing motors, batteries and controllers. A good charge controller is important for long battery life.

Example, description

A good example of e-bike is the Superdelite mountain which is specifically made for long off-road trips. 1,125 Wh of fully integrated power is effectively transferred to all terrains, whether you're riding up high mountains or steep trails.

All Two-wheelers

Climate and air pollution

Development of low-carbon transportation is a key element of climate action, since the transportation sector is estimated by the Intergovernmental Panel on Climate Change (IPCC) to generate 23% of global energy-related greenhouse gas emissions. By 2050 it is likely to reach one-third, when the global number of passenger cars is projected to more than double.

Consequently, promotion of public transportation and electric mobility is identified as crucial points in the combat against climate change.

E two-wheelers are invariably more eco-friendly than petrol-powered ones. This is not only a benefit for the climate. The lack of exhaust fumes and odour make for a fresh and pleasant riding experience, particularly when manoeuvring through traffic at low speeds or standing still. Electric motorcycle riders don't emit any exhaust fumes that contribute to air pollution. Removing gasoline, oil and combustion from the equation makes electric motorcycles a much more environmentally friendly choice for riders. By using electric instead of petrol or diesel motorcycles, we not only benefit ourselves, we also benefit the community as EV's reduce our collective carbon footprint as well as noise and air pollution.

What policies and strategies helped the success?

UNEP's Electric Mobility (eMob) Programme promotes the transition of low-income countries to zero emission vehicles. The UNEP e-Mobility programme is the only global programme that supports electric mobility for developing and transitional countries. It supports over 50 countries and cities to introduce electric buses, cars and two- and three-wheelers.

Some countries have pioneered a range of incentives to encourage e-mobility. See an overview below in the chapter on policies for two-wheelers

Scaling up the transition to electric mobility will require investments in battery charging infrastructure. In many countries, including Kenya, the electric power generation capacity is sufficient to support the charging infrastructure for e two-wheelers. However, while demand for motorcycles is high, particularly in rural areas, distribution networks are inadequate. However, this challenge may be tackled by using solar energy, setting up charging stations, and consulting boda-boda operators

1.11. Electric Three-Wheelers/Local Transport by INSEDA - INFORSE South Asia

E-Rickshaw

Description of the solution

Electric rickshaws (also known as electric tuk-tuks or e-rickshaws or toto or e-tricycles have become more popular in some cities since 2008 as an alternative to auto rickshaws and pulled rickshaws. This popularity is due to their lower fuel cost and ease of use compared to human-pulled rickshaws. They are being widely accepted as an alternative to petrol/diesel/CNG auto rickshaws. They are three-wheelers powered by an electric motor ranging from 650 to 1400 Watts. They are mostly manufactured in India and China. Battery-run rickshaws could be a low-emitter complementary transport for the low-income people, who suffer most from a lack of transport facility, if introduced in a systematic manner according to experts.

What the solution provides?

The e-rickshaws do not use petrol or diesel and use chargeable batteries instead, the travel costs are low, efficient and affordable for all sections of the society. These E-Rickshaws are more comfortable to drive when compared with the arduous task of manually pulled rickshaws. The e-rickshaws provide last mile connectivity at an affordable price. These are mostly used by travellers where other options like petrol or CNG auto-rickshaws are not viable for economic reasons.

Why is it successful, from a user-perspective?

The major growth drivers behind this tremendous growth are socio-economic and environmental benefits, along with the supportive government policy landscape:

Socio-economic benefits: The upfront cost of e-rickshaw is quite low compared to its counterpart ICE-based auto-rickshaw. The initial cost of e-rickshaw is Rs 0.6-1.1 lakh (700 - 1300 USD), whereas the cost of ICE-based auto-rickshaw Rs 1.5-3 lakh. Similarly, the running cost for an e-rickshaw is only Rs 0.4 (0,5 US cent) a kilometre as compared to Rs 2.1-2.5 a km for the ICE-based rickshaws. The maintenance issues related to e-rickshaws are less, which saves maintenance cost. E-rickshaws provide better employment opportunities to cycle-rickshaw drivers whose business is swiftly vanishing.

Supportive policy / mission / scheme: In India, continuous support has come through National Electric Mobility Mission, 2013; National Urban Livelihood Mission 2013, Pradhan Mantri Mudra Yojna, 2015; Smart City Mission, 2015; Faster Adaptation of Manufacturing of Electric Vehicles (FAME I and II), state's electric vehicle policy in the form of loans, regulatory framework and direct subsidies.

Energy savings or energy production

Average mileage of three wheelers is around 35 to 40 km per litre running on petrol or CNG which is around 25 to 30 ml of petrol per km costing around 2.1 to 2.5 Rs per km per person. The three wheelers (generally called autos) usually carry only one passenger and are not economical for short distances and therefore are not available for passengers who have to travel one or two kilometres. On the other hand, E rickshaws carry 4 to 6 passengers with the running cost of only Rs 0.4 a kilometre amounting to less than Rs. 0.1 per passenger per person.

Climate effects

E-rickshaws help mitigate air and noise pollution. At least 1,036.6 tonnes of CO_2 emissions can be mitigated a day (378,357 tonne CO_2 annually) if compressed natural gas auto are replaced by e-rickshaws.

Costs and time to construct

The initial cost of e-rickshaw is Rs 0.6-1.1 lakh (620 to 1320 USD). However, new models launched by renowned companies like Mahindra E-Alfa mini 4 seater costs Rs. 1.26 Lakhs (1514 USD) in India.

Lifetime

The life of these electric rickshaws is barely 1-1.5 years whilst batteries may need replacement every 6 months.

What policies and strategies helped the success?

More than anywhere else in India, green license plates – indicating the vehicle is powered by a rechargeable battery, not an internal combustion engine – are prominent in Delhi. To some extent, this has been enabled by the state government's concerted efforts to complement national policies that encourage adoption of EVs. India launched Faster Adoption and Manufacturing of E-Vehicle schemes in April 2015 and April 2019 to subsidise EVs, but their budgets have been under-utilized. So, with a growing ecosystem of manufacturers, the Delhi government's revised EV policy has focused on generating demand and providing subsidies, especially to borrowers looking to buy two- and three-wheelers, with a goal that one in four of all new vehicle registrations in 2024 would be for an EV.

The typical price for an electric three-wheeler from renowned companies starts around Rs 1.26 lakh (1514 USD), with more expensive models offered by automakers like Mahindra and Piaggio priced around Rs 1.7 lakh or higher. For an average driver, even the models at the bottom of the range would require him to pay around four months' earnings towards the cost of the vehicle.

For registered drivers, the Delhi government's financial incentives include a Rs 30,000 (360 USD) purchase incentive and 5% interest subvention on loans for the purchase of an e-rickshaw, and a waiver of road tax and registration fees. These drivers also receive Rs 7,500 (90 USD) for scrapping and deregistering old rickshaws with internal combustion engines to limit the number of old, polluting models on the roads and prevent informal operation of rickshaws.

How widespread is it, where it is popular?

Electric rickshaws are most popular in Asia, especially in China, India, Bangladesh and Nepal. The low-cost Chinese models were the first electric rickshaws to become popular in those countries. China, Japan, India, and European countries (Switzerland, France, Germany) have researched and developed electric tricycles for commercial transport and are attempting to capture the growing market in Asia.

Problems and challenges

Slow moving speed of e-rickshaws is a challenge outside city centres. Lack of parking space and haphazard halting on roads creates traffic jams in already congested areas such as metro stations and bus stops. Components are imported from outside as few countries produce some key components. Then the vehicles are assembled in India. These are usually non-standardised and assembled in local workshops without complying with standards. Unorganised players sell e-rickshaws. The e-rickshaws sold by the unorganised sector are of poor quality and operate on lead-acid batteries that need to be changed after every six to eight months.

The replacement cost per battery is Rs 25,000-Rs 28,000. The lead-acid batteries usually weigh close to 80 kilograms, which reduces vehicle mileage. As the battery cannot be refurbished, an e-rickshaw owner typically returns the battery to the vendor after its lifetime.

Used batteries are too often disposed of carelessly, harming the environment. The Union government discontinued subsidies for lead acid-based e-rickshaws from October 2019 in FAME I.

Example, description

Long before the Government of India announced its intention to have an all-electric fleet by 2030; three three-wheeled retrofitted battery rickshaw was taking the Indian cities by storm. In 2016, in Delhi alone, the number of electric rickshaws on the roads was over 1,00,000. India has always been home to the largest market for three wheelers and similar modes, as they provide a much needed solution for motorized mobility, which is affordable and frequently available.

Initially launched in Delhi during early 2010 with an objective to eventually phase out manual cycle rickshaws, the e-rickshaws presented themselves as an affordable and clean mode of mobility that had the immense potential of bridging the gap of first and last mile connectivity. In Delhi, these battery-fitted three-wheelers were able to provide the much needed first and last mile access to Delhi Metro, which received a mixed response; while it was welcomed by the passengers, the lack of regulation triggered concern for the authorities. The e-rickshaws were also spreading to other Indian cities such as Lucknow, Amritsar, Ahmedabad, Kochi, etc. In case of cities like Gaya and Jamshedpur, the e-rickshaws provided a para-transit solution for connecting remote villages to cities. The spread and acceptance of the electric rickshaws became inevitable. Also in Bangladesh,the electric three-wheelers have become popular for local, rural transport.

While e-rickshaws' growth was sporadic, there wasn't any clear regulatory framework for the registration of these vehicles. In wake of the exponential growth and problems such as congestion, the Government of India amended the Motor Vehicles Act (MVA) in December 2015 and defined e-rickshaws and e-carts. Following the amendment, authorities of Delhi, Gujarat, and Pondicherry came up with procedures to regularize these vehicles.

In spite of being surrounded by an array of controversies such as fatal accidents caused at unauthorized charging stations and road accidents, e-rickshaws have witnessed an unrestricted growth on Indian streets. The lack of regulation coupled with their sporadic expansion has come to symbolize the yawning cracks in the country's rigid regulatory framework that seem to create more problems than they fix. These vehicles are widely noted for carrying more than the prescribed number of passengers i.e., 4 and the components installed in the vehicle aren't verified. Agencies like ICAT and ARAI do control the approval of assembly lines and vehicle design permits; however, due to lack of control on conformity of production, sub-standard components continue to be used widely by manufacturers. Moreover, these vehicles run on batteries that in turn put extra strain on the overtaxed electricity grid. An average electric rickshaw takes up to 7-7.5 kWh of electricity, which is charged domestically or in some cases electricity is consumed through unregistered and illegal power connections. The power distribution companies incur losses of almost 20 lakhs per day in Delhi alone from illegal power connections.

1.12. Solar Dryers by INSEDA - INFORSE South Asia

Description of the solution

Solar drying is one of the most efficient and cost-effective, renewable, and sustainable technologies to conserve agricultural products. Reducing the existing high rates of global food loss and waste, including post-harvest loss, along the various production and supply chains, will play a key role in tackling the problem of food insecurity. In less developed countries, most losses mainly occur early in the value chain, especially in post-harvest handling and processing. The use of appropriate drying technologies can potentially enable small-scale producers to significantly reduce post-harvest losses, improve the quality of food, and generate income and employment opportunities.

A reduction of the moisture content prevents the risk of microorganism growth, minimizes many of the moisture-intermediated, deteriorative reactions such as enzymatic reactions, non-enzymatic browning, and oxidation of lipids and pigments, and substantially reduces weight and volume.

The open-air sun drying process greatly relies on ambient conditions and is very prone to contamination by dust, rain, wind, pests, and rodents, leading to low-quality products and a loss of farmers' income. The solar dryers are faster, more efficient, and more hygienic, resulting in lower crop losses relative to the traditional open-air sun drying. During the solar drying process, the moisture in raw agricultural materials is removed by conduction, convection, and radiation modes of heat transfers. The solar radiation passes through a transparent sheet and is retained as heat in a drying chamber or solar collector at a temperature of 30–60 °C. Thermal energy is then transferred through hot air that is led into the chamber by fans run by a solar PV panel.

Solar dryers cabinet can be made from wood, metal or bamboo. The cover can be made from net, glas or transparent polyethylene folia. The models are often equipped with a small solar-cell powered ventilator to increase efficiency. The bamboo made model has an advantage that it is lighter and inexpensive when bamboo is available (see case as example).

Solar dryers: Cabinet model from wood and glas (CRT, Nepal), cabinet from metal and glas (AIWC, India), Poly-Tunnel model from Bamboo, (INSEDA, India), and semi-industrial models (PHilMech) in the Philippines, and ESFRITA & TaTEDO in Tanzania.

There are also semi industrial models like the Philippines Center for Post-harvest Development and Mechanization (PHilMech) (www.philmech.gov.ph) modified the tunnel dryer model, which originated from the UHOH, Germany, to the Multi-Commodity Solar Tunnel Dryer

(MCSTD). This version comprises a heat collector, drying chamber, and fan/blower with a capacity of 250 kg. The heat collector and drying chamber are covered with a UV-stabilized polyethylene plastic sheet and mounted in metal frames with an inverted V shape. An axial fan with an electric motor is used to force air into the heat collector, increasing the drying air temperature to 45–60 °C.

What the solution provides?

Solar dryers are used for different crops in different countries. For example, they are commercially used for drying fish, meat, tomato, coffee, mango, medicinal plants, macadamia nuts, and rice crackers in Thailand and other countries. In India, solar dryers can be used for fruit, vegetables, medicinal plants, fish, and marine products. In China, it is used to dry corn, vegetables, fruits, and Chinese herbal medicines etc.

Why is it successful, from a user-perspective

People can earn extra income by drying some produce and selling it later. Bari and Papad (spiced dried products from certain types of pulses etc have lots of demand by Indian families) can be made and sold in the market.

The use of solar dryers enables small-scale producers to reduce post-harvest losses in a cost-effective and energy-efficient manner, improve the quality of food, and generate additional income and employment opportunities.

Energy savings or energy production

Fossil fuels and electricity are widely used as energy sources in most drying systems which results in high operational costs and environmental problems by increasing greenhouse gas (GHG) emissions. As a result, some food producers have shifted towards clean energy-based technologies such as solar and thermal energy in both direct and indirect forms (Eswara and Ramakrishnarao, 2013). Eltawil et al. (2018) suggested that the energy usage of the solar dryer could be computed using indicators such as embodied energy, time to energy payback, CO_2 emission, and carbon mitigation. Liu et al. (2015) indicate that the power consumption of the fan in the forced ventilation greenhouse dryer accounts for 5% of the total energy. The fan can be driven by local solar PV, see INFORSE-EVD Database. Solar dryer typically reduces CO_2 emissions by 1.4-3 tons per year when solar drying replaces electric or fossil-fuelled dryers.
https://www.inforse.org/doc/Pub_EVD_White_Paper_Climate_Mitigation_Adaptation_2018.pdf

Climate effects

Solar drying can also reduce climate change. If solar drying replaces commercial drying with gas, electricity, or coal, the CO_2 emissions of fossil fuel burning are avoided as often electricity is made with coal burning at power plants, which gives substantial CO_2 emissions.

With climate change, the untimely rains can destroy the harvest and therefore drying in safe condition to preserve the produce becomes necessary. In this way solar dryers are also contributing to climate adaptation.

Climate change can have negative impacts on food quality, physical availability and economic access to food. In other words, it affects nutrition and food security of vulnerable people. In this context, food dehydration technologies assist in preserving nutrition quality and improving

shelf life of fruits and vegetables etc. The food thus preserved could be used during drought and flood conditions. The larger stock of food also helps adapt to volatile food prices during climate induced disasters and become a reliable source of nutritious food.

Costs and time to construct

A simple low cost family size dryer developed and promoted by INSEDA could cost INR 8000 to 9000 (US$ 100 to 113) depending upon cost of materials, size and specification of construction of the solar dryer. The dryer can be constructed in 5 days which includes arranging for materials like bamboo, UV sheets etc. The tunnel dryer with 3 trays of 2-3 m^2 each has drying capacity around 18 kg/day of fresh fruit. If it is used half the year (i.e., 180 days/year) for various fruits, replacing drying with fossil fuel, it will dry around 3 tons of fresh fruit annually.

Lifetime

Average useful working life of a low cost family size dryer developed and promoted by INSEDA is around 5 years.

How widespread is it, where it is popular

The solar dryers are successfully demonstrated in Asian countries like India, Thailand, China, Philippines, Indonesia, and are picking up in Sub Saharan Africa such as Burkina Faso, Kenya, Uganda, and DR Congo. Open sun drying is also being practised in all these countries.

Some of the benefits of solar drying of agricultural and horticultural crops, spices and herbs and medicinal plants are given below because of which solar dryer are becoming popular:

- Farmers can get some cash value for the dried products when sold during lean period as huge quantities of food items go to waste during peak production while there is no food available during lean period.
- Drying food items (raw or cooked) in the solar dryer is fast compared to open sun drying.
- Solar dried food items are hygienic as they are covered with glass or polythene sheet, the food items are not contaminated with dust insects or bird droppings.
- Drying process does not require an external source of energy.
- Problem of food items eaten by birds is eliminated.
- It requires very low repair and maintenance.
- Household solar dryers are portable so can be carried to different places when required.
- Solar dryers can be used for various income generating activities like making spices, pickels, Baries (Baries are spicy, sun-dried dumplings made of grounded pulses and spices used in many Indian dishes) etc.

What policies and strategies helped the success?

India: The key factor for the success of the solar dryer in India has been the presence of a favorable enabling policy environment. In 2010, the Jawaharlal Nehru National Solar Mission (JNSSM), also known as the National Solar Mission, was launched by the Government of India and State governments to promote solar power.
During the second phase (2014–2022), the scaling of solar energy in the country has been promoted. Under this policy, a 30% subsidy is provided for the installation of solar-energy-driven equipment. In some States, such as Tamilnadu, the subsidy for setting up solar dryers was up to 50%.

China: To support the use of solar thermal energy in the country, Ruicheng et al. (2014) and Shuiying et al. (2011) report that China will (1) establish development goals and formulate a "Renewable Energy Law"; (2) carry out research on near (2020), mid-term (2030), and long-term (2050) energy strategies for the systematic and integrated development of solar energy, which will focus on market, technologies, industry, and policies; and (3) put forward various economic incentives such as providing financial assistance through investment subsidies as well as product and consumer subsidies for the solar industry.

The Philippines: Among various agricultural products, rice is one of the major crops in the Phillipines (United Nations Development Programme (UNDP), 2018). Post-production losses of rice in the country occur mainly in handling and drying (Food and Agriculture Organization (FAO), 2017). A tunnel dryer for drying paddy rice was tested at the International Rice Research Institute (IRRI) in the Philippines in 1989 by the University of Hohenheim (UHOH) (Djokoto et al., 1989). Thereafter, the Inflatable Solar Dryer (ISD) or Solar Bubble Dryer (SBD), which is an innovative, low-cost technology, was developed at the UHOH, IRRI, and GrainPro Inc (www.grainpro.com). The Republic Act (RA) 9513 or the Renewable Energy Act of 2008 was established to accelerate exploration and the development of the country's renewable energy resources, such as biomass, solar, wind, hydro, and geothermal power, and the ocean (Philippine Institute for Development Studies (PIDS), 2017).

Situation in Africa:
Solar drying technology presents great potential as an eco-friendly method to reduce post-harvest losses in low and middle-income countries. However, the adoption of the solar dryer technologies, particularly in sub-Saharan African (SSA) countries, is facing several challenges, such as high costs compared to income levels, lack of information, technology and financing, poor institutional and legal framework, and inadequate regulations and legislation on renewable energy (Karekezi and Kithyoma, 2002; Tchanche et al., 2009). Therefore, to scale up solar drying, governments should support renewable energy policies and encourage the use of solar technologies at both individual and industrial scales; cooperatives should be created at multilateral levels, such as farmers, government bodies, private organizations, and NGOs; solar dryers should be designed based on practical experience, local climate, and economic conditions. For example, low-cost and simple dryers should be disseminated to rural areas targeting small- and micro-enterprises and households. Training of users on solar drying for each crop should be provided; and national media networks should be generated in raising awareness of dryer applications to speed up the adoption of the technology.

Burkina Faso: The utilization of a PV-driven system to run the fans for active solar dryers in Burkina Faso can provide affordable electricity and support a sustainable energy generation system. However, the system application still faces many challenges, such as theft, poor access to standards and certifications, as well as incompetent technicians for installation and maintenance (Ramde et al., 2009). On the other hand, the current costs of solar components, such as a PV-panel, solar charge controller, and a battery, are still beyond the investment capability of rural customers (Ramde et al., 2009; Bensch et al., 2018) Nevertheless, this financial issue could be resolved through a solar microcredit program that could cover 40–50% of the investment costs (Holt, 2016). In Burkina Faso, high demand for active dryers integrated with a PV-driven system has been identified to dry fruits and vegetables at both cooperative and individual levels (Nonclercq et al., 2009; Boroze et al., 2014). To ensure a successful implementation in the country, a comprehensive data mapping of the solar radiation, testing facilities, standard protocols, production of local solar components, development of an efficient drying operation, as well as a promotion of tax incentives, should be established (Ramde et al., 2009).

Kenya: For many years, projects on solar drying have been conducted under Kenyan conditions researching the application of various dryer types for different commodities such as maize or fish, e.g., Othieno (1987), Thoruwa et al. (1996), Kituu et al. (2010), and Ronoh et al. (2010). Also, combined drying techniques with an additional desiccant have been developed (Thoruwa et al., 2000).
DR Congo: A low cost and locally made greenhouse dryer has been introduced by IITA as an alternative method to improve the quantity and quality of dried products. With the application of a solar dryer, for example, the cassava community processing center, which is managed by the youth and a women's group in Katana, Eastern DR Congo, recorded a significant increase in production of high-quality cassava flour and other derived products as well as improved income.

Problems and challenges of solar dryers
There is a need for a space to keep the dryer safe during rains. It cannot usually be used during the rainy season as there are chances of developing fungus if drying is too slow. The cost and technical knowhow are also challenges associated with Solar dryers. Apart from this, there can be a challenge of creating markets for solar dried products.

Examples, description

Bamboo Solar Poly Tunnel Dryer innovated and promoted by INSEDA in India can be either made for individual households or as a community solar dryer or for commercial purpose. The dryer is made from bamboo and UV stabilized transparent polyethylene (poly) sheets for harnessing energy from the sun for drying fruits, vegetables, spices and herbs in a clean hygienic way, retaining the natural colour and taste of these items, which can be stored for a longer time. This solar poly tunnel dryer has been designed and developed by the Secretary General and Chief Executive, INSEDA, for both hilly and plain areas of the country. Its size is 1.60-meter length x 1.00-meter width x 1.00-meter height (or 5 feet Length x 3-feet width, 3-feet height). The size can be increased based on the requirement and quantity of fruits and vegetables etc., for drying. To improve its efficiency, this solar dryer has been provided with two small exhaust fans which are operated by a 10-watt solar panel during the day. The dryer is successfully used in Ranichauri, a small town in Himalayan region of Northern India.

Solar dyer examples from the database of Local Solutions in South Asia:
- Poly Tunnel Solar Dryer from bamboo by INSEDA, India: inforse.org/evd/presentation/present_solution.php?id=59
- Cabinet Solar Dyer by AIWC, India: inforse.org/evd/presentation/present_solution.php?id=135
- Cabinet solar dryer by CRT, Nepal inforse.org/evd/presentation/present_solution.php?id=104
Solar dryers in Tanzania, Uganda, and Kenya, from the catalogue of local sustainable solutions in east Africa: https://localsolutions.inforse.org/pages/Solar-drying.php

Section 2 - Policies to Promote and Scale-up Local Sustainable Energy Solutions

2.1. Policies for Improved Cook-stoves (ICSs)

Information, campaign

Awareness of the benefits from the use of improved cook-stoves is crucial for the successful promotion of ICSs. Information should be directed towards the users as well as towards planners and decision-makers. For users, it is important to focus on benefits in the form of saved fuel, saved time to collect fuelwood, as well as increased safety (less risk of fires and burns) and health (less smoke in kitchen). This can be combined with information on the bad health effects of smoke (particles and tar gases that over time increase illnesses). The gender dimension is a major concern in the dynamics of any promotion strategy of ICSs. The issue of improved cook stoves is multidimensional: technical, economic, political, social, cultural and ecological. Each of these dimensions must be considered to understand and successfully promote the dynamics of distribution of improved stoves.

For planners and policymakers, the emphasis needs to be put on the structuring of the improved cook-stove (ICSs) sector to show how it can encourage the development of a sustainable autonomous market through local entrepreneurship. Placing great emphasis on these benefits as well as on job creation for young girls and boys through the creation or strengthening of young entrepreneurs in the marketing of improved cook-stoves (ICSs) is therefore crucial in the promotion strategy for the scaling up of ICSs.

Financial promotion of the local solutions to overcome the financial limits of the users

Different sources and mechanisms of financing can be mobilised, such as micro-finance institutions, mutual savings and loans, or revolving funds, institutional investments. They could be backed by international finance, for instance from the Green Climate Fund.

Taking into account the limited financial possibilities of the actors, including local stove producers, and the inadequate classic banking system for the sector, local actors should benefit from financial support for large scale implementation. This includes:

- financial support during the start-up of the activity (ICS production).
- funding for training of actors and the setting up of ceramics production in decentralized centres.
- support of 50% of the first orders from Groups of women promotion (GPF) for the start of their activities of marketing of improved stoves
- financial support to actors for the acquisition of equipment and materials.
- Permanent training and quality control

Providing long-term direct subsidies has been abandoned in many countries. However, developing a programme under the Green Climate Fund is possible. ENDA ENERGIE and its partners have been able to develop such a project and they are implementing it currently.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

CSO's role can consists of

I. promoting the extension of the distribution network and retailing of ICSs to households in the targeted regions.
II. Quality control of construction of ICS.
III. ensuring the reinforcement of communication and sensitization on the benefits of ICSs.
IV. ensuring the monitoring of project data.

ENDA ENERGIE is involved in a dissemination project (RFA) as an implementing entity. This project is meant to strengthen the growth of the dissemination of improved cook stoves. It aims at the extension and large-scale marketing of improved cook stoves (ICSs) in five regions of Senegal.

Capacity Building of persons: installers, local population, administration –

Training and capacity building focus on training and technical support for actors, equipment and material support for private operators and the setting up of ceramic production centres.

Training of the actors

The production and marketing of improved cookstoves are in most cases carried out by professionalized private operators, sometimes working in the informal sector. These are potters commonly called ceramists, traditional potters, craftsmen/ blacksmiths and distributors (shopkeepers, traders, associations, mutual societies, federations and women's promotion groups). To ensure the sustainability of production and marketing, the identified actors in the sector are trained in the techniques of manufacturing ceramic inserts, the metal part and the assembly of improved stoves. They are also trained in management, promotion and sales techniques for improved cook stoves.

The Chamber of Trades and Commerce of each region of intervention also participate in the training of the artisans to ensure supervision, monitoring and sustainability of achievements. In addition, master masons are trained for the production of domestic and institutional banco stoves in rural areas.

Technical support

Ceramists, traditional potters, blacksmiths, distributors and private operators who have acquired solid experience in the production/distribution of improved cook stoves benefit from technical support (quality control) and regular monitoring of their activities. As well as master masons for the production of domestic and institutional banco and institutional fireplaces in rural areas.

Make good technical solutions available: Tech-transfer, quality requirements & standards

The creation of standards and labels makes it possible to produce reliable, high-quality stoves and is an effective lever for increasing capacity and modernising production methods, while at the same time guaranteeing economies of scale that can lower stove prices.

References

PERACOD.- Vulgarisation des foyers améliorés au Sénégal : Les acquis du projet FASEN du PERACOD. https://d-nb.info/1127680684/34

PRISME.- Les foyers améliorés. Collection : Les technologies à haute performance technologique, n°7. 8p.

2.2. Policies for High-efficient Improved Cookstove

Information, campaign

Awareness of the benefits from the use of clean cookstoves and fuels has been very low, making outreach to the public and policymakers, a high priority for the sector. Few people are aware that the efficiency of biomass cookstoves can be improved to more than 50%. An information dissemination and awareness raising campaign is paramount in scaling up the use of high efficient ICS.

Financial promotion of the local solutions to overcome the financial limits of the users

Manufacturers of this particular stove have limited ability to realize economies of scale to lower prices to consumers. However, given the efficiency of the stove, carbon finance may offer an additional alternative for reducing the price and increasing the affordability of the cookstoves for the end-users. The hope is that revenues from the sale of such offsets will allow cookstoves suppliers to market these devices at a lower price, thereby expanding sales. Grants are also helpful in promotion of this stove. Grant funding for projects plays an important role in supporting TaTEDO to raise awareness, undertake capacity building of potential entrepreneurs and policy advocacy for this particular stove. Another option could be offering subsidies to manufacturers. For example, in the past ProBEC used to subsidize 30% of business start-up investments. Once operational, no direct subsidies were provided. EU – under the clean cook program in development in Tanzania, the EU is planning to provide performance-based grants for different clean cooking technologies including ICS.

Taxes and import duties, including taxes of fossil fuels and of local solutions

One could suggest tax exemption for the raw materials which are used to make this particular stove including iron sheet and fibre blanket. However, practically it is difficult to implement given that those materials have various other uses apart from making ICS.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

CSOs key roles in dissemination of this stove have been to undertake adaptive research in development of the stove, capacity building of potential manufacturers, policy advocacy, awareness raising and campaigns with aim to stimulate stove demand. In addition, in Tanzania TaTEDO has set up a company that produces the stoves.

Capacity Building of persons: installers, local population, administration

Capacity building is important for manufacturing, repair and maintenance. For instance, in Tanzania, TaTEDO has been providing training in the Folk Development Colleges (FDC) in the Southern part of Tanzania mainly on repair and maintenance of such stoves.

Make good technical solutions available: Tech-transfer, quality requirements & standards

To keep production costs as low as possible in a competitive market, stove producers often use lower gauge metal which breaks more easily. These practices obviously generate mistrust among end users. Without recognized standards, consumers do not know if they are buying a reliable product, while manufacturers of quality cookstoves often see their market share eroded with a flood of cheap copies. Therefore, the existence of standard and enforcement is critically important in scaling up the use of this stove.

2.3. Policies for High-efficiency Electric Pressure Cookers (EPC)

Information campaign

In the case of Tanzania, the main barrier observed for end-users at all levels was low awareness of using EPCs. Very few Tanzanians think that they will ever have the opportunity to cook using electricity and are unaware of the benefits of reduced household cooking expenditure, and the safe and clean cooking that is possible. This low awareness, if not resolved, will become a barrier for demand, support services and commercialization of electric cooking appliances and services.

Awareness raising on the usefulness of EPC is crucial for the introduction. This will stimulate demand, and encourage importers, distributors and retailers to stock and trade in EPCs as demand begins to grow.

Financial promotion of the local solutions to overcome the financial limits of the users

Low ability to pay is a problem for medium and low-income segments of end-users in both peri-urban/urban and rural communities, the latter due to seasonality of income. For peri-urban/urban end-users, the affordability barrier is because of a lack of priority put on cooking appliances, lack of adequate income and gender income allocation in the households. There is also a perception of a financial barrier to using an EPC, which overlaps with the 'Awareness' theme. Many peri-urban/urban households had tried to use electricity for cooking by using uninsulated and therefore less energy efficient appliances such as electric hotplates, which can use five times the energy to cook heavy foods such as beans as an EPC. The high electricity bills experienced through using inefficient electric cooking appliances gave them a false perception of the affordability of cooking with EPCs.

Credit services for EPCs would be advantageous for the low-income customers in peri-urban/urban settings, which are expected to see a growth in demand for the EPC once it is a fixture in middle to high-income kitchens.

Taxes and import duties, including taxes of fossil fuels and of local solutions

EPC Gross Margin and Tax Analysis - A gross margin analysis was undertaken to understand the profit of the market chain actors and to illuminate how taxes affect the price of the EPC for end-users. It was discovered that depending on the nature of the businesses involved in the supply chain, the tax burden ranges from 25–35%. This indicates the potential order of magnitude of savings if products were duty exempt and zero rated for VAT.

To address the end-user affordability barrier and the issue of required capital for import duty, advocacy should be pursued to exempt the EPC from import tax and VAT. The analysis also showed that if the saving is passed to the end-user, the price of the EPC could be reduced by 25–35%. This is the situation for solar PV modules and some associated equipment, which is

zero-rated and VAT-exempt in Tanzania; other countries have various exemptions. This is a significant saving, which will increase the number of end-users who are able to buy the appliance outright and decrease the payment burden on those who require credit services.

With regard to the issue of import tax, another potential future avenue would be prudent to think ahead to enable the manufacture of EPCs in-country, as the import of raw materials face much lower import duties than finished products.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

Role of CSOs include awareness-raising campaigns and promotion of EPCs to end-users and other market actors, Capacity building training on how to use the EPC for end-users and repair and maintenance, linking financial support for market chain actors and end-users, After sale services for EPCs. Advocate for import tax exemptions and quality standards.

Capacity Building of persons: installers, local population, administration

Closely associated with awareness raising is the requirement for end-user capacity building in the use of EPCs, to support integrating them into cooking practices. A new and unknown device can be intimidating, but this knowledge barrier can easily be overcome through live or recorded cooking demonstrations and dissemination of training materials.

A training of technicians to provide after sales services to EPCs in the event of malfunction or breakdown. This requires setting up the supply chain for spare parts, and ensuring end-users are aware that such a service exists, which will contribute to their increased confidence in purchasing and using the appliance. Once the market grows, the informal repair sector is likely to make efforts to 'catch-up', as it will be within the interest of electrical technicians to invest in learning to repair and maintain the devices as it becomes more common for people to approach them requesting repair services.

Make good technical solutions available: Tech-transfer, quality requirements & standards

Further advocacy work should focus on encouraging to set standards for eCooking devices to ensure only quality appliances are available, thus reducing the risk of appliances with a poor energy efficiency putting end-users off.

High quality EPCs are not easily available in the market, and as demand grows it is likely to be challenging for end-users to source high quality appliances. Standards can help to mitigate this risk.

References -https://sun-connect.org/wp-content/uploads/energies-15-00771-v2.pdf

2.4. Policies for Charcoal production - Efficient Charcoal Making

Most of the African energy policies tend to marginalize biomass energy though about 80% of the national total energy consumption comes from biomass. The omission of a policy objective or statement on sustainable charcoal production from the National Energy Policy means that for the duration of that particular policy cycle, there is no high-level commitment to produce charcoal and fuelwood more sustainably, nor to provide strategic oversight regarding its supply or quality.

Misconceptions about charcoal have led policymakers to select policies that seek to exclude charcoal from the national energy mix, rather than embrace sustainable production techniques. Also, the traditional informal nature of the sector where producers, transporters, and traders are often poorly educated, poor, and lack coordinating networks for advocacy. This contrasts with the advocacy capacity of stakeholders in the fossil gas sector where natural gas prospecting and development companies have resources, experience, and networks to lobby the Ministry of Energy intensively during the formulation of the Natural Gas Policy and the National Energy Policy. Also, companies promoting bottled fossil gas (LPG) are well organised and are lobbying for their fossil gas.

Furthermore, awareness of various laws and regulations regarding charcoal production has been reported to be low for charcoal producers in Tanzania.

Information, campaign

Information is important to charcoal producers and other stakeholders on the usefulness of efficient charcoal production kilns. This can be achieved through mass-media awareness raising campaigns, meetings with stakeholders, use of ICT materials, demonstrations for charcoal makers, etc.

Financial promotion of the local solutions to overcome the financial limits of the users

In many countries, the forest-sector's contribution to the national economy is marginal (2 to 4%), due to the fact that production and use of wood-base fuels are informal and thus escape official statistics (e.g., Uganda: formal sector 11% against 89 % in the informal sector). Consequently, forest governance receives little attention and meagre budgetary allocations. For this reason, national funding often fails to adequately reflect local governments' needs and sources of revenue. In consequence, local branches of the forest service display low human, technical, and enforcement capacities. This problem is often exacerbated by half-hearted or arbitrary decentralization of forest governance which leaves local administrators ill prepared for the challenge of promoting community involvement or investment by the private sector. Such institutional weaknesses lower the morale of local staff and invite corruption. Corruption coupled with unclear policy and legal frameworks is seen as a major cause of unregulated or even illegal charcoal businesses.

Uncertainty on re-investment of forest revenues in forest management and extension – For instance, the Tanzania Forest Act of 2002, stipulates that any fees, royalties or other imposts are owed to the Government of Tanzania. This provision means that all royalties are Central

Government revenues and cannot be paid to district or village governments directly. To that effect, there are no legal mechanism to ensure that forest generated revenues at district level are re-invested for forest management and extension undertakings.

Furthermore, the Tanzania's development vision and sectoral policies have **marginalized** the sustainable woodland management land use option for village land. That agriculture is valued more highly than natural woodland, in part, reflects systemic challenges in integrating the complex concepts under-pinning ecosystem service valuation in decisions over allocation of land and natural resources (Martinez-Harms et al., 2015).

Similarly the economic value of the charcoal trade, in Tanzania estimated at US$ 650 million, is poorly understood and is not communicated in national accounts (Sander et al., 2013). For example, official national figures on government revenues from natural forest products do not distinguish charcoal from other products, including timber. Zonal government revenue figures indicate that charcoal comprised between 10 and 71% of natural forest product revenues in some zones (TFCG, 2015b, Lukumbuzya and Sianga, 2016). The absence of official figures on the value of the charcoal trade contributes to it being **undervalued** as a land use option, when compared with crops with well-documented trade data. Thus, whilst charcoal has many similarities with traditional crops, in terms of its requirements for land, labor, and net primary production, it is not considered a crop in the agriculture policy, and it is under-valued when land use tradeoffs are being made between agriculture and woodland on village land.

Marginalization of sustainable charcoal production in the energy and forest sectors is exacerbated by the land policy in providing no explicit recognition of sustainable woodland management as a recognized land use, and by the agricultural policy in promoting the expansion of agricultural land. If woodlands do not generate income for their owners, including communities, the economic rationale to convert woodland to agricultural land is strengthened. Assuming that sustainable charcoal production can incentivize sustainable woodland management, an opportunity is therefore being missed to embed a sustainable financing mechanism into participatory woodland management.

Despite growing scarcity of wood, charcoal generally remains **underpriced** by more than 20 to 50%, relative to its economic cost in most African countries. This is mainly caused by insecure land-tenure, which leaves many forest areas open to free and unregulated access and use. In consequence, market prices of wood-based fuels reflect only the opportunity cost of labour and capital required for production and transport. Undervaluation translates into wasteful and inefficient production and consumption and creates a formidable disincentive for forest management and tree growing. The following examples illustrate the consequences:

- **Investment costs for improved kilns do not pay off as long as wood remains a free resource**. Despite training support, charcoal burners eventually abandon the improved technology. This is the main reason why the improved kiln has been disseminated for 20 years throughout Africa without much success.
- **Tree growing approaches stay ineffective, as planting and maintenance costs must be taken into account, when competing with open access resources**. Significant subsidies (e.g., Madagascar: 200 to 300 €/ha) are necessary to provide enough incentive. This holds also true for any investments in natural forest management.
- **Substitute fuels such as kerosene and LPG must be highly subsidized to be competitive**, as is the case in a number of countries (e.g., Senegal, Chad, and Tanzania. On the one hand, the need for substantial subsidies and fuel imports creates a long-term foreign exchange burden and tilts a country's trade balance. On the other, no subsidies can ever be high enough to benefit poor households – in consequence, only the wealthier segments of society benefit. Furthermore, state subsidies for substitute

fuels send wrong market signals, further discouraging investment into tree planting or forest management by communities or the private sector.

Open access to natural resources carries the risk of unsustainable overexploitation (the "tragedy of the commons"). By contrast, sustainable forest management presupposes clear and secure long-term forest tenure ("property rights"). By example, a community may be granted exclusive control over natural woodlands growing on their territory, and the exclusive right to sell wood-based fuels harvested/produced thereon. In return, the community would be bound to enter into a formal agreement with the forest service to manage the woodland sustainably and to use improved kiln technologies

Taxes and import duties, including taxes of fossil fuels and of local solutions

For the case of Tanzania, various taxes are reported to be charged on charcoal production and trade. The **fees and taxes are numerous and eroding charcoal dealers' profits, which is a disincentive to legal charcoal trade**. Therefore, the fees and taxes are identified as one of the obstacles to charcoal dealers' compliance to legal business.

Introduction of a **differentiated taxation scheme, and presupposes efficient tax collection is a way forward**. Differentiated taxation in this context means that only wood-based fuels stemming from open access areas are taxed. By contrast, communities/farmers who engage in sustainable management on their own properties would remain exempt from taxation (or similar disincentives). This needs to be certified by proof of origin (coupon system on the basis of sustainable exploitation quota). By taxing transport of cut firewood only, the system is comparatively easy to control and promotes efficient administration – as opposed to more extensive and highly decentralised systems based on the granting of firewood cutting permits.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

Overseeing forest management, sustainable harvesting, production and use of charcoal. They will also advocate and create awareness on the benefits available in the charcoal industry, assisting local communities in the formulation of by-laws and contracts as well as capacity building and developing networks. They will also play a role of watchdogs, provide advisory services, encourage active involvement of stakeholders; promote policy and legislation implementation; and conduct research. Other areas will be in facilitating fora, public debates and discussions; and defend interests of vulnerable and disadvantaged groups.

Capacity Building of persons: installers, local population, administration

In Tanzania, it is estimated that only about 25% of charcoal revenue is collected partly because most charcoal is transported using motorcycles and bicycles which by-pass checkpoints and do not pay the required permits and fees. Other contributing factors include limited human resource capacity for revenue collection.

It is generally accepted that district councils are unable to fulfil their role to monitor the adherence of forest management plans by villages. It is regrettable that there are no provisions in the forestry law for district councils to monitor the management of non-reserved forests on village lands. In the absence of the regular monitoring of adherence to forest management plans, at both central and village levels, it is not surprising that forest harvesting continues to be unsustainable. Also there is a need for capacity building of charcoal producers on use of improved charcoal production methods including kilns.

Make good technical solutions available: Tech-transfer, quality requirements & standards
There is a need to have uniform packaging material of specified size and with a capacity of carrying 50 kg of charcoal as required by Tanzania regulations. This will be useful in charging royalty payments. Efficient production including use of improved kilns such as Improved Basic Earthmond Kiln (IBEK) introduced and promoted by TaTEDO and utilization of efficient charcoal stoves in households, institutions and Small and Medium Enterprises (SMEs) should be institutionalized in regulations.

Specific policies for each solution, not included above

Sustainable production is more likely to be achieved in woodlands with secure tenure, formalized management, and harvesting plans designed to maintain the broad ecosystem functions of the forest or woodland. Evidence from Niger and Senegal, where the adoption of formalized, community-based wood fuel production has resulted in an increase in the forest stock (de Miranda et al., 2010). In contrast, in Tanzania and in many of the other top charcoal-producing countries in Africa, charcoal value chains are largely informal with production proceeding in the absence of sustainable harvesting plans (Sander et al., 2013; Schure et al., 2013). The informality of production, particularly the absence of formalized and sustainable harvesting, has contributed to widespread forest degradation and, to a lesser extent, deforestation, particularly in the vicinity of concentrated markets, such as large urban areas (Chidumayo and Gumbo, 2013).

Of course, formalization does not guarantee sustainability (Schure et al., 2013), and that there are examples of government attempts to control supply which have, instead, disrupted supply (Ribot, 1999), and of informal production in which forest ecosystem services are sustained (Ribot, 1999; Woollen et al., 2016). Currently there are few past examples of formalized, sustainable charcoal production in practice (de Miranda et al., 2010; Zulu and Richardson, 2013).

Given that land tenure is tied to land use in the Tanzanian land policy, the absence of explicit recognition for sustainable charcoal production as a land use category, risks the marginalization of sustainable woodland management in favor of agriculture and other cited land uses, particularly given the current trend to privatize village land. Recently, Tanzania has developed the National Charcoal Strategy and Action plan of 2022 among which enhanced sustainable charcoal production and utilisation is one of its strategic objectives.

Wood-fuel policies need to be designed within the context of a sustainable (rural) development approach, and principles of local control and participation adhered to in the planning process. Comparative advantages of locally produced/managed energy sources must be fully exploited. Charcoal can be made sustainable – specifically, through formalization of production, trade, markets, and consumption technologies.

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https://energypedia.info/images/1/1e/Shaping_charcoal_policies.pdf

2.5. Policies for Briquettes from biomass/agri waste and charcoal dust. By ENDA - INFORSE West Africa and REDES - INFORSE Latin America;

Some of the major challenges on the demand side include; poor quality of briquettes, lack of consistent supply, lack of awareness and lack of suitable cooking stoves to burn the briquettes, and affordability. On the other hand, the briquettes producers have limited access to finance to grow their businesses, lack of consistent consumers especially households, inconsistent availability of feedstock and lack of technological knowhow to produce briquettes.

Information, campaign

Briquette's end-users are broadly grouped into domestic (households), commercial-institutional (small/medium businesses, educational and health institutions) and industrial consumers (large thermal energy users including tea factories). Low community awareness of the potential benefits of briquettes limits its use, especially in households. Awareness raising is critically important and should focus to (i) create awareness of different briquettes types, (ii) highlight the benefits of briquettes relative to other fuels and, (iii) demonstrate how briquettes are best used and the right technologies (e.g. stoves) to use the briquettes. A consumer education and awareness raising program could be through meeting sessions, information dissemination and demonstrations on the use of briquettes.

Financial promotion of the local solutions to overcome the financial limits of the users

While most large-scale producers have access to different forms of finance including loans and grants, it remains a hurdle when it comes to small-scale producers. These entrepreneurs are often not able to meet the requirements for financing including collateral, in the case of debts. Financing can thus be advanced through varied forms such as Results Based Schemes (RBF), micro-financing, grant, etc. depending on the stage of technology development in a particular location.

Taxes and import duties, including taxes of fossil fuels and of local solutions

Briquette producers encounter low or absence of local technological capacity to fabricate densification equipment especially for non-carbonized briquettes. Of the four commonly used densifying equipment, that is, agglomerator, screw extruder, pillow briquettor and ram/piston press, only few of these are locally manufactured. The ram/piston/hydraulic press and pillow briquettors are imported from Europe, China or India. Ultimately, the cost of importation is prohibitive making it difficult for emerging briquettes producers to be able to procure quality machines. This challenge can be addressed in two ways; promoting local production and providing fiscal incentives (tax exemptions) to companies.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

CSOs have been playing a critical role in awareness creation; facilitating access to the suitable technologies; access to finance; advocating for policies and clear institutional frameworks that support uptake of briquettes and linking the producers to ready markets.

Capacity Building of persons: installers, local population, administration

Capacity building is important to enhance production of quality briquettes and appropriate use of it. Capacity building should focus on how to produce quality briquettes that meet standards. Area of focus could be on how to carbonize biomass wastes, milling, binding, pressing, drying, packaging, transportation and utilization.

Make good technical solutions available: Tech-transfer, quality requirements & standards

One of the key barriers to uptake of briquettes especially at the household level is the quality of briquettes. For example, Tanzania Bureau of standards and Kenya Bureau of Standards developed regulations to guide briquette production in their countries: (MEDC 12 (1323) DTZS) for Tanzania and DKS 2912:2020 for Kenya Solid biofuel — Sustainable Charcoal and carbonized briquettes for household and commercial use — Specification. The standard specifies requirements for sustainable production of charcoal and carbonized briquettes from a range of feed stocks including wood and by-products of wood processing, agricultural waste and solid waste. They provide metrics such as moisture content, volatile matter, ash content etc.

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2.6. Policies for Biogas, Household Scale, by INSEDA - INFORSE South Asia

Information, campaign

In many Asian countries, campaigning for household biogas is not very important as sufficient awareness is already there. However, the campaign needs to show biogas as one of the green technologies. Biogas campaigns need to be part of campaigns with other technologies, since a biogas plant requires a sufficient number of bovines and enough water on a daily basis, which is not available for all.

Financial promotion of the local solutions to overcome the financial limits of the users

In India, the Government is promoting household biogas and there is a subsidy. However, the subsidy is thinly distributed from central Govt. to State and then to District to Block to Panchayat and then to village. As a result, not everyone can get a subsidy even if they are willing. Many poor families also need financial assistance in the form of loans from rural banks or microfinance etc. For a 2 cubic meter family size biogas plant there is around a subsidy of USD 150 out of around USD 600 construction cost in most of the Indian States to USD 275 in North-Eastern region where construction cost is much higher. There is a need for removal of all fossil fuel subsidies to create a level playing field. This includes the gradual removal of subsidies to lower the retail price of fuels to consumers as well as eliminating tax breaks for exploration and exploitation of fossil fuel reserves. According to the IMF current fossil fuel subsidies represent 6.5% of global GDP, the highest externality ever recorded. https://mnre.gov.in/img/documents/uploads/file_s-1592215264726.pdf

As an example, INSEDA's Gold Standard VER (Voluntary Emission Reduction) project is aimed at mitigating greenhouse gases (GHGs) via household bio-digesters and at increasing the efficiency rate of the biogas plants by bundling household anaerobic biogas plant installed in the rural areas of Kerala and Madhya Pradesh. Biogas generated from the bio-digesters helps in replacing firewood used for domestic cooking purposes, thus improving the quality of air in the cooking space and also reducing the drudgery imposed on women.

This project perfectly illustrates the immense benefits to be gained for participants in the Gold Standard VER process and the potential for sustainable, nationally appropriate mitigation activities. However, the present process of lengthy registration, verification, and certification has serious shortcomings, particularly for the project developers. The extensive reliance on external agencies for the detailed documentation of every step is prohibitively expensive; problematic, given a rural setting; and time-consuming for small-project developers. The absence of funding or a financial safety net (for instance, the lack of a provision allowing advance payments from buyers to ease monetary pressures on participants) can impede the smooth functioning of the process.

It is recommended that, in keeping with the constraints of grassroots needs and finances, the Gold Standard process should be reformed and simplified, and a funding process should be put in place. Without addressing these concerns, the most valuable mitigation projects (which are in rural areas) will end up being excluded from this process. It is also recommended that there be

further appropriate capacity-building of NGOs and other grassroots stakeholders involved in the carbon credit project.

Taxes and import duties, including taxes of fossils and of local solutions
Some countries have harmonized sales tax (HST) which is paid on purchases/expenses related to commercial construction and operation of biogas facilities (input tax credits). However, this is difficult to replicate. The Ontario, Canada, the Marginal Effective Tax Rate, which includes federal taxes, currently stands at 32.8 per cent (used for larger biogas plants). The harmonized sales tax and Corporate and Income Tax, together with previously announced Ontario and federal tax cuts, will bring Ontario's marginal effective tax rate in 2010 down to 18.6 per cent - below the Great Lake states average.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process
Involvement of CSOs is critical as household biogas plants are feasible in rural areas where CSOs are linked with communities and are helpful in promotion, implementation and monitoring.

Capacity Building of persons: installers, local population, administration
The Govt. of India has fixed annual training targets for construction and maintenance, refresher training course, users' training, turnkey workers and staff training. Similar training should be initiated by Governments of other countries.

Make good technical solutions available: Tech-transfer, quality requirements & standards
Technology transfer of household biogas plants to other countries is very important. The Ministry of New and Renewable Energy (MNRE), Govt. of India has approved different types of biogas plants which are eligible for Govt. subsidy and turnkey projects. The implementation is done through PSU banks (Public Sector Units) / NABARD (National Bank for Agriculture and Rural Development)/ IREDA (Indian Renewable Energy Development Agency). There are coordination committees at State and District level. A village level database of beneficiaries is created and is uploaded on the website. The State nodal departments are to maintain records of status of plants. geotagging of the plants at the time of approval and also when commissioned. Photographs are also maintained in records and all plants are physically verified at ground level before a completion certificate is issued and headquarters conducts a 10 to 15% sample verification. There is a need to develop knowledge, raise awareness and implement regulations, standards and certifications for safe trading and use of biogas.

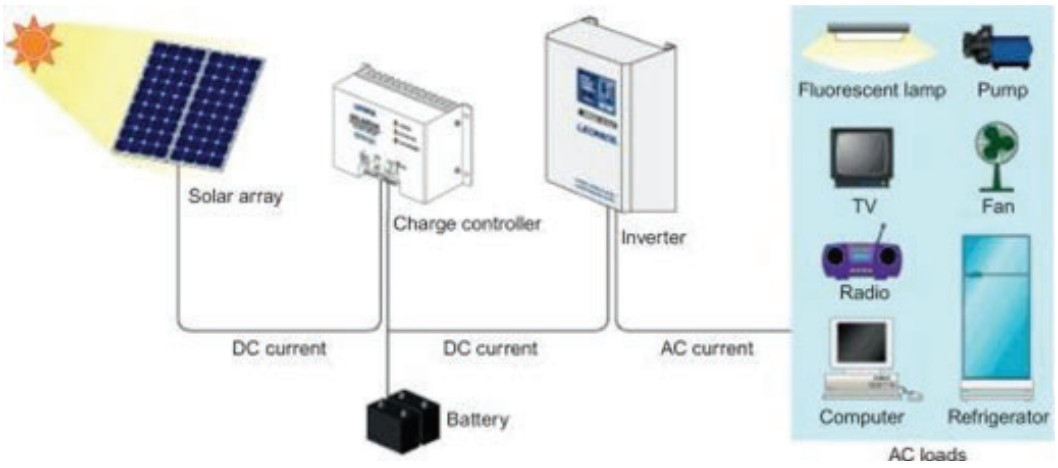
Specific policies for each solution, not included above
Policy support required will vary depending on the particular location in question, but at the high level the global industry needs, as mentioned in report on "Global Potential of Biogas" of World Biogas Association:

- The drafting of national energy plans to raise the level of renewable energy production and consumption over a future period (a decade is normal) and incorporating into these targets for the production of biogas by anaerobic digestion.
- Anaerobic digestion to be urgently included in all government strategies for meeting greenhouse gas abatement targets recognising the GHG abatement benefits of anaerobic digestion and incentivised via carbon markets.
- Anaerobic digestion to be included in all renewable energy generation incentives.
- The implementation of circular economy strategies with AD at their core; and anaerobic digestion to be nominated as the preferred method of treatment of all biodegradable wastes (human sewage and food; agricultural; commercial; industrial) accompanied by policies to increase capture.

2.7. Policies for Solar Home Systems, by INSEDA - INFORSE South Asia

Information, campaign

A lot of information is available across the countries on solar home systems (SHS) and the systems are easily available in the markets. It needs to be part of the proposed solutions, but a specific campaign is not needed anymore.



Financial promotion of the local solutions to overcome the financial limits of the users

Governments in various countries have designed different kinds of incentive policies based on the characteristics of different market development phases, including supply push policies for R&D and industry and demand-pull policies for market development.

Policy infrastructure in the renewable energy sector in India took shape with the foundation of the Commission of Alternate Sources of Energy (CASE) in 1981, in the Department of Science & Technology. It became an independent Department of New Energy Sources (DNES) in 1982 and a full-fledged Ministry in 1992.

Who are the decision-makers in India?
The Ministry of New and Renewable Energy (MNRE) is the nodal Ministry of the Government of India for all matters relating to new and renewable energy. The broad aim of the ministry is to develop and deploy new and renewable energy for supplementing the energy requirements of the country. They provide direct and indirect tax benefits such as sales tax, excise duty exemptions, and custom duty exemptions.

National Solar Mission
Jawaharlal Nehru National Solar Mission (JNNSM) 2010, also known as the Solar Mission, is a part of India's National Action Plan on Climate Change (NAPCC). There are three phases to the mission: Phase I (2010–12), II (2013–17), and III (2017–22). Under Phase I, the Rooftop PV and Small-Scale Generation Programme (RPSSGP) aims to encourage the development of rooftop and ground-mounted solar systems.

The Indian government revised the Solar Mission in 2014. It targets 100 GW installed capacity of solar electricity by 2022. To reach this ambitious target, the government announced several policies to promote solar energy.

Here is some information on the policies and regulations that directly impact solar energy development.
As for the timeline of solar policies, some major policies are important for growth of renewable energy. Such as "Electricity Act, 2003","National Electricity Policy, 2005", "Tariff Policy, 2006",

The "Integrated Energy Policy, 2006" gave provisions for preferential tariff and quotas for opting for renewable energy.
The Government of India initiated mission mode action plans for sustainable growth under National Action Plan on Climate Change (NAPCC) 2008 to address climate change. Its first mission was to intensify solar energy development. It not only set the RPO at 5% of the total grid's purchase but also a decade long 1% year-on-year RPO growth.

The introduction of Generation Based Incentives(GBIs) was for small grid solar projects below 33 kW. GBIs are for bridging the gap between a base tariff of INR 5.5 and the tariff put in place by the Central Electricity Regulatory Commission (CERC) as a fiscal incentive.

Jawaharlal Nehru National Solar Mission (JNNSM), 2010 is one of the eight fundamental National Mission's which comprise India's NAPCC which targeted 20,000 MW of grid-connected and off-grid solar power capacity by 2022 with 2000 MW as the share of off-grid capacity.

Renewable Energy Certificates (RECs), 2011
RECs is a market-based mechanism. It was introduced to enhance renewable energy capacity. It levels the inter-state divergences of renewable energy generation and the requirement of the obligated entities to meet their RPOs with a differentiated price for solar and non-solar.

The Clean Energy Cess (2010) was introduced to levy the amount of INR 50 (0.63 US$) to every tonne of coal used in the country. The cess created the National Clean Energy Fund (NCEF) that aimed to fund clean energy projects. It provided up to 40 per cent of the total costs of renewable energy projects through the Indian Renewable Energy Development Agency (IREDA). The Cess has now grown to INR 400 (around 5 US$) per tonne of coal used.

According to the latest notification by MNRE, 30% to 90% Government subsidy on benchmark capital cost is available for all consumers. But it depends on what capacity and type of solar system being installed.

Subsidy one may get for installing a solar system:

1kW Solar System – 3kW Solar System = 40% Subsidy
4kW Solar System – 10kW Solar System = 20% Subsidy
More than 10kW Solar System = No Subsidy

The Bangladesh Solar Home Systems (SHS) Program is the largest national program in the world for off-grid electrification. Begun in 2003, SHS installations under the Program ended in 2018. It is the longest, continuously operating off-grid electrification program in the world.

The SHS Program was led and implemented by the Infrastructure Development Company Ltd (IDCOL). Over a 15-year period beginning in 2003, over 4.1 million SHS were sold and supported using a competitive business model that offered consumers a choice of quality SHS, made affordable with financing. About 14 percent of the Bangladesh population (2011 Census), about 20 million people, obtained electricity services through the SHS Program. The SHS Program enabled one-quarter of the unelectrified rural population in 2003 to obtain electricity services far sooner than would have been possible with grid electricity. Building on the credibility gained, SHS distribution to the poorest households under other government programs and commercial SHS sales picked up in later years along with IDCOL-financed sales.

Grameen Shakti, one of the INFORSE South Asia members and project partner in Eco village Development project in South Asia, has installed more than 1.8 million SH.

Taxes and import duties, including taxes of fossils and of local solutions

The tax and investment subsidy policy is in line with the implementation of PV development by reducing the investment threshold. The cases in various countries prove that investment subsidies could help the PV market to realize rapid formation. However, the subsidy is not assessed on the basis of the quantities of power generated, which adds a lot of uncertainty to the subsequent power supply. This confirms that tax and investment incentives should be used as supplementary support instruments but not as the major policy. In India, tax on goods is 12% and services are 18%.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

Civil society plays a crucial role in low-carbon innovation in terms of learning and competence-building. An MIT study in rural India suggests that ongoing efforts supporting the adoption of "off-grid" energy sources such as solar-powered lanterns and microgrids can successfully bring people in remote areas basic energy services from renewable resources—without waiting for a state-run power grid to reach them. The researchers conclude that demonstrations by trusted nongovernmental organizations can inspire households to adopt solar power and help spread the use of renewable energy worldwide. https://energy.mit.edu/news/encouraging-solar-energy-adoption-in-rural-india/

Grameen Shakti, one of the INFORSE South Asia members and project partner in Eco village Development project in South Asia, has installed more than 1.8 million SHS and holds the eminence of implementing the highest number of SHS by a single organization in the world. This large network of SHS is generating 300 MWh electricity every day, benefiting more than 8 million rural people, covering the remotest corner of the country.

Capacity Building of persons: installers, local population, administration

Capacity building at the local level in remote areas could play a vital role. Barefoot College, brainchild of Bunker Roy who founded the College in 1972, started training young people and semi-literate and illiterate rural women to be solar engineers in the 1990s. Important as many people are not able to install it -
https://www.wipo.int/wipo_magazine/en/2009/03/article_0002.html

Make good technical solutions available: Tech-transfer, quality requirements & standards

PV technology has made tremendous progress over the past few decades, with strong support from governments and technology transfer has already been done in major countries.
https://journals.sagepub.com/doi/full/10.1177/0144598720979256

Important to follow standards to guarantee to deliver results and involve regulatory agencies. "The rise of solar power has generated an array of innovative new products traded across the globe. Since 2016, the World Customs Organization (WCO) has sought to clarify where to place solar energy products in its harmonised system of international trade codes. The WCO's next major update includes codes for solar energy products. The new harmonised system of international trade codes, or HS2022, is set to take effect in two years' time. Clearer, simpler codes should facilitate trade, support the development of incentives for renewables and improve the monitoring of energy access worldwide. The WCO Council adopted these amendments to the Harmonized Commodity Description and Coding System (HS) in June

2019. They will enter into force on 1 January 2022 for all 159 WCO Contracting Parties (158 countries and the European Union)."
https://energypedia.info/wiki/Quality_Standards_for_Solar_Home_Systems_(SHS)

As per the publication "Quality Infrastructure for Climate Change Mitigation and Adaptation to Climate Change: Potentials, opportunities and chances in Sub-Saharan Africa, in most Sub-Saharan African countries, a favorable policy and an economic and institutional framework still need to be created. Qualified service providers are lacking, and services need to be improved which leads to quality and safety issues in the installation of rooftop photovoltaic systems. The fast development of technologies in the global market makes it difficult for local industries to keep up and at the same time, capacities to effectively control the quality of imported renewable energy technologies are often lacking. Some countries decide to protect their local industries through local content laws or customs duties, thus creating trade barriers and a national market with limited incentives to be competitive concerning quality. The establishment of a functioning quality infrastructure is thus essential if the expectations of policy makers, investors and consumers are to be met. Quality infrastructure services help to increase the quality and safety of renewable energy installations and provide consumers with confidence in this technology. Quality assurance and support services are necessary throughout the value chain.

The International Renewable Energy Agency (IRENA) has identified several benefits of a functioning quality infrastructure for policy makers, manufacturers, professionals and end users. For policy makers, quality infrastructure enables the detection of low-quality products, which allows growing markets to be protected and strengthened and economic growth to be stimulated. Moreover, it helps provide assurance that the renewable energy installations will perform according to expectations, thus supporting the financial viability of the technologies and increasing the return on investment, including that of public incentives for renewable energies. For manufacturers, quality infrastructure can open new markets if locally provided quality infrastructure services are internationally recognized and prove the quality of local products. Through testing and certification, as well as through the implementation of a quality management system in accordance with international standards, products and manufacturing quality can be improved. For the renewable energy industry, certification (for instance, of installers) facilitates hiring processes and improves the competitiveness of service providers.
https://energypedia.info/wiki/Quality_Infrastructure_for_Solar_Energy_in_the_Context_of_Climate_Change

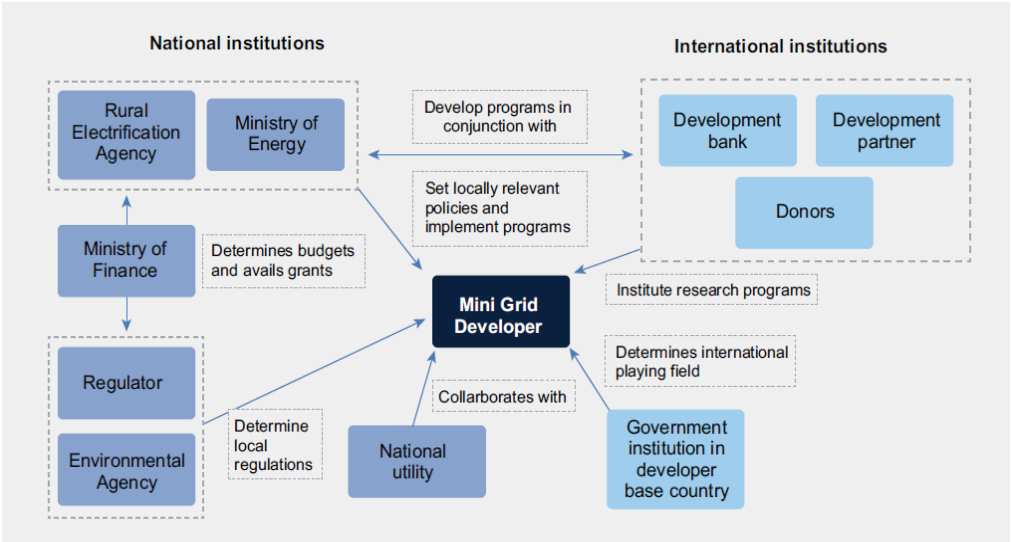
2.8. Policies for Mini-Grids

Key decisions are taken when introducing new technologies and sociotechnical systems in general. All the more when we consider that Minigrid is a system, not a product.

This entails various levels of decision making: private and public. Usually we see overlapping policies, for example aiming at different strategic goals (e.g. SDGs).
Different policies have different roles and also different degrees of success. Enabling conditions for shifting development pathways are to be defined at a higher level, i.e., development policy and role of electrification. This means introducing Minigrids within policy packages instead of isolated initiatives, e.g., as a component of long term climate policy. When considering systems within already established bigger grids, policies should be included under Distributed Energy renewable resources and focus on community energy solutions.

Information, campaigns

FIGURE ES.7 **Sample institutional framework affecting mini grid developers**



For users to demand Mini grids, they need to be informed from trustworthy sources about the benefits when compared to the current prevailing options. Thorough assessments of technological needs have proven a convenient tool to address the lack of understanding of different key actors involved in the adoption processes. Development of a large community of practitioners (extended peer communities) may be the best approach available, as opposed to usual expert judgement asked by government agencies.

Success cases are most efficient in terms of demonstration effect for the general public, final beneficiaries and policy decision makers. Information campaigns can help final users understand how much money they can save. Differentiation of targets is key: general public vs minigrid direct beneficiaries vs decision makers at all levels (see figure ES 7).

Energy policy for Electrification, reaching SDG7 targets

Countries with a comprehensive approach to planning—which consists of main grid extensions, mini grids, and solar home systems—have achieved the fastest results in electricity access (according to *Tracking SDG7: The Energy Progress Report* shows that, World Bank and others 2019). Countries with the fastest gains in electrification between 2010 and 2018 include Bangladesh, Cambodia, India, Kenya, Myanmar, Nepal, Rwanda, and Tanzania.

Compared with the main grid and solar home systems, mini grids are a more viable solution for off-grid areas with high population density and demand. Extending the main grid to serve smaller remote communities that consume a limited number of kilowatt-hours (kWh) per month is prohibitively costly in most cases. Meanwhile, solar home systems are ideal for areas

with low population density and low demand. Mini grids are generally the most economically viable option for servicing areas that are too expensive for the main grid to reach in a timely manner but have high enough demand and population density to support commercial viability.

Climate policy

NDCs and long-term strategies are key for mid- and long-term energy policies, including access to finance (e.g., Green Climate fund and special IFI programmes), carbon pricing and taxing.

The climate effects of this solution are dependent on the emission profile of the local power production and the extent of substitution of fossil fuels, e.g., diesel for the gensets and combustion of other fuels, e.g., GPL, kerosene etc. It is the substitution of local fossil fuel use and the emissions of mini-grid electricity relative to central grid electricity that should be taken into account with regard to climate goals.

Financial promotion with subsidies, carbon financing, micro financing

Since mini grids deal with public goods and are capital intensive investments Public Finance is needed in most cases. Energy cost and quality, i.e. tariffs and subsidies addressing a level playing field are decided at high level, usually national. Job creation, climate policy and other SD goals (see above) are also good examples of social oriented policies that justify public finance included in the policy package.

Subsidies

- Governments may need to provide subsidies to cover the added costs and attract investments in communities where incomes are too low to charge a cost-recovery tariff.
- Subsidies can be in the form of investments subsidies, low-interest loans, operational subsidies, and subsidies to low-income groups.
- Subsidies can provide Lifeline tariffs, where the first kWhs used are set at a low price to allow the poor also to benefit from electricity.
- Subsidies can be used to set the same tariff for mini-grid users and users of the central grid. This is very popular among mini-grid users and is introduced in some countries, e.g., Senegal.

Taxes and import duties, including taxes of fossil fuels and of local solutions

Carbon taxes may help to make renewables in general more attractive but not specifically mini grids. Taxes on some imported capital goods such as inverters or PV modules may hamper implementation. On the other hand, domestic production of capital goods is usually favoured in terms of jobs and trade balance. These decisions cannot be taken outside the long-term policy package and without early and informed participation of stakeholders.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process CSO intervention in implementation.

Public participation makes a difference at all levels. Design of the Mini grid, operation and payment should be dealt with taking into account users and local social organizations.
In some countries, NGO-lead companies have been driving mini-grid development, for instance in Mali.

Capacity Building of persons: installers, local population, administration

Mini grids can be deployed more rapidly than the main grid. Their planning and implementation are more conducive to spontaneous entrepreneurial development, while grid expansion involves several institutions (ministries, utilities, rural electrification agencies) in a longer and more complex series of steps. Nevertheless, implementation may need intervention at various levels of both public and private spheres including beneficiary participation, e.g., community energy (see fig ES.7 above). Mini grids can be a relatively low-cost and timely solution to supply electricity to people in areas that the main grid is unlikely to reach or deliver reliable electricity services in the medium term (five years and more). In such regions, mini grids have an edge over main-grid expansion/ reinforcement in several ways.

Policymakers may view investing in mini grids as a waste of resources in the longer term if they are meant to be replaced by a more cost-efficient main grid with cheaper power supply options. But the arrival/reinforcement of the main grid does not necessarily mean that the investment in mini grids would be wasted. Indeed, mini grids' generation and distribution assets can be reused in an integrated system, either separately or together, if they are following or can be upgraded to standards for main grids.

Reusing mini grids' generation and distribution assets can enable developing countries to shape their power system into a centralized grid that integrates local systems. On the other hand Community energy solutions can take advantage of availability of connection points and maturity of smart grids systems including advanced storage in urban and peri-urban areas.

Capacity Building

Designing and enforcing grid-compatible standards requires significant human resources from governments. For example, in Cambodia the regulator advises developers on how to build mini grid systems so that they can integrate with the main grid later (Tenenbaum 2018: 30)

Make good technical solutions available: Tech-transfer, quality requirements & standards Technology policy.

Mini grids often use smart, remotely controlled electricity meters that allow customers to prepay for their electricity, for example in a pay-as-you- go (PAYG) model. They also often use remote monitoring systems to manage the status of the system in real time from a distance. They can integrate partnership programs throughout the lifecycle of the mini grid that stimulate the local economic development of their clients and do this in collaboration with suppliers of energy-efficient appliances as well as microfinance providers. One possible collaboration partner is mobile network providers that require local power.

The combination of falling costs, new technologies, and favorable enabling environments has made third-generation mini grids a cost-effective option to connect 490 million people worldwide, complementing grid

TABLE ES.5 **Current and projected tariffs, costs, and profits of mini grid operators, 2019 and 2030**

Item	2019	2030
Average tariff/kWh	0.45	0.26
Cost of service/kWh	0.43	0.21
Profit on mini grids deployed this year (millions of US$)	28	608
Cumulative profit on all mini grids deployed (millions of US$)	153	3,343

Source: ESMAP analysis.
Note: kWh = kilowatt-hour.

extension and solar home systems to reach universal electrification by 2030 (Tracking Sustainable Development Goal (SDG) 7: The Energy Progress Report 2020, World Bank's ESMAP).

One key aspect is technology trajectories since costs of PV, batteries and inverters have been falling more than expected and this trend is likely to be continued, particularly with regards to storage. Learning curves are relevant not only at the technological frontier, i.e., world market, but also for national long term planning key issues, e.g., local costs and benefits.

Quality requirements and tech standards

Defining clear technical standards and commercial options for integration can address key concerns of mini grid developers and entice them to invest. What happens when the main grid arrives is a major concern for mini grid developers. Investors face two risks: The first is that their assets might be stranded. This can occur when the main grid builds over the mini grid, pulling customers to the cheaper or better service the main grid offers. The second risk is expropriation of assets, which occurs if the utility or the government takes over the mini grid assets without adequate compensation. Governments that are serious about increasing electricity access will want to mitigate these risks to foster mini grid investments and hasten electrification.

Two sets of actions can reassure potential mini grid investors. The first set would define clear technical standards for mini grids, enabling them to connect to the main grid. The second would establish clear rules on commercial options available to mini grids when the main grid arrives. The two sets are intertwined, so they need to be dealt with together.

Setting clear technical standards is key to allowing future connection of mini grids to the main grid at minimal cost. Setting main-grid standards and granting a right to connect, subject to compliance with standards, may be useful where the main grid is likely to expand soon; light standards may be enough where the main grid is likely to expand later.

Technical standards for connection with the main grid should cover the following aspects:

- Equipment (distribution network poles, conductors, and insulators) that ensures the network can handle the quantities of electricity that flow when energized by the main grid.
- Generation synchronization, to ensure the safe and reliable operation of the grid when connected to the mini grid generator.
- Interoperability, which refers to the capability of two or more networks, systems, devices, or components to interact, communicate, and exchange information securely and effectively.

Guaranteeing mini grids, the right to connect, subject to compliance with standards, can further reassure investors. Without a legal requirement, the operator of the main grid may be tempted to exert discretionary power and reject the connection of a mini grid.

Setting grid-compatible or main-grid standards can be useful when the grid is expected to be expanded within the lifetime of a mini grid's assets. At that point, a mini grid operator may well not have received the required return. Having the option to connect to the main grid may allow a mini grid operator to earn the expected revenue, preserving the value of the investment.

2.9. Policies for Efficient Light and Electricity Use, INFORSE Secretariat

As explained in the section on solutions for efficient and light and other electricity use, there is huge potential for increasing efficiency and saving expensive electricity. Since manufacturers of lamps and electric appliances do not save anything with energy efficient products, they have little incentive for producing efficient equipment. In addition, often energy efficient lamps and appliances are more expensive to purchase than inefficient ones, but the extra costs will easily pay off with electricity saving after some time, from a few months to a few years. Thus, many consumers will intuitively go for the low-cost purchase rather than looking at the total economy of the purchase of an energy consuming appliance. Therefore, public policies are important to introduce efficient lamps and electric appliances. Different policies have different roles and also different degrees of success. The following pages give an overview of the main policies and where they are best used.

Information and campaigns

For consumers to demand efficient lamps and appliances, they need to be informed from an independent source about the benefits. If the information is independent, it is normally more trusted by consumers, as company sale materials normally do not show the less positive sides of a project. There are many forms of information campaigns and consumer information. Some of the most successful are:

- National campaigns via internet, TV, radio, newspaper entries and other mass-media. This can be a good way to reach many, but is not always effective. In particular for internet-based information it is critical that many people see the website or social media. It is also critical that information is leading people to action and should be very practical as well as realistic. It should tell people how to act, what they can save, as well as other benefits as well as pitfalls, such as risk of counterfeit products, eventual damage with common types of power failures etc. Many countries have online information for energy efficiency. Not all online information is equally useful. A good example of a useful website is the one by the governmental financed UK Energy Savings Trust, https://energysavingtrust.org.uk/how-be-energy-efficient-online/

- Local campaigns at events and/or with energy advice offices can be an important way to promote energy efficiency with personal contacts, where users can get help to save energy, can see energy efficient lamps and some energy efficient appliances, can get answers for questions and can get locally adapted advice with focus on typical issues in the area, what is available locally, etc. An issue with local campaigns is that it is expensive to reach a majority of the population in this way.

- Local energy advisers can assist individuals in saving energy, buying the most cost-effective solutions, including electricity costs, etc. They can visit the homes of the users, they can communicate to users via phones or at local energy advice offices. The advisers can combine advice in efficient electricity use with for instance clean cooking, health and other issues. Local energy advisers can be efficient as good advice can help families to save a lot, if there are solutions available that the families can get and afford. As for local campaigns, it is costly to reach a large part of the population in this way.

- Energy labels, where all producers and importers have to inform about the energy efficiency of the products they sell. This is used in the EU, USA, China and many other places. It is by law an obligation for companies to put an energy label on products showing energy efficiency in a standardized way.

For online sale, the label should be on the website together with other information about the product. Among the benefits are:

- that all products should have the energy label, so it is easy for consumers to compare,
- that it is proven to be efficient, and
- that the companies that shall pay for the label, so the cost for states is limited; but it is important that the state allocate funds for introducing the label and also to make market surveillance, checking that labels are actually showing the correct energy efficiency.

Link to EU Energy label:
https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/about_en

Financial promotion with subsidies, carbon financing, micro financing

Many schemes have promoted energy efficient lamps and appliances with subsidies and micro-financing. Typically grants are useful for introducing energy efficient equipment, to get the first users to use the product and tell friends about it. In some cases special types of subsidies can be helpful. An example is giving away a large number of energy efficient lamps in a country where most people use traditional, incandescent lamps and where there is a power crisis. It is faster to make people change to efficient lamps than building a new power plant. For this to save electricity, it is, however, important that people replace the incandescent lamps, not just use more lamps. Thus, collection of the incandescent lamps can be part of the campaign.

Micro-financing can overcome the investment barrier, where energy efficient equipment costs more, but where consumers save the extra costs in a few months or years. To be most useful, the savings should pay back the loan in less than 3 years. In some successful cases, the power company has been in charge of this, collecting the pay-back of the micro-loan together with the electricity bill. In this way, the consumer's bill will not go up, and when the investment is paid back, the bill will go down.

Taxes and import duties, including taxes of fossil fuels and of local solutions

Taxation including import duties change the user economy of different solutions and thereby the opportunities for people to afford them. It is possible to use reduced or no taxes and import duties to introduce efficient lamps and electric appliances for a time-limited period, similar to subsidies. The choice between subsidies and reduced taxes often depends on what is easier politically.

In general taxes and import duties should not distort the market in favor of fossil fuel or electricity use, so the same taxes and import duties should be applied to imports of fuels for electricity production as for energy efficient equipment.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

CSOs can have several important roles for energy efficiency. Some of them are:

- CSOs are advocating for better rules for energy efficient products, with strong groups, such as the CSO cooperation "Coolproducts Campaign" in EU, www.coolproducts.eu and the American Coalition for an Energy Efficient Economy, www.aceee.org
- CSOs play and active role informing and campaigning for energy efficiency, including with the local solutions catalogue on the INFORSE website, http://localsolutions.inforse.org/, the INFORSE – partner website on energy efficiency, https://selnee.rea.org.ua/en/ , and the website of Centre for Alternative Technology in Wales (https://cat.org.uk/info-resources/free-information-service). Beside the internet-based information, many CSOs are also involved in physical information events, as when TaTEDO promotes efficient electric cooking with e-cookers.
- CSOs can manage local energy advice centres and have local energy advisers.

Capacity Building of persons: installers, local population, administration

Basic information of potential for efficient lamps and electric appliances is important for decision-makers on all levels. The above-mentioned campaigns and information initiatives should provide that for the decision-makers, but there is a need for training of the advisers and campaigners. This should include regular updates as new solutions become available and some solutions change in price etc.

Make good technical solutions available: Tech-transfer, quality requirements & standards

The most effective policies for energy efficient lamps and appliances are mandatory requirements for energy efficiency and quality of products. In EU, USA, China and many other markets, mandatory requirements, for instance for high-efficient lamps, have reduced power demand considerably and saved consumers for large part of their electricity bills. In EU, the "ecodesign" regulation require efficiency for almost 30 product groups, most of which are using electricity, see
https://ec.europa.eu/info/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/energy-efficient-products_en.

An extra argument for setting energy efficiency requirements is that manufacturers of electric equipment, that have production of low-efficient equipment, will try to sell the low-efficient products in countries without requirements. This type of "efficiency-dumping" is best avoided with national efficiency requirements.

Behind requirements for energy efficiency are standards, specifying methods to measure the efficiencies in a well-defined manner to give a level playing field and to ensure that the required energy efficiency is also being implemented with efficient products on the market. In the European Union, the standards are managed by CEN, Comité Europeene des Normes that manage thousands of standards, for energy efficiency as well as for many other purposes.

While electric equipment is imported in all countries, this is not necessarily the case for the efficient types, so for specific, efficient products, introducing them into new countries can help their energy efficiency.

2.10. Policies for Electric Two-Wheelers

Information and campaigns, standards

As individuals, companies and cities alike search for solutions for the climate crisis, electric Two-wheelers (e-bikes, e-scooters, e-motorbikes) are increasingly recognized as a valuable tool in the climate mitigation toolbox. Awareness raising of the powerful solutions that e-bikes offer by engaging in a variety of educational and informational events is critically important.

In Kenya, the National Climate Change Action Plan 2018-2022 announced a series of measures facilitating the introduction of EVs and identified the opportunity to reduce 60% of two-wheeler emissions via a transition to electric motorcycles. In June 2020, Kenya adopted technical standards covering vehicles, batteries and safety requirements.
Studies have shown that e-mobility bears the second highest mitigation potential for transport emissions in Kenya, (as most of the electric generation mix is produced from renewables)

Awareness of e-bikes and e-motorcycle is an important first step toward more widespread adoption. In 1st June 2022, ABU DHABI - As part of its endeavours to enhance security levels and to raise awareness on measures of safe driving requirements among cyclists and electric scooter riders, and in order to implement bicycles and electric bikes regulations in the emirate, the Integrated Transport Centre of the Department of Municipalities and Transport in Abu Dhabi, launched a public awareness campaign urging cyclists and e-scooter riders to adhere to the safety requirements and instructions on directional boards while driving.

The campaign further encouraged said riders to avoid illegal behaviours that could compromise their safety and the safety of all society members.

Financial promotion of the local solutions to overcome the financial limits of the users: Subsidies for local solutions, carbon financing, micro financing

Rwanda capped electricity tariffs for charging stations and rent-free land for them, preferential parking and travel lanes for electric vehicles around Kigali, and restrictions on the ages and emissions of polluting vehicles. The Rwanda's second Nationally Determined Contribution (NDC) of May 2020, identifies electric mobility as part of its climate change mitigation measures. The NDC envisions a progressive adoption of electric buses, cars and motorcycles from 2020, replacing conventional vehicle sales and diminishing transport fuel imports.

Government Sponsored Loan - The country of Scotland went a step further in June 2018 by initiating a comprehensive e-bike incentive and publicity program worth £1.3 million ($1.7 million). Interest-free loans were introduced to provide private citizens with up to £3,000 ($3,900) towards the purchase of e-bikes. £700,000 was made available to councils, public sector bodies, and community groups for the creation of e-bike pool schemes, construction of secure parking, and the purchase of safety equipment. An additional £100,000 was set aside to fund e-bike demonstrations at community centers around the country (Sutton 2018).

The city of Paris, France, offers its citizens a partial purchase subsidy of 33% towards the purchase of an e-bike. The offer, available since 2017, is capped at 400 € ($460) for a personal e-bike and 600 € ($700) for a cargo bike. In addition, up to 400 € ($460) can be awarded for the purchase of equipment necessary to convert a conventional bike to an e-bike. The program also offers commercial entities no larger than 50 employees a 400 € ($460) incentive towards an e-bike or conversion kit and up to 1,200 € ($1,300) towards the cost of a cargo bike ("Lutte contre la pollution : les aides financières à la mobilité" 2018).

Taxes and import duties, including taxes of fossil fuels and of local solutions
Many countries are adopting measures in three broad areas: i) price subsidies, ii) tax breaks and iii) a range of privileges on road use, for example, free or reserved parking, charging and other facilities. Price subsidies – for example to vehicles and electricity tariffs – are sometimes accompanied by a more indirect mechanism to tip the price balance away from ICEs: some countries have imposed fuel efficiency standards on ICE vehicles that raise their cost – thus advantaging EVs. Tax exemptions may include exemption or reduction of fuel tax, registration fees, or import duties; these are currently offered in many countries to consumers and the auto industry during the early stage of EV adoption.

In Kenya, the financial Bill of 2019 reduced excise duty rates for all battery electric vehicles and also provided incentives in the form of reduced excise tax for EVs from 20 to 10% in 2019.

US New E-BIKE act of 2021 introduces 30% US federal tax credit for electric bicycle purchases. The new legislation is designed to make electric bicycles more affordable to average Americans.

Luxembourg's e-bike incentive program offers a flat rate tax deduction for the purchase of a conventional bike or an e-bike limited to 250 watts and 25 km/hour. Citizens can claim a 300 € ($340) tax deduction for their purchase ("Portail Du Développement Durable et Des Infrastructures: Frequently Asked Questions" 2018).

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

Information sharing, awareness raising and advocacy on fostering an enabling environment for e-bike.

Capacity Building of persons: installers, local population, administration
Training in repair and maintenance might be important

Make good technical solutions available: Tech-transfer, quality requirements & standards

Government should lead the development of standards for ease of use of charging infrastructure by various vehicle manufacturers, service providers and home-based users. A policy framework should also be set up for recycling and reuse of batteries. Establish harmonized technical regulations and technical standards on charging infrastructure and battery swapping systems, and operate these facilities to ensure safety and interoperability of the systems. Interoperability allows users to have seamless access to charging facilities regardless of their vehicle models. It also reduces the costs of providing and operating charging facilities and battery swapping services because different manufacturers can cooperate in providing and operating these infrastructures and services.

Develop the technical regulations and standards related to vehicle disposal and recycling of expired batteries/accumulators. The improper treatment of electric batteries or accumulators affects the environment negatively. Developing technical regulations and standards will mitigate these negative impacts and may reduce the cost of producing batteries for two-wheelers.
Develop comprehensive regulations and standards related to the safety of electric two-wheel users and other road users.

Specific policies for each solution, not included above

Provision of preferential parking spaces for EVs at major transport nodes, city centre and commercial areas.

Using policy and regulation to pave the way for two-wheeler electrification in Vietnam https://theicct.org/wp-content/uploads/2022/03/ldv-asia-using-policy-and-regulation-to-pave-way-for-two-wheeler-electrification-in-vietnam-mar22.pdf

Electric two-wheelers in Africa? Markets, production and policy https://www.greengrowthknowledge.org/sites/default/files/Electric%20two-wheelers%20in%20Africa.pdf

How E-Bike Incentive Programs are Used to Expand the Market https://rise.esmap.org/data/files/library/united-states/Texas/EE/United%20States_Texas_E-bike%20Incentives.pdf

Integrated Transport Centre launches awareness raising campaign on riding bicycles, electric scooters safely in Abu Dhabi https://www.zawya.com/en/life/integrated-transport-centre-launches-awareness-raising-campaign-on-riding-bicycles-electric-scooters-safely-in-abu-dhabi-kqnq1p4v

2.11. Policies on E-Rickshaw, INSEDA - INFORSE South Asia

Information, campaign

Further information dissemination and campaigns in African countries are needed. For example, Japanese electric two- and three-wheeler manufacturer Terra Motors is set to ramp up the exports of its India-made e-rickshaws to Africa. The company plans to ship 5,000 units of e-rickshaws a year to countries such as Ethiopia, Nigeria, Tanzania and Sudan.

The Delhi local government in India has started a "Switch Delhi" campaign where several users, environmentalists, celebrities, and industry leaders have come forward to applaud the campaign. According to officials, three-wheelers have emerged as the highest-selling EV segment in Delhi since the launch of Delhi's EV policy in August 2021.

The campaign is focused on generating awareness on the benefits of EV three-wheelers along with the benefits offered under the Delhi EV policy for those who want to make the switch from ICE (Internal Combustion Engine) vehicles to electric vehicles.
https://www.sundayguardianlive.com/news/delhi-govts-switch-campaign-focusing-electric-three-wheelers

Financial promotion of the local solutions to overcome the financial limits of the users

More than anywhere else in India, green licence plates – indicating the vehicle is powered by a rechargeable battery, not an internal combustion engine – are prominent in Delhi. This licence plate aids in offering preferential treatment to zero-emission vehicles, such as parking, free admission in congested areas, and a reduced toll on highways. To some extent, this has been enabled by the state government's concerted efforts to complement national policies that encourage adoption of EVs.

India launched Faster Adoption and Manufacturing of E-Vehicle schemes in April 2015 and April 2019 to subsidise EVs, but their budgets have been under-utilized. So, with a growing ecosystem of manufacturers, the Delhi government's revised EV policy has focused on generating demand and providing subsidies, especially to borrowers looking to buy two- and three-wheelers, with a goal that one in four of all new vehicle registrations in 2024 would be for an EV.

For registered drivers, the Delhi government's financial incentives include a Rs 30,000 (360 US$) purchase incentive and 5% interest subvention on loans for the purchase of an e-rickshaw, and a waiver of road tax and registration fees. These drivers also receive Rs 7,500 for scrapping and deregistering old rickshaws with internal combustion engines to limit the number of old, polluting models on the roads and prevent informal operation of rickshaws.

Faster Adoption and Manufacturing of (Hybrid &) Electric Vehicles (FAME - India)-I &II: The scheme provides financial incentives for the purchase of electric and hybrid technology vehicles. With a financial outlay of Rs. 795 crore (100 million US$), it was initially launched for two years (2015-17) – Phase I, which was further extended till March 2019. The Phase I of the scheme provided subsidies for the purchase of eight models electric three-wheelers L5 category (L5 - A three wheeled motor vehicles with maximum speed exceeding 25 kmph and engine capacity exceeding 25 cc if fitted with a thermic engine, or motor power exceeding 0.25 kW if fitted with electric motor) ranging from Rs. 25,000 to Rs 61,000 (316 to 770 US$). The subsidies are availed by buyers upfront at the point of purchase and the same is reimbursed to the

manufacturers from the Department of Heavy Industries (DHI) on a monthly basis. In Phase II of FAME, a uniform subsidy of Rs 10,000 (126 US$) per KiloWatt Hour has been allocated to support five lakh three- wheelers.

Taxes and import duties, including taxes of fossils and of local solutions

Government efforts in India towards promoting EVs include placement of EVs in a lower Goods and Service Tax (GST) slab of 5% in comparison to a GST of 12% for conventional ICE vehicles, and lowering the GST on lithium ion batteries from 28% to 18% from July 2018. Furthermore, to ease the installation of charging infrastructure, the Ministry of Power (MoP) recently amended the Electricity Act, 2003, to legalise resale of power (at regulated tariffs) to allow the distribution companies and electricity service providers to set up charging infrastructure. The MoP has also come up with a roadmap for installation of adequate charging stations. The roadmap suggests the installation of charging stations (with at least 2 charging ports) at every 3 – 5 km in urban agglomerations and at least one charging station every 25 km on a highway (PIB, 2018).

CSO implementers, key roles of CSOs, role of CSOs as actors in the process

E-three wheelers are feasible in cities and outskirts and for short distances in rural areas. However, CSOs can play a role in awareness creation and guide consumers on aspects such as purchase of EVs, available subsidies, performance of EVs and location of charging stations.

Capacity Building of persons: installers, local population, administration

It is important to build capacities of relevant government officials, consultants and practitioners in transport departments and urban local bodies for smoother adoption and facilitation of EVs by different users.

Make good technical solutions available: Tech-transfer, quality requirements & standards

Regulated procedure or policy should be introduced to scrap old vehicles. Too often, batteries are dismantled unscientifically causing pollution and even accidents.

In order to push the adoption of e–autos, following amendments in the permit system can take place:

- As per the age of ICE-powered auto-rickshaws permit renewal should be restricted (starting in highly polluted cities)
- For the initial one-year, open permit system for e-autos should be practised.
- The e-autos should have no or reduced permit fees.
- Permit renewal period for e-autos can be increased in comparison to ICE auto-rickshaws.
- The types of permits that apply for auto rickshaws as commercial vehicles include contract carriage. In most of the metropolitan cities, “closed permit” is issued for the auto-rickshaws to avoid road congestion. However, in smaller cities with absence of public transport, “open permit system” is practiced. A flexible carriage system for e-autos can be adopted.

Safety Standards

The market currently has a huge number of variants of e-rickshaw which do not fall under the category of L5 three-wheelers. Thus, there has to be proper safety checks prior to the approval of the vehicle as this may lead to accidents.

Planning Zones
Electric vehicles zones within cities can be identified/ demarcated for plying of e-autos. These could include tourist centres and parks.

Charging Infrastructure

Charging infrastructure serves as a crucial factor apart from the regulations impeding the growth of e-three-wheelers. Though the electric autos can have home-based charging infrastructure, dedicated public charging infrastructure needs to be developed to support charging needs of e-vehicles. Apart from the provision of public charging stations, provision of charging points should also be there at parking spots in places like malls, and marketplaces. Pilot initiatives with the public transport authorities to promote first and last mile connectivity can further provide the charging infrastructure.

Specific policies for each solution, not included above

International best practices

Globally, several policies, implementation mechanisms and approaches are being promoted for the growth and uptake of EVs. Thus, it is important that global best practices in the EV three-wheeler spaces are identified and translated to the national context to address the associated challenges around the adoption of EVs.

Sri Lanka
Branding the electric tuk-tuk – Under the 2018 budget, the concept of 'tourist-friendly tuk-tuk' was conceived in collaboration with the hospitality industry. This program provides for existing three-wheeler drivers to register with the Sri Lanka Tourism Development Authority (SLTDA) so that a three-wheeler would not only be a mode of transportation but enable the driver to serve as a local tour guide as well.

Increasing the import taxes on diesel tuk-tuk – As per the 2018 budget proposal, import taxes on a diesel three-wheeler increased by around `50,000 in order to encourage the transition to environmentally friendly electric three-wheelers.
Scrapping – The government will discard and sell as scrap the non-roadworthy three-wheelers.

Philippines
Collaborations – One private sector gave e-jeepneys to operators for free in exchange for advertising rights.
Pilots – Joint venture between Department of Energy and Asian Development Bank (ADB) to put 100,000 electric powered tricycles on roads.
Financial Institutions – The government networked with Land Bank of the Philippines (LBP) and other financial conduits, such as rural banks, transport cooperatives, multi-purpose cooperatives to provide loan facilities to drivers of the electric three-wheelers.

Partnerships based Pilots – The Singapore headquartered Decacorn's, Grab (which is on its way towards becoming a 'super app' to provide everything online) has announced to partner with the owners of eco-friendly three-wheeler vehicles (EVs), electric tuk-tuks, in Chiang Mai city, a tourist and cultural center in northern Thailand.

The key takeaways from the above mentioned international best practices that can be adopted:

- The electric three wheelers can be given edge to ply in tourist destinations and institutional areas.
- Regulatory restrictions on the diesel three wheelers can push adoption of electric auto rickshaws.
- Scrapping subsidy to old vehicles can compensate the price difference between electric and ICE autos
- Additional benefits such as advertising incentive (incentives for advertising on social media such as Facebook, Instagram, Google influencer, etc.) will attract more buyers
- The initiatives and pilots of electric auto rickshaws within the city will make them more visible and reliable.
- Ease in financial assistance will strengthen the adoption process
- Establishment of charging stations at the major terminals or metro station will also encourage electric three wheelers.

https://www.teriin.org/sites/default/files/2020-02/Policy%20brief%20-%20EV%20Three-wheelers.pdf

2.12. Policies for Solar Dryers, INSEDA & INFORSE South Asia

Information, campaign

Information dissemination and campaign are required for Solar dryers as well as for market development for dried products which can be on local level depending upon the food items being dried.

Awareness about the appropriate decentralised renewable energy (DRE) technologies, which includes solar dryers amongst the relevant stakeholders is required for taking necessary decisions. Further, given that these are new forms of technologies for many consumers, awareness campaigns will help in increasing credibility and adoption of these products by end-users and financiers. INFORSE and Climate Action Network South Asia is developing a catalogue on local solutions, describing costs and benefits of solutions, how to get them etc. Here solar dryers are featured, see https://www.inforse.org/evd/output/solution_list.php

In collaboration with relevant partners, the Ministry of New and Renewable Energy (MNRE) plans to make available a digital catalogue/portal of DRE-powered livelihood solutions to be updated regularly, which could be used by various stakeholders for awareness creation. This catalogue will include detailed information on the solution, installation, usage and best practices to increase income.

Financial promotion of the local solutions to overcome the financial limits of the users

In India, subsidies are available for solar dryers. In recent years, a wave of innovators and entrepreneurs has come up with a variety of decentralised renewable energy (DRE) livelihood applications, which are not only energy-efficient but also economically viable. These include a myriad of solutions such as solar dryers, solar or biomass powered cold storage/chiller, solar charkha, etc. Modular design of such DRE livelihood applications ensures scalability without large investments. Besides, energy efficiency of such solutions is also important, as it in turn, determines their economic viability by reducing the size of the generation and storage (if required) asset.

To promote decentralised renewable energy (DRE) livelihood applications, which include solar dryers, the Ministry of New and Renewable Energy (MNRE), Govt. of India has proposed a policy framework to provide a conducive environment for development and large-scale adoption of these appliances as described below.

Since DRE powered solutions are capital intensive in nature, financing for the end-users and enterprises would be critical to enable the adoption of solutions and scale-up of the sector. In partnership with financial institutions, a financing facility offering first loss default guarantee with partial risk coverage to facilitate access to credit for entrepreneurs and end-users would be developed. With this facility in place, financial institutions may explore development of collateral-free financial products to help meet short-term financing requirements of enterprises as well as stipulate minimum tenure for various values of loan to end-users to ensure repayments are aligned with additional income of the end-users. The facility would encourage financing to women end-users, self-help groups and collectives. Acquisition of assets is particularly challenging for micro businesses, marginalized communities and women. Therefore, enterprises with opex based financial models such as pay-as-you-go, and rental models may also be supported for credit facilitation.

To further enable end-user financing, the ministry may work towards:

- Recognition for DRE-based livelihood solutions under the existing provisions of priority sector lending
- Preference to DRE-enabled variants of technologies under existing interventions such as Rural Innovation Development Fund
- Inclusion of DRE-powered livelihood solutions in the list of products that could be supported under MUDRA, PMEGP

In collaboration with relevant partners, MNRE will commission development of rapid assessment tools, which could be used by bankers and financiers to assess the economic viability of DRE livelihood solutions for various end-users. Such tools, partnerships and training in association with institutions such as NABARD will be used to inform financiers about DRE technologies for livelihoods and equip loan officers in their assessment.

Taxes and import duties, including taxes of fossil fuels and of local solutions
Solar dryers are mostly constructed on site using different components such as UV sheets, bamboo, solar panels, a charge controller and battery etc. These components have different taxes and therefore it is not possible to suggest tax benefits for the solar dryer specifically. Subsidy and financial assistance therefore are more important for scaling up the solar dryers.

CSO implementers, key roles of CSOs, role of CSOs as actors in the process
Role of civil society organisations is extremely important to promote solar dryers and other similar technologies in rural areas, as they are well connected with local communities and skilled manpower is required for the construction of solar dryers. The awareness and proper training of farmers is also required for the effective utilisation of the solar dryer as different crops / food items need specific parameters for effective drying.

Besides, the role of CSOs is also essential in creating market linkage and consumer awareness for the use of dried products. Identification of the target group of consumers is also needed, for which CSOs can play a vital role.

MNRE as proposed would partner with livelihood focused civil society organisations (CSOs) and relevant ministries to integrate the discussion on DRE-powered solutions for livelihoods at national and local livelihood summits, town halls and support the demonstration of such technologies at trade fairs and exhibitions.

Capacity Building of persons: installers, local population, administration
Capacity building, as mentioned above is not only essential in construction of the solar dryers but also in their proper utilisation.

DRE livelihood applications have the potential of creating new local job opportunities in operations & maintenance and installation/fabrication. Trained human resources will be required for these activities. The availability of a trained workforce will further help in increasing the credibility of products for consumers and financiers.

Skill India, SuryaMitra, Biogas Mitra and Varun Mitra initiatives have not only created technology and allied service specific training modules but also trained a pool of youth across many locations. MNRE will facilitate in developing and implementing skills and training programs for DRE livelihood applications, which include solar dryers, with Skill Council for Green Jobs, IITs promoting development and technology, National Institute for Rural Development and other organizations of stakeholder Ministries/ Departments.

Existing community level institutional platforms, such as SHG federation, FPOs (Farmers Producer Organisations), KVKs (Krishi Vigyan Kendra - Agriculture science Centres) etc. will be mobilized to build capacity of potential users/buyers to boost adoption of DRE technologies. Linkages will be established in existing government schemes like MUDRA to support micro-entrepreneurship in the value chain for DRE applications for livelihoods. To such an end, technical training will be complemented with entrepreneurial training modules. A targeted emphasis would be placed on creating skilling and entrepreneurship opportunities for youth from SC/ST communities and women in non-traditional job roles.

Make good technical solutions available: Tech-transfer, quality requirements & standards
To obtain the desired quality and assure a good return for the producers, the solar dryers must be properly designed and scaled to meet the requirements of specific crops and environments.
To ensure a successful implementation, a comprehensive data mapping of the solar radiation, testing facilities, standard protocols, production of local solar components, development of an efficient drying operation, as well as a promotion of tax incentives, should be established.

Specific policies for each solution, not included above

***Thailand*:** In Thailand, drying is one of the main post-harvest approaches to preserve the quality of agricultural products. Small-scale farmers mostly use open-air sun drying. Since 2013 the Thai MoE has launched many projects for promoting the use of a parabolic solar dryer with the successful example of solar-dried bananas to support the development of renewable energy (CRE) projects in communities.

India: One key factor for the success of the solar dryer in India has been the presence of a favorable enabling policy environment. In 2010, the Jawaharlal Nehru National Solar Mission (JNSSM), also known as the National Solar Mission, was launched by the Government of India and State governments to promote solar power. During the second phase (2014–2022), the scaling of solar energy in the country has been promoted. Under this policy, a 30% subsidy is provided for the installation of solar-energy-driven equipment. In some States, such as Tamilnadu, the subsidy for setting up solar dryers was up to 50%.

Burkina Faso: In Burkina Faso, high demand for active dryers integrated with a PV-driven system has been identified to dry fruits and vegetables at both cooperative and individual levels (Nonclercq et al., 2009; Boroze et al., 2014).

DR Congo: A low cost and locally made greenhouse dryer has been introduced by IITA as an alternative method to improve the quantity and quality of dried products. With the application of a solar dryer, for example, the cassava community processing center, which is managed by the youth and a women's group in Katana, Eastern DR Congo, recorded a significant increase in production of high-quality cassava flour and other derived products as well as improved income.

Links:
https://www.sciencedirect.com/sdfe/reader/pii/S0973082622000229/pdf
Review of solar dryers for agricultural products in Asia and Africa: An innovation landscape approach

Local Sustainable Solutions – East Africa

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- Cooking fuels
- Light, Electricity
- Water
- Growing food, oils
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Local Solutions. Database for Eco-village Development in South Asia.

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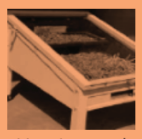
Heating and cooling


Water supply


Organic gardening and agriculture


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