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Assessment of the Improved Stove Market in Bangladesh

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The Bangladesh Cookstove Sector: Current State and Future Opportunities

Executive Summary

Improved Cook Stove (ICS) programs have long been promoted (since 1988) in Bangladesh, but efforts to create a sustainable market, driven by demand, have so far been scarce, ICS reaching a mere 1.7 % market share. Nevertheless, one vendor, Grameen Shakti, has been able to demonstrate an exponential growth in sales[1] of ICS in the last two years and it is possible for other organizations and enterprises to achieve similar results if previous successes with other renewable energy (RE) technologies, notably solar PV, are any indication.

Taking the example of PV, Bangladesh represents one of the most successful examples of market development for solar home systems (SHS) through an enterprise-based program[2]. More than 1.1 million households have purchased SHS from NGOs and SMEs, bringing electricity to off-grid rural areas and decreasing the use of fossil fuels (kerosene). The utilization of an autonomous Government of Bangladesh (GOB) non-banking financial institution, the Infrastructure Development Company, Ltd (IDCOL[3]), to provide end user refinancing, institutional development support, and extensive monitoring of system installation, has allowed for the rapid development of a solar energy market and opened up a whole range of opportunities for other RE technologies, such as biogas digesters and, potentially, ICS.

Bangladesh was selected as the target market for this study because of its potential to demonstrate rapid deployment of ICS given its unique position at the forefront of SHS commercialization and other off-grid renewables, its previous efforts in promoting ICS, as well as the government's interest in increasing adoption of ICS through market development.

USAID wishes to understand the bottlenecks of the ICS sector in order to help develop effective models for the commercialization of efficient cookstoves and, in doing so, make a major contribution to meeting the targets of the Global Alliance for Clean Cookstoves.

The main conclusions from this study are the following:

	Findings	Hypotheses
1. Stove Design	The choice is limited at present to one dominant design.	Opening up choices to a wider range of designs including portable stoves is needed to reach larger numbers of users. (See also row 4.2.)

[1] Grameen Shakti (main reference in ICS sales in Bangladesh) expects to sell around 300,000 Bondhu Chulha stoves in 2011 compared to around 150,000 sold in 2010 and 30,000 in 2009.
[2] The analysis suggests that success of this initiative was driven by reliable, quality technology, trained technicians, microfinance to end-users, and a comprehensive legal and financial framework established by GOB (Practical Action, "Poor's people energy outlook 2010").
[3] http://www.idcol.org/

2. Social Marketing	Bangladesh has a history of social marketing which has proven successful in family planning, oral rehydration and sanitation.	These techniques would be valuable for increasing demand for stoves through awareness about the health and fuel savings benefits of improved stoves.
3. Existing Organizations	The vast majority of enterprises and NGOs engaged in the ICS market are small POs of GIZ. Larger Enterprises (NGOs and SME 'Partner Organizations' (POs)) are experienced in selling domestic biogas and solar home systems under the IDCOL program. At least one of them, Grameen Shakti, can market and distribute ICS (currently 25,000 stoves each month from some 200 retail outlets).	An enabling environment to facilitate entry of larger enterprises and NGOs, including IDCOL POs currently engaged in SHS and biogas sales, could substantially accelerate the deployment of stoves in Bangladesh.
4. Standards and testing	There is currently no national level agency that establishes quality standards for stoves and conducts M&E.	Creation of such an agency or the assignment of tasks to an existing agency will support the scaled dissemination of quality stoves.
4.1	Carbon financed stoves, in particular, require well equipped testing centers and benefit from strong M&E institutions.	Putting into place strong testing and monitoring resources will support faster, cheaper, and more reliable monitoring and verification processes.
4.2	Promoters have yet to carry out a rigorous assessment of improved cook stoves which users are prepared to purchase.	A central entity tasked and empowered with conducting research and testing, establishing standards, disseminating information and promoting compliance will support the scaling of stove sales without an accompanying "market destroying" deterioration in quality. (Link to activities in Row 1.)
5. Carbon Finance	Carbon finance has brought in external private capital, expanded production and retail outlets, and increased sales. However its durability is uncertain.	The upcoming first verification of the JP Morgan CDM project will test if the monitoring is sufficiently rigorous to generate the expected carbon credits.

6. Access to Finance	Many POs currently have limited access to financing to expand their operations.	Increased access to financing (possibly through IDCOL or commercial banks) will help scale current production and marketing activities.

Recommendations: Based on: 1) the country's sizable demand for improved cookstoves, and 2) its history of successfully commercializing other clean energy technologies, the authors believe that **Bangladesh is a suitable candidate** for a USAID-sponsored improved cookstove program.

Such a program should seek to **leverage, expand and adapt existing assets** to accommodate more stove-oriented activities. These existing assets include:

- Proven **social marketing practices;**
- **Operational architecture** being used to sell other clean energy technologies, (e.g., solar, biogas);
- **Financial architecture** being used to sell other clean energy technologies;
- **Enabling environment** already supporting the dissemination of clean energy technologies;
- **USAID environmental programs** focusing on biodiversity and conservation;
- The existence of **global carbon markets**; and last but certainly not least,
- The **group of actors** already significantly involved in commercialization of improved stoves (Grameen Shakti, GIZ and their 200 POs, and JP Morgan).

Such a program should also **take a broad-based, foundation-building approach** to market development. Given the market's relatively nascent stage, investing resources in building the right foundation is critical to future success. Attempts to bypass this step will likely result in reduced impact. Examples of broad-based sector building to be considered include:

- Raising **consumer awareness** about stove availability, benefits, and proper use and maintenance;
- Investing in the identification, transfer to the Bangladeshi market, and promotion of **appropriate stove designs** that combine high efficiency and emissions performance with cultural acceptability and affordability;
- Building local capacity to provide affordable and timely **market and performance data, and testing and M&E services** to stove sector actors; and
- Assisting in the creation of enabling environments to promote commercial stove sector activities, notably facilitating **access to finance** but also maintaining transparent and **fair policy frameworks**.

Due to the interrelated and interdependent nature of all the activities to be pursued, the authors believe it is unwise to consider carving off a single focus area for attention. It is recommended that any market development support program be **holistic** in nature and exhibit **tight coordination** between work programs.

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Acronyms

BCSIR	Bangladesh Council of Scientific and Industrial Research (BCSIR)
BDT	Bangladeshi Taka
CCT	Controlled Cooking Test
CCTF	Climate Change Trust Fund
CDM	Clean Development Mechanism
CPA	CDM Program Activity
EPA	United States Environmental Protection Agency
GDP	Gross Domestic Product
GIZ	Deutsche Gesellschaft für Internationale Zusammenarbeit (German Agency for International Cooperation)
GOB	Government of Bangladesh
GS	Grameen Shakti
The Alliance	Global Alliance for Clean Cookstoves
GVEP	Global Village Energy Partnership
IAP	Indoor Air Pollution
ICS	Improved Cook Stoves
IDCOL	Infrastructure Development Company Limited
IFC	International Finance Corporation
JPMVEC	J.P. Morgan Venture Energy Corporation
KFW	Kreditanstalt für Wiederaufbau
KPT	Kitchen Performance Test
LGED	Local Government Engineering Department
NGO	Non-Governmental Organization

ODA	Official Development Assistance
PCIA	Partnership for Clean Indoor Air
PO	Partner Organization
POA	Program of Activities
SHS	Solar Home System
SME	Small and Medium Enterprise
UNICEF	United Nations Children's Fund
USAID	United States Agency for International Development
VER	Verified Emission Reductions
VERC	Village Education Resource Center
WB	World Bank
WBT	Water Boiling Test

Bangladesh Stove Sector At-A-Glance

- **DEMOGRAPHICS**
  - Population of Bangladesh = 160 Million[4]
    - Urban population = 28% (or 45 Million people in 10 Million households; 4.4 people per household)
    - Rural population = 72% (or 115 Million people in 24 million households; 4.6 people per household)
    - The urbanization rate is 3.5%
  - Bangladesh is the country with highest population density
  - Population below poverty line: 40% (2010 est.)[5]

- **ECONOMICS**
  - GDP Per Capita = $1,700 PPP (2010 est.) (IndexMundi.com)
  - Real GDP growth rate = 6% (2010 est.) (IndexMundi.com)
  - Average annual inflation = 4% (1990-2009) (UNICEF.org)
  - The labor force is divided among agriculture (45%), industry (25%) and services (30%) (IndexMundi.com)

- **FUEL CONSUMPTION**
  - Biomass supply/demand: accounts for 68% of primary energy consumption, and over 90% of household energy needs
  - Annual household biomass consumption = 44 Million tons, or 79% of the country's total biomass consumption (LGED, 2006) (that's over 1 ton per household)
  - In rural areas[6]:
    - 95% of households use biomass to cook all or part of their meals
    - Fuelwood constitutes 41% of total biomass cooking energy with some 84% of households using fuelwood for cooking
    - Agricultural residues, leaves, and grass account for 39% of cooking energy with 76% of households using some form of 'leafy biomass' to cook
    - Animal dung makes up around 17% of the cooking energy with around 55% of households using dung cakes and sticks for cooking
    - About 40% of all fuelwood is purchased from local markets; HED Consulting Ltd estimated that the % of fuelwood purchased had increased to 50% by 2008.
    - At the household level fuelwood accounts for 44% of total energy use and 38% of the cost; this comes to an annual cost of fuelwood of around USD $32.70 in 2004.
    - The price of dry woody biomass is approx. 5 to 8 BDT per kg, depending on the quality
    - The price of charcoal is approx. 6-10 BDT per kg
  - In urban areas:
    - Commercial operations (hotels, food shops, bakeries etc.) mostly use rice husk and saw dust briquettes
    - Street food vendors use twigs, cowdung cake, leafy biomass, briquettes
    - Fuelwood traders sell wood in bundles (50-60kg) costing around 250-400 BDT

[4] IndexMundi.com, accessed 2011
[5] CIA World Fact book, accessed 2011
[6] Based on WB/ESMAP 2010 study using data from 2004 Survey

- In the slums of Dhaka:
    - 60% of 5.58 Million people use firewood and twigs for their daily cooking

- **COOKSTOVE MARKET**
    - Total *potential* improved cookstove market = 29 Million stoves (GIZ)
        - 24 Million rural households
        - 3 Million urban households
        - 2 Million institutions
    - Estimated number of functioning improved cookstoves in market = ~500,000 (1.7% of total cookstove market) (2011 est.)
    - Surveyed use rates: 0.9-1.5% (estimate)[7]

[7] ICS are used more in the monsoon months when more cooking is conducted inside the home.

Introduction and Methodology

The Global Alliance for Clean Cookstoves[8] (the Alliance), a public-private partnership led by the United Nations Foundation, focuses on creating a "thriving global market for clean and efficient household solutions." USAID, as a founding partner of the Alliance, has commissioned this study, through Winrock International, to develop and document innovative models for the creation of a commercial cookstove market in Bangladesh, with a focus on getting to scale. This is consistent with the Alliance's overarching goal of reaching the global target of "100 by 20," i.e. 100 million homes to adopt clean and efficient stoves and fuels by 2020.

The purpose of this study was to identify locally operating organizations in Bangladesh involved in improved cookstove activities and programs with significant capacity of achieving scale, as well as to propose areas of intervention where USAID funding could help eliminate clearly identified obstacles to scaling up. Potentially replicable commercialization models in other energy sectors (solar home systems and biogas plants) were closely studied.

Bangladesh, a market of more than 29 million households[9], has been selected as a potential target for activity (1) due to its remarkable success in commercializing solar home systems, due in part to the role played by IDCOL, a GOB non-banking financial institution, in end user refinancing, (2) because the grounds for innovative market-based interventions have been set up by its decade long efforts to develop the ICS sector, and (3) Bangladesh's remarkable success in driving social change through public awareness and social marketing campaigns for deeply enrooted traditional behaviors (e.g., sanitation, oral rehydration, and family planning).

Winrock International conducted the study from November through December 2011 with assistance from a subcontractor, E+Co, and USAID. The research agenda included a short desk study that sought to highlight the major market players and trends as well as drivers in the sector. Through the desk study, organizations and individuals were identified and contacted. The field visit was organized so as to coincide with the Partnership for Clean Indoor Air (PCIA)-sponsored Stove Design and Testing Workshop led by Aprovecho Research Center and facilitated by Winrock International (Dhaka, Bangladesh, November 30 –December 3, 2011), which brought together many of the key stove players in Bangladesh and gave the study team the opportunity to do on site interviews as well as collect useful information on the efficiency of improved stoves currently being sold in Bangladesh.

[8] http://cleancookstoves.org/
[9] Source: GIZ interview and presentation on ICS, 2011.

History

In Bangladesh, development and promotion of improved cookstove programs can be divided roughly into three stages. During the 1970s and early 1980s research and development for efficient energy usage was started to curb deforestation. The Bangladesh Council of Scientific and Industrial Research (BCSIR) mainly led this work. What resulted was over 30 different cookstove designs aimed at reducing growing pressure on insufficient biomass fuel resources in the country. The stoves' higher efficiency in fuel burning (almost 50% less biomass consumption than in a traditional stove) was expected to be promoted by all development stakeholders.

The late 1980s and 1990s (the second stage) saw a marked shift in focus from saving trees to saving people's lives and improving health and welfare. Programs led by BCSIR that disseminated improved cookstoves to thousands of households throughout the country were then viewed as a means to reduce indoor air pollution (IAP), identified as a major source of health hazards among rural women and children. Phase I (1989-1991) and Phase II (1991-2001) of the BCSIR stove program took place in this context.

BCSIR's major contributions to the sector included developing stove designs suitable for Bangladesh, the same basic designs with slight modifications that are still used by all the major ongoing initiatives, and elevating the priority of improved stoves within the GOB. BCSIR, in its early phases, however, did not promote a fully market-based approach to stove dissemination; customers were only asked to contribute clay for their stoves.

In the past few years (the third stage) the focus of household energy programs has shifted to employing increasingly commercial approaches. There was increased marketing and promotion of improved cookstoves by NGOs and private entrepreneurs. German Agency for International Cooperation (GIZ), and NGOs such as VERC and Grameen Shakti are now the main organizations promoting improved cookstoves in Bangladesh.

GIZ efforts began in 2004 as part of the Sustainable Energy for Development Program (2004–2011) with a substantial funding commitment along with partnership arrangements with a large number of NGOs and small companies. The program has focused efforts on identifying locally acceptable and reliable technology and designs, and developing systems for marketing and maintenance. The stove models promoted by them are called 'Bondhu Chulha,' which are slightly modified versions of the BCSIR stove models and are now made of concrete rather than clay, for better durability.

GIZ has supported 200 partner organizations (POs), mainly NGOs and small enterprises, as primary players in promoting improved stoves throughout Bangladesh. The POs are in direct contact with the consumers and have a strong community presence. Training and institutional support is a key component of the GIZ program. GIZ has trained stove technicians, NGO workers and private entrepreneurs who have constructed more than 175,000 improved cookstoves to date. Partner organizations receive financial support from GIZ to expand production, market their products and carry out after sales services. Although GIZ discourages the practice, a number of POs interviewed were found to be subsidizing sales of stoves using the institutional development funds they were receiving from GIZ.

Around this same time, there were a number of other improved stoves programs coming into existence which focused on building the capability of entrepreneurs to enter the market. One group of actors included Winrock International, VERC, and Concern Worldwide Bangladesh, who jointly implemented the USAID-funded Project entitled "Reduction of Exposure to Indoor Air Pollution through Household Energy and Behavioral Improvements." This project took place between 2005-2007 in the urban slums in the northwest of Bangladesh, resulting in 580 stoves during the project period. A second group was Practical Action which has trained several dozen entrepreneurs that are currently engaged either full or part time in the construction of stoves. UNDP and UN-Habitat came into the sector in 2011 with a focus on ultra-poor populations vulnerable to natural disasters, such as cyclones and floods, and provided around 90% subsidy to users (40,000 stoves). For more information about these programs, refer to Appendix 2.

In the last three years, the trajectory of the stove market changed again with the introduction of carbon finance. In 2008, JP Morgan, after its acquisition of Climate Care, initiated the development of a CDM Program of Activities (PoA) to expand the sales of both domestic and institutional improved wood burning stoves in partnership with GIZ (then GTZ). GIZ supported the launch of a private sector company, SZ consultancy, which would, for a decreasing percentage of the carbon revenue (40- 25-20% during the first three years and 20% throughout the remaining 25 years), manage the aggregation, monitoring and reporting on stoves installed by GIZ's 200 Partner Organizations. A second CDM Program Activity (CPA) managed by Grameen Shakti, which started its ICS program in 2006, was subsequently added to the PoA. The PoA was officially registered under the UNFCCC in September 2011 with JP Morgan Venture Energy Corporation as the Coordinating/ Managing Entity (CME). The first certified emission reductions (CERs) are expected to be issued after official verification in 2012. VERC has also registered an ICS carbon finance project in the voluntary market.

Findings

Potential Market Size

The potential size of the Bangladesh cookstove market is estimated by GIZ to be around 29 million customers: 24 million rural households, 3 million urban households, and 2 million institutions like restaurants and hotels[10] (See Figure 1). These customers represent the 90% of Bangladesh families that use traditional cookstoves for cooking and heating.[11]

[10] GIZ Presentation

[11] "Promotion of Improved Cookstove in Rural Bangladesh", Working Paper No. 22, BRAC Report, May 2011 (herein known as "BRAC Report").

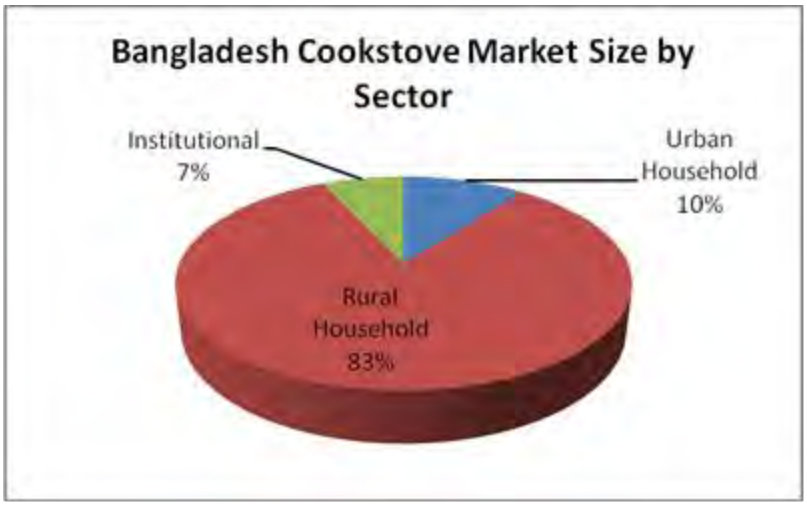

Figure 1. Cookstove Market Size by Sector

Estimates of Stoves in Use

The World Bank reports that BCSIR installed 300,000 ICS models up to the completion of their Improved Cookstove Program in 2001[12] (See Figure 2). After that, the stoves began to disappear as they broke at a faster rate than they were replaced. As of 2006, ICS use among rural Bangladesh households was at 0.8% during the rainy season and 0.5% of households during the dry season.[13]

However, the market picked up again with the commencement of the GIZ program. With ICS sales growing rapidly, the number of ICS in-use is much larger than it was just last year. A rough estimate of market size suggests that as of April, 2011 there were as many as 510,000 ICS in-use compared to 424,000 in June, 2010 (see figure2). Grameen Shakti alone expects to sell around 300,000 Bondhu Chulha stoves in 2011 compared to around 150,000 sold in 2010 and 30,000 in 2009[14].

In all, about 900,000 improved cookstoves are estimated to have been installed, but because stoves, even with proper maintenance, do not last forever, only 510,000 stoves are estimated to still be in use today. It is not known how extensively the installed improved stoves are used but we can assume that their usage is lower during the dry winter months when many rural households cook outside, by a similar ratio as was documented for 2006 by the BRAC (2011) study.

[12] "WB Report". Alternatively, installation numbers by phase show 62,848 ICS installed during Phase I from 1994 to 1997 and 117,573 ICS installed during Phase II from 1998 to 2001 (Source: Hossain. "Improved Cookstove and Biogas Programmes in Bangladesh" *Energy for Sustainable Development*, June 2003)

[13] BRAC Report

[14] Numbers were eventually revised to 440,000 units in 2011.

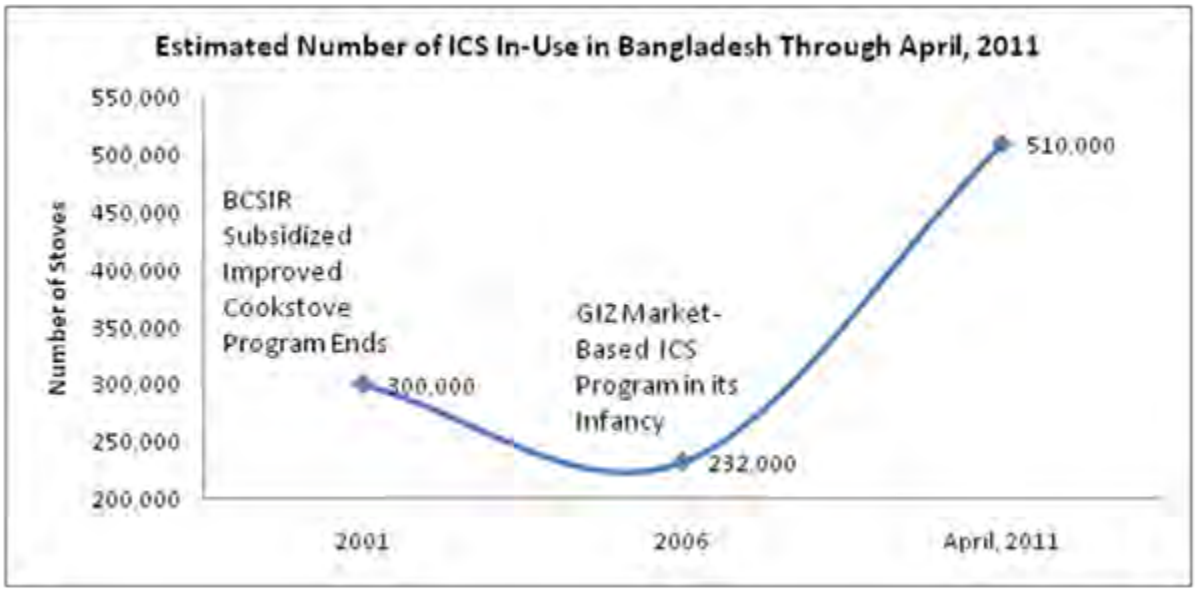

Figure 2. Number of ICS In-Use in Bangladesh through April, 2011

These estimates suggest that the market for cookstoves is capable of and, in fact, poised for continued dynamic growth if the right enabling environment conditions are met.

Carbon Finance

Provided the global market for carbon credits remains strong, the sales of ICS within registered programs continue to grow as planned, and the upcoming verification of the PoA is successful, the generation of carbon revenue could provide a substantial boost to the expansion of the market for improved cook stoves by attracting external private capital to the space.

Although exact amounts are not shared publicly, revenue from forward sales of carbon credits have already been used to expand the sales network of Grameen Shakti and have also found their way to a number of the SZ/GIZ Partner Organizations. VERC's carbon finance ICS project in the voluntary market was successfully verified in 2010 and has received payment of around $8,000 in 2011 for the resulting Verified Emission Reductions (VERs). Success in generating substantial carbon revenue by these pioneers will no doubt encourage other initiatives to follow either under the voluntary Gold Standard or CDM.

Stove Production and Marketing

The stove market is generally typified by a lack of branding and product differentiation. Marketing for stoves is mostly conducted using demonstrations and word-of-mouth. The bulk of stove manufacturing is conducted in small manufacturing plants, although two factors create confidence in the sector's capacity to supply an increasing demand: (1) manufacturing plants have great flexibility in adapting their production capacity and (2) some larger manufacturers working with RE technologies (solar, biogas) have capacity to increase production quickly if needed. Areas of dynamic market growth in the future will likely center around upgrading marketing and distribution processes.

Stove Pricing, Subsidy Levels, and Role of Carbon

The Bondhu Chulha is currently priced within the following ranges depending on location and supplier:

- 1-pot: BDT 800 to 900 (USD $10.67 to $12.00)
- 2-pot: BDT 1,000 to 1,100 (USD $13.33 to $14.67)
- 3-pot: BDT 1,200 to 1,300 (USD $16.00 to $17.33)

The prices include stove installation and warranty[15].

GIZ has been providing financial support to each of its active POs, based on signed contracts for a fixed number of stoves, to partially cover costs for both manufacturing and marketing of ICS. Typical support amounts for a contract covering 1,000 stoves are:

- Market development: BDT 100 (USD $1.33) per stove;
- Manufacturing Support (to keep technicians employed): BDT 250 (USD $3.33) per stove;
- Training of technicians: lump sum BDT 100,000 (USD $1,333); and
- Marketing support: lump sum of BDT 40,000 (USD $533).

First contracts are generally for 300 stoves followed by a second contract for 1,000 stoves with successful POs, and the average amount of support provided by GIZ has been USD $4,000 in its current phase.

In return for this support, GIZ asks its POs to report on stove sales, monitor the stoves for performance, and provide needed maintenance to users. GIZ asks POs not to pass on financial incentives by reducing the selling price of stoves to customers, in order to avoid creating any market distortions. However, it was learned through interviews that POs do often provide discounts to customers. This puts pressure on other suppliers such as Grameen Shakti who feel that they cannot increase prices to cover their full costs of marketing and selling stoves in these same markets. GIZ sees the need to continue to provide this level of financial support to POs until the anticipated carbon revenue begins to flow and expects that a similar level of support can be continued to POs after that happens.

Grameen Shakti sells its Bondhu Chulha stoves to customers at similar prices as that listed above and has been partially covering its internal costs for marketing and for expanding its manufacturing centers and retail outlets, to achieve rapid expansion in sales, from carbon revenue received as advance payment from JPMVEC. Given some anticipated uncertainty in the flow of carbon revenue, Grameen Shakti considers its ICS operations as currently loss making and needing to be cross subsidized by its more established and profitable business selling solar home systems.

It is interesting to compare the level of support above for GIZ POs selling ICS to that provided by IDCOL to its POs for sales of solar home systems[16]:

[15] POs are required to provide a guarantee to their customers of one year for the stove plus a commitment to provide free maintenance for 5 years in case of breakdown, other than for materials.

- Refinancing per SHS: USD $285 max (68% of system cost[17]),
- Grant A (system buy down) per system: USD $25,
- Grant B (PO Institutional Development) per system: USD $3[18].

There are some similarities between the manner in which GIZ is supporting its POs which are selling Bondhu Chulhas and how IDCOL has structured support to POs participating in the SHS and biogas markets. This is particularly true of marketing and institutional support grants to POs. At the same time the major difference is that there is no end-user financing required for the Chulhas, which cost a fraction of what the SHS or biogas digesters cost and are too small to require loans to purchase, and hence there is no requirement for refinancing, which constitutes the bulk of the financial support currently being provided by IDCOL. A second difference is that the GIZ program supports small NGOs and SME POs and is not designed to supply the funding needs of large NGOs or SMEs, such as Grameen Shakti.

Enterprises engaged in the ICS sector do have a requirement for credit which is currently unmet. The credit is required, not to refinance the vendor financing, which is generally not needed for stoves , but to expand their own operations. Enterprises seeking to expand their sales require working capital for increasing manufacturing centers and storage sheds, opening additional retail outlets, purchasing trucks to transport stoves, advertising their products, and carrying out house to house marketing. The support provided under the GIZ stoves program meets many of these needs for small NGOs and small companies but is not designed to meet the needs of larger SMEs and NGO players. IDCOL does not have a mechanism to provide working capital to its SHS and domestic biogas POs either. Grameen Shakti reported that they have had to finance the expansion of their ICS operations internally after unsuccessfully requesting credit from IDCOL to expand.

Stove Performance and Monitoring

Stove testing has been a somewhat neglected area in the past few years by most of the organizations implementing stove programs in Bangladesh. In the 1970's, when the stove models were first developed and disseminated, testing was done in the laboratory for thermal efficiency and emissions. In recent years, standard testing protocols have been developed and adopted by the international ICS community (see text box below for the standard tests); in addition the demands of carbon finance have increased the level and rigor of field testing to ensure the validity of offsets. These protocols have yet to be effectively incorporated into the stove sector in Bangladesh.

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[16] A similar formula is applied by IDCOL for financing domestic biogas plants where purchasers must make a minimum down payment of 15% and IDCOL refinances up to Euro 190 per digester. BDT 9,000 (USD $120) is provided as an incentive to the buyer to buy down the cost.

[17] Financing formula for SHS: 15% has to be paid by purchaser as down payment with 85% provided as vendor finance. Of this 85%, up to 80% is refinanced by IDCOL: 80% of 85% = 68%.

[18] Due to the rapid expansion of the SHS market, IDCOL is planning to phase out the Institutional Development grant to established POs from 2012 and have it available only for new POs.

The three standard tests which are used globally to evaluate stove performance are given in the box below:

> **The Water Boiling Test (WBT)** -- a laboratory test that compares stove performance while completing a standard task in a controlled environment to investigate the heat transfer and combustion efficiency of the stove.
>
> **The Controlled Cooking Test (CCT)** -- a field test that measures stove performance in comparison to traditional methods when a cook prepares a local meal to investigate stove performance using local fuels, pots, and practice.
>
> **The Kitchen Performance Test (KPT)** -- a community field test that measures fuel use in homes after stoves have been distributed to ensure real-world savings and use.
>
> http://www.aprovecho.org/lab/work/testingandeval/testprotocol

Despite not having an active ICS program anymore, BCSIR's Institute for Fuel Research and Development is still the most credible laboratory for testing stove performance in the country. GIZ used the BCSIR laboratory to compare performance between clay and concrete Bondhu Chulhas using the WBT, preceding the switchover to promotion of the concrete version. By their own account, the BCSIR laboratory needs updating, training of research staff, and new equipment to continue to perform testing functions. Updating and equipping the laboratory would also allow BCSIR to carry out emission testing, which is not currently available for stoves in Bangladesh. No institution in Bangladesh currently has the mandate to set technical standards for stoves at present. One of the questions which should be addressed as part of an investment into a national stoves program is if BCSIR should have this mandate or be limited to managing the laboratory that can carry out high quality stove performance and emission tests.

The relatively low cost of setting up a stove testing laboratory, typically several thousand dollars, has meant that a number of institutions in the country have begun to invest in such facilities or intend to do so shortly. Following the stove testing training in December 2011 at its premises, described below, VERC has plans to invest in a testing and training center to be able to train many more technicians so that they can conduct the CCT and WBT on stoves in the field for their own large stove dissemination program and for others.

For monitoring, GIZ requires its 200 partners to undertake visual monitoring of stove performance and to carry out sample surveys as a condition of the support provided to them. A number of the individual partners have received training on conducting WBT and CCT tests but they are not required to carry them out under the program at present. Following the December 2011 training at VERC, GIZ intends to

repeat similar stove testing training more widely among its POs, invest in better testing facilities, and review its monitoring requirements to include regular testing.

Grameen Shakti has a simple testing laboratory in Komila district where they conduct the WBT tests. After receiving training on the CCT and WBT at the workshop conducted by Aprovecho and Winrock International at VERC in December 2011, they intend to start training their technicians in all the districts. They also intend to better equip the lab in Komila and open more testing labs as their operations expand. As project participants under the CDM Program of Activities registered by JPMVEC, Grameen Shakti and GIZ/SZ consultancy are highly motivated to regularly test and monitor performance of stoves being disseminated under their programs.

In December 2011, Winrock International and Aprovecho Research Center organized a PCIA-sponsored Stove Design and Testing Workshop in Dhaka, Bangladesh. The venue of the workshop was the VERC office premises. About 15 organizations participated in the stove testing workshop.

The workshop gave an opportunity to test some of the popular stove models in Bangladesh. The stove models tested were as follows:

1. Bondhu 1 Pot Chulha (with chimney) made with cement
2. VERC 2 Pot Chulha (with chimney) made with clay
3. Traditional clay stove without chimney constructed in situ by VERC employees.

The results (Appendix 6) show that both the 1 pot cement model of Bondhu Chulha and the clay model of the 2 pot VERC stove perform much better than the traditional stove, with specific fuel consumption reduced by 34% and 59%, respectively. [19] The Bondhu Chulha took the least time to boil 2.5 L of water, around 18 minutes, while the VERC Chulha took 25 minutes, compared to 31 minutes taken by the traditional stove. The specific fuel consumption was least and thermal efficiency was highest for the VERC Chulha model. Although the performance test results of the improved cook stoves being promoted in Bangladesh seem reasonable, there were concerns expressed by some of the participants about difficulties with cleaning chimneys, which could result in smoke coming back into the kitchen and lead to users abandoning the stoves. The international trainers noted the limited variety in stove designs currently promoted in the Bangladesh market and wondered if they presented sufficient choice to meet the needs of the whole market.

Stove Design

The traditional stove in Bangladesh is partly underground single pot cook stove (Appendix 5). Round bottomed cooking vessels, most commonly used in Bangladesh cooking, fit into the stove. These stoves do not have a grate or chimney so they have only about 10% thermal efficiency, produce a lot of smoke,

[19] The particular traditional stove that was tested was quite different in terms of design principles (the diameter and depth of the combustion chamber and the width of the pot channel gaps) compared to the usual traditional stoves found in Bangladesh. Hence, comparisons between either of the improved stoves and this traditional one, which was not entirely dry, should be considered suspect. Further testing is recommended in order to refine the results.

soot and un-burnt volatile organic matter that pollute the indoor air and adversely affect the health of the householders.

The improved stove models that are promoted in Bangladesh are currently limited to:

- BCSIR stove models: The fixed mud stoves with chimney which may be 1 pot, 2 pot, or 3 pot. These stoves had been originally designed by BCSIR and are now being promoted by VERC. These stoves are built in situ by trained technicians using a fabricated mold. The characteristic features of these stoves are: a) cast iron grate, b) single piece chimney pipe made of clay or cement with a chimney cap.

- Bondhu Chulha: The fixed cement stove with chimney which may be 1 pot, 2 pot, or 3 pot. These stoves are the concrete models of the same BCSIR stove models mentioned above. These stoves are being promoted by Grameen Shakti and GIZ partner organizations. The characteristic features of these stoves are the same as the BCSIR stoves with a concrete grate sometimes used in place of the cast iron grate the chimney made of two parts with a collar joining the two for ease of cleaning. A 'T' shaped connector is provided in case the chimney needs to be removed for cleaning.

The testing carried out during the PCIA training in December 2011 demonstrated that these designs do significantly reduce fuel consumption (see Appendix 6) compared to the traditional stove. However, there were questions raised, particularly by international and regional stove experts at the training, on whether these two designs provided sufficient choice to potential future consumers. The lack of continued R&D in stove design and absence of new initiatives to introduce well designed portable stove models can be a major obstacle to reaching the full potential market of ICS users at a time when there is interest from a range of parties, including the GOB, Alliance and USAID, for commercialization and scale up of the Bangladesh stove market.

Implementers of ICS programs have assumed that the existing designs fully meet local cooking needs and that prospective users in Bangladesh will either not find the new designs acceptable or will be unable to afford them. Countries, such as China, India, and Kenya, which have large dynamic stove markets all provide consumers a range of stoves to choose between. It is interesting in the context of this assessment to examine the experience with market development of portable stove models that are selling well in neighboring India.

It is instructive to note that India's National Program on Improved Cookstoves, which ended in the year 2000, also started out with only fixed stove designs with a chimney. The private sector was found to be successfully selling high quality portable stoves of a variety of designs once that program ended. This encouraged India's ongoing National Biomass Cookstove Initiative to promote portable domestic stoves which are able to pass the performance standards set by the Bureau of Indian standards.

The Indian experience has demonstrated that the main advantage of portable stoves is that they are very suitable for commercialization. They are easy to brand and tend to have consistent high performance both in terms of low emissions and high fuel efficiency since they are mass produced in a

factory setting as per specification. Their attractive designs and range of quality and price transform them into aspirational products rather than basic necessities. One reason portable stoves could be particularly attractive in the case of Bangladesh is that they can easily be moved inside the house during the monsoon season; and during natural calamities (floods and cyclones) the stoves can be carried along with the other household items if there is a need to relocate.

Similarities between the two countries in terms of climate, cuisine and cooking habits, fuel and cooking vessels used makes the India experience instructive for Bangladesh. Appendix 5 lists portable stoves which are most popular in India in both urban and rural settings. It will make sense to pilot some of these best-selling stove models in Bangladesh to test if they should be offered as part of a future national stoves program.

Institutional Stoves

Institutional stoves are used by tea stalls, street food vendors and small restaurants, as well as by hospitals, schools and madrassas in Bangladesh. These are usually one or two-pot ICS of bigger dimension, compared to the domestic models, and are made with bricks and clay. The models used originate from the BCSIR Institutional Stove models with a metal grate and a chimney. In Dhaka, street food vendors use wood for cooking whereas vendors in peri-urban areas use twigs, cow dung cakes, and leafy biomass. Larger restaurants and bakeries use briquettes in their institutional stoves. Institutional stoves also use rice husk as fuel – these tend to be the 1 pot model.

Institutional stoves are part of the JPMVEC Program of Activities, where they are referred to as "non-domestic" ICS. So Grameen Shakti, and GIZ Partner Organizations do supply these stoves. GIZ provides BDT 4,000 per stove to its POs to cover their institutional development and marketing costs. The market is relatively small at present. However, given that the expected annual carbon abatement is around 27.5T of CO_2 per stove compared to around 1T for domestic stoves, they may be promoted strongly by carbon finance projects.

Main Actors

Below is a list of generalizations of the main actors involved in the stove sector. For more details, see Appendix 2: Market Players.

1. End Users – End-users are being asked to substitute an ICS product for traditional stoves, which are either self-built (free) or cost a tenth of the price of an ICS. Therefore, it is quite clear that ICS needs to be more attractive to the end-user, become an aspirational product so that a higher price will be paid. Also, increasing pressure on biomass should lead to higher fuel prices, so fuel efficiency will play an important role in the purchase decision[20]. More variety in the ICS market may be needed, since there is no one single stove that can satisfy all the needs of users. The market requires a number of different technology options and price points to accommodate the heterogeneity of end users and fuels. The experience from India which could also be

[20] For fuel saving results, see Appendix

relevant in Bangladesh is that portable stoves could be attractive to large numbers of users, both urban and rural.

2. Government –Although BCSIR, a government agency, has played a crucial role in introducing ICS and disseminating the technology, the GOB's current commitment to subsidize additional stoves through BCSIR under the Climate Change Trust Fund may be counter-productive and have potentially market contaminating effects now that more commercially oriented distribution models are in place. The GOB for the most part has not played a significant role at a policy/regulation level, particularly in regards to standards, certification and testing protocols setting. The Ministry of Power, Energy and Mineral Resources in 2009 did, however, introduce its first Renewable Energy Policy which included provisions for stimulating market development for cookstoves. It has yet to be seen whether the policy's implementation will be effective.

3. IDCOL – IDCOL does not have a program to support ICS at present. However, its central role in the remarkable scale up of the SHS market in Bangladesh and the successful addition of a second program in its portfolio for promoting domestic biogas naturally brings up the question about IDCOL's role in a future ICS program. This assessment argues for the establishment of a national ICS program which establishes technical and quality control standards, a protocol for independent monitoring of installations carried out by POs, supports an awareness program, and establishes a mechanism for providing financing and business development support to POs to expand their market. Since similar elements already exist in IDCOL's ongoing SHS and biogas programs with technical and financial support from a number of donor organizations, it would be natural to look to IDCOL to add ICS as a third technology program area. The main difference between the existing programs and ICS would be in the financing mechanism. IDCOL currently provides POs with refinancing for each SHS and biogas installation on concessionary terms. POs use this money and additional support they are given for organizational development and marketing to expand their businesses. IDCOL also receives a fee from donors and GOB for each installation to cover its transaction costs. While this arrangement has worked well for SHS and biogas which are priced in the range of USD $400-500 and most users participate in an installment payment plan, it would not work for a USD $12 ICS for which micro credit is too expensive to administer and typically not required and the fees currently charged by IDCOL per system would be prohibitive. POs participating in an ICS program require working capital to expand their operations. They also require funds for marketing and organizational development. For IDCOL to coordinate the scale up of Bangladesh's ICS sector, a novel system needs to be developed which allows it to meet these needs while covering its own costs.

4. Donor Projects – Donor supported efforts have been dispersed to date and standards and policies have not been agreed upon. This has resulted in conflicting approaches particularly in terms of program design. The GIZ program supports the commercialization of the stove sector in Bangladesh unlike UNDP and UN Habitat which have provided heavy subsidies for the purchase

of stoves by vulnerable sections of the population. Although most POs consider that there has currently not been significant 'leakage' from the subsidized to the commercial market, this could change with UNDP/ UN Habitat's planned expansion of their program to supply some 400,000 subsidized stoves. Despite its commitment and significant contribution to commercialization of the sector, GIZ's continued support to a limited set of partners, has both created a sense of dependency among the participating POs, and also distorted the market for growing enterprises such as Grameen Shakti which are trying to sell to a commercial market. Technology standards have not been specified and agreed upon across donor funded programs and there has been insufficient testing of efficiency of the stoves being sold. Both of these issues can be addressed by putting in place a national program endorsed by the GOB, with consistent policies for market development and technology standards, similar to what IDCOL is currently providing for the SHS and domestic biogas sectors. On the standards, any future national stoves program in Bangladesh can benefit from a current effort being led by the Partnership for Clean Indoor Air and the Global Alliance for Clean Cookstoves to develop international voluntary standards for improved stoves, through an ISO International Workshop Agreement, which is planned to be developed in the coming months.

5. Private Sector Stove Suppliers

Small NGO and SME POs of GIZ – they represent some 80% of business players competing in the ICS sector and have been financially supported either by BCSIR or the GIZ program, or both. They're generally tied to a smaller, specific geographic area. Currently relying on transitioning to carbon finance, most of them have failed to create viable entities capable of sustainably participating in an ICS market. In the absence of subsidies and/or carbon finance, they would not be able to face costs of marketing and sales.

Medium to Large Sized Vertically Integrated NGOs –Grameen Shakti has successfully adopted market-based strategies to promote its stoves, vertically integrating its value chain and obtaining full control from production to sales. Although its operations are smaller, VERC has also developed a vertically integrated supply chain with quality control and monitoring mechanisms for stove products installed by its branches following the requirements of its carbon finance project. These larger NGOs, which have terminated their partnership with GIZ, do face bottlenecks created by insufficient funds to expand production and marketing. Carbon credits could mean substantive entry of capital that should allow them to significantly expand operations or recover investments made to scale up operations. Even if the carbon revenue does not materialize to the extent it is anticipated, the fact that they have established an extensive network means they could flourish if they had access to concessionary financing similar to that being received by POs under IDCOL's SHS and domestic biogas programs. Because of their existing networks and developed capacity to produce and distribute stoves, they represent potentially important enterprises to expand the stoves market. Given the interest of other large NGOs in Bangladesh in the RE sector such as BRAC Foundation, with the right enabling environment NGOs with

extensive networks in rural areas could potentially play a major role in the dissemination of stoves.

RE Companies and NGOs: POs of IDCOL's Solar/ Biogas Programs – SMEs and NGOs working on solar and biogas have benefitted from various financial schemes (mainly promoted by World Bank, KfW, ADB, SNV, GIZ and supported by GOB via IDCOL) that have helped them grow their businesses and build resilience. Their structure, mentality and know-how would allow them to enter the ICS market with relative ease if they were so inclined. So far, in addition to Grameen Shakti which is the largest player in both of these RE markets, a number of the smaller SHS and domestic biogas POs are also POs under the GIZ ICS program. If a national program for ICS could be launched, perhaps through IDCOL or another similar organization, a number of the larger POs active in SHS and biogas sectors are likely to be interested in promoting ICS as well.

Other Small Companies (Sanitary Shops and Masons) – recently identified as partners by the GIZ/ SZ programs to scale up stove manufacturing and distribution. They are familiar with materials suppliers but new to ICS technology (standards and efficiency requirements) and market. GIZ is planning on training some 5,000 masons, as early as by July 2012, working with sanitary shops on manufacturing stoves (providing them with molds and composition) and SZ will bring in the expertise on marketing and after-sales services, as well as the paper work to obtain carbon credits from ICS sales. The GIZ strategy appears to be to meet their objective of installing 500,000 new stoves each year per CPA through this large number of trained masons[21]. There is a real risk, however, that the requirement to rigorously monitor the installed stoves to the standards required for the CDM project to the satisfaction of the international verifiers will be prohibitively expensive to meet with this strategy of dramatically increasing the numbers of stove suppliers.

Carbon Project Developers – Carbon finance can be a powerful force increasing the rate of adoption of improved cook stoves, but it is not without risks – risks inherent to carbon markets, the risk of backlash from being perceived as too exploitative, risks of distorting or over-saturating the market, along with general business risks. The Bangladesh JPMVEC PoA is the first globally registered Program of Activities under the Clean Development Mechanism covering improved cook stoves. JP Morgan reportedly agreed to provide substantial upfront payments[22] to the two main Project Participants, SZ Consultancy and Grameen Shakti, to finance their activities under the PoA. This upfront investment has been used by both the program implementers to expand sales. VERC receives carbon payments

[21] Earlier versions of the JPMVEC CDM Program of Activities Design Document showed this number to be the goal by Year 3 of the program.

[22] As per the PoA Design Document titled "Improved Cooking Stoves in Bangladesh" Version 7.1 Section A.4.3 posted on the CDM Registry website:
http://cdm.unfccc.int/filestorage/D/O/V/DOVKI43UMLXRWNY0Q6HFGTP1B89C57/PoA-DD.pdf?t=bUR8bHlhMTlnfDAAfNRH5yba4nUdrWtPOCoM

for Verified Emission Reductions (VERs) generated from its stove project from Seattle based MicroEnergy Credits[23], a for-profit social enterprise which describes its role as a financial intermediary which links microfinance institutions to the carbon markets when they lend for clean energy. Once the CERs and VERs[24] are generated and the implementers are confident of how much carbon revenue they will be generating, they can choose to use the resources to lower the price of stoves or bring finance to end-users, replacing the role of capital subsidies to lower income customer segments.

For convenience, the organizations reporting numbers of stoves distributed are summarized below. Possible double counting between programs has not been taken into account.

Name	Dates	Stoves Disseminated	Current Status/Future Plans
BCSIR Phase I and II	1989-1991 & 1999-2001	300,000	Phase III announced to distribute 28,000 stoves in seven districts using the Climate Change Trust Fund
GIZ Phase I and II	2004-2011	175,000 (via POs)	Uncertain funding situation beyond 2012. Phase III will train 5,000 masons tied to sanitary shops.
Grameen Shakti	2006-present	480,000 (via 188 sales centers)	Monthly sales of 25,000 and growing.
VERC	2000-2011	48,000	42,000 stoves installed by a network of 93 NGOs coordinated by VERC with support of ARECOP[25]; over 6,000 stoves installed under carbon finance project started since 2008.
UNDP & UN-Habitat	2011	40,000	Implemented through POs which receive technical assistance from GIZ. Plans to expand to 400,000.

[23] http://microenergycredits.com/about/
[24] JPMVEC is also generating VERs for the abatement from stoves for the period until the CDM PoA was registered.
[25] http://www.verc.org/ics.html

Practical Action	2001-2011	7,000	Expansion through full time and part time entrepreneurs.
Winrock/VERC	2005-07	580	Entrepreneurs continue sales beyond end of project.

Market Drivers

1) High cost of firewood is a major driver to acquire efficient stoves for those households which purchase fuel at present in rural areas, towns, and peri urban areas. GIZ estimates that households that purchase firewood can save BDT 250-400 (USD $3.33 to $5.33) per month, giving a payback period for the ICS of just 2-3 months. The Non Renewable Biomass (NRB) Assessment[26] carried out by HED Consulting for JPMorgan Climate Care in 2008 concluded that: a) there is a major shift in recent years from almost universal "free" collection of fuelwood to a situation where 50% of wood fuel is now purchased; b) there is a marked increase in the prices of fuelwood in the last decade; and c) due to the scarcity and lack of free access to fuelwood, there has been fuel switching from wood to more economic fuels like dung, leaves and crop residues. The World Bank/ESMAP study "Restoring Balance: Bangladesh's Rural Energy Realities" had concluded from survey data that around 40% of fuelwood was purchased in 2004 and provides another data point to support HED's claim that the shift continues to more purchased fuelwood.

2) The ability of the carbon finance engine to drive stoves into the market is undeniable. The value addition derived from the sale of carbon offsets can easily dwarf the "natural" value addition of the stove, even after registration, monitoring and verification costs are taken into account provided that these costs are reasonable managed.[27] The possibility of generating carbon revenues has attracted larger, more sophisticated, often international players into the market with much deeper pockets. The JPMVEC PoA Design Document argues that "Carbon finance has been identified as the only realistic and adequate source of finance to overcome the existing barriers and having the scale and consistency over time necessary to implement and expand the sales of ICS in Bangladesh, and at the same time maintain quality and customer adherence. This is substantiated by the fact that the J.P. Morgan only agreed to provide considerable up front finance for the development of the PoA because future CDM revenue was taken into consideration when making the investment decision."

3) Decreasing availability of gas in the urban areas (new buildings are not being served), represents an opportunity for higher end stoves to enter the market (some 3 million households in urban areas, or 30% of the total, according to GIZ). With an urbanization rate of 3.5%, the lack of new gas connections will be increasingly felt, representing an opportunity for adoption of higher-end fuel efficient stoves.

[26] http://cdm.unfccc.int/filestorage/D/O/V/DOVKI43UMLXRWNY0Q6HFGTP1B89C57/PoA-DD.pdf?t=bUR8bHlhMTlnfDAAfNRH5yba4nUdrWtPOCoM

[27] That is, a single stove seller with adequate volumes can generally do this. Whether or not SZ Consulting will be able to conduct the monitoring and verification tasks for 200 POs for a reasonable cost is to be seen.

Also, the low availability of LPG in rural areas and higher associated cost (gas as well as stoves) suggests a potential market for more advanced stoves targeting the middle of the pyramid.

Trends

1) There is increasing demand for stoves, due to recent door-to-door marketing campaigns (made possible by the expected carbon funds), greater availability of stoves in the marketplace, and a growing scarcity of biomass for fuel (which translates into higher fuel prices).

2) Incipient carbon finance is entering the market, which should drive greater interest for the sector (each stove resulting in 1T CO_2e/year reduced emissions, which at current market price represents some USD $10 /stove/year). This is also channeling funds to after-sales services in the form of mandatory monitoring of installed stoves.

3) The market in Bangladesh risks stagnating on a single product offering (one basic design, with small variations of number of pots, made out of either mud or concrete). The experience from ICS users in India, which share similar food and cooking habits, suggests that customers prefer a range of choices in stoves. Portable stoves in particular have shown ease of commercialization and various models can meet the needs of urban and peri-urban as well as rural consumers.[28]

4) Most of the programs to promote ICS, being implemented (Grameen Shakti, Practical Action, GIZ/SZ) or planned (SNV), are increasingly either enterprise-based, or provide marketing support, training, and seed capital and are moving away from direct subsidies to the user. The exceptions are the planned BCSIR program to disseminate 28,000 stoves in 7 districts funded by the Climate Technology Fund and plans by UNDP and UN Habitat to supply some 400,000 stoves, both at highly subsidized rates. There is a risk of these programs distorting the market unless they are specifically targeted at vulnerable populations which cannot pay for stoves.

Obstacles to market development

In order for Bangladesh to achieve universal clean cooking access,[29] production capacity must expand overall, achieving more economies of scale, so as to be able to compete in a non-subsidized scenario.

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[28] The government of India's stove program went through a similar phase as Bangladeshi programs of restricting promotion to a few designs of fixed stoves with chimneys.

[29] Practical Action (2010) sets the minimum standard for cooking and water heating to be 1kg of woodfuel or 0.3kg of charcoal or 0.04kg of liquefied petroleum gas (LPG) or 2 litres of kerosene or ethanol per person per day, taking less than 30 minutes per household per day to obtain. It also sets the minimum efficiency of improved wood and charcoal stoves to be 40% greater than a three-stone fire in terms of fuel use. Further, it sets an annual mean concentration of particulate matter ($PM_{2.5}$) <10µg/m^3 in households.

The IEA (WEO 2011) defines clean cooking facilities as those "which can be used without harm to the health of those in the household and which are more environmentally sustainable and energy efficient than the average biomass cookstove currently used in developing countries. This definition refers primarily to biogas systems, LPG stoves and advanced biomass stoves."

The World Bank (Household Cookstoves, Environment Health and Climate Change, 2011) distinguishes between "improved cookstove" of the legacy variety, "advanced biomass stove" referring to the more recent manufactured

For small and medium NGOs, production technology (e.g., machine manufacture) as well as production techniques (inventory management, transportation, sales and data collection) could stand improvement. Another bottleneck involves the stove marketing and distribution segments of the supply chain; more actors are needed and they need to be well trained and financed to fulfill their role.

Small and medium NGOs may be relying excessively on expectations of carbon credits to increase their production capacity (driven by demands of donors[30] and partners), which is risky. Many report that their margins without carbon or donor funding are too slim to cover transportation, marketing and after sales costs, which are needed to create a thriving business. According to SZ Consulting, record keeping and reporting by partner NGO's and SMEs on installed and functioning stoves is of variable quality, which has led to further investments in a network of local "managers." The transaction costs of monitoring and verifying ICS data from 200 partners could be prohibitive. A possible negative verification report, which would result in reduced carbon revenue, would discourage these players from continuing in the ICS programs and many small NGO's may abandon this program for other social assistance programs (health and sanitation for example). This problem of monitoring stoves to the level of rigor required for generating carbon revenue will likely become even more complicated once GIZ and SZ expand their program to include an additional 5,000 masons and sanitary shops as planned[31].

Due to uniform management structure, consistent record keeping, and ability to hire and retain qualified technicians, the larger actors, have fewer obstacles to contend with in monitoring and quality control of stoves. They have demonstrated the capability to expand production capacity to meet increasing demand, and have invested in expanding their networks of manufacturing plants and distributors, relying on potential carbon credits. Their extensive networks in rural areas also provide them a cost advantage in raising awareness and marketing their products. This space is currently rather sparsely populated with only Grameen Shakti and to a lesser extent VERC demonstrating significant numbers of sales. This limited participation can be explained by the absence at present of a national ICS program in Bangladesh comparable to what is available through IDCOL for SHS and domestic biogas. The existing GIZ program with a larger number of POs and average support of USD $4,000 per Partner Organization caters to smaller NGOs and SME partners. Should a national ICS program be initiated with the ability to attract larger players, a number of potential future POs, both NGOs and private enterprises, including those currently participating in the IDCOL programs, are likely to be interested in entering the stoves market. Bangladesh's large and well-established NGOs, such as BRAC Foundation and Proshika, are expected to have particular interest given their long involvement in biogas and other renewable energy technologies. In addition to promoting existing designs, these large players can also act as vectors for introduction of new higher-end stoves, since they have financial capacity to invest in adapting their production technology (to replicate imported models).

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variety, and the "effective improved stove" which is cheaper but closer in performance to the advanced biomass stove.

[30] Some small NGOs who participated of the UNDP program had to increase their production capacity to 1,000 stoves in a period of 3 months (source: EJAG and Asrayyan Sheba Sangstha, Dhaka 12/3/11).

[31] Although the program has already been approved and is on the process of being set in place, some basic details such as payment of carbon credits to local masons not having bank accounts has not, according to SZ consulting, yet been solved.

On the demand side, customers are seeking products that are available, affordable, and appropriate. ICS currently being sold in the market may not be what the demand is asking for, which might be a different kind of stove (a portable, lighter, easier to install, more versatile stove), of better quality and without additional parts susceptible to breaking (chimney, cap, grate). Stoves need to respond to demand.

For a more complete barrier analysis, see Appendix 3: Barrier Analysis.

Recommendations

Possible interventions in the stove sector can be classified as:

1) Market Intelligence,
2) Consumer Education,
3) Technical Standards, Testing and Certification
4) Product Development,
5) Policy and Regulation,
6) Business Development Support,
7) Access to Finance, and
8) Cross-cutting recommendations

Appendix 7, Opportunity Analysis seeks to roughly map the space for a proposed future USAID program to substantially expand the deployment of stoves in Bangladesh.

Our analysis suggests that USAID support will likely show excellent returns by investing in a broad sector program which includes all the main components listed (market analysis, consumer education, supporting technical standards and testing capacity, policy support, BDS support, and facilitating both carbon and commercial financing). GIZ, for instance, has yet to invest in introducing new designs, establishing testing centers, and in assisting the larger enterprises, hence USAID support in these areas would not be redundant.

Recommended actions are listed below for each of the components:

1. Market intelligence

Carry out a survey in partnership with stove companies and IDCOL/BCSIR to quantify and qualify the demand for improved cookstoves, both domestic and institutional, in rural and urban settings; and willingness of users to pay for ICS products available in the local, regional and international market. Make this market intelligence available to stove companies and promoters. A more in-depth report on the main market barriers which stand in the way of a vibrant demand-driven market for ICS would also be of use.

2. Consumer Education

Work with the Social Marketing Company to market appropriate products and develop messages to overcome the barriers which are currently inhibiting potential users from purchasing stoves. Also

explore linking up with existing USAID programs in the fields of biodiversity and conservation, health and sanitation, and gender, in order to spread awareness to the populations that those programs work with.

3. Stove Quality: Technical Standards, Testing and Certification

Provide support for performance testing (efficiency and emissions in both lab and field) and certification of stoves by both assisting in the establishment of well-equipped labs and in providing training for proper testing procedures. A technical group (similar to IDCOL's Technical Committee composed of academics, industry players and international advisers) needs to be given the responsibility for establishing technical standards for ICS promoted under the program and specifying testing, certification, and monitoring protocols to be followed both in the laboratory to assess technical performance and in the field to assess its actual performance. The Technical Committee would have the responsibility to decide which performance parameters in terms of fuel efficiency, emissions, durability, and safety, need to be tested for before a stove is certified as an acceptable product. The Committee will refer to the standards developed by the Alliance and other international bodies and take local conditions into consideration in determining the standards for Bangladesh. Laboratories and test centres which are qualified to perform tests and certification will themselves be certified by the Technical Committee.

4. Product Development

Further investigation into portable, attractive stove models is recommended. Some examples of stoves available elsewhere in the world have been included in Appendix 5. Once designs have been tested for performance (in the laboratory and in the field), and tested for cultural acceptability and affordability (using focus groups and pilot sales projects), efforts can be made to promote the designs, first among existing stove programs and producers and then among the general public.

5. Policy and Regulations

Work with GOB to implement its Renewable Energy Policy (2009) which endorses creating an enabling environment for renewable energy technologies and supports attempts to stimulate market development for improved cookstoves. Specific policies which would support the development of such a market are:

a) Avoid distorting the market through GOB funding of new programs which provide ICS free or at highly subsidized rates unless it is to easily identified ultra-poor households;

b) Endorse and provide the mandate for a capable national level organization, such as IDCOL, to coordinate the market development for ICS. Under the leadership of this mandated organization:

    a. Require performance testing of stoves to provide confidence to users;

b. Establish official cookstove adoption targets and financing mandates;

c. Remove customs from high efficiency imported improved cook stoves which are not currently manufactured in country.

Ideally, a capable organization with a good track record, like IDCOL, would be endorsed by GOB and agree to administer a national ICS program. However if such a competent GOB endorsed agency were not be found, a centralized model managed by the wrong organization could in many ways be worse than a decentralized approach. If IDCOL were to add ICS as a third program area to their off-grid renewable energy portfolio, a financing mechanism would need to be agreed from which POs can avail of credit to expand their operations. IDCOL has some of its own internal resources which it could invest in such a credit fund and it would expect investment from donors or GOB if additional resources would be required. IDCOL would also need funds from donors or GOB to cover its costs of carrying out quality control of products and monitoring installations. Identifying the right institution and building their capacity to take on these tasks could be one of the tasks under a USAID funded project. If IDCOL or similarly competent organization could not be convinced to take on the task of coordinating the national ICS program, it would still be possible for USAID to implement a program to support the commercialization of ICS in Bangladesh as a project but with more limited goals in terms of ICS numbers achieved and percentage of households reached.

6. Business Development Support

Link actors in the cookstove supply chain to 1) each other, 2) entrepreneurship education programs, and 3) a source of low cost or free business advisory, accounting and legal services.

Connecting actors to each other will foster business-to-business sales, collective lobbying for policy priorities, and peer-to-peer mentoring. General entrepreneurship programs should emphasize knowledge and skills in the following general domains: financial management and reporting, business planning, operations, marketing, and leadership. This should be supplemented with learning resources specific to carbon finance and cookstove management. Business advisory services can leverage global mentor networks in addition to local resources and should provide a stable, ongoing support system for cookstove actors. Business development support, in order to be effective, should be tightly integrated in the effort to foster access to finance.

7. Access to finance

Access to enterprise and carbon finance is important for efforts to scale up the cookstove sector. Enterprises need a combination of debt, equity, letters of credit, and overdraft facilities to manage their capital requirements while growing. This need is even more accentuated in the presence of carbon finance, which creates immense pressure for fast growth while simultaneously creating a sizeable lag in revenue realization.

There are a number of options for creating access to finance that is affordable to enterprises and suitable for their needs. 1) Local commercial banks or non-banking financial institutions, given the right

framework and incentive structure, may be convinced to lend to this sector. 2) A large development finance institution, multi- or bi-lateral agency, may agree to create a specific funding vehicle and contract its administration to another entity with experience in the sector. 3) It is possible to link the Bangladeshi cookstove sector to an impact investing platform and/or angel investing network that will facilitate the flow of financing. All of these options represent high value but also high touch interventions.

8. Cross-cutting Recommendation: Synergies with other USAID-funded programs

Synergies with USAID's environmental programs (biodiversity for example) need to be explored when designing the new ICS program. USAID's ongoing Integrated Protected Area Co-Management (IPAC) project contributes to sustainable natural resource management and enhanced biodiversity conservation in targeted forest and wetland landscapes in Bangladesh. It currently has a goal of installing some 42,000 improved cook stoves to reduce the burden within these landscapes. Consideration of forest management and biodiversity protection, in relation to fuelwood supply, may be included in future projects that also aim to reduce greenhouse gas emissions, preserve forests and soil, and insulate households from excessive fuel expenditures and collection burdens. Given that there is little empirical data relating increased use of ICS with decreased deforestation, it is proposed that a study be carried out jointly by the proposed clean cook stoves program and the follow on activity to USAID's IPAC project to carry out a study to investigate if such a link can be made.

Given USAID Bangladesh's priority to health and gender, it would be highly attractive if the role of ICS in contributing to health and gender benefits could also be quantified. Further activities should include attention to stove emission testing and monitoring, and behavior change issues associated with adoptions of any new stove designs not previously available in the Bangladeshi stoves market.

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Appendix 1: Illustrative Distribution Companies

Company V.1 – This first company has no access to finance. Two percent of its sales revenue is spent on marketing and 10% on vehicle hire for transporting the stoves.

		PROJECTIONS				
	2011	2012E	2913E	2014E	2015E	2016E
Sales forecast:						
Units of domestic stoves	4,125	5,500	6,875	8,250	8,250	8,250
Unit Price/ Domestic stove	$25.00	$26.25	$27.56	$28.94	$30.39	$31.91
Total Sales ($)	**$ 103,125**	**$ 144,375**	**$ 189,492**	**$ 238,760**	**$ 250,698**	**$ 263,233**
Cost of Sales						
Unit Cost/ Domestic stove	20.00	21.00	22.05	23.15	24.31	25.53
Prime Costs	82,500	115,500	151,594	191,008	200,559	210,586
Labor Costs	1,680	1,764	1,852	1,945	2,042	2,144
Total Cost of sales	84,180	117,264	153,446	192,953	202,601	212,731
Gross profit	**$ 18,945**	**$ 27,111**	**$36,046**	**$45,807**	**$48,098**	**$50,502**
Gross Profit Margin	18.4%	18.8%	19.0%	19.2%	19.2%	19.2%
Variable Operating Exp.						
Marketing/Sales	2,063	2,888	3,790	4,775	5,014	5,265
Vehicle hire	10,313	14,438	18,949	23,876	25,070	26,323
Total Var. Op. Exp.	**$ 12,375**	**$ 17,325**	**$ 22,739**	**$ 28,651**	**$ 30,084**	**$ 31,588**
Variable as % of Sales	12.0%	12%	12%	12%	12%	12%
Fixed Operating Exp.						
Salaries & related costs	8,400	8,904	9,438	10,005	10,605	11,241
Office expenses/maintainance	600	660	726	799	878	966
Auditing and Accounting	300	330	363	399	439	483
Bank Charges/other exp.	120	132	145	160	176	193
Total Fixed Op. Exp.	**10,120**	**10,026**	**10,673**	**11,362**	**12,098**	**12,884**
Total Operating Exp.	**$ 22,495**	**$ 27,351**	**$ 33,412**	**$ 40,013**	**$ 42,182**	**$ 44,472**
EBITDA	**(3,550)**	**(240)**	**2,635**	**5,794**	**5,915**	**6,031**
EBITDA Margin	-3%	0%	1%	2%	2%	2%
Interest	-	-	-	-	-	-
Depreciation	183	200	200	200	200	200
EBT	**(3,733)**	**(440)**	**2,435**	**5,594**	**5,715**	**5,831**
Tax	-	-	730	1,678	1,715	1,749
Net profit after tax	**$ (3,733)**	**$ (440)**	**$ 1,704**	**$ 3,916**	**$ 4,001**	**$ 4,081**
Net Profit Margin	-4%	0%	1%	2%	2%	2%
Add Back: Depreciation	183	200	200	200	200	200
Net Cash Flow to Owners	(3,550)	(240)	1,904	4,116	4,201	4,281

Company V.2 – This company is able to access a $20,500 loan to purchase a truck, a motorbike, and $7,000 more inventory. It spends 5% of its sales revenue on marketing, which has allowed it to increase its sales, and has the vehicle hire expenses replaced by a much lower loan payment, increasing their margins. With the higher margins and more working capital, the enterprise has been incentivized to increase its sales activity, driving net income considerably higher than in the first case. This model shows that the enterprise can also comfortably make its loan repayments and is not overly indebted.

		PROJECTIONS				
	2011	2012E	2013E	2014E	2015E	2016E
Sales forecast:						
Units of domestic stoves	4,125	11,000	13,750	16,500	16,500	16,500
Unit Price/ Domestic stove	$25.00	$26.25	$27.56	$28.94	$30.39	$31.91
Total Sales ($)	**$ 103,125**	**$ 288,750**	**$ 378,984**	**$ 477,520**	**$ 501,396**	**$ 526,466**
Cost of Sales						
Unit Cost/ Domestic stove	20.00	21.00	22.05	23.15	24.31	25.53
Prime Costs	82,500	231,000	303,188	382,016	401,117	421,173
Labor Costs	1,680	1,764	1,852	1,945	2,042	2,144
Total Cost of sales	84,180	232,764	305,040	383,961	403,159	423,317
Gross profit	**$ 18,945**	**$ 55,986**	**$73,945**	**$93,559**	**$98,237**	**$103,149**
Gross Profit Margin	18.4%	19.4%	19.5%	19.6%	19.6%	19.6%
Variable Operating Exp.						
Marketing/Sales	2,063	14,438	18,949	23,876	25,070	26,323
Vehicle hire	10,313	0	0	0	0	0
Total Var. Op. Exp.	**$ 12,375**	**$ 14,438**	**$ 18,949**	**$ 23,876**	**$ 25,070**	**$ 26,323**
Variable as % of Sales	12.0%	5%	5%	5%	5%	5%
Fixed Operating Exp.						
Salaries & related costs	5,011	8,400	8,904	9,438	10,005	10,605
Office expenses/maintainance	342	600	660	726	799	878
Auditing and Accounting	300	300	330	363	399	439
Bank Charges/other exp.	89	120	132	145	160	176
Total Fixed Op. Exp.	**6,442**	**9,420**	**10,026**	**10,673**	**11,362**	**12,098**
Total Operating Exp.	**$ 18,817**	**$ 23,858**	**$ 28,975**	**$ 34,549**	**$ 36,432**	**$ 38,422**
EBITDA	**128**	**32,129**	**44,969**	**59,011**	**61,805**	**64,727**
EBITDA Margin	0%	11%	12%	12%	12%	12%
Interest	-	2,226	1,840	1,316	733	127
Depreciation	183	2,200	2,200	2,200	2,200	2,200
EBT	**(55)**	**27,702**	**40,930**	**55,494**	**58,872**	**62,400**
Tax	-	8,311	12,279	16,648	17,662	18,720
Net Income after tax	**$ (55)**	**$ 19,391**	**$ 28,651**	**$ 38,846**	**$ 41,210**	**$ 43,680**
Net Profit Margin	0%	7%	8%	8%	8%	8%
Add Back: Depreciation	183	2,200	2,200	2,200	2,200	2,200
Less: Amortization	-	2,103	4,564	5,087	5,671	3,075
Net Cash Flow to Owners	128	19,488	26,286	35,958	37,740	42,805

Appendix 2: Market Players

1. End Users – Stove end users represent a wide ranging and heterogeneous mix. Fuel choice is governed largely by availability and price, but end users have much more complicated relationships with the actual cooking technology. They are influenced, but not uniformly, by a number of variables in addition to price. A study from Stanford University[32] suggests that gender might play a role when making purchase decisions. This argument is confirmed by other studies[33], stating that "it is usually men who decide the way in which energy is accessed". This should also be taken into account when designing social marketing campaigns (if research is done prior to the campaign, this should be easily identifiable).

2. Government – Government involvement has lacked strategic planning in its efforts during the past 20+ years, not only in the technology it has promoted (which was insufficiently tested), but also in the schemes used to distribute ICS (mainly subsidy-based).
    a. The Ministry of Environment recently set up a **Climate Change Trust Fund**, to which 100 million USD have been allocated annually, out of which some 78 million USD are to be allocated by the Climate Change Unit (Ministry of Environment) to various adaptation projects, funding namely a BCSIR III Phase ICS program (1.3 million USD). Statutory norms though, prevent private companies from benefiting from this fund.
    b. **BCSIR** published a public tender for seven ICS companies or NGOs to act as the program's regional implementers. We observed, throughout our interviews, a relative lack of knowledge of this ongoing process at stakeholder level.[34]
    c. **Ministry of Power, Energy and Mineral Resources** was involved in GIZ's first ICS program in 2004, in all policy related issues. There has not been continuity in regards to that involvement and no stakeholder interviewed mentioned the Ministry's involvement.

3. Donor Projects – Donors have followed mainly two paths: the fully subsidized one (UNDP, aimed at very poor populations, selling ICS at 90BDT) or the market-based scheme (GIZ, Practical Action). The German Federal Ministry for Economic Cooperation and Development supported the "Sustainable Energy for Development" program implemented by GIZ from 2004 to 2010. USAID funded for the "Indoor Air Pollution Program" implemented by Winrock, VERC and Concern Worldwide from 2005-07. KfW and SNV support the National Domestic Biogas and Manure Program which is implemented by IDCOL. The World Bank, Global Environment Facility, KfW, GIZ, and the Asian Development Bank support the Rural Electrification and Renewable Energy Development Program which is focused on solar home systems.

[32] Intra-household externalities and low demand for a new technology: experimental evidence on improved cookstoves", Grant Miller and A. Mushfiq Mobarak- November 2011
[33] Practical Action (2010) *Poor People's Energy Outlook 2010*. Rugby, UK.
[34] Important partners such as SNV had not been informed of these GOB activities.

GIZ: their project on ICS derived from the USAID funded project on illegal logging and promotion of IGA. It has worked since then with 200 NGOs and entrepreneurs (90% NGOs) providing training (BDS) and financial support (down payment of 400- 500 BDT per stove sold was given to its PO's, which did not transfer the subsidy onto the consumer but used it to fund its marketing activities[35]). Monitoring of sales is currently being done within the JP Morgan partnership with SZ Consulting (under CDM), a spinoff of the GIZ ICS project[36] that works with those 200 partners built up by GIZ. In this regard, GIZ did not get involved in carbon finance, beyond merely bringing partners together, because it is a private sector area. GIZ continues the BCSIR tradition of promoting only those stoves which have chimneys. Although GIZ has promoted 1-, 2- and 3-pot cookstoves in the past, their preference is currently for the 1- or 3-pot stoves since there are significant risks of lowering stove efficiency if the second pot hole (in the 2-pot stoves) is left open.

USAID/Winrock/VERC/Concern Worldwide: Another enterprise-based ICS program is the USAID-funded Project "Reduction of Exposure to Indoor Air Pollution through Household Energy and Behavioral Improvements," jointly implemented, from 2005 to 2007, by Winrock International, VERC, and Concern Worldwide Bangladesh in the northwest of Bangladesh. The main objective was to increase awareness of indoor air pollution, change household energy behaviour, and promote a commercial market for improved cookstoves through entrepreneurs. The program disseminated 580 improved cookstoves during the project period and a number of entrepreneurs continue to be in business selling stoves. VERC led the technology component of the program. Concern Worldwide developed behavior change messages and disseminated these messages through health volunteers, ward health committees, and municipal governments. The Appropriate Rural Technology Institute (India) collaborated with Winrock and VERC and undertook improved cookstove testing. Local municipal authorities were engaged for awareness raising, and members of the government's network of health volunteers were trained to promote behavior change messages for indoor air pollution reduction and use of improved cookstoves. This program promoted three types of improved cookstoves: one-pot portable and two-pot cookstoves (based on BCSIR models), and the Grihalaxmi, a one-pot stove without a chimney developed from a model from the Appropriate Rural Technology Institute, with a top grate that acts as a flame concentrator and a cast-iron bottom grate.

UN Habitat and UNDP: They have focused on providing improved cookstoves to the ultra-poor populations which are most vulnerable to natural disasters such as cyclones and floods. The stoves are around 90% subsidized and users only pay around BTK 90. The program receives technical support from GIZ since the stoves are supplied by NGO

[35] This information was contrasted during POs interviews, such as EJAG (on 12/03/11).
[36] SZ Consulting is a non for profit private company, whose owner is Dr. Khaleq, GIZ ICS Program Manager.

partner organizations of GIZ. Interviewed NGOs did not see the high subsidy distorting the market for commercial stoves since the very poor were clearly identified by UNDP. Over 40,000 subsidized stoves have been installed and UN Habitat is preparing a follow on program for another 400,000 stoves.

4. Private Sector Stove Suppliers by Type of Involvement
    a. Stove manufacturers – Bangladesh is a unique example of NGO involvement in market driven initiatives. We find many small (EJAG), medium (Hilful Fuzul) and large (Grameen Shakti, VERC, BRAC) NGOs working to promote ICS adoption by vertically integrating their value chains (from production to retail). Private manufacturers (Rahman Renewable Energy Company, Sidiqqi Sanitation) are small to medium size, the latter usually working also on other RE technologies (biogas, SHS). For more information on NGO and private entrepreneurs please refer to interview minutes. The largest more significant example is Grameen Shakti (GS):
        i. GS started its solar program in 1996, biogas in 2005 and ICS in 2006, having reached sales, by 2011 of 400,000 stoves. In February 2010 they introduced the concrete stove. They have 188 offices dedicated exclusively to ICS and 1,348 offices across the country. They work directly with end users, manufacturing all their products, selling and installing them (vertically integrated value chain). They conduct internal trainings for their own staff. They are currently losing money on this enterprise and are subsidizing operations from internal resources and advance carbon revenue. They have been forced to shut down 6 production centers for continued loss. They accept a zero marginal profit on ICS because they are claiming carbon credits (via the JPMEVC CDM project), resulting in approximately USD $10/stove/ year (equivalent of 1 T of CO2/ year), which should translate in some USD $5 million. They have done a big investment in the past few years which they expect to fully recover in the next few years with carbon credits.
        ii. Hilful Fuzul: They have moved away from the NGO approach to a “social business” one, where products sold are done on a market based approach (generating profit) but are chosen in terms of their social benefits. They also work in increasing access to finance for rural women. Their profits are used only to further develop the organization (a not-for-profit company). Mr. Rufiq Al Islam, the owner, believes most of the NGOs will be shifting to a social business approach, in order to be sustainable and in the light of decreasing ODA. An ICS standalone program cannot function (margin in 2011 is 1% or less due to increase in materials, in 2010 was 5%): it needs support from other RE technologies, such as solar home systems (SHS). His marketing strategy is to pair up SHS with ICS, offering discounts and free ICS based on the purchase of a SHS:

ICS	1 POT	2 POTS	W/ SHS
CONCRETE	1000 BDT	1,500 BDT	- 50%
BRICK	4- 5,000 BDT	6- 7,000 BDT	- 40- 30%
MUD	780 BDT	N/A	FREE

He also applies various discounts depending on the size of the SHS, for example:

- On a 2 light SHS (sells at 10,000 BDT), he offers a discount of 20-40% on an ICS built with bricks (aimed at higher income households).
- On a 3 light SHS that he sells for 20,000 BDT, he makes a profit of 4,000 BDT (15- 20% margin), so he offers a free mud ICS.

He also facilitates microcredit, for which he has partnered up with Palli Karma Sahayak Foundation, a GOB institution.[37] He pairs up a free ICS with micro finance for solar home systems institutions.

Target population	Type of microloan	Amount of loan	Interest rate
25%- very poor	"Hardcore poor"	4- 7,000 BDT	8%
60%- average	End User Microcredit	< 50,000 BDT	12.5%
15%- small business	Microenterprise Loan	> 50,000 BDT	12.5%

In relation to carbon credits, he is also a partner with SZ but has not yet received any money, so he's quite disenchanted.

b. Providers of End-User Credit – Most of the POs interviewed have developed end-user microfinance (MF) schemes, to give access to other RE technologies (SHS and biogas). These schemes represent a significant overhead cost for companies to apply it to ICS alone. It is recommended to pair up ICS with other technologies (through discounts on sales or free ICS when purchasing a SHS or a biogas plants) and use carbon credits to fund overhead costs related to financing for end-users (for example coordinating the monitoring calendar with collection of payments).

[37] PKSF was selected in 2010 by the CCU, as the organization through which channel funds from the CCTF to NGOs. Source: interview with CCU, 12/08/11.

c. Carbon Project Developers – The potential for improved stove projects to generate carbon revenue has attracted international private sector investment into this sector. J.P. Morgan Venture Energy Corporation (JPMVEC) has registered the world's first CDM Program of Activities (PoA) for improved cookstoves in Bangladesh with the objective to, during the course of 28 years, transform the kitchens of households through the sale and distribution of ICS by the Partner Organizations ("POs"), the target being to install 500,000 ICS during the first two years of the PoA and an additional 500,000 ICS per year thereafter. As the coordinating/managing entity for the PoA, JPMVEC coordinates the efforts from different POs to distribute ICS in Bangladesh. POs act as Activity Implementers and sell ICSs on a commercial basis. POs receive technical support from JPMVEC to disseminate and guarantee quality of ICS. The two POs named in the PoA documentation are Grameen Shakti and SZ Consultancy, both having received advance payments, although not all POs having signed contracts with SZ have received funds at the time of writing of this study. Once the first verification of the credits takes place, it is likely that many other initiatives will be launched in Bangladesh, either in the voluntary or compliance markets. Carbon credits need to be further regulated, so as to ensure that the benefits reach all the way down to the end-user, benefitting not only the set up of an ICS market, but also facilitating access to cleaner cooking technologies for the broader population.

Appendix 3: Barrier Analysis

The table below attempts to list the primary barriers for stove market and then rank them by importance. Measures for addressing these barriers are listed and totals and weighted averages calculated.

			Adressed By...						
Barrier	Importance	Applicability	Access to Capital	Business Dev. Support	Stove Technology	Awareness	Policy & Reg	Testing	Other
Customers have difficulty determining quality	3	Broad				1 Public education	1 Standards put into practice and made available to all	1 Testing for certification	
Sellers struggle to distinguish their brand	1	SME Sector		1 Brand development and marketing services					
High transportation costs for a bulky, low margin good	3	Broad	1 Vehicle financing						
Inconsistent quality of production	2	SME Sector	1 Financing to upgrade production methods	1 Technical Assistance				1 Cheaper, available testing facilities	
Mismatch of production timelines to actual sales	1	SME Sector		1 Support for forecasting, supply management					
High upfront cost of other stove design might deters some customers	2	Broad	1 Carbon-based end-user finance schemes						
Expansion financed slowly through retained earnings and subsidies	2	SME Sector	1 Access to credit						
Stove acceptability based on cultural practice	2	Broad			1 More 2nd generation designs needed that address cultural issues				
Limited business skills (eg separate accounting practices)	2	SME Sector		1 Entrepreneurship support					
Simple Totals			**4**	**4**	**1**	**2**	**1**	**2**	**0**
Weighted Average			**0.27**	**0.18**	**0.06**	**0.12**	**0.09**	**0.15**	**0.00**

Appendix 4: Interviewees

Name of Partner	Improved Cook stove related activities
Asrayyan Sheba Sangstha Contact: Ms. Suria Nargis, Executive Director E: sangstha@yahoo.com T: 88-04227-78318 M: 88-01711-018984	Local NGO actively involved in manufacturing stoves and chimneys and marketing ICS since 2008. They have trained manpower and built 1700 domestic and 20 commercial cookstoves through active marketing. Targets rural populations; regular monitoring; stoves built are made of concrete that are manufactured by using prefabricated die sets.
ESHO JATI GORHI (EJAG) Contact: Ms. Nazma Akter, Executive Director E: ashojatigore@yahoo.com T: 88-0631-62212 M: 88-01710-880987	Local NGO working to raise awareness on improved cook stoves (through GIZ support) and biogas.
Grameen Shakti Contact: Mr. Abser Malik, Acting Managing Director E: g_shakti@grameen.com T: 88-0280-35345 M: 88-01711-567042	Largest single producer and retailer of improved cookstoves, GS, part of the Grameen group, is one of the JPMEVC partners, and has been working since 2004 in increasing sales of ICS so as to reach scale. It forecasts sales of 440,000 stoves by the end of 2011 and has committed to sales of another 500,000 cookstoves by 2013 (as per the CDM program).
GIZ Bangladesh Contact: Mr. Eric O. Gomm, Program Coordinator Sustainable Energy for Development E: otto.gomm@giz.de T: 88-0966-6701 181 M: 88-01713-035813	The German development agency has been the main driver in Bangladesh for the promotion of ICS, working with a network of more than 200 partners over 7 years and reaching sales of 45,000 ICS. It is now expanding its partnership to sanitary shops and masons.
Hilful Fuzul Samaj Kallyan Sangstha Contact: E: T: M:	Local NGO involved in dissemination of improved cookstoves and biogas technology through support from GIZ. Has installed around 16,000 household and institutional ICS since Dec 2008.
Local Government Engineering Department (LGED) Contact: Engr. Partha P. Sarkar	Government department involved in implementation of biogas program that led to installation of 15,000 household and institutional plants from 1998-2003. They have over 500 offices

Project Manager, Sustainable Rural Energy E: ppsarkar86@yahoo.com T: 88-0281-44058 M: 88-01911-577877	at the district and sub district levels throughout the country.
Practical Action Bangladesh Contact: Engr. Uttam K. Saha, Program Manager, Infrastructure Services Program E:uttam.saha@practicalaction.org.bd T: 88-0286-50439 M: 88-01556-323066	International NGO involved in capacity building, raising awareness and implementing improved cookstoves dissemination projects in Bangladesh since 2001 in collaboration with BCSIR, Climate Care, DFID, DGIS, GVEP that has led to training of hundreds of NGOs and people, and installation of more than 7,000 improved cook stoves.
Rahman Renewable Energy Co. Contact: Mr. Redwanoor Rahman, Managing Director E: redwanoor@gmail.com M: 88-01911-058095 M: 88-01712-586110	Local private company involved in installation of more than 500 household biogas and 1200 improved cookstoves with support from SNV and GIZ.
Resource Development Foundation (RDF) Contact: Md. Abul Kashem, Director E: abulkashm2007@yahoo.com M: 88-01733-065517 M: 88-01716-966466	Local NGO working as a development partner for GIZ in dissemination of improved cookstoves (Bondhu Chulha) and training local technicians. Has installed more than 5,000 ICS since 2009.
SZ Consultancy Services Ltd. Contact: Mr. Md. Khalequzzaman, Managing Director E: sz@szbd.info T: M: 88-0181–9499778	One of two local Project Participants in the JP Morgan registered PoA with the responsibility to aggregate and monitor results of GIZ's 200 POs.
Village Education Resource Center (VERC) Contact: Mr. Anowar Hossain Mollah, Project Coordinator, Climate Change and Health E: verc@bangla.net T: 88-0277-10412 M: 88-0171–6540181	VERC is a local NGO that has been working on ICS program since 1987. It formed a national network named "Improved Cookstoves Program in Bangladesh" in the year of 2000 with the support of ARECOP-Indonesia. The Network involves 93 NGOs working across 28 districts in the country and has a 17-member Executive Committee led by VERC. Through the network, approximately 42,000 improved cookstoves have been installed, 20 demonstration centers have been established, and 864 staff and community people have been oriented on ICS technologies.

	VERC has been implementing a project entitled "Development of an Improved Cookstoves Project to Secure Carbon Finance for its Long Term Sustainability" since June 2008. More than 6,300 improved cookstoves have been installed through this program. VERC's target is to disseminate 114,000 ICS in 13 districts by 2015 for 592,800 people. There are about 40 staff have been involved with the ICS program of VERC. 9 staff members have received advanced training on ICS technology from abroad. Besides this, more than 125 stove builders have been developed at the field level by VERC who are active in the field. VERC has also developed 13 improved cookstove models.
Women Development Program Contact: E: T: M:	Local NGO working to promote ICS as a way to improved health of women and children. Organized around 500 kitchen management trainings benefiting more than 9,000 women. Among the several trained, 22 women work as ICS technician/installers.
IFC Contact: Mr. Md. Taif Ul Islam, Operations Analyst, SEDF E: MIslam5@ifc.org T: 88-0288-33752 M: 88-0171–4169350	IFC has been decisive in advocating before the Central Bank for concessional rates for farmers to have access to improved energy production via the installment of biogas plants, which has driven the RE market and opened opportunities for other technologies.
Eastern Bank Ltd. Contact: Md. Khursed Alam E: Head of Business, SME Banking T: 88-0271-19605 M: 88-0172–9220055	Local commercial bank, working with IFC in facilitating access to finance for poultry farmers, following Central Bank circular norms.
IDCOL Contact: Mr. Islam Sharif, CEO E: islamsharif@idcol.org T: 88-0291-02171-8 M:	GOB created non-banking financial institution that brings finance to enterprises and NGOs to work on RE technologies, having succeeded in creating a viable market for SHS.
CCU (CCTF) Contact: Mr. Md. Rashadul Islam, Director, Climate Change Unit, Ministry of Environment & Forests E: rashadul62@gmail.com T: 88-0295-15503	The Unit, part of the MoE, is responsible for managing the CCTF. Private companies are ineligible for this Fund.

M: 88-0172–9094218	
Bangladesh Council of Scientific & Industrial Research (BCSIR) Contact: Dr. Md. Abdur Rouf, Principal Research Officer, Institute of Fuel Research and Development E: roufmd@yahoo.com T: 88-0286-13022 M: 88-0155–6318036	GOB scientific research institution, responsible for the first initiative on ICS in Bangladesh, promoting subsidies-based schemes. BCSIR developed over thirty ICS designs. The performance efficiency for BCSIR stoves was reported to be 25–28 percent, which reduced fuel consumption by over 50 percent compared to traditional stoves. Among these designs the one-pot, 2-pot, and 3-pot fixed clay stoves with chimney were promoted as part of the earlier BCSIR programs. BCSIR is working in its III Phase program to be implemented by 7 partner NGOs and companies.
Sidiqqi Sanitation Contact: E: T: M:	Medium size company, engaged in the production and distribution of ICS. It has been involved in many of the existing ICS programs, and has tried to build up a network of manufacturing local plants to reduce structural costs.
Social Marketing Company (SMC) Contact: Mr. Ashfaq Rahman, Managing Director E: a.rahman@smc-bd.org T: 88-0281-1423-29 M:	Social marketing company, having worked in the past with USAID in reproductive health social marketing campaigns. SMC is also a manufacturer and distributors of products marketed.
SNV Contact: Mr. Rajeev Munankami, Senior Advisor E: rmunankami@snvworld.org T: 9102171-8 (ext 41) M:	This international partner based in the Netherlands has successfully supported the setting up of a domestic biogas program within IDCOL and has brought technical assistance to RE entrepreneurs. It's planning on expanding its RE portfolio to ICS.

Appendix 5: Stove Types Most Used in Bangladesh

A. Improved Stoves

1Pot Concrete Bondhu Chulha with concrete grate promoted by GIZ	2 Pot Mud Stove BCSIR Model promoted by VERC	3 Pot Mud Stove promoted by GIZ
A cement 'T' to take chimney out from side wall instead of roof from a GIZ PO	3 Pot Bondhu Chulha with cement grate promoted by GIZ	Chimney in 2 parts with a door in the upper part to help clean chimney promoted by GIZ

B. Traditional Stoves

1 pot traditional partly submerged stove without chimney	The semi-enclosed verandah that serves as kitchen in rural households	Annual storage of fuelwood in a village household

Other stoves available outside Bangladesh

Beyond promoting the widely used Bondhu Chulha and the earlier BCSIR designed ICS, on which it is based, there have been no new initiatives in Bangladesh to design new stove models or to introduce well designed portable or fixed stove models that sell well globally or regionally in other parts of South Asia. Implementers of ICS programs have assumed that the existing designs fully meet local cooking needs and that prospective users in Bangladesh will either not find the new designs acceptable or will be unable to afford them. Countries, such as China, India, and Kenya, which have large dynamic stove markets all provide consumers a range of stoves to choose between. At this crucial point when there is interest in dramatically scaling up access to ICS in Bangladesh, it is instructive to examine the experience with the market development of different stove designs in neighboring India.

This experience, outlined below, shows that different consumers are likely to choose a variety of stove designs if they are available and that it may be pilot test some of the more popular ones in Bangladesh as part of the proposed USAID project.

1. After India's first stove program, National Program on Improved Cookstoves (NPIC) which promoted fixed stove designs with a chimney, was formally closed in 2000, some stove entrepreneurs and many stove companies introduced new portable stove models of their own design. These stoves were well accepted by the consumers because of their many advantages and excellent performance. Realizing the consumer demand and advantages of a well-designed portable stove, the present Indian government stove program, National Biomass Cookstove Initiative (NBCI), is also promoting portable domestic cookstove models. Several portable stove models, of both international and domestic design, were tested at the government testing centers and passed the performance standards set by Bureau of Indian Standards. Some of the more popular stoves which were approved by the Indian government and have been performing well in the Indian market are also likely to be attractive to consumers in the Bangladesh market.
2. The climate, geography, food and cooking habits, fuel used, and cooking pots in many parts of India are similar to that of Bangladesh. This makes it possible to predict, based on the India experience, which stoves are likely to perform well in Bangladesh. However the stoves do need to be pilot tested in Bangladesh to ascertain market demand for them in Bangladesh.
3. Advantages of portable stoves are they are very suitable for commercialization being mass produced in a factory as per specification and usually made of metal and/or ceramics and it is difficult for users to modify their dimensions. They tend to be lighter, are easy to transport in large quantities to different markets where they can be sold. Larger "built in" stoves require the services of trained artisans for installation and cannot be sold on the open market.
4. Another reason portable stoves could be attractive in the case of Bangladesh is that they can easily be moved inside the house during the monsoon season; and during natural calamities (floods and cyclones) the stoves can be easily carried along with the other household items if they need to relocate.

None of these stoves listed below have a chimney but they have clean combustion hence emissions are low (follow up testing is necessary to confirm this), along with being efficient and using less fuel. The argument to consider chimneyless stove options in Bangladesh stems from the fact that in majority of the rural homes in India and Bangladesh cooking is done in a semi covered verandah – one end of the verandah is covered on three sides with low mud wall (100cm) up to waist level and then from waist up to roof thatching or tin it is jute cloth/palm fronds etc. In certain homes with larger compound area the kitchen is separated from main house and that too is fashioned in a similar way with low mud walls. In such cases where the stove is in a verandah or a separate semi covered space, the need for a chimney to remove air pollutants from the living quarters is not as critical. Thus all the associated problems with chimneys regarding proper installation, cleaning, and clogging are also eliminated. It has been noticed that in many cases the stove project implementers have convinced the users to install the stove inside the home so that chimneys can be installed which can result in higher levels of indoor air pollution than if they had installed a chimneyless stove outdoors, especially if the chimney gets clogged—we certainly want to avoid this outcome.

In Bangladesh there is a demand for biomass stoves both in the urban /peri-urban market as well as in the rural market. It is likely that urban consumers will be able to afford the higher end portable stoves with extremely low emissions. Rural consumers are likely to favor lower cost stoves. Examples of both are listed below.

URBAN/PERI URBAN Market

The Philips Forced draft stove

Location, continent: Asia
Location, country: India

Stove information

Model: Improved
Application: Households – Rural & Urban
Type of stove: Gasifier, Portable
Fuel: Branches, Briquettes, Twigs, Wood
Number of people served: 6
Utensils: All types of utensils

Construction

Materials: Ceramic, Metal
Designer: Philips Electronics
Construction method: Manufactured in a factory near Delhi

Dissemination

Availability: Commercially available
Distributors: Sold through rural marketing chain
Price in US$: $100 approximately
Start date: Oct 13, 2010
Project/Program or commercial distribution: 2004 - ongoing
Number of stoves sold or distributed: 700

Performance

Efficiency: 40-42%
Fuel saving: 50%
Duration of cooking session: 12-15min
Emissions: Very low emissions

The First Energy Forced draft Oorja pellet stove.

Location, continent: Asia
Location, country: India
Location, specifics: Tamil Nadu

Stove information

Model: Improved
Application: Households
Type of stove: Portable
Fuel: Pellets
Utensils: Flat based vessels, Pot bellied pans and pots

Construction

Materials: Other metal
Designer: BP Oorja
Construction method: Manufactured at a central production factory and then distributed across India through regional sales channels

Dissemination

Availability: Commercially available
Distributors: Samruddhi retail sales (Tamil Nadu - Villgro)
Price in US$: $28
Start date: Aug 5, 2009

Performance

Fuel saving: 40 %
Duration of cooking session: 30 min
Turn down ratio: 4

The Envirofit rocket stove

Location, continent: Asia
Location, country: India

Stove information

Model: Improved
Application: Household & Institutional, Rural & Urban
Type of stove: Portable
Fuel: Branches, Briquettes, Charcoal, Wood
Number of people served: 10
Utensils: Aluminium, Steel, Copper, Pressure Cookers

Construction

Designer: Envirofit
Construction method: The stoves are of various models few of which have refractory chamber and few of which have metalic chamber, they help in reducing the toxic emissions up to 80%, reduce the fuel consumption up to 50% and reduce the time spent in cooking up to 50%. They are portable and come with warranties ranging between 1-5 years based on the model. They work with any biomass fuel.

Dissemination

Availability: Commercially available
Distributors: Distributors in South India (Karnataka, Andhra Pradesh,Tamil Nadu, Kerala) and also Maharashtra, warehouses as well.
Price in US$: $20 - $50
Start date: Jan 16, 2008
Project/Program or commercial distribution: The current channel has been through the Distributor - Dealer network comprising of retail shop owners, village entrepreneurs, local NGO's, self help groups and in Karnataka also supported by MFI.
Number of stoves sold or distributed: 96,000

Performance

Efficiency testing method and who did it: The testing was done by Professor Kurchania of Maharana Pratap University, Udaipur, India
Efficiency: 36%
Power rating of the stove in KW: 1.57 KW
Fuel saving: 50%
Fuel consumption in g/l: 200
Duration of cooking session: 22min
Turn down ratio: 4
Emission testing method and who did it: The testing was done by Professor Kurchania of Maharana Pratap University, Udaipur.
Emissions: CO: 150-264 ppm, CO2:1400-1600 PPM, TSP: 1.3g/m3

Contact details

Contact person: Harish Anchan
Contact info: 91-09343333722-Mr. Harish Anchan

RURAL Market

The Envirofit rocket stove (see previous description)

The Vivek sawdust stove

Location, continent: Asia
Location, country: India

Stove information

Model: Improved
Application: Households, Rural
Type of stove: Portable
Fuel: Saw dust
Utensils: All types of standard cooking utensils

Construction

Materials: Other metal
Dimensions: 220x265
Designer: Appropriate Rural Technology Institute, Pune, India
Construction method: The stove is fabricated from mild steel sheet

Dissemination

Availability: Commercially available
Distributors: The sole distributor is:
Samuchit Enviro Tech Pvt Ltd
6, Ekta Park Co-op Hsg Soc,
Behind Nirmitee Showroom, Law College Road,
Pune 411 004, India
Fax: 91 20 25460138
Email: samuchit.envirotech@gmail.com

Price in US$: $15, 2009
Start date: Jan 1, 2003
Project/Program or commercial distribution: Distribution is mainly through NGOs, SHGs, exhibitions, sales counters in weekly markets, etc.
Number of stoves sold or distributed: 5000

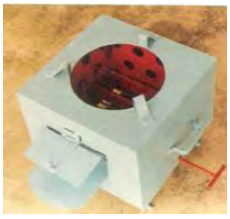
Performance

Efficiency: 25%
Fuel consumption in g/l: 138
Duration of cooking session: 40 min for 5 l water
Emission testing method and who did it: Emission testing was done at Aprovecho Research Center, using Emissions Collection Hood.
Emissions: CO: 17.6 g, PM: 1381 mg

Contact details

Contact person: Dr. Priyadarshini Karve (samuchit.envirotech)
Website: www.samuchit.com

The Harsha Multifuel Portable stove



Location, continent: Asia
Location, country: India

Stove information

Stove ID: INDIA PATENT NO-166168
Model: Improved
Application: Households
Type of stove: Portable
Fuel: Branches, Briquettes, Charcoal, Coal, Dung cakes, Pellets, Twigs, Wood
Number of people served: 10
Utensils: Both flat and round bottom pots

Construction

Materials: Metal
Dimensions: 262X262 X268
Designer: S.KHUNTIA, Scientist, IMMT (formerly RRL), CSIR, Bhubaneswar - 751013, India
Construction method: Made out of mild steel sheets or any other metallic sheet as per drawing. All parts are welded together to form a stove. It is a chimneyless portable stove.

Dissemination

Availability: Commercially available
Distributors: More than 50 small scale manufacturers, approved by MNRE (formerly DNES/MNES), Govt of India, in different states of India. The stoves were propagated under NPIC through nodal state govt agencies, like OREDA-Orissa, WEBREDA-West Bengal etc in different states of the country.
Price in US$: $11, 2009
Start date: Jan 1, 1990
Project/Program or commercial distribution: More than one million stoves sold in different parts of the country under NPIC programme of DNES/MNES, Govt of India through its state nodal agencies.
Number of stoves sold or distributed: 1,000,000

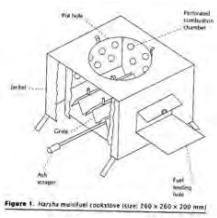
Performance

Efficiency testing method and who did it: Tested by Technical Back-up Units at IIT-Delhi, RRL(CSIR), Bhubaneswar as per approved method of DNES (presently MNRE), Govt of India, and approved by DNES (presently MNRE), Govt of India for propagation under NPIC in the country during the year 1990. Water Boiling Test. Efficiency: Wood: 31%, Dung cake: 42%, Bagasse: 34%, Raw coal: 24%
Efficiency: 31%
Power rating of the stove in KW: 1.13 to 1.65 KW
Fuel saving: 50%
Fuel consumption in g/l: Wood, dung cake & bagasse: 1.2 kg/hr, coal: 0.70 kg/hr
Duration of cooking session: 2 hrs test period. Water boiling time: 2.7 to 3.25 min/lit as per fuels
Turn down ratio: 1
Emission testing method and who did it: Tested by TBU-IIT-Delhi and RRL (CSIR), Bhubaneswar, Govt of India. Gas analyser, GLC for measurement of Carbon monoxide & carbon dioxide, TSP.
Emissions: CO/CO2= less than 2%, TSP= less than 2.25 gm/m3

Contact details

Organization email: skhuntia@immt.res.in
Contact info: S.KHUNTIA, Scientist – G & Head, Design & Rural Technology, Institute of Minerals & Materials Technology (formerly RRL), CSIR, Bhubaneswar - 751013, e-mail: khuntias@gmail.com, khuntias@yahoo.com, skhuntia@immt.res.in
Website: www.csir.res.in, www.immt.res.in

Drawings



Philips Natural Draft Stove

Location, continent: Asia
Location, country: India

Stove information

Stove ID: 4008
Model: Improved
Application: Households, Rural & Urban
Type of stove: Portable
Fuel: Wood
Number of people served: 6
Utensils: All normally used household cooking utensils in Indian kitchen, e.g. roasting pan, Kadhai (fry pan), steam (rice) cooker, utensils having minimum base diameter of greater than 100mm

Construction

Dimensions: Ht320mm, 310mm Base dia.
Designer: C.G.Ashtamkar
Construction method: Stable pot rest
Steel burning chamber with natural draft ventilation for best fuel combustion

Efficient mechanical flame control system
Portable
Sturdy base

Dissemination

Availability: Commercially available
Distributors: In the process of launching
Price in US$: $22, 2010
Start date: Apr 15, 2010
Project/Program or commercial distribution: Pilot Marketing: distributed 250 stoves through NGO network
Number of stoves sold or distributed: 250

Performance

Efficiency testing method: lab test
Power rating of the stove in KW: 2.8 kW (on solid wood)
Fuel saving: 27%
Fuel consumption in g/l: 162
Duration of cooking session: 24min/5ltr water
Turn down ratio: 4
Emission testing method and who did it: Emission testing method used - WBT of the University of California Berkeley
Testing is performed at Philips research lab at Netherlands and by ARTI, Pune at Philips Lab as well as at field
Emissions: CO:2.89PPM

Appendix 6: Main results from the EPA (PCIA)-sponsored Bangladesh WBT/CCT (Water Boiling Test/ Controlled Cooking Test) training workshop, led Aprovecho Research Center and facilitated by Winrock International at the VERC Center (Savar, Bangladesh), December 2011.

A stove testing workshop was conducted at VERC Center in Savar, Bangladesh by PCIA in collaboration with Aprovecho Research Centre in December 2011. The workshop gave an opportunity to test some of the popular stove models in Bangladesh. The stove models tested were as follows:

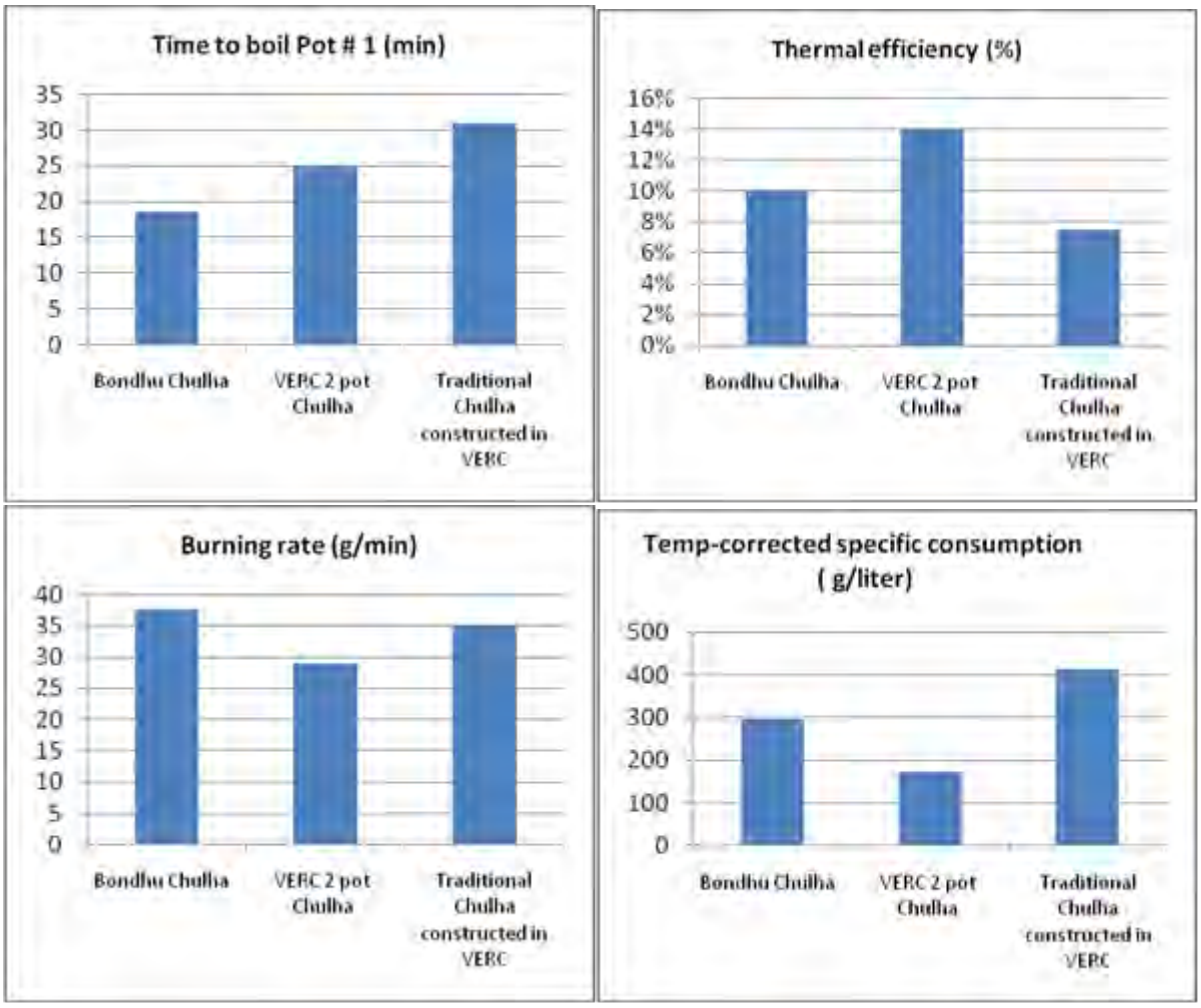
- Bondhu 1 Pot Chulha (with chimney) made with cement
- VERC 2 Pot Chulha (with chimney) made with clay
- A traditional clay stove without chimney constructed in situ by VERC employees. The particular traditional stove that was tested was quite different in terms of design principles (the diameter and depth of the combustion chamber and the width of the pot channel gaps) compared to the usual traditional stoves found in Bangladesh.

The WBT results of the three types of stoves are as follows:

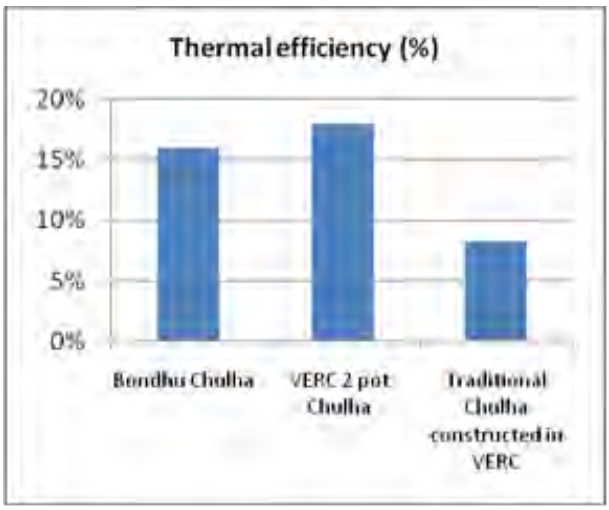
1. HIGH POWER TEST (COLD START)	**Units**	**Bondhu Chulha**	**VERC 2 pot Chulha**	**Traditional Chulha constructed in VERC**
Time to boil Pot # 1	Min	18.5	25	31
Burning rate	g/min	37.7	29	35
Thermal efficiency	%	10%	14	7.5
Specific fuel consumption	g/liter	288.1	179	434
Temp-corrected specific consumption	g/liter	295.6	174	415
Firepower	Watts	11560	8880	10636
2. HIGH POWER TEST (HOT START)	**Units**			
Time to boil Pot # 1	Min	18.5	20	22
Burning rate	g/min	26.2	29	37
Thermal efficiency	%	13%	17	9.5
Specific fuel consumption	g/liter	207.3	150	327
Temp-corrected specific consumption	g/liter	210.9	145	317
Firepower	Watts	8027	8842	11303

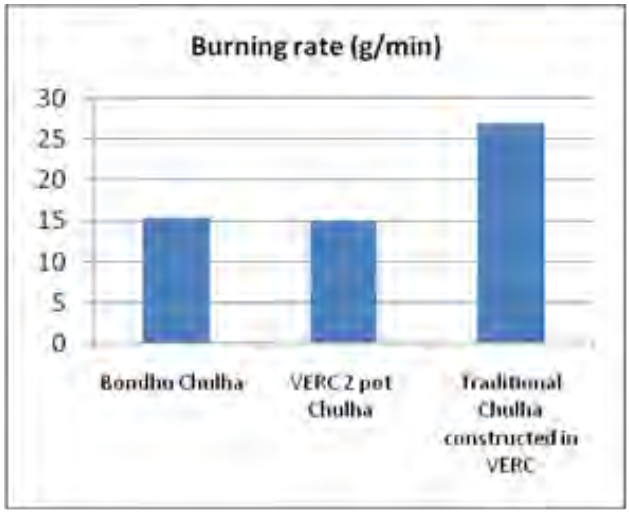
3. LOW POWER (SIMMER)	Units			
Burning rate	g/min	15.3	15	27
Thermal efficiency	%	16%	18	8.3
Specific fuel consumption	g/liter	483.0	228	672
Firepower	Watts	4686	4651	8301
Turn down ratio	--	2.43	2	1

Comparison of High Power (Hot Start) Results of the three Bangladesh stoves mentioned above



Comparison of Low Power (Simmer) Results of the three Bangladesh stoves mentioned above

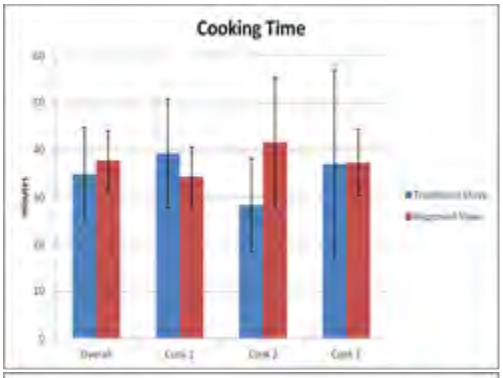


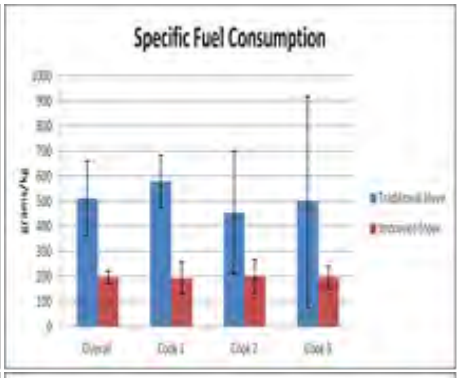


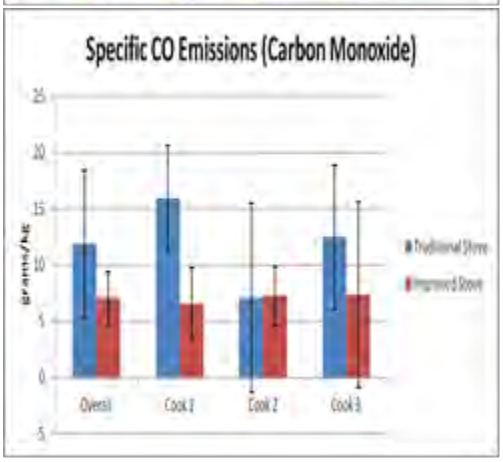
RESULTS FROM THE CONTROLLED COOKING TEST OF THE VERC 2 POTS STOVES

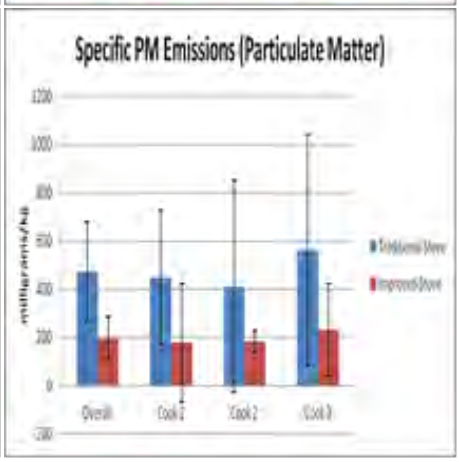
CCT Resuts	
Indicator measured	Percent Reduction with Improved Stove
Time to Cook	None
Specific Fuel Consumption	61%
CO Emissions	40%
PM Emissions	58%
CO2 Emissions	42%

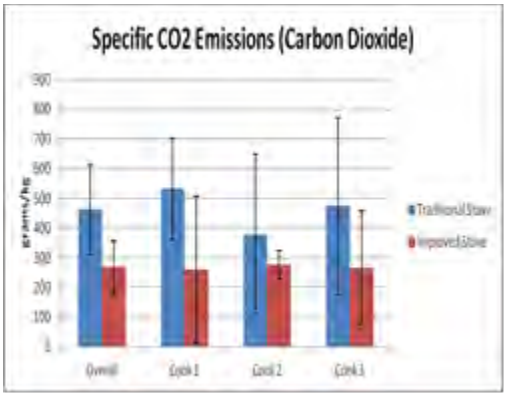
All error bars represent 95% confidence intervals







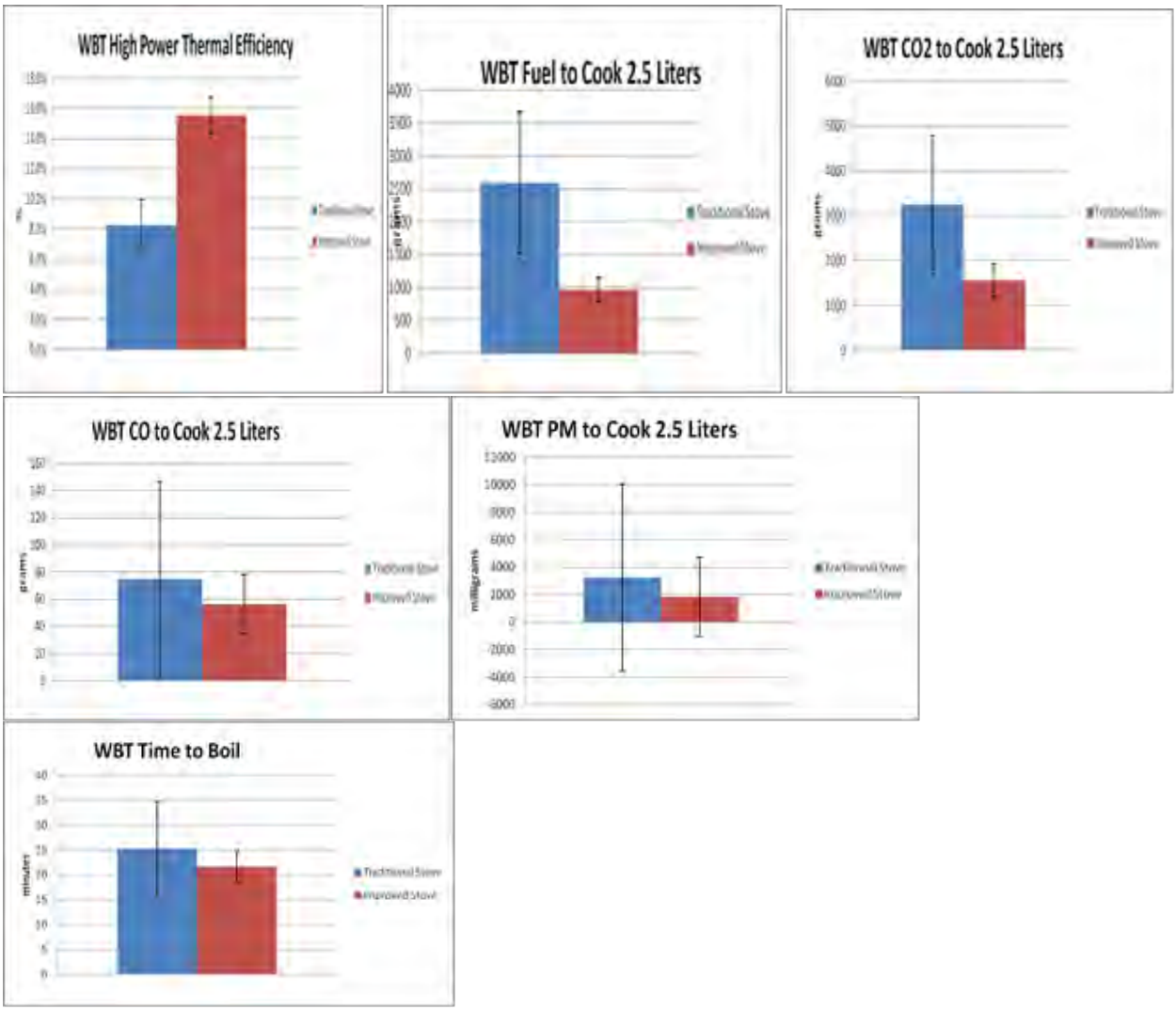




Comparison of Results from the WBT of the VERC 2 pot clay stove with chimney and the traditional 2 pot clay stove without chimney.

Standard Performance Measures		VERC 2 pot traditional stove	VERC 2 pot chimney stove
Fuel to Cook 2.5L	g	2594	969
CO to Cook 2.5L	g	75	56
PM to Cook 2.5L	mg	3252	1817
Energy to Cook 2.5L	kJ	47762	17850
Time to Boil	min	25	22
CO2 to Cook 2.5L	mg	3248	1559
High Power Thermal Efficiency	%	16	8

All error bars represent 95% confidence intervals



Appendix 7: Opportunity Analysis

AREAS	**MICRO** 1- 4 workers Retailers (sanitary shops) Producers (masons, small production units)	**SMALL** 5- 14 workers Small NGOs and private companies	**MEDIUM** **1**5- 45 workers NGOs Renewable energies entrepreneurs BRAC- VERC (large organisations with small ICS teams)	**LARGE** 50+ workers Grameen Shakti
Market Intelligence	Very close to final consumer allows for better access to demand info, but macro info on market trends and innovation does not get here.	Fair market intelligence, but few info on R&D (lack of innovation at product level).	Most have other business on the side, which allows them to have access to info on the external markets about new products, prices, trends.	Information at the macro level, but because the value chain is destructured, the info on demand does not travel upwards, and thus their strategic planing is not done on the basis of demand needs.
Consumer Education	Limited capacity to educate consumer. Only markets what is financed by donors or partner organisations of various AOD based schemes.	Awareness raising is part of the AOD funded programmes, but they have been incapable of raising demand after the first purchase.	Materials for awareness raising are prepared and distributed among quite a large network of office branches at the upzila level, but so far have failed to deliver significant results. There are no measurements as to renewal of purchases.	Capable of branding and educating consumers. Have capacity to do door-to-door education, demonstrations and participate of fairs. Have failed to raise demand and do not present information on renewal of purchases.
Technical standards	Information about building criteria is communicated and monitored by the funding organisation but since they have not been agreed upon, nor sufficiently tested, cookstoves on the market and efficiency levels differ.	They have access to testing exercises but further information on R&D is not being transferred. There are no channels to do so (no coordination forum, no government dissemination).	They implement internal quality control processes, according to a set of working standards, which can follow results from test exercises, to which they have access, or rather, maximization of profit, thus selling non optimal efficiency stoves.	Test are being conducted (VERC), supported by international organisations (Aprovecho, Winrock) but information is not feeding into strategic planing. Macro info on international standard setting (eg ISO) is not being transferred to them.
Policy and regulation	Could have access to government funding via partner organisations, but this strategy has not been incorporated by Government, so it is unlikely.	Will most likely benefit from BCSIR funding, via their work with partner organisations at the local level.	Depending on what scale the BCSIR Phase III program reaches, it can have a negative impact due to heavily subsidized ICS.	Customs on imported stoves could impact positively their margins.
Business development	GIZ and SZ working to bring BDS to sanitary shops and masons, in marketing, manufacturing and sales.	GIZ spin off, SZ, becoming the main BDS partner with small POs, there is an inherent risk, related to SZ capacity to do so, that this will not reach them, jeopardizing their capacity to participate of an increasing market for ICS. Small private companies need to be supported in financial litteracy, business planning and proposal writing, operations and finally, carbon finance, to ensure that they are well invested.	Medium size companies and NGOs have often expanded or originated their businesses around other RE technologies, like biogas and SHS. The relative success of SHS has brought resilience to those who have participated of that amrket, bringing them a relative financial health that will allow them to fund, temporarily, zero marginal profit in regards to ICS. But they need further access to finance for increasing transportation costs, technology adaptation if new models are imported and manufactured and sales and marketing technical assistance and training.	Large stakeholders have financial capacity to fund demand surveys, field testing for products as well as social marketing campaigns. Support can be given in these areas, in the form of a partnership between companies to fight IAP by promoting healthier cooking habits.
Access to finance	Partner organisations (like GIZ and SZ) are shifting their support to small scale stakeholders, providing them with capital to start ICS manufacturing.	Partnered in the past with subsidies based programs (BCSIR, UNDP), they have built themselves with distorted financial structures that puts at risk their capacity to access finance from enterprise based scheme programs and partners (IDCOL or Commercial Banks).	Having diversified their business to other renewable energy technologies (solar, biogas), they have built "companies" capable of generating profit from pairing up ICS sales with other products.	Carbon market will provide the necessary capital to continue developping demand.