

Clean Cooking: Identification of Green Business Potential in India

HIGHLIGHTS



Growth Forecast for
Carbon Sinks sector
in India

P 24



Job potential for
Carbon Sinks sector

P 28



Occupational map for
Carbon Sinks sector

P 33

Preamble

Through research and investment in cleaner cooking fuels and technologies, efforts are being made to provide clean cooking solutions since mid-twentieth century. However, around 38% of the world's population still continues to be dependent on traditional biomass for cooking, majority of them staying in developing countries. (IEA, World Energy Outlook 2016)

The world has taken note of serious impact traditional biomass cooking practice has on health, environment and livelihoods. Past few years have witnessed initiatives, both at global and national levels, bringing together government, industries, financial institutions and civil societies to collectively attempt at providing clean energy for all.

In September 2015 at the United Nations Sustainable Development Summit, member nations adopted 'Transforming our world: the 2030 Agenda for Sustainable Development', a set of 17 Sustainable Development Goals (SDG). Goal 7 of the SDGs aims to ensure access to affordable, reliable, sustainable and modern energy for all. On 2nd October 2015 India announced its Intended Nationally Determined Contribution (INDC) for reduction in greenhouse gas emissions. One of its main mitigation strategies is to create clean and efficient energy systems with focus on promoting renewable sources and efficient use of energy.

With huge number of Indians still continuing to depend on traditional biomass for cooking, clean cooking solutions will be instrumental in India's efforts to fulfil its INDC commitments and achieve Goal 7 of the SDGs. To accomplish this, availability of human resources with required skill sets will be equally crucial as presence of scalable, practical and affordable solutions; accessible financing; and enabling policies for adoption of clean cooking practices.

Skill Council for Green Jobs (SCGJ), an initiative of the Government of India aligned to the National Skill Development Mission, is mandated to identify and develop required skills to enable India meets its potential for Green Business including Clean Cooking. The concept note on Clean Cooking sector, published by SCGJ critically looks at the present scenario in the cooking sector, the challenges and possible solutions. It forecasts future trends and skilling requirements in clean cooking sector. The document specifically looks into Portable Improved Cookstoves and Biogas sectors' value chain, occupational map and job roles. It is hoped that the document will be helpful to researchers, practitioners, and policy makers in their effort to secure clean cooking solution for all and will act as a roadmap for building qualified and skilled human resource pool for the same.

Executive Summary

About 3 billion people, mainly in South Asia and Sub-Saharan Africa—are still relying on solid fuels for cooking and heating (UNDP and WHO 2009; IEA 2012). In a business- as-usual scenario, it is estimated that about 2.5 billion of people will still depend on traditional biomass for cooking and heating in 2030 (IEA 2012).

Household air pollution (HAP) is a significant public health, environmental, gender, and livelihoods issue - 4.3 million premature HAP deaths occur globally every year. Solid fuel use and charcoal production results into 0.5–1.2 billion MT in carbon dioxide (CO₂) and 25% of global black carbon emissions annually. Women and girl children spend up to 5-8 hours per day on cooking activities, with 20% of that time devoted to the collection of fuel impacting opportunities for their gainful employment and education (Global Alliance for Clean Cookstoves 2013). Furthermore WHO estimates around \$ 90 billion will be saved globally every year with switch to clean cooking practices.

250 million Indian households consume approximately 1104 TWh of energy for domestic cooking every year (IESS, 2014). As per the 2011 Census figures, 87% of rural households and 26% of urban households still depend on biomass for cooking. Around 25% of the 4.3 million global premature HAP deaths occur in India alone every year. In fact, 400 million people in India (of which 90% are women) are exposed to the negative health impacts associated with indoor air pollution from use of biomass, resulting in respiratory, pulmonary and vision problems. This underlines the need for adoption and sustained use of clean cooking practices by all.

Today, there are wide range of options in clean cooking segment - portable improved biomass cookstoves, biogas, ethanol/methanol based cookstoves, electricity based cooking and LPG/PNG. Government of India has taken initiatives to promote clean cooking. It spent INR 4,15,470 million subsidizing household LPG consumption in 2012-13. It has undertaken flagship programs for promotion of clean cookstoves and biogas.

However, penetration of clean cooking practices continue to be low in India due to lack of affordable, reliable and accessible options. As per 2011 Census data, only 29% of households use LPG, 0.1% of households use electricity and 0.4% of households depend on biogas as a primary source of cooking fuel. As per an estimate only 0.25% of Indian households use improved biomass cookstoves (GIZ, 2014).

A strategy based on LPG alone to provide clean cooking solution to all would be very costly for the country. As per the estimates of the International Energy Agency (IEA), 632 million people in India would continue to depend on solid unprocessed biomass for cooking and space heating needs, even in 2030. Taking into consideration the fact that India has one of the largest livestock population in the world totaling to 81 million of milch animal (livestock census 2012), there are immense opportunities for improved biomass cookstoves and biogas in the country. What is required from the government is initial public funding, conducive policy environment and structural reforms to enhance innovation, ease of doing business and entrepreneurship for promotion of clean cooking sector.

Cooking sector will witness a shift from traditional biomass based cookstoves to clean cooking solutions. In urban areas this shift will be toward LPG, PNG and electricity whereas in villages people will switch to LPG, improved cookstoves and biogas. Within improved cookstoves segment it is projected that over the years the share of highly processed biomass based ICS and Ethanol / Methanol based ICS will increase over traditional biomass based ICS.

Jobs in improved cookstove will increase initially but, due to higher automation in manufacturing in later years, jobs will either increase at a lower rate or will decrease. This would also happen because it is assumed that with growth and development, cooking fuel preferences in India will largely resemble developed nations of today i.e. a mix of LPG, PNG and electricity. Hence, eventually demand for solutions like ICS and biogas will decline.

Clean cooking sector is projected to become more organized and skill driven resulting in requirement of skilled and professionally trained workers. This has been reflected in the occupational map and job roles for improved cookstoves and biogas segments.

Clean Cooking Solutions

Chapter	Contents	Page No.
1	Introduction	1-7
2	Technological Options	8-15
3	Growth Forecast	16-25
4	Job Potential Estimates	26-29
5	Process Flow	30-32
6	Occupational Mapping	33-41
	References	42

Chapter 1

Introduction

- **Background**
- **The Case for Clean and Improved Cooking**
- **Global Campaign and Initiative**
- **Fuel Usage and Trends in India**
- **Cooking Fuels: Occupational Types and Social Groups**
- **Usage of Cooking Fuels: Inter State Variation**
- **National Programs with Respect to Energy Needed for Cooking**

Background

Solid fuels in the form of traditional biomass (wood, charcoal, crop residues, and animal dung) are used by about 2.6 billion people, while solid fuels in the form of coal are used by about 0.5 billion people, mainly in China and to a lesser extent in India and South Africa. 1.3 billion people lack access to electricity, more than double that number—about 3 billion people, mainly in South Asia and Sub-Saharan Africa—are still relying on solid fuels for cooking and heating (UNDP and WHO 2009; IEA 2012). In a business-as-usual scenario, it is estimated that about 2.5 billion of people will still depend on traditional biomass for cooking and heating in 2030 (IEA 2012).

There is a new and growing global mobilization about household energy access issues. This is driven by the realization that considerable health benefits can be gained by improving indoor air pollution with the use of clean cook stoves and fuels. An important milestone of this mobilization is the launch of a public-private initiative, the Global Alliance on Clean Cook stoves (GACC) led by the United Nations Foundation to help 100 million households adopt clean and efficient stoves and fuels by 2020 (United Nations Foundation 2010). The recognition by the UN Sustainable Energy for All Initiative that providing efficient cook stoves and clean fuels to poor households should be part of the broader objective of energy access for all by 2030 (United Nations 2012) created another impetus.

It is well documented that exposure to indoor air pollution (IAP) from the inefficient combustion of solid fuels in low-quality stoves is a significant public health hazard (Smith and others 2009; Venkataraman and others 2010). Recent data indicate that about four million people die prematurely every year from illness attributable to IAP from household solid fuel use (Lim and others 2012). By using clean cooking solutions, health-damaging IAP exposures can be reduced by more than 90 percent in comparison to solid fuels (Smith, Rogers, and Cowlin 2005; MacCarty and others 2010).

With the rapid urbanization in many countries in Sub-Saharan Africa, South Asia, and Central America, inefficient use of wood fuels and in some cases inefficient production of charcoal might be threatening forest cover in the neighboring catchment areas (Arnold and others 2003). The reliance on fuel wood for cooking and heating is increasingly drawing attention to the role in global warming of black carbon originating from incomplete combustion of fossil fuels, particularly diesel, and other sources, including biomass. There is a growing body evidence that black carbon acting alone might be the second most important factor affecting the rise in global temperatures after carbon dioxide (CO₂) (Ramanathan and Carmichael 2008; Gustafsson 2009; Bond and others 2013).

Developing countries like India are confronting the vulnerabilities associated with the looming climate crisis on one hand and the challenges of development and poverty alleviation on the other, which are closely associated with providing energy access to the energy poor in the country. As per the National Sample Survey 68th round, the dominant fuel mix in rural India still consists of firewood and chips, with around two thirds of the households still dependent on them. However, the transition to cleaner cooking fuels has largely materialized in urban India, with 68.4 per cent of the households using LPG (Government of India, 2015). The choice of fuel is also contingent upon socioeconomic conditions. The factors that determine the selection of energy carriers include affordability, physical access, physical availability and socio-cultural factors like conventional cooking fuels, etc. Energy access also has severe gender implications, including the use of women's time and their health. Hence, the strategy of climbing the energy ladder means addressing energy development, poverty, social justice, equity and gender issues as parts of the same political process of development.

While the Government of India is making impressive strides in expanding the usage of LPG for cooking among the population, recent reports suggest that as many as 30 million households will continue to use solid fuel for cooking in 2040, highlighting the importance of considering improved bio-mass cook stove solutions alongside clean fuels like LPG. (Source: CSTEP, "Quality of Life for All: A Sustainable Development Framework for India's Climate Policy", 2015). Improved Cook Stoves also play an important role since they allow people either to make use of more modern fuels, or use traditional fuels much more efficiently, reducing or avoiding dangerous indoor air pollutants.

The Case for Clean and Improved Cooking

Environment	Health	Gender
<ul style="list-style-type: none"> ▪ Solid fuel use and charcoal production results into 0.5–1.2 billion MT in carbon dioxide (CO₂) and 25% of global black carbon emissions annually ▪ 1.36 billion tons of wood fuel used across the developing world causing forest degradation and deforestation 	<ul style="list-style-type: none"> ▪ Resulting exposure to air pollution due to solid fuel combustion to meet basic household energy needs causes an estimated 4.5% of the global burden of all the human diseases ▪ The use of solid fuels, primarily for cooking, has been estimated to be responsible for at least 4.3 million premature deaths annually and 110 million disability-adjusted life years (DALYs) 	<ul style="list-style-type: none"> ▪ Women and girls are at higher risks of negative HAP-linked health outcomes and physical injury due to their proximity to cooking fires ▪ Women spend up to 5-8 hours per day on cooking activities, with 20% of that time devoted to the collection of fuel ▪ Decreased educational and livelihood opportunities for girl children and women as they are primarily responsible for fuel collection in many cultures

Source: Global Alliance for Clean Cookstoves

Table 1: Benefits of Cleaner Cooking (\$ billion per year)	
Health-care savings	0.38
Time savings due to childhood and adult illnesses prevented: school attendance days gained for children and productivity gains for children and adults	1.46
Time savings due to less time spent on fuel collection and cooking: productivity gains	43.98
Value of deaths averted among children and adults	38.73
Environmental benefits	6.07
Total benefits	90.62

Source: WHO (2006)

Global Campaign and Initiative

Sustainable Energy for All

In September 2011, UN Secretary-General Ban Ki-moon shared his vision for making sustainable energy for all a reality by 2030. He launched 'Sustainable Energy for All' as a global initiative that would mobilize action from all sectors of society in support of three interlinked objectives:

- Providing universal access to modern energy services;
- Doubling the global rate of improvement in energy efficiency; and
- Doubling the share of renewable energy in the global energy mix

Governments from 106 countries and the European Union have partnered with 'Sustainable Energy for All' to advance the three objectives on the country level. India is a partner in Sustainable Energy for All.

Over 50 High Impact Opportunities (HIOs) have been identified, with a wide range of stakeholders undertaking actions that will have significant potential to advance Sustainable Energy for All.

'Universal adoption of Clean Cooking Solutions' is one of the High Impact Opportunities.

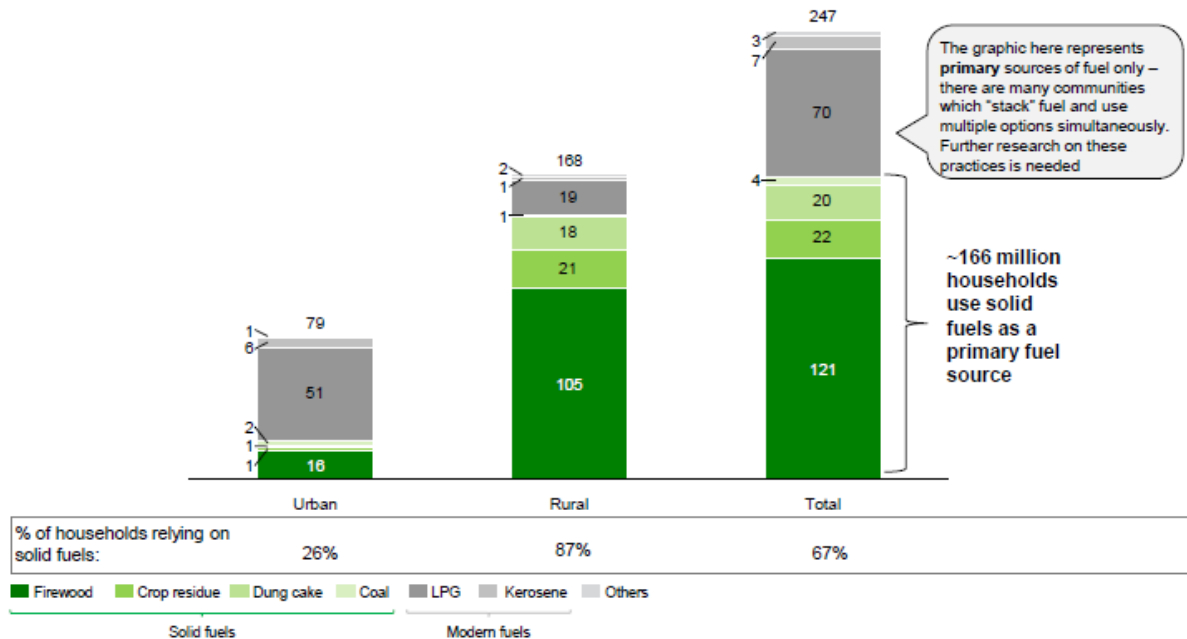
Fuel Usage and Trends in India

Around 67% of overall Indian households rely primarily on solid fuel for cooking, in rural areas, this figure is much higher at around 85% (Table 2).

Table 2: Fuel Usage Trend in India			
Cooking Fuel	India	Urban	Rural
Firewood	49%	20%	62%
Crop Residue & Cow Dung	18%	6%	24%
Kerosene	3%	8%	<1%
LPG	28%	65%	11%
Other	1%	<1%	1%

Census: 2011

Primary fuel usage breakdown (2011)
(millions of households)



Source: Census of India 2011; Dalberg Analysis

Cooking Fuels: Occupational Types and Social Groups

As per the report 'Energy Sources of Indian Household for Cooking and Lighting' published by National Sample Survey office, Ministry of Statistics & Programme Implementation, Government of India in September 2012:

- The percentage of rural households using firewood and chips is 83-87% for the lowest six decile monthly per capita expenditure (MPCE) classes. This percentage falls as MPCE level increases. By contrast, the percentage of rural households using LPG for cooking rises steadily with increase in MPCE level, from 0.5% in the lowest MPCE class to 37% in the highest.
- For urban India the percentage of households depending on firewood and chips for cooking falls at a rapid rate from 60% in the lowest MPCE class to only 0.6% in the highest. The percentage of urban households using LPG rises steadily from 18% in the lowest MPCE class, reaching 83% in the highest class.
- In rural India, firewood and chips were used by 89% of ST households, 81% of SC households, far more than 66% of households of the 'others' category. Use of LPG was seen in only 4% of ST, 6% of SC, much lower than 19% households of the 'others' group. In urban India, use of LPG for cooking was least frequent among Scheduled Castes (48%) and also low among Scheduled Tribes (52%) compared to the all-groups incidence of 64.5%.
- Among the different household types in rural India, the incidence of use of firewood and chips was highest (88%) for agricultural labour households. LPG was used for cooking by 19% of those self-employed in non-agriculture, and by only 3% of agricultural labour households. Household classified as 'agricultural labour' were found to be using mostly the cheapest forms of energy for cooking – firewood and dung cake.
- Percentage of households using LPG as primary energy source for cooking was the highest among regular wage/salary earners (77%) followed by the self-employed (68%), and least prevalent among casual labour households (29%). Firewood and chips was the primary energy source for cooking for 49% of casual labour households, being rare among regular wage/salary earning households (7%).

Above figures clearly indicate that economically and socially backward sections in the society, relatively speaking, are lagging behind in access to clean cooking solutions. In India, in spite of high percentage of electrification, use of electricity as main source of cooking is reported at 0.1% of households in both Rural and Urban areas. Large electricity generation, transmission and distribution projects primarily benefit industry and urban populations, while most rural and poor people depend on biomass (OECD, 2006b). This necessitates effective, comprehensive policies to include the forms of energy used by the poor for cooking rather than concentrate on provision of electricity alone as an end in itself (World Energy Outlook 2006, International Energy Agency).

Usage of Cooking Fuels: Inter State Variation

- As per the report 'Energy Sources of Indian Household for Cooking and Lighting' published by National Sample Survey office, Ministry of Statistics & Programme Implementation, Government of India in September 2012, in rural areas the percentage of households depending on firewood and chips for cooking exceeded 70% in all major states except Punjab and Haryana. In Chhattisgarh, 94% of the households used firewood and chips for cooking, which is the highest among all major States, followed closely by Rajasthan (92.5%) and Madhya Pradesh (90.5%). (Refer table below)
- Dung cake was the major fuel for cooking for 29% of rural households in Punjab, 20% in Uttar Pradesh, 18% in Haryana and 15% in Bihar.
- Compared to other states, incidence of LPG use was much higher for Punjab (34% households), Kerala (26% households) and Tamil Nadu (25% households). However, in case of Kerala and Tamil Nadu, like all other states, incidence of use of firewood & chips continued to be higher in spite of high LPG penetration (70% households in both states).
- Use of LPG was least in Chhattisgarh (2% households), Jharkhand (2.5%), Bihar (3.5%), and Odisha (3.7%).
- In Andhra Pradesh, and Odisha, 4-5% households reported 'no cooking arrangement'.

Statement 1R: Per 1000 distribution of rural households in each major State by primary source of energy used for cooking

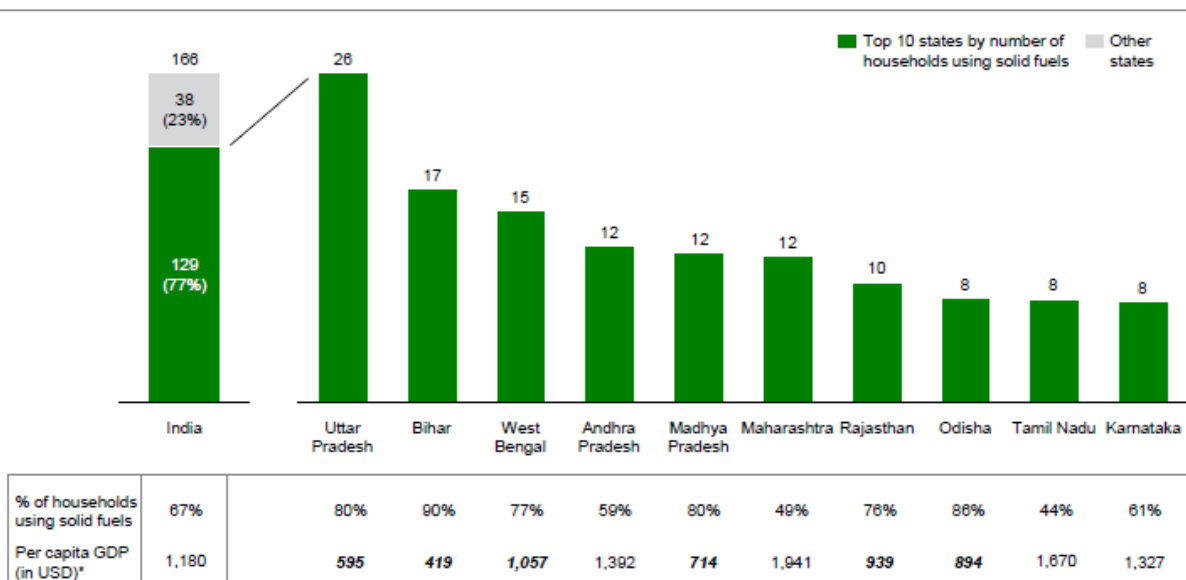
State	per 1000 number of households using						all*
	firewood & chips	LPG	dung cake	kero-sene	others	no arrangement	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
							Rural
Andhra Pradesh	749	194	0	7	3	47	1000
Assam	850	142	0	5	0	1	1000
Bihar	743	35	148	2	73	0	1000
Chhattisgarh	941	20	9	8	4	17	1000
Gujarat	857	106	11	22	4	0	1000
Haryana	580	214	180	15	6	5	1000
Jharkhand	776	25	35	2	144	18	1000
Karnataka	857	107	0	15	2	20	1000
Kerala	700	265	0	3	5	28	1000
Madhya Pradesh	905	55	32	1	5	2	1000
Maharashtra	782	170	1	16	12	19	1000
Odisha	843	37	39	2	36	43	1000
Punjab	326	337	289	11	33	5	1000
Rajasthan	925	56	14	4	0	2	1000
Tamil Nadu	701	254	0	26	0	19	1000
Uttar Pradesh	700	58	196	1	41	4	1000
West Bengal	734	48	44	6	162	6	1000
all-India	763	115	63	8	35	16	1000

* includes households not reporting primary source of energy for cooking

Source: NSS Report No.542: Energy Sources of Indian Households for Cooking and Lighting

Ten States account for nearly ~ 75% of all household solid fuel use in India

Number of households using solid fuels as primary source for cooking
(millions of households)



Source: Dalberg Analysis; Census of India 2011; Ministry of Statistics and Programme Implementation; data.gov.in

National Programs with Respect to Energy Needed for Cooking

India is a partner in Sustainable Energy for All. On 2 October 2015, India communicated its Intended Nationally Determined Contributions (INDCs) to the UN Framework Convention on Climate Change (UNFCCC), committing to cut the emissions intensity of GDP by 33-35 per cent by 2030 from 2005 levels. In FY 2012-13, Indian government spent INR 41,547 crore subsidizing household LPG consumption (Sharma et al., 2014). In Union Budget 2016-17, the government announced its plan to extend LPG connections to 5 crore BPL families in the next 3 years. However, there is a total of over 12 crore households without a clean cooking solution. Hence a strategy based on LPG alone may be a costly and time consuming solution. Some of the other initiatives undertaken by Government of India are promotion of biogas and clean cook stoves.

- Unnat Chulha Abhiyan (UCA)** - This program launched by MNRE on June 27th 2014. Initially it was named as National Biomass Cook stoves Initiatives to enhance use of improved biomass cook stoves. It aims to develop and deploy improved biomass cook stoves for providing clean energy solution with a view to reduce drudgery of women and children through reduce consumption of fuel wood, saving in cooking time and reduction of emissions. The program has a target to disseminate 2.4 million household-level improved cook stoves and 3.5 million community sized stoves by end of 2017 and has a budgetary outlay of INR 294 Crores.
- National Biogas and Manure Management Program (NBMMP)** - With the estimated possibility of more than 12 million family size biogas plants in the country (MNRE, 2013) and the co-benefit of organic rich fertilizer for farm use, biogas can be an important source of fuel for cooking in certain rural areas. Being in implementation since 1981, the program has installed 45 lakh plants by 31st March 2013. In the twelfth five year plan (2012-2017), INR 650 crore has been budgeted for setting up 6.5 lakh biogas plants across the nation.

Chapter 2

Technological Options

- **Technological Options for Clean Cooking**
 - **Improved Biomass Cook Stoves**
 - **Ethanol / Methanol Based Cook Stoves**
 - **Biogas**
 - **Electricity Based Cooking**
 - **LPG / PNG Based Cooking**

Technological Options for Clean Cooking

The technological options, which could potentially provide clean cooking energy to significant proportion of population, are several and diverse. The table below is a representation of technological options/ devices for clean cooking (Source: World Bank July 2015)

	Improved Solutions		Clean Cooking Solutions		
	Legacy and Basic ICS	Intermediate ICS	Advanced ICS	Modern Fuel Stoves	Renewable Fuel Stoves
	  	   	   	  	   
Key Features	Small functional improvements in fuel efficiency over baseline technologies; typically artisan produced	Rocket style designs with highly improved fuel efficiency and moderate gains in combustion efficiency; some with high-end materials	Fan jet or natural draft biomass gasifiers with very high fuel and combustion efficiencies; may require pellet/briquette fuel	Rely on fossil fuels or electricity, have high fuel efficiency, and very low particulate emissions	Derive energy from renewable non-woodfuel energy sources; some are supplementary rather than primary cookstoves
What's Included?	<ul style="list-style-type: none"> • Legacy biomass and coal chimney^a • Basic efficient charcoal • Basic efficient wood 	<ul style="list-style-type: none"> • Portable rocket stoves • Fixed rocket chimney • Highly improved (low CO₂) charcoal stoves 	<ul style="list-style-type: none"> • Natural draft gasifier (TLUD or side-loading) • Fan gasifier/ fan jet • TChar stoves 	<ul style="list-style-type: none"> • LPG and DME • Electric and Induction • Natural gas • Kerosene^b 	<ul style="list-style-type: none"> • Biogas • Methanol • Ethanol • Solar ovens • Retained heat cookers
Potential Impact^c	Moderate		High		

Improved Biomass Cook Stoves

At present, traditional cook stoves are the most widely used solutions for cooking in rural India. Data from the 68th round of the National Sample Survey (NSS) suggests that as of 2011-12, around 80% of the Indian households used some form of traditional fuels to satisfy their cooking and heating needs (Jain et al., 2014). Traditional cookstoves typically exhibit very low thermal efficiency (of the order of 10% - 15%) and produce harmful emissions as a result of inefficient combustion process whereas, improved biomass cookstoves (ICS) help in reducing the health impacts, due to better combustion efficiencies.

'Improved biomass cookstoves' (ICS) is used as an umbrella term that refers to an array of stove designs and technologies. There are multiple ways by which these stoves can be classified. One of the widely used segregation is on the basis of the 'mechanism of air augmentation inside the combustion chamber'. On this basis the stoves can be classified as natural draft and forced draft. On the basis of portability, the stoves can be segregated into fixed and portable types. On the basis of fuel used, the stoves can be classified as traditional biomass based stoves and highly processed biomass fuel based stoves.

In natural draft cook stove the air required for combustion is circulated naturally whereas in forced draft cook stove an external fan is attached to it which run on external power from mains/ battery/ TEG for proper circulation of air for combustion.

For the fixed type cook-stoves, platform are prepared using brick and cement for increasing durability and ease of operation. Two and three pot fixed type cook-stoves are provided with chimney made of cement pipes and terracotta pipes depending on their suitability and affordability. This helps to reduce indoor air pollution and results in achieving healthy environment.

The improved cook-stoves may be made of metal, ceramic and terracotta/ pottery (durable type) and combination thereof. Based on this, the stoves can be categorized as metallic (MS, SS, cast iron and combination thereof), metal clad ceramic/ pottery and ceramic types.

Bureau of Indian Standard has released a standard on Solid Biomass Chulha 'IS Standard 13152 (Part I):2013'. Table 3 below states the requirements of the standard.

Table 3: IS Standard on Solid Biomass Chulha				
Sl. No.	Type of Biomass Cookstove	Standard Performance Parameters		
		Thermal Efficiency (%)	CO (g/MJd)	TPM (mg/MJd)
1	Natural Draft Type	Not less than 25	≤ 5	≤ 350
2	Forced Draft Type	Not less than 35	≤ 5	≤ 150

Policies and Programs Overview:

In 1983 National Program on Improved Chulhas (NPIC) was launched with the objectives to reduce fuel wood consumption and removing / reducing smoke from kitchens. It introduced ICS to reportedly around 35 million households but, failed at ensuring their sustained use. The key reasons of failure were a) large government subsidies with minimal user contribution which resulted in the stove builders focusing on complying with government specifications only, b) lack of effective monitoring and evaluation system, c) limited awareness raising and training programs, and d) limited after sales support. It is followed by National Biomass Cookstoves Initiative (NBCI) with focus on enhancing combustion efficiencies, which could also lead to emissions and smoke reduction. It stressed on establishing state-of-the-art testing, certification and monitoring facilities and strengthening R&D programs. Recently NBCI was reshaped into the Unnat Chulha Abhiyan, which was launched in June 2014 (Dhamija, 2014; MNRE, 2014b).

Case studies:

Technology Informatics Design Endeavour (TIDE), established in 1993, is a not-for-profit organization which seeks to apply appropriate technology to rural situations. It works through a network of extension agents who learn about a new technology from TIDE and then set up a business to manufacture and market this technology in a particular area. By the end of 2009, TIDE and its entrepreneurs had supplied 11,840 small business stoves, 7,000 domestic stoves and 200 1–5 kW hydro-power plants, which together represented wood savings of nearly 65,000 tons/year and 116,000 tons/year avoided CO₂ emissions. Nearly 121,000 people are now benefitting from the stoves.

In 2011 Greenway Grameen started selling their smart stoves. Initially met with skepticism it was averaging 5,000 unit sales per month within six months and in 2016 Greenway Grameen has managed to sell over three lakh units in India. Its single-burner high-efficiency cooking stove helps save 70 percent fuel cost (uses wood, agro-waste, cow-dung, and charcoal), minimizes harmful emissions (around 1.5 tons of CO₂ per stove) and reduces cooking time by almost 304 productive hours per year on an average. The USP is also that it is durable, and portable with no moving parts. Today it is India's largest cook stove seller exporting to Nepal, Bangladesh and Mexico.

Community based cook stoves

Community based cook stoves replaces inefficient traditional cook stoves at community level like Mid-Day meal school, Aganwadis, Gurudwara etc. Under UCA programme of Ministry of New & Renewable Energy a target of 3.50 lakh community biomass improved cook stoves will be deployed by 2017. At present there are about 15 community cook stove models approved by MNRE.

Ethanol / Methanol Based Cook Stoves

Cookstoves based on ethanol and methanol can be used for cooking, water heating and heating of buildings. The technology can be applied in households, institutions (e.g. schools) and industries where it is used for boiler heating. Ethanol is produced from sugar plants or other sources of biomass and is safer and less polluting than petroleum fuels. Methanol on the other hand is produced from synthesis gas (carbon monoxide and hydrogen), itself derived from oil, coal or, increasingly, biomass. A well designed ethanol / methanol based cookstoves produces no harmful emissions and are powerful generators of carbon credits.

Case Study on use of ethanol based cook stove - Zanzibar, Tanzania

Observations

- Women reported enhanced safety for children who are in cooking area, reduced smoke exposure.
- Fuel was reported to be consumed too fast, and the price of fuel was seen to be too high.
- Women chose to use their ethanol stoves in addition to (not instead of) their existing stove; Ethanol stove was seen as status symbol.

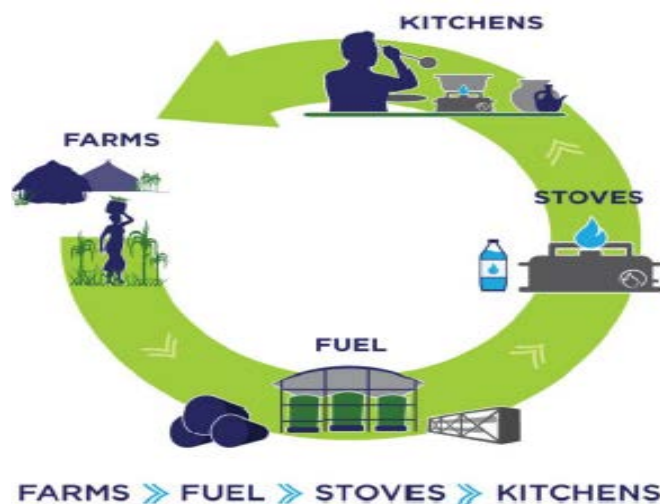
Perceived Environmental Impacts

- Forest resources are being depleted rapidly, as wood collection and charcoal production / sale are important sources of income-generation and employment.
- Indoor air pollution was reduced with use of ethanol stove.
- Resource utilization opportunity in the form of unused molasses from sugar factory, which is currently viewed as a pollutant.

Highlighted Socio-Cultural Issues

- Commercialization challenges linked to restrictions on alcohol (imported alcohol is taxed as beverage alcohol regardless of use).
- A successful carbon credit program is not established for this model, despite institutional partner efforts to participate.
- While feed stocks are readily available, infrastructure for distribution and distillation facilities need to be established.
- Unlike in India, religious traditions in the study did not emerge as an area for cultural incompatibility.

Below diagram shows agricultural waste is converted into ethanol, which generates employment as well as a sustainable source of efficient and safe cooking fuel. (Source: 2016 Meeting of the American Association of Geographers (AAG), San Francisco, CA)



Biogas

Biogas is a clean, non-polluting fuel that contains about 55% to 75% methane (CH₄), which has high calorific value and is very similar to natural gas in combustion characteristics (National Academy of Sciences, 1977). It can be produced from cattle dung, human waste and other organic matter arising from household consumption through anaerobic digestion in a biogas plant. The digested material or slurry, which comes out of the plant, is a form of enriched manure, when dried and can be used for soil enrichment in farms.

There are broadly two common types of digesters that are found; fixed dome and floating dome. A fixed-dome plant consists of a digester with a fixed, non-movable gas holder, which sits on top of the digester. When gas production starts, the slurry is displaced into the compensation tank. Floating-drum plants consist of an underground digester and a moving gas-holder. The gas-holder floats either directly on the fermentation slurry or in a water jacket of its own. The gas is collected in the gas drum, which rises or moves down, according to the amount of gas stored (UNDP, n.d.).

The production and use of biogas is determined by two important factors viz. ambient temperature and regularity of use. While the production can occur below 20°C (psychrophilic conditions), the optimal conditions for most methanogens, a type of bacteria that drives the conversion, is between 20°C and 35°C (Minde, Magdum, & Kalyanraman, 2013). This poses a challenge in part of the country where temperature drops below 20°C during winter.

A little more than 1 million households in the country report the use of biogas as the primary source of cooking, as per Census 2011. A total of ~ 4.6 million biogas systems have been installed so far (CSO, 2014) over the course of the last three decades. Clearly, a large fraction of the installed systems are defunct and efforts to promote biogas as a clean cooking energy solution have not yielded success. The main reasons for plants becoming non-functional are structural and operational problems, non-availability of cattle/dung/water, easy availability of other convenient fuels, chocking of inlet/outlet, corrosion/leakage in pipeline, scum formation in digester slurry and water accumulation in gas pipe. At policy level government programs promoting biogas have been top-down in approach driven by targets set by the central government. The prescribed structure is designed around adoption of the technology with low consideration of people's needs particularly in rural households. There were too many entities in the implementation chain in each state, which led to inefficiencies in ground-level planning and roll-out. Funds available for training was insufficient and women who have been prime user of biogas were not involved, leading to poor operation and maintenance. The subsidies provided by the NBMMP required individual households to invest INR 6000–8000 towards the cost of sand and bricks which was a significant financial outlay for most rural families. In absence of proper financial linkages, it became a deterrent in uptake of biogas.

Policies and Programs Overview:

The National Project on Biogas Development (NPBD) was launched in 1981 with the aim to bring clean cooking energy solutions to rural areas. The NPBD was revamped into the National Biogas and Manure Management Programme (NBMMP) with the objectives of promoting biogas not just as a source of clean cooking but to reduce the drudgery of women engaged in collecting firewood, improving the state of sanitation and waste management in rural areas, reducing pressure on local forests, the ability to impact GHG emissions arising from better management of animal dung and the co-benefits to soil fertility by the use of digested products from a biogas plant (MNRE, 2014a). However, the program suffer from poor allocation of fund. In the last Five Year Plan (2007-12), the total expenditure over the period was a mere INR 440 Crore or 1% of the annual (FY 2013-14) expenditure on LPG subsidy (Lok Sabha, 2013).

Challenges around implementation and sustainability of biogas can be overcome through a revised bottom-up approach to policy, which highlights the contextual and demand-side issues around adopting the technology. Training and education of householders, and particularly women, is needed in relation to the maintenance of digesters, feedstock suitability and the environmental and potential livelihood benefits. A pro-poor, multi-institutional, partnership models, which include end-user microfinance, cooperatives and community funds are needed to overcome the high start-up costs associated with renewable energy technologies and its wider adoption (Rahaa, et al., 2014)

The Grameen Shakti initiative in Bangladesh provides a range of different economic models for financial assistance to rural households to adopt renewable energy technologies. The government encourages and partners with NGOs, micro-finance institutions and international donor agencies which enables a wider reach to rural households and provides improved financial and implementation strategies replacing the 'technology push' approach

Electricity Based Cooking

In the recent years, electricity based cooking is making inroads into the country, especially in urban areas. Due to erratic power supply with frequent outages in most of the rural areas, electricity based cooking has not witnessed any significant penetration in rural India. Electricity for cooking is used in many forms, from a simple electric stove to induction-based cooking.

An electric stove or electric hot plate is a portable table-top stove that relies on electricity to power the appliance. Heat generated in the heating elements of a hotplate is used for cooking the food. The heating surface of a hotplate is made of a high performance, tubular element with a round cross section. Electric stoves/hot plates are available in two variants – with uncovered heating element and having a sealed tubular heating element. Induction cooktops operate on the principle of electromagnetic induction. On supply of electricity, the induction coil within the stove generates a magnetic field causing circular current to be rapidly created in the base of the cookware resulting in the generation of heat, which then gets directly transferred to the food being cooked (Consumer Voice, n.d.).

LPG / PNG Based Cooking

LPG / PNG is natural gas supplied for cooking purpose. PNG is distributed through a pipeline network, providing uninterrupted supply of gas for cooking to households whereas, LPG comes in cylinders of different sizes. As of November 2014, around 2.5 million Indian households have PNG connections and 175 million LPG connections. They are mainly methane with a small percentage of other higher hydrocarbons.

India has subsidized LPG for over three decades in order to facilitate a transition from unclean traditional cooking fuels to modern and cleaner forms of cooking energy. Although the complete transition is only limited to 20% of the population (Jain, Agrawal, & Ganesan, 2014), the rising subsidy outlay on domestic LPG and excessive import dependence pose grand challenges in meeting the demand. India's reliance on this imported fossil fuel was as high as ~89% for the year 2012-13 (CSO, 2013).

High Efficiency Gas Cookstoves

Conventionally blue flame high pressure gas burners used in commercial kitchens and other industrial applications provide pressurized centric heat with low heat efficiency. While using the technology, it is observed that the equipment emits carbon soot and increases the ambient heat. Safety is an eternal concern in this technology.

Agnisumukh an award-winning startup entity from Bangalore, manufactures commercial kitchen equipment driven by energy efficient radiant heat gas burner which is flameless, smokeless and noiseless. The burners produce uniform heat just like charcoal emitting far-infrared rays and operate under low gas pressure. Far infrared rays are more potent than microwave and induction waves as it operates at a frequency of 300GHz to 30 THz. The frequency of microwave and induction is between 300 MHz to 300GHz. Agnisumukh burners works on all forms of gas - LPG, CNG and Bio-Methane.

Cooking on high efficiency gas burners leads to

- Preserving nutrition in food
- No emission of carbon soot resulting in clean pot and pan. As a result water and detergent are saved
- Device is safer as it operates under low gas pressure
- Saving of gas fuels over 30%
- Lower ambient heat in kitchen
- Faster cooking
- High thermal efficiency at 69% under IS: 14612
- No daily maintenance for cleaning the burner
- Heat can be given from top, down or any desired direction
- Increased productivity – user can do multi-

Main constraints towards large scale adoption and sustainable use of clean cooking solutions are lack of dependable, practical and affordable solutions. LPG, in spite of unsustainable subsidy still remains unaffordable for many whereas electricity is highly unreliable as a source of energy for cooking. Infrastructure for production and distribution of ethanol and methanol is at nascent stage. High dependence on biomass for cooking and availability of huge quantity of animal residue provide immense opportunities for promotion of improved biomass cookstoves and biogas as clean cooking solutions. However, India's experience at promotion of these options has been far from encouraging. Both National Programme on Improved Chulhas (NPIC) and The National Project on Biogas Development (NPBD) failed to achieve their goals. One of the key reasons of their failure was heavy dependence on subsidy leaving little resources for monitoring, research and other key components of the project. Also a high dependence on subsidies prevented the beneficiaries from developing a sense of ownership (Planning Commission, 2002).

At the initial stage, some level of public financing is usually required in any social development program however, subsidized programs are not always sustainable in long run. A market-based approach in the promotion of clean cooking solutions is often viewed as the best way to ensure their sustainability. What is required from the government is initial public funding, conducive policy environment and structural reforms to enhance innovation and ease of doing business.

Chapter 3

Growth Forecast

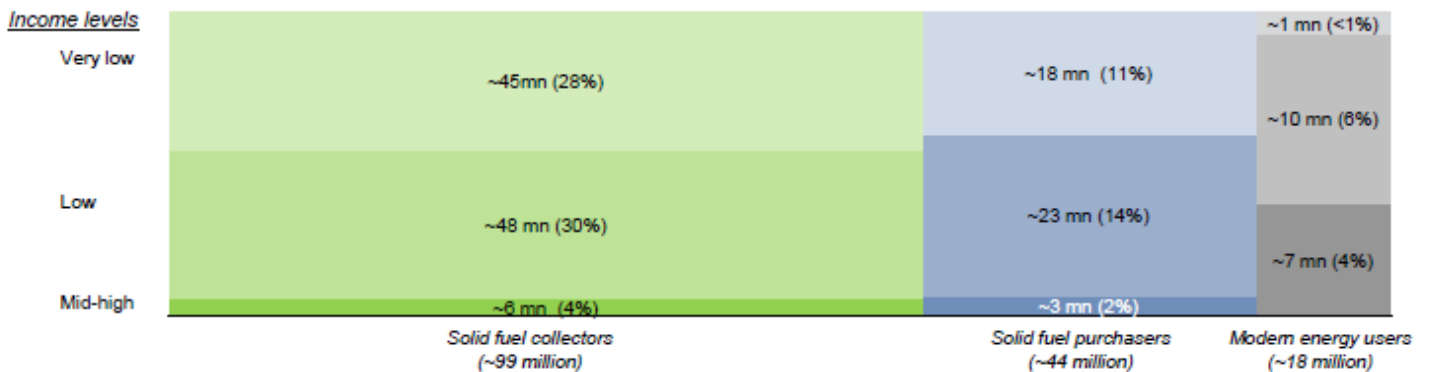
- **Market Scenario for Clean Cooking Solutions in India (Demand and Growth Projection)**
- **Projection of Primary Source of Energy for Cooking**
- **Demand Projection of Improved Cook Stoves**
- **Demand Projection of Biogas**
- **Business Model - HYDGAS**

Market Scenario for Clean Cooking Solutions in India (Demand and Growth Projection)

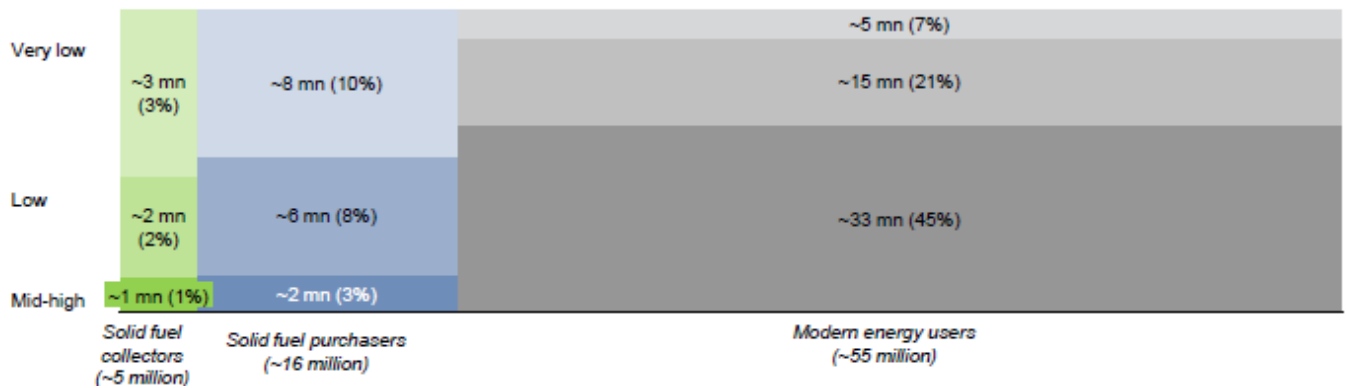
High dependence on traditional biomass as energy for cooking in rural India, provides opportunity for clean cooking solutions penetration in rural market. As compared to urban market, potential is twice large in rural areas. However, income levels in rural parts are lower than urban pockets. Hence, a key challenge will be to ensure that clean cooking solutions are affordable enough for the end-consumer (either by bringing down the price point or by enhancing the availability of consumer financing options)

Indian households by customer segment (100% = 235 million households)¹

Rural market (~161 million households)



Urban market (~74 million households)



Note: Excludes around 12 million households which use "other" fuels that are not identified by Census of India 2011. Source: Dalberg Consumer Segmentation Database; NSSO 2004/2006 and 2009/2010 database; Census 2011; Planning Commission of India.

Projection of Primary Source of Energy for Cooking

In February 2014 Indian Energy Security Scenarios 2047 (IESS) was launched by Planning Commission as an energy scenario building tool. The tool has been so developed, that it can create hundreds of scenarios with different combinations of levels/efficiencies of energy demand and supply sectors. Projection made by IESS for cooking sector has been made at GDP growth rate of 7.4% Compound Annual Growth Rate (CAGR). Further following assumptions have been made in making the projection –

- On an average a household needs 7 MJ of useful energy per day to cook.
- No distinction made between commercial cooking and cooking within the household as the average useful energy needed is the same and both cooking is done to satisfy the needs of the same population.
- With growth and development, cooking fuel preferences in India will largely resemble developed nations of today. Therefore the role of modern sources of energy will increase significantly in the coming years.
- The primary source of fuel accounts for most of the fuel used for cooking by the household. Therefore stacking of fuels though present is assumed to be such that there is only one and not two or three predominant sources of fuel.
- Implementation of cash transfer programs and similar subsidy programs will assist households in choosing modern, more convenient fuels without costs being a barrier to uptake.
- The investment needed to switch to modern fuels or switch between modern fuels is not prohibitive.
- Urban households will switch from LPG to PNG due to convenience and efficiency concerns. This switch will be aided by the fact that the piped gas network can be made easily available in densely populated urban areas as it is more efficient, convenient than LPG. Even in rural areas, PNG networks could be established in certain densely populated settlements, which could aid PNG penetration.
- Reliable hours of electricity supply may not be incentive enough for majority of urban and rural households to switch to electricity. This is assumed based on a strong preference for gas based cooking in India. Access to LPG in rural India is bound to increase from its current levels given the push from government

IESS further draws four scenarios. Level One is the most pessimistic situation. Level Two is slightly less pessimistic and takes into account some technological improvements. Level Three is more optimistic, and considers government policy intervention towards a better future. Level Four is the most optimistic; it is an ideal situation that is drawn from whatever is physically possible from today. For the purpose of this study, only scenario 1 - the most pessimistic and scenario 2 - the most optimistic situations are considered.

IESS uses 2012 as the base year and forecasts energy use for 2017, 2022, 2027, 2032, 2037, 2042 and 2047. Using compound annual growth rate following projections have been made for cooking sector.

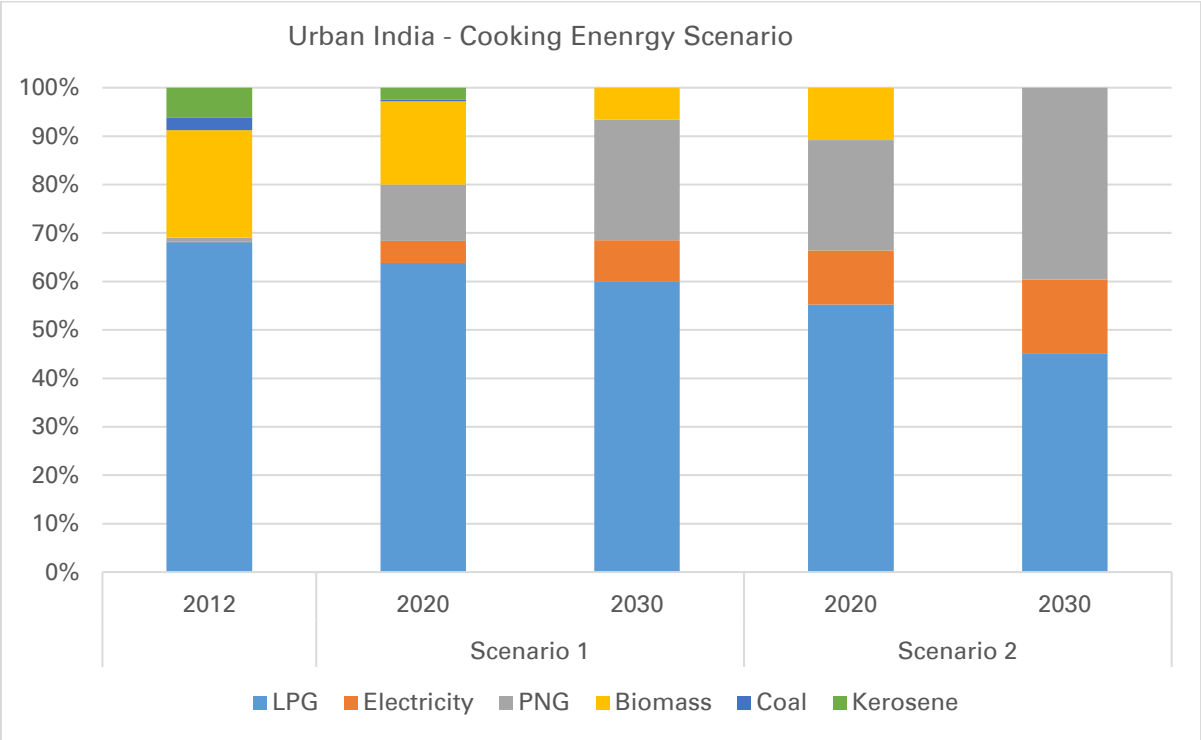


Table 4: Urban India - Cooking Energy Scenario					
Year	2012	Scenario 1		Scenario 2	
		2020	2030	2020	2030
LPG	69%	63.8%	59.9%	55.2%	45.2%
Electricity	0%	4.6%	8.6%	11.2%	15.2%
PNG	1%	11.6%	24.9%	22.8%	39.6%
Biomass	23%	17.2%	6.6%	10.8%	0.0%
Coal	3%	0.4%	0.0%	0.0%	0.0%
Kerosene	6%	2.4%	0.0%	0.0%	0.0%

Source: IESS

By 2030 there will be complete elimination of coal and kerosene as source of energy for cooking in urban India. Under both the scenarios, almost 85% HHs will be using PNG or LPG for cooking by 2030. However, in scenario 2 HHs using PNG will be 60% higher than in scenario 1. In 2030, use of electricity as cooking solution will be 50% higher in scenario 2 than in scenario 1. In scenario 1 almost 7% of the population will still be using biomass for cooking in 2030 whereas in scenario 2 use of biomass will be completely eliminated from urban areas (Table 4).

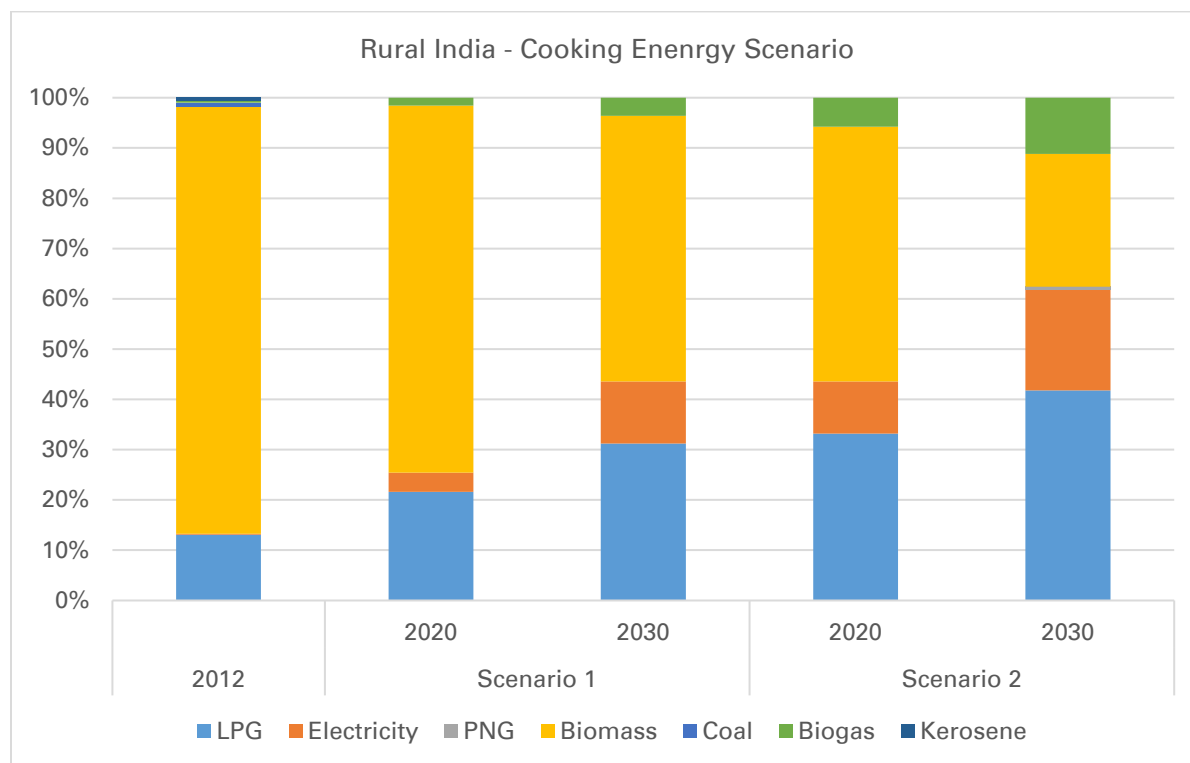


Table 5: Rural India - Cooking Energy Scenario					
Year	2012	Scenario 1		Scenario 2	
		2020	2030	2020	2030
LPG	13.1%	21.6%	31.2%	33.2%	41.8%
Electricity	0.1%	3.8%	12.4%	10.4%	20.0%
PNG	0.0%	0.0%	0.0%	0.0%	0.6%
Biomass	84.9%	73.0%	52.8%	50.6%	26.4%
Coal	0.8%	0.0%	0.0%	0.0%	0.0%
Biogas	0.4%	1.6%	3.6%	5.8%	11.2%
Kerosene	0.6%	0.0%	0.0%	0.0%	0.0%

Source: IESS

There will be a shift from biomass to LPG, electricity and biogas as source of energy for cooking in rural India. Between 2012 and 2030, use of biomass will come down from almost 85% HHs to 53% in scenario 1 and 26% in scenario 2. Use of LPG and electricity will see an increase with about 44% and 62% HHs using them for cooking in scenario 1 and 2 respectively. In scenario 2 almost 1/10th of the HHs will be using biogas as energy for cooking by 2030. Kerosene as a source of cooking fuel will be eliminated in both the scenarios by 2020 (Table 5).

Demand Projection of Improved Cook Stoves

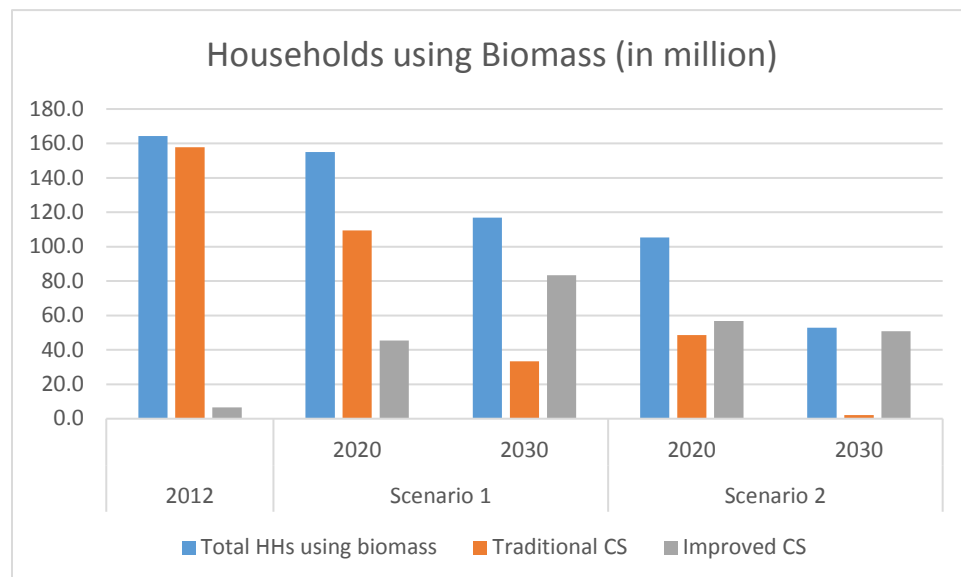


Table 6: Households using Biomass (in million)					
Year	2012	Scenario 1		Scenario 2	
		2020	2030	2020	2030
Total HHs using biomass	164.3	155.0	116.8	105.4	52.9
Traditional CS	157.7	109.5	33.4	48.7	2.1
Improved CS	6.6	45.5	83.4	56.7	50.8

Source: IESS

By 2030 number of households (HHs) using biomass as source of energy for cooking will see a decline of almost 30% in scenario 1 and by 67% in scenario 2 in absolute terms. As a result number of HHs dependent on biomass for energy for cooking will witness a fall from 164.3 million in 2012 to 105.4 million in scenario 1 and to 52.9 million in scenario 2.

Use of traditional cookstove will also see a decline. Amongst HHs using biomass, number of HHs using traditional cookstove will come down from a high of 157.7 million in 2012 to 48.7 million in scenario 1 and to just 2.1 million in scenario 2 by 2030. This will be below households using ICSs in 2030 - 56.7 million in scenario 1 and 50.8 million in scenario 2 (Table 6)

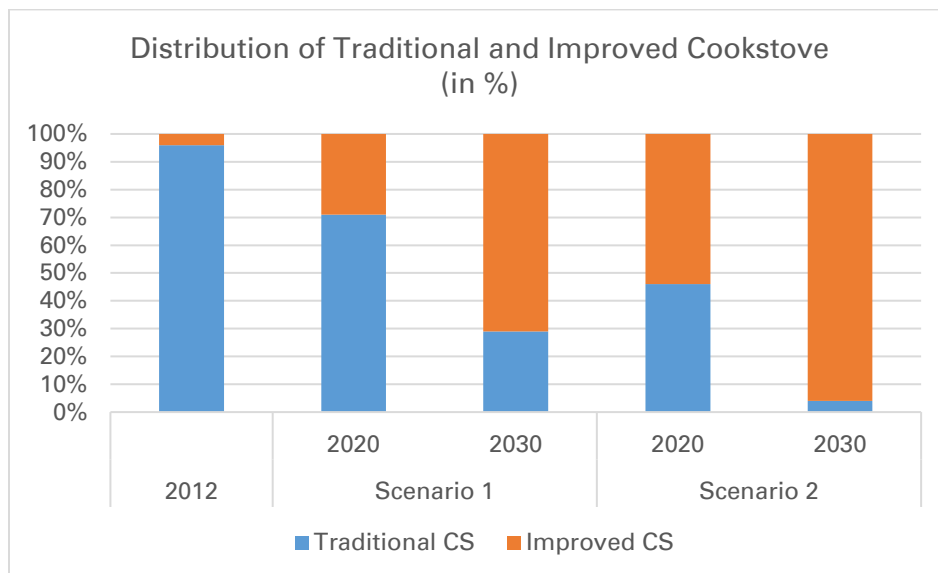
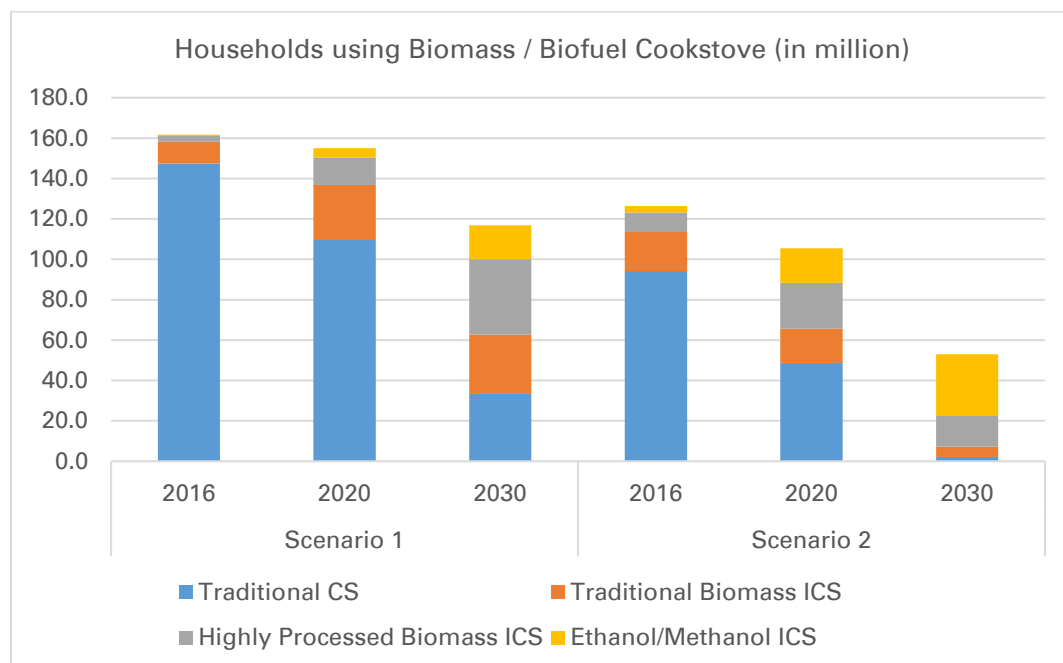


Table 7: Distribution of Traditional and Improved Cookstove amongst HHs using biomass fuel for cooking (in %)

	2012	Scenario 1		Scenario 2	
		2020	2030	2020	2030
Traditional CS	96%	71%	29%	46%	4%
Improved CS	4%	29%	71%	54%	96%

Source: IESS

In percentage terms, HHs using traditional cookstove will come down from a high of 96% of HHs using biomass for cooking in 2012 to 29% in scenario 1 and to 4% in scenario 2 by 2030 (Table 7).



Traditional-ICS distribution in numbers						
	Scenario 1			Scenario 2		
	2016	2020	2030	2016	2020	2030
Traditional CS	147.5	109.5	33.4	94.2	48.7	2.1
Total HHs using ICS	14.3	45.5	83.4	32.1	56.7	50.8
HHs using traditional biomass ICS (%)	75%	60%	35%	60%	30%	10%
HHs using highly processed biomass ICS (%)	20%	30%	45%	30%	40%	30%
HHs using ethanol/methanol ICS (%)	5%	10%	20%	10%	30%	60%
HHs using traditional biomass ICS (in million)	10.7	27.3	29.2	19.3	17.0	5.1
HHs using highly processed biomass ICS (in million)	2.9	13.6	37.5	9.6	22.7	15.2
HHs using ethanol / methanol ICS (in million)	0.7	4.5	16.7	3.2	17.0	30.5

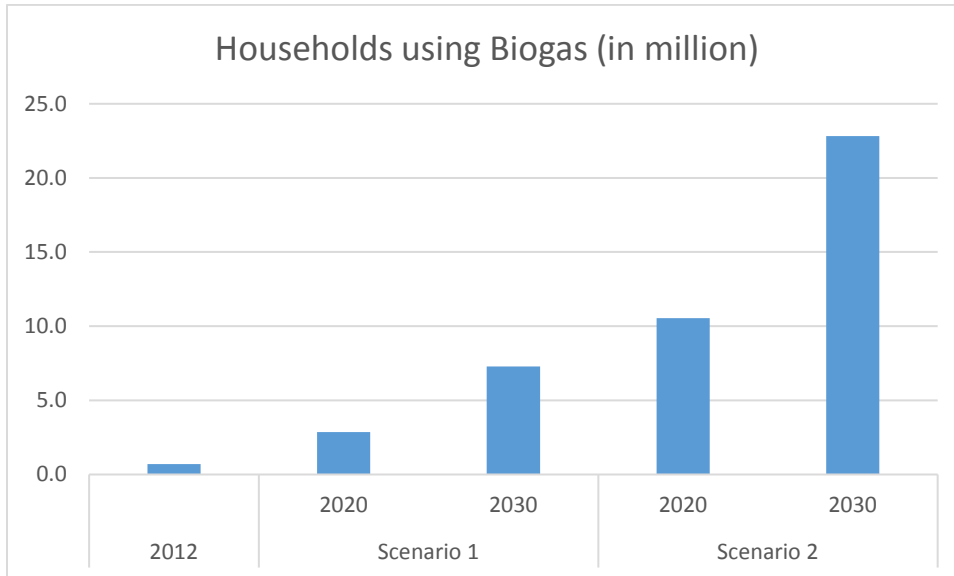
Source: IESS

For above calculation it is assumed that in coming years there will be –

1. Affordable ICSs in market which use highly processed biomass fuel, ethanol and methanol
2. Highly processed biomass fuel, ethanol and methanol will be easily accessible and affordable. Their supply will be reliable
3. Government promotion of ICSs using highly processed biomass fuel, ethanol and methanol due to better performance

As a result there will be a shift from traditional biomass based ICS to highly processed biomass fuel, ethanol and methanol based ICS. Assumption regarding share of traditional biomass, highly processed biomass, and ethanol/methanol based ICS in total number of HHs using ICS has been made in the (table 8).

Demand Projection of Kitchen Linked Biogas



Households using Biogas (in million)					
	2012	Scenario 1		Scenario 2	
		2020	2030	2020	2030
Biogas	0.7	2.9	7.3	10.5	22.8

Source: IESS

There will be an increase in number of HHs using biogas as primary source of energy for cooking. From 0.7 million HHs in 2012, it will go up to 10.5 million in scenario 1 and 22.8 million in scenario 2 by 2030.

BUSINESS MODEL: HYDGAS

Overview: Hydgas is a cooktop that produces its own gas. It uses water as fuel and uses electricity to convert it to hydrogen and oxygen and uses that to cook food. It produces gas as needed, so there is no storage of any gases in Hydgas, which makes it completely safe compared to LPG.

<p>Key Partners</p> <ul style="list-style-type: none"> ▪ Household Consumers ▪ Food services & restaurants ▪ Retail storefronts ▪ Leisure & Hospitality sector ▪ Entrepreneurs 	<p>Key Activities</p> <ul style="list-style-type: none"> ○ Sustained energy production without fossil fuel input supply ○ Continual innovation to enhance efficiency regularly ○ Rigorous marketing of product ○ Collect feedback, suggestion and information ○ Analyzing consumer demand and traffic <p>Key Resources</p> <ul style="list-style-type: none"> + Employees + Raw materials 	<p>Value Proposition</p> <ul style="list-style-type: none"> > Lucrative substitute to LPG > No emissions > Judicious use of environmental resources > Creation of green jobs > Service on request > Enhancement in source segregation > Sustainable business recognition to high volume users > Detailed customer segmentation analytics 	<p>Relationships</p> <ul style="list-style-type: none"> ✦ Social engagement ✦ Customer service ✦ Dedicated service for large scale buyers ✦ Identify and retain frequent / large-scale users ✦ Attract more citizens <p>Channels</p> <ul style="list-style-type: none"> → Website → Mobile App for Android → Mobile App for iOS → Stores → Social Media (Facebook, Twitter) → Online Advertisement → Regional Sales and Support Teams → Conferences 	<p>Customer Segments</p> <ul style="list-style-type: none"> Σ Restaurants Σ Domestic consumers Σ Retail outlets
<p>Cost Structure</p> <ul style="list-style-type: none"> ➢ Staff ➢ Operational Expenditure ➢ Capital Expenditure ➢ Brand Promotion ➢ IT Infrastructure 		<p>Revenue Streams</p> <ul style="list-style-type: none"> × B2B Sales × B2C Sales × Ad Revenue: Google Websites × Advertising campaigns 		

Chapter 4

Job Potential Estimates

- **Job Potential Estimates in Clean Cooking**
 - **Improved Cook Stove**
 - **Kitchen Linked Biogas**

Job Potential Estimates in Clean Cooking - Improved Cook Stove

In 2015 total employment in India was 58,000 in ICS and 85,000 in biogas. 10 million ICS were manufactured employing 76000 people in 2012 (Renewable Energy and Jobs Annual Review 2016).

Every 1 million increase in annual unit sales of solar lantern, ICS and portable biogas requires roughly:

- 5000 new sales and service associates spread across rural areas
- 500 Area sales and marketing managers in adjoining semi-urban areas
- 50-100 highly skilled business development managers and product engineers in urban areas
(Skill Solutions for off grid clean energy; April 2015)

Assuming that 5600 additional jobs in sales and marketing will be equally distributed across solar lantern, ICS and portable biogas sectors, every 1 million increase in unit sales of ICSs will require 7600 jobs in manufacturing and 1867 jobs in marketing and sales.

IESS forecast has been used to calculate total HHs using ICS every year. From this annual increase in number of HHs using ICS has been calculated. It is assumed that lifespan of an ICS will be five year and once out of use, an old ICS will be replaced by another ICS. Annual ICS replacement thus calculated has been added to annual increase in number of HHs using ICS to calculate total annual demand for ICS (Table 9)

Table 9: Annual Demand of ICS (in million)		
Year	Scenario 1	Scenario 2
2020	11.9	12.2
2030	15.1	6.8

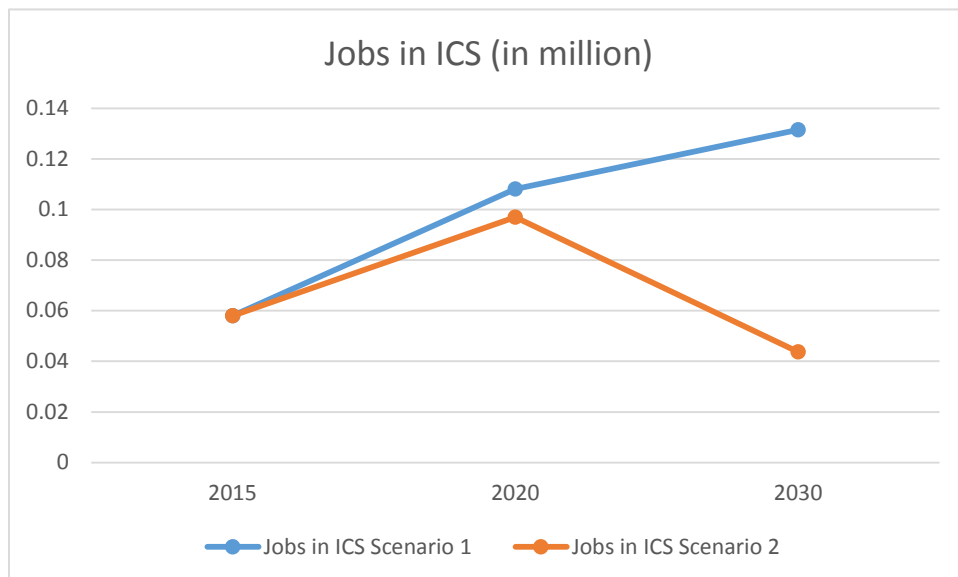
Source: IESS

Further it is assumed that due to automation in production in coming years, number of jobs required in ICS manufacturing will reduce as follows (Table 10). Rate of automation has been assumed to be higher in scenario 2 due to more favourable conditions.

Table 10: Decrease in ICS manufacturing jobs due to automation				
Year	Scenario 1		Scenario 2	
	Percentage decrease in workers requirement	No. of workers required for manufacturing 1 million ICSs	Percentage decrease in workers requirement	No. of workers required for manufacturing 1 million ICSs
2020-25	5%	7220	20%	6080
2026-30	10%	6840	40%	4560

Based on this jobs projection for 2020 and 2030 in improved cookstove sector has been made (Table 11)

Table 11: Job in ICS (in million)		
Year	Scenario 1	Scenario 2
2015	0.058	0.058
2020	0.11	0.10
2030	0.13	0.04



Jobs in ICS sector will increase in scenario 1 initially at a faster pace and then at a slower rate to reach 0.13 million in 2030. In scenario 2, jobs will increase initially and then will decline to reach 0.04 million in 2030 (Table 11). This would happen because it is assumed that with growth and development, cooking fuel preferences in India will largely resemble developed nations of today i.e. a mix of LPG, PNG and electricity. Also due to automation in manufacturing of cookstoves, job required in manufacturing of cookstoves will decrease.

Job Potential Estimates in Clean Cooking - Kitchen Linked Biogas

As per as study by Department of Renewable energy, MPUAT, Udaipur on the economics of a biogas plant; for constructing a family type biogas plant of capacity 3 to 4 m³ as estimated 36 maydays will be required. The different job roles for these 36 maydays are given in Table 12 below

Table: 12 Labour requirement for construction of kitchen linked biogas plant	
Activity	Mandays required
Pit Digging	10
Construction Mason	5
Construction Labor	15
Dung Filling	5
Pipe Fitting	1
Total	36

Source: Department of Renewable Energy, MPUAT, Udaipur, Study (Dr. Deepak Sharma)

Given the seasonal nature of rural construction sector, it is estimated that construction of biogas plant will generate employment 150 maydays per person per year. This mean a person will be able to construct, on an average, 4.16 biogas plants. In addition to this 1867 sales and marketing jobs will be required for every 1 million biogas plant (Skill Solutions for off grid clean energy; April 2015).

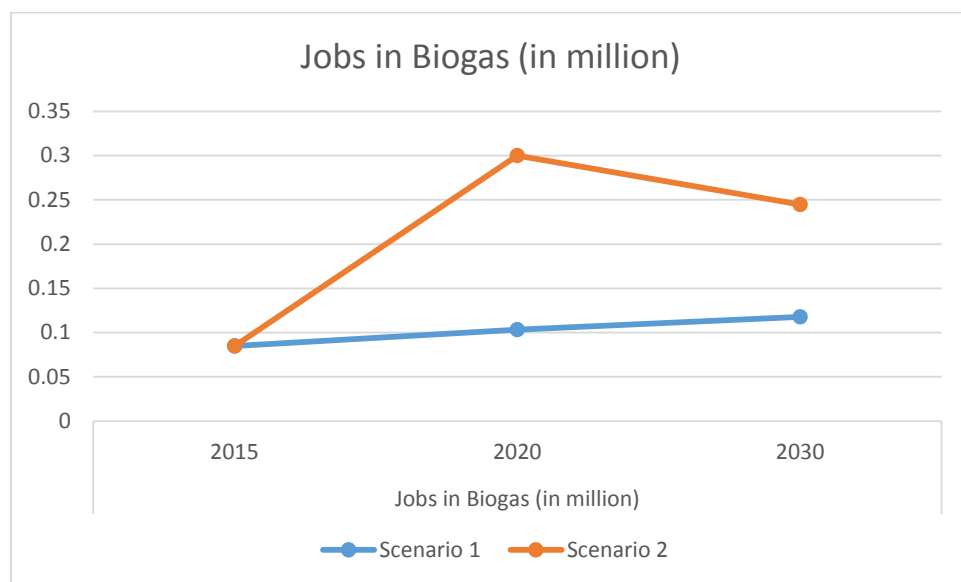
IESS forecast has been used to calculate total HHs using biogas every year. From this annual increase in number of HHs using biogas has been calculated. It is assumed that lifespan of a biogas plant will be 15 year and once out of use, an old biogas plant will be replaced by another biogas plant. Annual biogas plant replacement thus calculated has been added to annual increase in number of HHs using biogas to calculate total annual demand for biogas plant (Table 13)

Table 13: Annual Demand of Biogas Plant (in million)		
Year	Scenario 1	Scenario 2
2020	0.43	0.49
2030	1.25	1.02

Source: IESS

Based on this jobs projection for 2020 and 2030 in kitchen linked biogas plant sector has been made (Table 14)

Table 14: Job in Kitchen Linked Biogas Plant (in million)		
Year	Scenario 1	Scenario 2
2015	0.085	0.085
2020	0.1	0.11
2030	0.3	0.24



Jobs in biogas sector will increase at a steady rate in scenario 1 whereas in scenario 2 it will increase at an increasing rate initially before starting to decline. This would happen because it is assumed that with growth and development, cooking fuel preferences in India will largely resemble developed nations of today i.e. a mix of LPG, PNG and electricity.

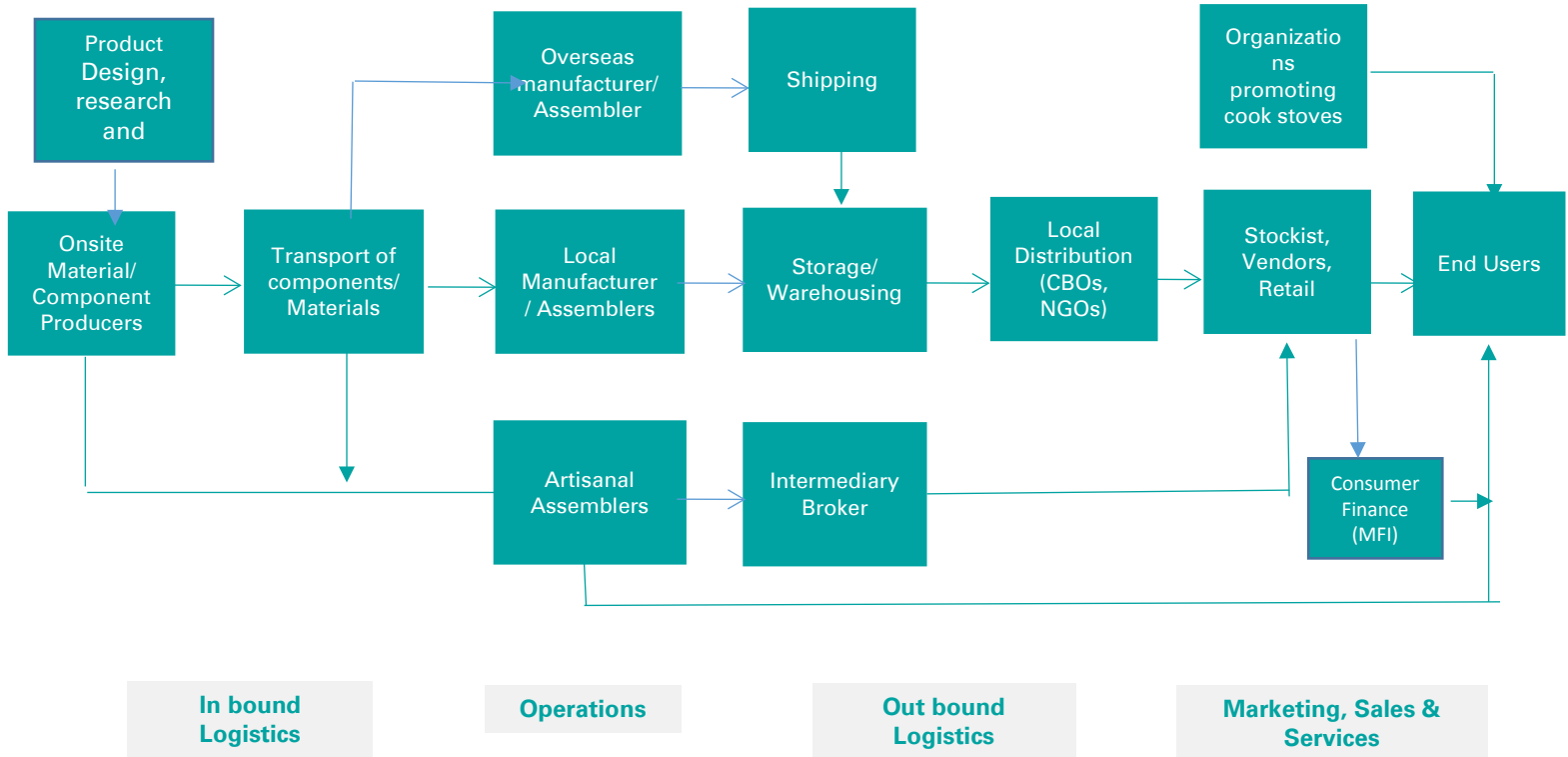
Chapter 5

Process Flow

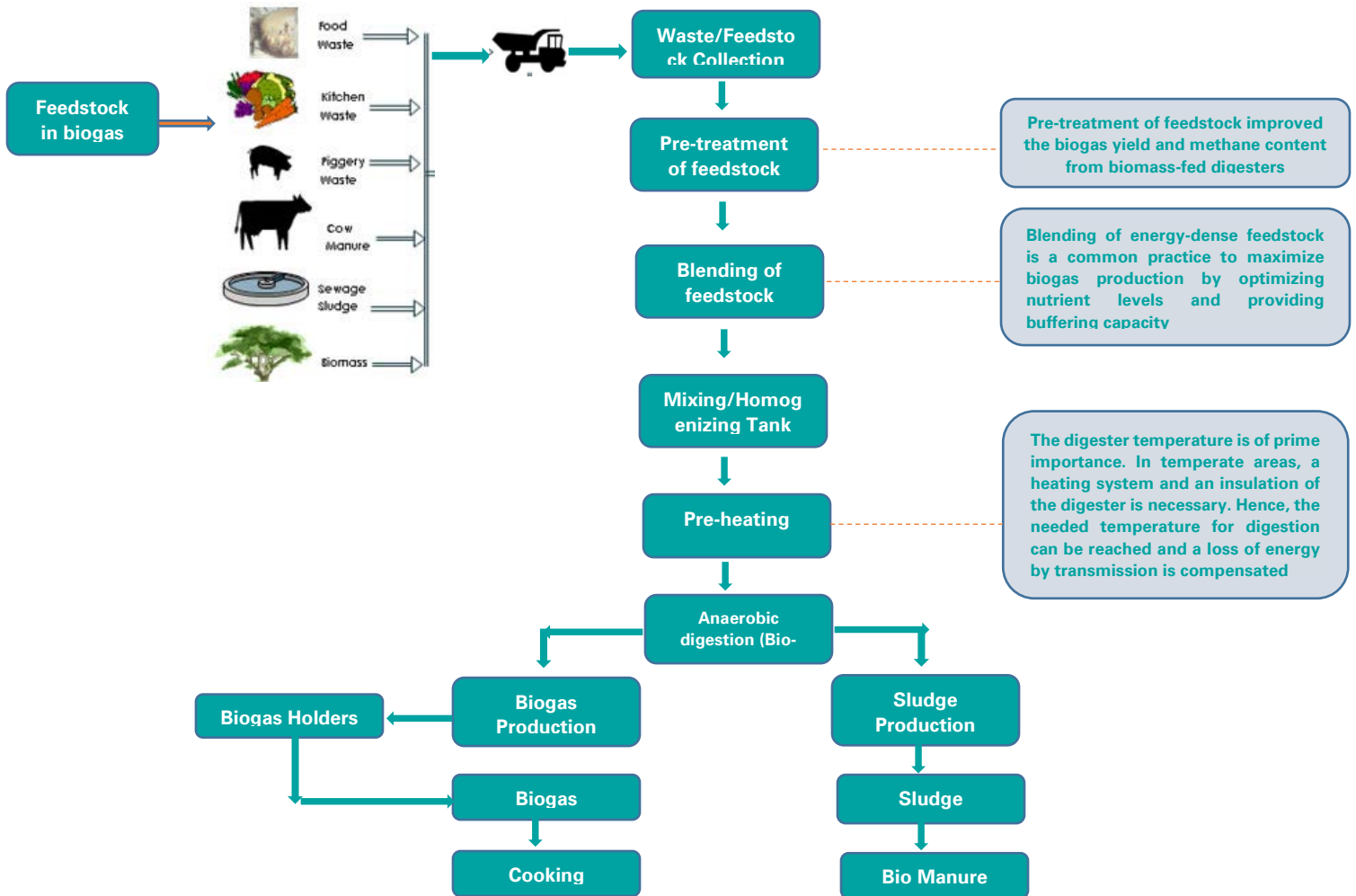
- **Current Industry Process Mapping**
- **Improved Cook Stove**
- **Biogas**

Current Industry Process Mapping- Improved Cook Stoves

The cook-stove value chain in India is fragmented with several options for production and distribution existing. Components are often made separately and assembled by other business. Several middlemen exist in the value chain before stoves are sold through markets and retailers.



Current Industry Process Mapping- Biogas plant



Chapter 6

Occupational Mapping & Skill Gap Analysis

- **Occupational Job Roles**
 - **Improved Cook Stove**
 - **Biogas**

- **Occupational Mapping**
 - **Improved Cook Stove**
 - **Biogas**

Occupational Job Roles - Improved Biomass Cook Stove

Stage-Value Chain	Activities involved	Job Roles
Research, Product Design and Development	Development of efficient and cost effective designs of biomass cook-stoves with reduced emissions.	<ul style="list-style-type: none"> ▪ Manager R&D ▪ R&D Research Associate ▪ Manager Design ▪ ICS Designer ▪ Helper - R&D
Quality Control	Carrying out performance testing of biomass cook-stoves as per BIS Standard for Bio-Mass Cook Stove	<ul style="list-style-type: none"> ▪ Quality Control Manager ▪ Quality Supervisor ▪ Quality Assistant ▪ Helper - Q&A
Off-site Material/Component Producers	<p>Production of components required for improved Cook Stove:</p> <p>Structural materials</p> <ul style="list-style-type: none"> ▪ Combustion chamber ▪ Insulation and envelope ▪ Accessories (grate, skirt, etc.) <p>Functional materials</p> <ul style="list-style-type: none"> ▪ Thermoelectric generator ▪ Heat conducting probe ▪ Heat sink <p>Refractory ceramics</p> <ul style="list-style-type: none"> ▪ Prefired refractory shape (refractory fired to final "brick") ▪ Plastic refractory (refractory shaped to need) ▪ Castable refractory (shape cast) ▪ Ceramic fiber (potential backup material) ▪ Powdered refractory filler <p>Metallic materials</p> <ul style="list-style-type: none"> ▪ Steel (mild steel, Cr steel, stainless steel) ▪ Cast iron 	<ul style="list-style-type: none"> ▪ Portable Improved Cookstove Entrepreneur ▪ ICS Entrepreneur (Fixed ICS)

<p>Manufacturing</p>	<ul style="list-style-type: none"> ▪ The main stove body is usually built up from the ground, around a simple mould (e.g. banana stem) that is removed to create the firebox and air passage cavities. ▪ They can be made with low-cost local materials such as clay, sawdust and lime mortar. ▪ Tools needed are also relatively inexpensive (e.g. shovel, sieve, trowel, measuring tape.) <p>Portable Stove – Ceramic Liners</p> <ul style="list-style-type: none"> ▪ The ceramic liners for portable stoves generally require higher quality standards and are usually made using moulds, left to dry and then fired in a kiln. ▪ They require a high quality of clay which must be carefully prepared before putting into the moulds.. ▪ Likewise, the requirement for kiln firing can make this a potentially capital-intensive venture unless access can be arranged to an existing kiln. <p>Portable Stove - Steel Cladding</p> <ul style="list-style-type: none"> ▪ Steel is usually used to clad the ceramic liner, following ▪ Basic sheet working/forming techniques. ▪ Tooling required is relatively inexpensive: hammer, chisel, anvil (or suitable iron girder). 	<ul style="list-style-type: none"> ▪ Managing Director ▪ Program Manager (Plant) ▪ Manager Project (Portable ICS) ▪ Manager Project (Fixed ICS) ▪ Manager Project (Commercial Cookstove Installation & Service) ▪ Plant O&M Engineer ▪ Project Associate ▪ CCS Installer / Trainer ▪ CCS Service Engineer ▪ Plant Supervisor ▪ Installer (Fixed ICS) ▪ Supervisor CCS ▪ Customer Support Representative ▪ Machine Operator ▪ Assembler ▪ Fitter ▪ Potter ▪ Helper - Production
<p>Distribution Networks and store keeping</p>	<p>Meeting demand and supply of products (Focusing on building supply chains). This would include store keeping and transportation of stock, materials and goods. ICS are stored in warehouses in close proximity to or in project area. This can be up to one week before distribution</p>	<ul style="list-style-type: none"> ▪ Store In-charge / Supervisor ▪ Store Assistant ▪ Helper - Store
<p>Marketing & Sales</p>	<ul style="list-style-type: none"> ▪ Marketing (Advertisements thorough media, display of posters, Door to door campaign, tie-up with NGO's etc.) ▪ Sales through distribution network 	<ul style="list-style-type: none"> ▪ Marketing manager ▪ Sales & Maintenance Executive ▪ Door to Door Sales Agent

Finance	Capital raising – both long term and working capital. Maintenance of books of accounts Provision of funds to consumers	<ul style="list-style-type: none"> ▪ Finance Manager ▪ Finance Officer ▪ Accountant ▪ Office Assistant - Finance

List of Job Roles - Improved Biomass Cook Stove

S.No	Job Role	Critical /General	NSQF Levels
1	Managing Director	Critical	8
2	Program Manager	General	7
3	Portable Improved Cookstove Entrepreneur	Critical	6
4	Manager Project (Portable ICS)	Critical	6
5	ICS Entrepreneur (Fixed ICS)	Critical	6
6	Manager Project (Fixed ICS)	General	6
7	Manager Project (Commercial Cookstove Installation & Service)	General	6
8	Quality Control Manager	General	6
9	Finance Manager	General	6
10	Manager R&D	Critical	6
11	Manager Design	General	6
12	Marketing manager	General	6
13	Plant O&M Engineer	Critical	5
14	Project Associate	General	5
15	CCS Installer / Trainer	General	5
16	CCS Service Engineer	Critical	5
17	QA Supervisor	Critical	5
18	Store In-charge / Supervisor	General	5
19	Finance Officer	General	5
20	R&D Research Associate	General	5
21	ICS Designer	General	5
22	Plant Supervisor	General	4
23	Installer (Fixed ICS)	General	4
24	Supervisor CCS	General	4
25	Customer Support Representative	General	4
26	QA Assistant	General	4
27	Store Assistant	General	4
28	Accountant	General	4
29	Sales & Maintenance Executive	Critical	4
30	Machine Operator	General	3
31	Assembler	General	3

S.No	Job Role	Critical /General	NSQF Levels
32	Fitter	General	3
33	Potter	Critical	3
34	Office Assistant	General	3
35	Helper	General	2

Occupational Job Roles - Biogas

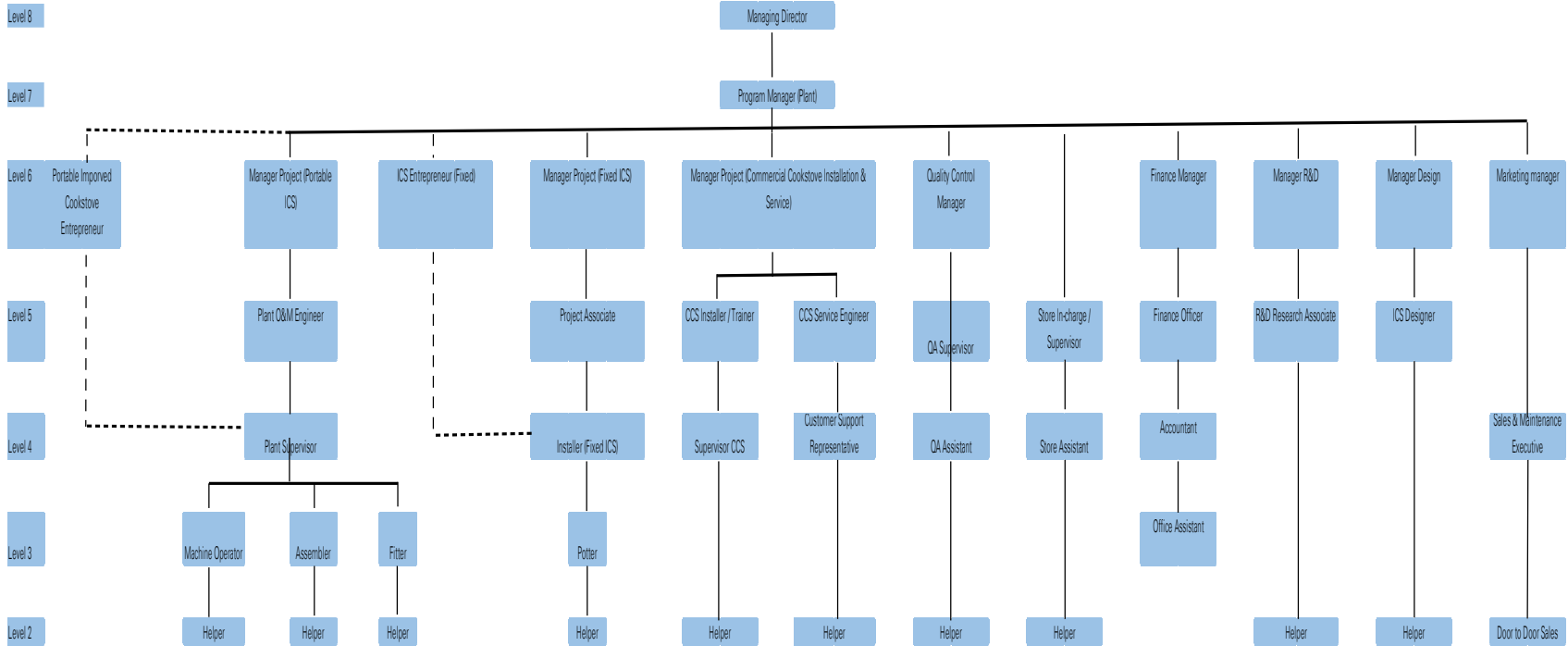
Stage-Value Chain	Activities involved	Job Roles
Feedstock in Bio-Gas Plant	Supply of Feedstock from various industries/farm etc. to be used in Bio-Plant	<ul style="list-style-type: none"> ▪ Feed Supplier
Transportation and Waste/Feedstock Collection	Collection and storage of feedstock to be used in the digester. Transportation usually contracted out to local businesses (Local transporters).	<ul style="list-style-type: none"> ▪ Storage in-charge ▪ Store helpers ▪ Drivers
Pretreatment of feedstock	Mechanical pre-treatment Biological pre-treatment Thermal pre-treatment	<ul style="list-style-type: none"> ▪ Lab Technician – Pretreatment ▪ Supervisor ▪ Helper
Blending of feedstock	Blending of energy-dense feedstock is a common practice to maximize biogas production by optimizing nutrient levels and providing buffering capacity	<ul style="list-style-type: none"> ▪ Executives – Blending ▪ Supervisor ▪ Helper
Mixing/Homogenizing tank	The mix tank is a concrete or metal structure where manure is deposited by a manure collection system. It serves as a control point where water can be added to dry manure or dry manure can be added to dilute manure.	<ul style="list-style-type: none"> ▪ Executives - Mixing/Homogenizing ▪ Supervisor ▪ Helper
Pre heating	The digester temperature is of prime importance. In temperate areas, a heating system and an insulation of the digester is necessary. Hence, the needed temperature for digestion can be reached and a loss of energy by transmission is compensated	<ul style="list-style-type: none"> ▪ Executives - Preheating ▪ Supervisor ▪ Helper
Anaerobic Digestion, Biogas Production, Biogas Holding & Bio-gas Utilization	<p>Digesters consist of the digestion tank as such, which is thermally insulated, plus a heating system, mixer systems and discharge systems for sediments and the spent substrate.</p> <p>Biogas Holders (Floating drum gasholders & Fixed Dome Gasholders)</p> <p>Laying down of pipelines for transportation of gas to households for cooking</p>	<ul style="list-style-type: none"> ▪ Managing Director ▪ Production Manager ▪ Construction & Maintenance Manager ▪ Assistant Manager Maintenance ▪ Fabricator ▪ Mason ▪ Helper
Marketing & Sales	<ul style="list-style-type: none"> ▪ Marketing (Advertisements thorough media, display of 	<ul style="list-style-type: none"> ▪ Marketing Head ▪ Marketing and Sales Executive ▪ Office Assistant

	posters, Door to door campaign, tie-up with NGO's etc.) ▪ Sales through distribution network	
Finance	Capital raising – both long term and working capital. Maintenance of books of accounts Provision of funds to consumers	▪ Finance Manager ▪ Accountant ▪ Office Assistant

List of Job Roles - Biogas

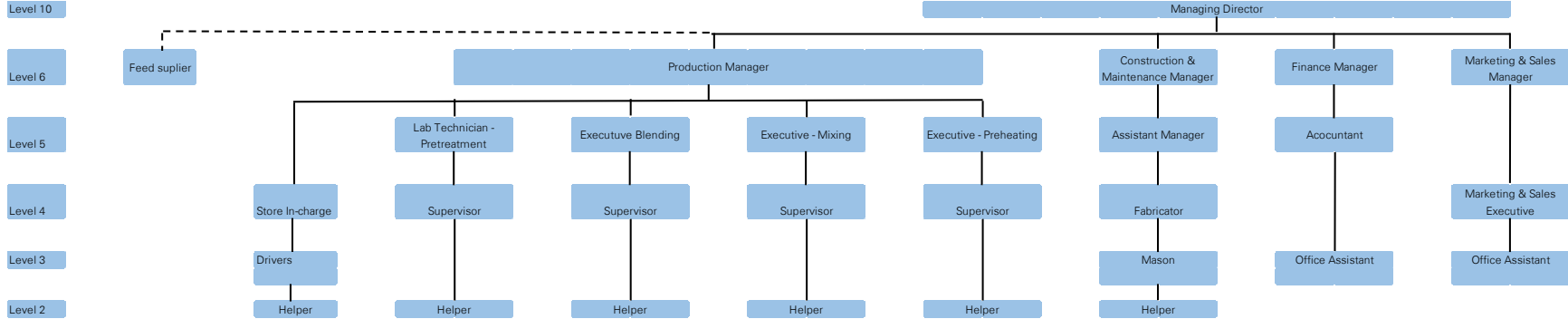
S.No	Job Role	Critical /General	NSQF Levels
1	Managing Director	General	8
2	Construction & Maintenance Manager	General	6
3	Assistant Manager Maintenance	General	4
4	Fabricator	Critical	4
5	Mason	General	3
6	Production Manager	Critical	6
7	Lab Technician – Pretreatment	Critical	5
8	Supervisor - Pretreatment	General	4
9	Helper - Pretreatment	General	2
10	Executives – Blending	Critical	5
11	Supervisor - Blending	General	4
12	Helper - Blending	General	2
13	Executives - Mixing	Critical	5
14	Supervisor - Mixing	General	4
15	Helper - Mixing	General	2
16	Executives – Preheating	Critical	5
17	Supervisor - Preheating	General	4
18	Helper - Preheating	General	2
19	Feed Supplier	General	6
20	Storage in-charge	General	4
21	Store helpers	General	2
22	Drivers	General	3
23	Finance Manager	General	6
24	Accountant	General	5
25	Office Assistant - Finance	General	3
26	Marketing Manager	General	6
27	Marketing and Sales Executive	General	5
28	Office Assistant - Sales	General	3

Occupation Mapping – Improved Biomass Cooking Stoves



Occupational Map Clean Cooking.xlsx

Occupation Mapping – Biogas



Occupational Map Clean Cooking.xlsx

References

1. Skills and Occupational Needs in Renewable Energy. International Labour Office, 2011.
2. Nationwide Mapping of Stakeholders in The Clean Cook Stove Value Chain in Ghana. Centre for Energy, Environment and Sustainable Development, 2014.
3. The State of the Global Clean and Improved Cooking Sector. Energy Sector Management Assistance Program & Global Alliance for Clean Cookstoves, 2015.
4. Indian Improved Cookstoves: A Compendium. the FAO Regional Wood Energy Development Programme in Asia, 1993.
5. Abhishek Jain, Poulami Choudhury, And Karthik Ganesan. Clean, Affordable and Sustainable Cooking Energy for India Possibilities and Realities beyond LPG. CEEW Report, 2015.
6. Moreshwar Hude. Future of Cook stoves: Review and Recommendations. TERRE Policy Centre 2014
7. Energy Sources of Indian Households for Cooking and Lighting, NSS 66 Round, 2009-10
8. Skill Solutions for Off-Grid Clean Energy Skill Solutions for Off-Grid Clean. CLEAN Strategy Series, 2015.
9. Energy for Cooking In Developing Countries, Chapter 15. OECD/IEA, 2006, pp. 419-445.
10. User Guide for India's 2047 Energy Calculator Cooking Sector, www.indiaenergy.com.
11. Household Cookstoves, Environment, Health and Climate Change: A New Look at an Old Problem. The Environment Department (Climate Change) The World Bank, 2011.
12. Dalberg Global Development Advisors. India Cookstoves and Fuels Market Assessment. Global Alliance for Clean Cookstoves, 2013.
13. Energy Used by Indian Households. NSS 50 Round, 1993-94.
14. Energy Sources of Indian Households for Cooking and Lighting. NSS 68 Round, 2011-12.
15. Koffi Ekouevi. Scaling Up Clean Cooking Solutions - The Context, Status, Barriers and Key Drivers. International Finance Corporation, 2013.
16. Azeem Hafiz P A, Rashid Ahamed R, Muhamed S A, Sharukh M. Study of Biogas as a Sustainable Energy Source in India. International Journal of Research in Mechanical Engineering Volume 4, Issue 3, May-June, 2016, pp. 58-62.
17. World Energy Outlook Special Report. OECD/IEA, 2016
18. Debadayita Rahaa, Pinakeswar Mahantab, Michèle L. Clarke. The implementation of decentralised biogas plants in Assam, NE India: The impact and effectiveness of the National Biogas and Manure Management Programme. Energy Policy, Volume 68, May 2014, Pages 80-91.
19. Renewable Energy and Jobs: Annual Review, International Renewable Energy Agency, 2016
20. Sharma Shruti. Subsidies to Liquefied Petroleum Gas in India: An assessment of the direct benefit transfer in Mysore. GSI and IISD, 2014
21. The Kaleidoscope of Cooking - Understanding Cooking Behaviour and Stove Preferences in Rural India. GIZ, 2014
22. India's Intended Nationally Determined Contribution: Working Towards Climate Justice. Government of India, 2015
23. Indian Energy Security Scenarios 2047. NITI Ayog, 2014