Title:

Curriculum for Establishment of Certificate Programme in

Cookstove Design, Development and Testing

(Draft)

To be Organised at:

Cookstove Testing and Expertise Laboratory (C-Lab)
KNUST Campus

The course participants will meet in the Cookstove and Testing and Expertise Laboratory (C-Lab) of Technology Consultancy Centre at the Kwame Nkrumah University of Science and Technology (KNUST) Campus, Kumasi, Ghana.

The course will be instructed by faculty and technicians who have acquired both practical and theoretical experience in cookstove design, development and testing through hands-on engagements by implementing field-base projects in Ghana and other developing countries. Resource persons from other reputable institutions who conduct research and develop cookstoves and other heat retention devices will be invited to participate in the training programme.

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INTRODUCTION

Cookstove is a heat retention device that plays a very significant role in cooking and boiling for household and commercial purposes. There are several designs of cookstove that can be found on the Ghanaian market, some use electricity, liquefied petroleum gas (LPG) and biomass in the form of charcoal, firewood, cow dung, briquette, pellet etc. Some of these stoves come with challenges including low thermal efficiency, smoke pollution, heat loss and safety issues that have adverse effect on the health of end-users and the environment. In light of the foregoing challenges, there is the need to develop programmes, standards and testing facilities that would help guide local fabrication of cookstove and other heat retention devices.

In the year 2015, the Technology Consultancy Centre (TCC) setup a Cookstove Testing and Expertise Laboratory (C Lab) to serve the northern part of Ghana and its surrounding countries. The purpose of the C-lab is to provide testing, research and expertise in the field of cookstove design, prototype development, and training of local manufacturers, retailers, end-users as well as students. The lab is a state-of-the-art facility equipped with cutting-edge equipment and tools to undertake cookstove design, prototype development, testing and training.

This curriculum describes the training objectives, methods, courses, and criteria for assessing trainees who would be provided the opportunity to have hands-on training, knowledge and skills can help create jobs and generate income in Ghana and other developing countries. The section below describes the course objectives.

COURSE OBJECTIVES

The objectives of this course are in summary, to:

1. Equip participants with knowledge to understand the principles and concepts of cookstoves, fuels and fire
2. Enable participants to learn and understand the parameters relevant for testing and evaluation of cookstoves and how they relate to each other
3. Build the skills of the participants on the use of hand tools and equipment for cookstove design, development and manufacture and the risk associated with them.
4. Guide participants to identify the appropriate materials for cookstoves development and manufacture
5. Equip participants to understand and apply the design process and support them to prepare technical and business plan for solving a challenge.

COURSE DESCRIPTION

This course will cover the following topics: historical background, concepts and principles; parameters for identifying a good stove; tools and workshop safety; materials for stove building; and the design process.

Day	Topic	Remarks
SESSION 1: UNDERSTANDING THEORETICAL CONCEPTS OF COOKSTOVES		
1	**Historical background, concepts and principles** • History cookstoves and how different types of cookstoves have evolved over the years	

	• Cookstoves concepts and definitions • Principles of cookstove design and development (heat enclosure, heat transfer, fuels, fire, etc.) • Environmental, health, social and economic factors associated with the use of cookstoves • Principles guiding material selection, costing and estimation	
2	**Parameters for identifying a good stove** • Power output • Thermal efficiency • Ease of starting fire • Energy consumption • Fire power • Emission (CO, CO_2, $PM_{2.5}$) • Global warming impact	
3	**Parameters for identifying a good stove** • Stove safety • Costing and estimation • Time to boil • Temperature and relative humidity • Moisture content of fuels • Energy content and heat capacity	
4	**Tools and workshop safety** • Build the skills of the participants on the use of basic hand tools for cookstove design, development and manufacture and the risk associated with them. • Guide participants to identify the appropriate materials for cookstoves manufacture • Enable participants to learn and understand the parameters relevant for testing cookstoves • Equip participants to understand the design process and support them to prepare technical and business plans for solving a challenge.	
5	**Materials for stove building** • Identification of materials (metals, insulators, wood, clay etc.) • Application of materials in the development of the stove	Locally available materials will be used for building the prototypes
SESSION 2: PRACTICAL HANDS-ON ACTIVITIES		
6	**The design process** • Gather information • Framing the problem • Set design requirements • Generate ideas	Participants will work with selected communities to gather information and frame the problems
7	**The design process (Working session)** • Analyse and experiment • Evaluate concept and choose the best idea	This will be done in collaboration with selected communities

	• Work out the details	
8	**The design process (Working session)** • Build prototype • Test and evaluate • Get feed back	Prototype testing will be done using the facilities at the C-lab
9	**The design process (Working session)** • Build prototype • Test and evaluate • Get feed back	Prototype testing will be done using the facilities at the C-lab
10	**Presentation of prototypes**	Presentation will be reviewed by course instructors

LEARNING OBJECTIVES

At the end of the training programme, participants should be able to:

- Understand the principles and concepts of cookstoves, fuels and fire with emphasis on household, commercial and institutional cookstoves
- Acquire hands-on skills on the use of hand tools and equipment for cookstove design, development and manufacture and the risk associated with them
- Apply the parameters relevant for designing, testing and evaluation of cookstoves
- Identify the appropriate materials for cookstoves manufacture
- Apply the design process and prepare technical and business plan for solving a challenge

TEACHING AND TRAINING METHODS

The content of this programme will be delivered and facilitated by competent faculty and technicians of KNUST who have knowledge, expertise and hands-on skills in design, development and testing of cookstoves and other heat retention devices. Participants will be shown how to use various tools, equipment, measuring and testing devices to enable them apply the acquired skills during the practical session. They will also have hands-on skills on welding, cutting, folding, riveting, drilling, lathe turning, punching among others that will equip them to work effectively during the prototyping stage.

The instructors will guide the participants to identify appropriate materials for cookstoves development and manufacture. Locally available materials will be used for building the prototypes. Participants will be put into small groups for class assignments, projects and discussions on various cookstove design challenges common in the communities that need to be addressed. They will work with selected communities to gather information, frame the problems, set design requirements and generate ideas. All of these will form the first part of the design process.

The second part of the design process will focus on the working session where the participants will analyse and experiment their ideas, evaluate concept, choose the best idea and work out the details. The participants will have the opportunity to develop possible solutions that can be

turned into prototypes. Prototype testing will be done using the facilities at the C-lab. The developed prototypes will be presented to a panel of instructors for assessment and feedback.

METHODS FOR ASSESSING LEARNING

The following methods will be employed to assess the participants on how the learning process has been effective.

- Class assignments
- In-class short quizzes
- Group presentations
- The participants will test the developed prototypes and outcome of the test will be assessed

EXPECTATION FOR STUDENTS/TRAINEES

The expectation for the students and trainees includes:

- Trainees are expected to be punctual during all lesson periods and prepared for lessons by reading and researching on relevant materials and books
- Trainees should actively participate in the training activities so that they can derive maximum benefit through learning by doing
- Trainees should respect the right of other trainees by not imposing their views on them. In the class every contribution counts and should be respected as such
- The trainees should conform to high standard of behavior in the use of the training and learning facilities at the C-lab
- It is expected that the trainees will work together with other participants in a team/group work. This will help them learn how to work in a team to achieve team goals and objectives
- Conflicts and disagreements among trainees should be resolved through the appropriate channels. If possible it should be addressed by the facilitators
- Trainees are not to bring food or snack to the C-lab during the training, however trainees can bring water. The C-lab is expected to be kept clean as possible.
- Phones, tablets and i-Pods can be used in class only for activity relating to the training, otherwise trainees is expected to switch off their devices to allow participants focus on what they are learning.
- Trainees are expected to handle tools and equipment with utmost care

READING AND RESOURCES

Participants will utilize web-based readings and resources for background information on cookstove design, development and testing.

Readings/resources include:

AirNow website (2016). Extremely High Levels of PM2.5: Steps to Reduce Your Exposure. [http://www.airnow.gov/index.cfm?action=aqibasics.pmhilevels], (accessed February 2016)

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Berkley Air Monitoring Group (2012). Stove Performance Inventory Report; Prepared for the Global Alliance for Clean Cookstoves; United Nations Foundation: Washington, DC, USA.

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Global Alliance for Clean Cookstove (GACC). The water boiling test version 4.2.3. In Cookstove Emissions and Efficiency in a Controlled Laboratory Setting; GACC:Washington, DC, USA, 2014.

Genitha I., Lakshmana Gowda B. T. and John Diamond Raj (2014) Design, Fabrication and Performance Evaluation of Domestic Gas Oven, *IOSR Journal of Engineering*. Vol. 04, Issue 05, ||V5|| PP 35-38.

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GSA, (2016b). GSA Standards Work Programme Bulletin January, Ghana Standards Authority (GSA), Accra, Ghana.

HEVAC Humidity Group. Humidity and its Impact on Human Comfort and Wellbeing in Occupied Buildings. Available online: http://www.humiditysolutions.co.uk/wp-content/uploads/2016/06/HUMIDITY-AND-THE-IMPACT-ON-HUMAN-COMFORT-250416.pdf (accessed on 3 December 2016).

Inkoom, D.K.B., & Biney, B.S. (2010). The potential of liquefied petroleum gas (LPG) as a viable energy option for the industrial sector in Ghana. *Journal of Sustainable Development in Africa, 12*(6), 34-61.

Jerneck A, Olsson L (2013) A smoke-free kitchen: initiating community based co-production for cleaner cooking and cuts in carbon emissions. *Journal of Cleaner Production, Elsevier Ltd,* 60:208-215.

Jetter, J.J.; Kariher, P (2009). Solid-fuel household cook stoves: Characterization of performance and emissions. Biomass Bioenergy, 33, 294–305.

Kodgule and Salvi, 2012. Exposure to biomass smoke as a cause for airway disease in women and children. Current Opinion in Allergy and Clinical Immunology 12, 82.

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MacCarty, N.; Ogle, D.; Still, D. (2008). A laboratory comparison of the global warming impact of five major types of biomass cooking stoves. Energy Sustain. Dev. 12, 56–65.
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Silltoe, P (1997). "The Earth Oven: An Alternative to the Barbecue from the Highlands of Papua New Guinea." The Anthropologists Cook Book: 1997. 224–231
Smith A. (2013). Creative Capacity Building CCB Design Workbook, Adapted Course Material from D-Lab, Massachusetts Institute of Technology (MIT), Cambridge, USA.
Smith, J (2011). Protecting Health and the Planet with Clean Cookstoves Carbon Market Helps Boost African Energy Project**.** National Geographic News [http://news.nationalgeographic.com/news/energy/2011/02/110215-cookstoves-sustainable-development-ghana/], (accessed February 2016)
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WHO (2006) Household air pollution and health. Media Centre Fact sheet N°292, [http://www.who.int/mediacentre/factsheets/fs292/en/], (accessed February 2016)
WLPGA (2012). Why LPG. Cooking for Life, World LPG Association (WLPGA). [http://www.cooking-for-life.org/the-challenge/why-lpg], (accessed January 2016)

OTHER RELEVANT INFORMATION SOURCES:

Other relevant information sources include:

- Cleancookstoves.org/technology-and-fuels
- Aprovecho.org
- Stoves.bioenergylists.org
- Oregonlive.com
- Youtube.com/stoves