# Case Studies of Holistic Approach to Engineering: GNH-Engineering

**Nadim Reza Khandaker**

DOI: https://doi.org/10.17102/bjrd.rub.10.2.009

**Abstract**

The ethos of Lama Drukpa Kunley of: "Outwardly, I live for my pleasure and inwardlyI do everything in the right moment" can be the research ethos of engineering researchers to solve problems of communities they reside in. This paper with the help of three case studies outline what good can be done by some simple research and innovation to help the communitiesby solving their pressing needs as expels of GNH engineering. The case studies were: 1. Ensuring that people have arsenic safe water in Phuentsholing, Bhutan, 2. Making biogas from waste rice cooking wastewater using a homemade reactor with waste plastic chemical drum, and 3. The Stack Pot Heater to disinfect water and produce drinking water.

**Key words**: *GNH engineering, Arsenic-safe water, rice wastewater to biogas, stack pot heater/disinfector*

## Introduction

The concept of Gross National Happiness (GNH) was first introduced to the world by his Majesty Jigme Singye Wangchuck as a holistic approach to development. In this sprit thispaper will report on three Case Studies that will serve as examples holistic engineering that serves the simple needs of the community and helps them to be happy in their daily lives and can be considered as GNH engineering. Simple innovations and exercise in applied engineeringthat makes their lives better. A concept that was probably rooted in the folk lore's of Bhutan and preached by its famous Lama Drukpa Kunley to describe his humanitarian philosophy and said:

“am happy that I am a free Yogi.
So I grow more and more into my inner happiness.
I can have sex with many women,
because I help them to go the path of enlightenment.
Outwardly I'm a fool
and inwardly I live with a clear spiritual system.
Outwardly, I enjoy wine, women and song.
And inwardly I work for the benefit of all beings.
Outwardly, I live for my pleasure
and inwardly I do everything in the right moment.
Outwardly I am a ragged
beggar and inwardly a blissful Buddha.”

Can we not apply the same principle in our research ethos to solve the problems our communities face, to make their life better? Would it not have been wat the great Yogi’s would have professed. Through three simple case studies this paper will highlight what the essence ofthe holistic approach to engineering could be: 1. Ensuring that people have arsenic safe water in Phuentsholing, Bhutan, 2. Making biogas from waste rice cooking wastewater using a homemade reactor with waste plastic chemical drum, and 3. The Stack Pot Heater to disinfectwater and produce drinking water.

## Case Study 1

The first case study is an exercise in ensuring that people relying on ground water from underground aquifers in rock formation as their source of drinking and cooking water are drinking arsenic free water. The town of Phuentsholing, a border town in southern Bhutan bordering west Bengal India, with a population of around twenty thousand, obtain theirwater from ground water. Since Phuentsholing it is bordering West Bengal India where the groundwater is known t be contaminated with arsenic it is a concern also for Phuentsholing. The water was never tested for arsenic till with till an effort by some young faculty in the College of Science and Technology, Bhutan and a senior engineer from Bangladesh collected water samples from different locations in Phuentsholing and flew the samples to Bangladesh and the water samples were tested for arsenic. All the samples collected from all the supply sources tested negative for arsenic meaning the arsenic concentration was 0.0 mg/L.

Figure 1. Water sampling program with city engineer and in Phuentsholing Bhutan.

This is an example where engineers with their own effort without thinking of lofty research goals provided a service to a community. Is this not a classic example of GNH engineering where the community will sleep in peace knowing their children are drinking arsenic safe water.

**Case Study 2**

The second cases study where waste starch from rice cooking is used in a homemade digester to produce biogas for household cooking. Rice is a staple for people of Bhutan and Bangladesh. While cooking rice starch rich wastewater is generated, for one kilogram of rice cooking roughly five liters of wastewater rich in starch is drained and discharged to the sewer. This starch rich wastewater was characterized to have a biochemical oxygen demand ($BOD_5$) value of 23450 ± 796 mg/L, could be used to generate biogas with a biogas generation potential of 190 ± 46 mL/g $BOD_5$ (5.38 ± 0.75 L of biogas/per L of rice cooking wastewater) with the methane content of 78 % [1].

This is an excellent source of biogas that is not being utilized but literally thrown down the drain. This potential was realized in a pilot study where a 210 L waste plastic drum was converted to a biogas reactor. The seed source was cow dung and the reactor was fed waste starch water generated from rice cooking from an urban household.

After a period of culture acclimation of twenty days a biogas burner was used to use the biogas generated from the starchdigester showing that wastewater from rice cooking can be used to produce biogas to augment the fuel required in cooking. This would be highly applicable in all of rural South Asia where rice is a staple.


Figure 2. Homemade biogas reactor using recycled chemical drum to produce biogas from ricecooking wastewater rich in starch.

The existing biogas reactor in College of Science and Technology can be converted toa rice cooking gray water treatment system cum biogas generator to augment their energy requirement for cooking. This is again an example of GNH engineering. Simple engineering concepts applied to address the needs of the community.

**Case Study 3**

The Stack Pot Heater Water Disinfector is a simple devise where you stack a pot full of wateron to of a pot where rice is being cooked. The seam generated from the rice cooking condenseson the bottom of the pot above and transfers the latent heat from the steam to heat the water inthe top pot.

The efficacy of the process was evaluated in a controlled experimental program. The results indicated that our process would heat the water to temperatures that would inactivate pathogenic bacteria, viruses, and protozoa. In trial runs by raising the water temperature to 76.6±0.9°C, utilizing the latent heat generated from rice cooking. Further, if one wants to bring thewater to rolling boiling, it requires ~ 3.0 minutes of additional direct heating after preheating with our system. This additional heating would require a normal expenditure of LPG of 0.073 Kg to bring to boil 10 L of water after preheating; whereas direct heating to bring 10 L of waterto boil from an ambient temperature of 23.0°C would require 0.24 Kg of LPG. We feel that this system will go a long way to address this public health crisis faced every year in Bangladesh and to address the safe water crisis faced by the million in South Asia [2].

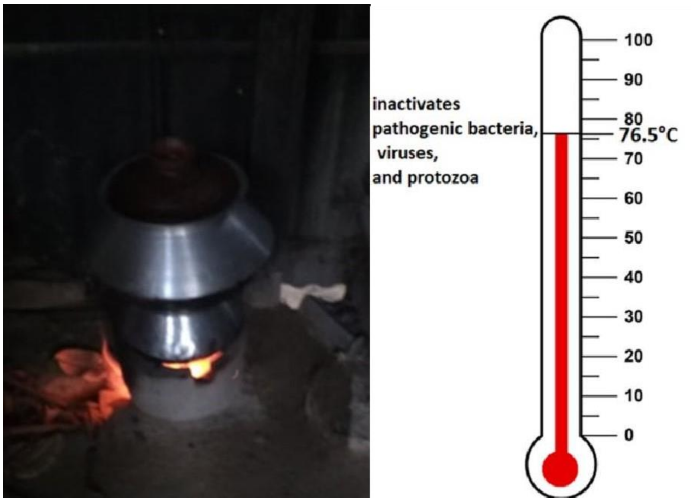


Figure 2. Stack Pot water heater disinfector to disinfect water while cooking rice.

## Conclusion

The philosophy of simple engineering application by being at one with the communityand understanding their needs can be considered the essence of GNH engineering. The case studies highlighted in this clearly shows the value of engineers and researchers working for the needs of the community and focus the research interest as such.

## Reference

S. M. Shabab Islam, Umme Farah Shakin Neha and Nadim Reza Khandaker Defining TheBiogas Generation Potential and The

Kinetics Of Biogas Generation For House- Hold Generated Rice Cooking Wastewater. (2019) International Conference on Environmental Sustainability and Resource Security (ICENSURES 2019). Page 99-102. ISBN 978-967- 17605-0-5

Nadim Reza Khandaker, and Shirya Rashid. (2018). Latent heat from rice cookingto disinfect drinking water. Conference: International Conference on Energy, Environment and Economics, At: Heriot-Watt University, Edinburgh, United Kingdom, Volume: 4, Pages 35-42.

## About the author

**Nadim Reza Khandaker** has a Bachelors in Chemical Engineering, MS in EnvironmentalEngineering, and A PHD in Environmental Engineering all from the United States of America. He is a licensed Professional Engineer in two Provinces in Canada. He has overthirty years of professional engineering experience working both in Developed and Developing Economies. Currently he is a faculty ant North South University, Bangladesh.