

Ramelan, Agus; Usup; Anggraeni, Nova

## Article

# Rumah Tahu Mandiri Energi (RTME): New pattern on tofu production without fossil fuel consumption in Sentra Tahu Cibuntu, Bandung, West Java

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**Table of Contents**

- 1        **EDITORIAL:REDISCOVERING THE POTENTIALS OF INDONESIA FACING THE CHALLENGES IN THE ASEAN REGION**  
BENNY TIAHJONO, Cranfield University, Cranfield  
DESSY IRAWATI, BNI BANK Business Representative in the Netherlands, Netherlands
- 3        **CONSERVING INDONESIA'S NATURE AND CULTURE THROUGH EMPOWERMENT OF INDIGENOUS TECHNOLOGY IN CREATIVE INDUSTRY SMES**  
ELZAVIRA FELAZA, Universitas Indonesia, Indonesia
- 11       **COALBED METHANE - AN UNCONVENTIONAL - CLEAN ENERGY. THE FORMING, EXTRACTION, AND POTENTIAL OF INDONESIA'S COALBED METHANE AS FUTURE SOURCE ENERGY FOR INDONESIA**  
LUCY KARTIKASARI, Institut Teknologi Bandung, Indonesia  
TRISNA SUNTARA, Institut Teknologi Bandung, Indonesia
- 20       **INDONESIAN MARINE BIODIVERSITY AS A SUSTAINABLE RESOURCE TO SUPPORT INDONESIAN PHARMACEUTICAL INDUSTRY IN ASEAN PHARMACEUTICAL MARKET**  
ANDIKA PUTRA RIANDY, Sriwijaya University, Indonesia  
ALVIONITA HANDAYANI, Sriwijaya University, Indonesia
- 25       **RUMAH TAHU MANDIRI ENERGI (RTME) : NEW PATTERN ON TOFU PRODUCTION WITHOUT FOSSIL FUEL CONSUMPTION IN SENTRA TAHU CIBUNTU, BANDUNG, WEST JAVA**  
AGUS RAMELAN , Indonesia University of Education , Indonesia  
NOVIA ANGGRAENI , Indonesia University of Education , Indonesia
- 34       **APPLYING NANO-CARBON AS COATING MATERIAL FOR SLOW-RELEASED FERTILIZER TO INCREASE INDONESIAN RICE YIELD AND TO REDUCE NITROGEN LOSS IN SURFACE WATER OF PADDY SOIL**  
ANDIKA PUTRA RIANDY, Universitas Sriwijaya, Indonesia

DINI FUADILAH SOFYAN, Universitas Sriwijaya, Indonesia

- 41 **IMPROVING WADUK JATILUHUR'S FISHERIES PRODUCTS TOWARDS ASEAN GLOBAL MARKET BY ESTABLISHING AQUACULTURE COOPERATIVE**  
DIMAS GELAR PAMUNGKAS , University of Indonesia, Indonesia  
KARTIKA SUKMATULLAHI, University of Indonesia, Indonesia  
HAFIQI AMHARIPUTRA, University of Indonesia, Indonesia
- 49 **CONTROLLING WINDU SHRIMP QUALITY USING APRIORI ALGORITHM THROUGH SMARTPHONE-BASED APPLICATION**  
FIRDAUS K. GANI, Telkom University, Indonesia  
RAHMAD HIDAYATULLAH S, Telkom University, Indonesia  
RAHMAT FAISAL WAHYUDI , Telkom University, Indonesia  
SATRIA NUR HIDAYATULLAH, Telkom University, Indonesia
- 55 **DEVELOPMENT OF VOCATIONAL MARINE SCHOOLS IN INDONESIA AS A STRATEGY FOR REDISCOVERING INDONESIA'S MARITIME POTENTIAL**  
IRFAN TEGUH PRIMA, Universitas Indonesia, Indonesia  
M. HAZMI ASH-SHIDQI, Universitas Indonesia, Indonesia  
OPI ARISTYA, Universitas Indonesia, Indonesia
- 63 **THE UTILIZATION OF TECHNOPRENEURSHIP TO DEVELOP INDONESIAN GEOGRAPHICAL INDICATION PRODUCTS**  
MONICA DWIYANTI, University of Indonesia, Indonesia  
HANS TOPRIL, University of Indonesia, Indonesia  
ANTONIUS SATRIA, University of Indonesia, Indonesia

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## **RUMAH TAHU MANDIRI ENERGI (RTME) : NEW PATTERN ON TOFU PRODUCTION WITHOUT FOSSIL FUEL CONSUMPTION IN SENTRA TAHU CIBUNTU, BANDUNG, WEST JAVA**

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### **ABSTRACT**

The main background of this research was the high dependency on conventional fuel oil i.e. LPG in tofu industry at Sentra Tahu Cibuntu, Bandung. Author had studied and explored the idea and potency of biogas based on tofu liquid waste (whey) as the substitute of LPG by designing the prototype which was named *Rumah Tahu Mandiri Energi (RTME)* model. The methods that we applied for this research were experimental research and literature. The expected results were that the potency of tofu waste to be processed into biogas has a very good prospect, guide book of how to make biogas for the tofu producer, prototype of *Rumah Tahu Mandiri Energi* as basic study effort of the implementation of tofu waste biogas has been made and the community of Sentra Tahu Cibuntu shown good responds regarding the model of RTME.

**Keywords:** whey, biogas, *rumah tahu mandiri energi (rtme)*.

### **1. INTRODUCTION**

In Indonesia there are many sector of traditional tofu industry in large scale of quantity. Tofu industry in Indonesia spread evenly from Sumatra to Papua according to that tofu is the popular food among Indonesian people. Noted the total of the unit of tofu industries in Indonesia reach 84.000 units with capacity of production more than 2.56 tons per year (Sadzali, 2007). Tofu industry produced two forms of waste, solid and liquid waste, liquid waste also well known as whey. The solid waste and whey came from the process of washing, boiling, pressing, and tofu shaping, with the result of the large amount of whey has been produced. Total emission that was produced by 20 million cubic from tofu industry in Indonesia per year was about one million ton of carbon dioxide (CO<sub>2</sub>) equivalent per year. In the process of tofu production, the majority of the producer really depended to fuel oil or fossil fuel. This dependency has big significant impact in determining the production quantity and the tofu price in case if the prices of fossil fuel upraised. In other part, in the process of tofu production, the majority is really depending on the usage of fossil fuel. This kind of situation can be anticipated by optimising the management of the production itself. Whey is an organic matter which is decay-able easily by microorganism in the state of oxygen-less (anaerobe). The potency of whey to be formed to be biogas can be optimised as substitution of fossil fuel usage in tofu process production. The simplicity in making of biogas from the tofu waste will support to implement this program in all scale of tofu industries in Indonesia. Therefore, the authors

propose a solvable and applicable idea which called “*Rumah Tahu Mandiri Energi: New Pattern on Tofu Production without Fossil Fuel Consumption*”. By substituting the conventional fuel to tofu waste biogas, we expected that in the future tofu production is no longer depend on fossil fuel. Furthermore, recycling of tofu waste to biogas can create a tofu production chain which does not spend much on fuel regarding that the required biogas is derived from the waste of tofu production itself.

## **2. RESEARCH METHODS**

### **2.1 Time and Research Site**

This research was held in three months, started on August 2013 to October 2013. The research done in two sites, they are Sentra Tahu Desa Cibuntu, Bandung and Research Centre of UKM LEPPIM UPI. Sentra Tahu Desa Cibuntu was used to the data and needed material, whereas Research Centre of UKM LEPPIM UPI was used as a lab for prototype making and data processing.

### **2.2 Research Method**

This research applied experimental method as research method. Te method aimed to study particular variable to other variable toward experimenting in special condition which intentionally created (Fathoni, Abdurrahmat.2006).

### **2.3 Population, Sample, And Research Target**

Population in this research was tofu liquid waste from tofu-making centre at Desa Cibuntu, Bandung. The reason of choosing tofu waste from that place because its condition and potency as tofu-making centre could be generalised as research result. It could be also implemented in other tofu-making industry. Sample in this research was randomly taken from the available population by using 5 litres of tofu liquid waste accorded to research need.

### **2.4 Collecting Data Instrument**

This research applied the list below as collecting data instrument:

- a. Experiment Work Sheet. The sheet was piece of technical instruction of doing experiment of research prototype-making.
- b. Observation Guide. The Observation Guide sheet was used to record observation result related to tofu waste biogas prototype implementation potency at Sentra Tahu Desa Cibuntu.
- c. Interview Guide. The interview guide was used to record information related to data of using tofu waste as biogas potency at Sentra Tahu Desa Cibuntu.
- d. Experiment Result Sheet. This sheet was a data collection of prototype try-out result.

### **2.5 Data Analysis Design**

Descriptive data analysis method was used to investigate the experiment work sheet, observation, and interview. Analysis with quantitative approaching was used to investigate the experiment result sheet.

### **2.6 Research Design**

This research has done in a few steps to make the research product (prototype). The graphic below is the research design flowchart.

## **3. RESULT**

Tofu industry produced two kinds of waste, they are solid waste and liquid waste or whey. Solid waste of tofu usually made use of animal feed. Meanwhile, the whey usually only discharged directly into the environment. Whey from tofu processing is organic waste that is easily broken down by microorganisms. It reached 20 litres of waste per kilo grams of soybean that was spent to make tofu. Liquid waste is produced by tofu industry is generally a viscous liquid called boiling water (whey). It contained 6gr/kg of

Biological Oxygen Demand (BOD) and 130gr/kg of Chemical Oxygen Demand (COD) (Potter, 1994). Based on the data above, it can be predicted that whey is potential to harness as biogas. In producing biogas from tofu waste should use an anaerobic reaction, the reaction of decomposition of organic compounds by microorganisms in state of oxygen-less.

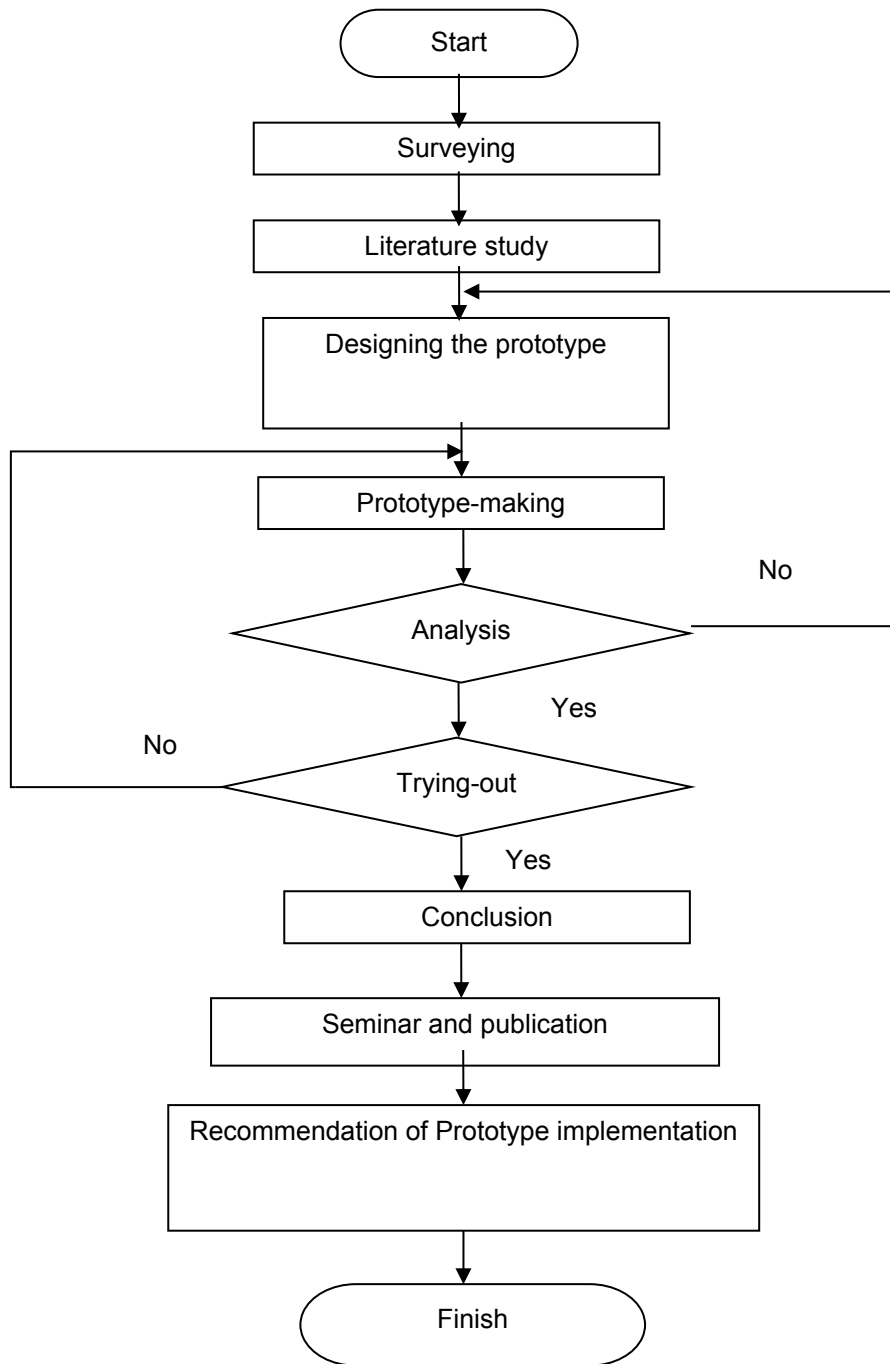


Figure 1 : Research Design Flowchart Diagram

Microorganism like bacteria can breed well in anaerobic conditions and produce biogas. Biogas is a mixture of CH<sub>4</sub>, CO<sub>2</sub>, CO and H<sub>2</sub>S. The more the concentration of methane (CH<sub>4</sub>) the higher the energy contained in the biogas. Processing of whey into biogas by the addition of a starter

such as animal dung takes 8-10 days. From tofu whey treatment with the capacity of 283,8m<sup>3</sup>/day will be obtained 442.6 m<sup>3</sup>/day of per kilo gram of soybean that produces 9.46 litres liquid water and each kilo grams of soybean will produce 15 litres of biogas (Sadzali, 2007). Here is a block diagram of the implementation stage of whey biogas in tofu industry.

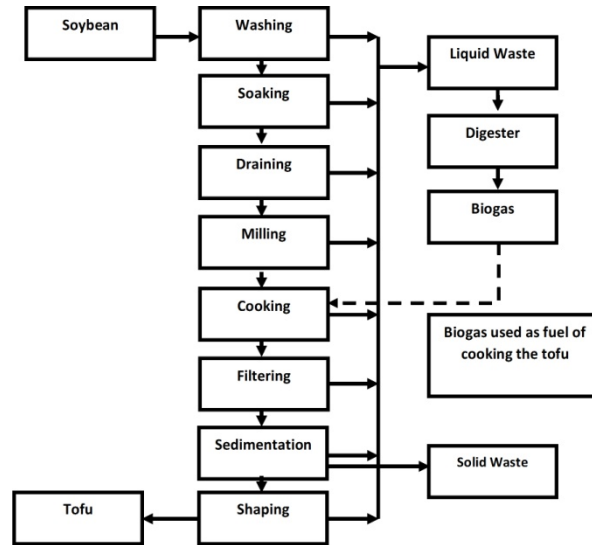


Figure 2 : Block Diagram of Tofu Waste Biogas Implementation as a fossil fuel substitute in Tofu Industry

They could be obtained through the process of washing, soaking, milling, cooking, filtration, sedimentation, and tofu shaping. To produce biogas, they had to be flowed into the anaerobic digester. Whey decomposition process in the digester takes an average of 8-10 days. Here's an example of anaerobic digester design for biogas production:

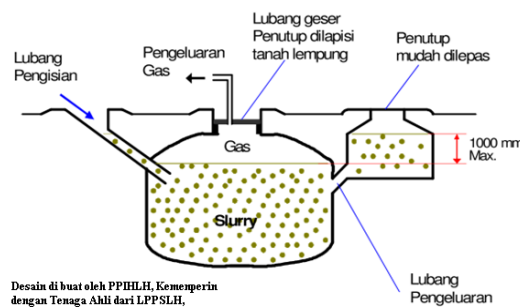


Figure 3 : Fixed Dome Model Digester

Slurry (waste water) flowed into the reactor through slurry inlet. Stirring the slurry could be done in several ways, such as mechanical agitation, circulation substrate biogas reactor, biogas production or circulation to the biogas reactor using a pump. Stirring process was intended to reduce sedimentation and improve the productivity of biogas reactor. To set the gas pressure in the reactor can be done by adjusting the pressure safety valve. Pressure regulation set to go out in a biogas reactor. Residues from biogas making process were in the form of organic compounds that already fermented. Residue removed through the outlet worked with the principle of residue hydrostatic pressure equilibrium. Residue that comes out first was the first waste water after a

certain retention time is 20-30 days (Noviansyah, 2012). Decomposition of biogas reactors can be piped directly to the cooking furnace or stove to cook soybean mixture in tofu production. The use of biogas whey as a substitute of fossil fuel in the tofu industry expected to create a new pattern in the process of production of tofu. New pattern meant that tofu production process without the use of fossil fuel.

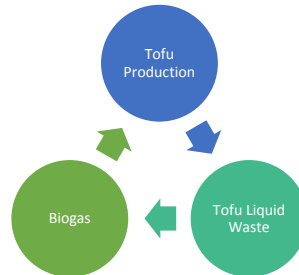


Figure 4 : Tofu Production Chain without Fossil Fuel Consumption

The picture above shows that the use of biogas as a fuel substitution can form a continuous chain in the tofu production. Tofu processed-waste products that had turn into biogas which can be used again for the production of tofu, so on. So with this new pattern, tofu industry can continue producing to the maximum production without being dependent on fuel prices.

## 4. DISCUSSION

### 4.1 Tofu Waste Potency To Be Biogas at Sentra Tahu Cibuntu, Bandung

*Sentra Tahu Cibuntu* had been producing a lot of liquid waste every day. Most of tofu liquid waste directly channelled out to the sewer without being utilised for other purposes. This has led the authors to make *Rumah Tahu Mandiri Energi* Model in order to optimise the waste liquid at Sentra Tahu Desa Cibuntu as biogas. Based on the results of literature study, tofu liquid waste has the potential to be used as biogas. Mostly the produced-waste by the tofu industry was a viscous liquid that has separated from the tofu clot which was called whey. This fluid contains high levels of protein and biodegradable. From preliminary analysis of the results can be known that ratio of BOD / COD of waste was  $3274/5771 = 0.567$ . This value shown that tofu liquid waste was biodegradable, by that the liquid waste could be treated biologically. Because tofu has a COD value of 5771 mg / l, the waste could be processed through an aerobic process. Further stated that an aerobic microbes use organic compounds as electron acceptor in the oxidation process of biology. In addition, organic compounds required as growth factors, which was the building block of cells. Growth factor could not be synthesised from simple carbon sources and was only required in very small quantities. With an influent COD 5771 mg / l indicated organic matter content was high enough, so that the availability of organic matter as a source of carbon, energy, and the electron acceptor in the growth factor for microbial bioenergy processes had been fulfilled (Sani, EY Tesis.2006).

Here are some pictures that shown the potency of tofu waste water at Sentra Tahu Cibuntu to be used as biogas.



Figure 5 : The Tofu Production in *Sentra Tahu Cibuntu*



Figure 6 : Waste was directly-channelled into the gutter at *Sentra Tahu Cibuntu*

#### 4.2 Biogas-making of Tofu

Making biogas of tofu waste was very simple and not much different from making biogas of other materials such as biogas from cow dung. Here are the steps to make biogas from tofu liquid waste:

1. Former water from tofu soaking, pressing, and washing hereinafter referred to as the tofu liquid waste collected into the reservoir container.
2. Tofu waste were evenly-stirred in the reservoir container waste, and then channelled into the Tofu Waste inlet pipe to the reactor.
3. Close the reactors tightly to ensure anaerobic conditions in the reactor when tofu waste fermentation process lasts.
4. The process of waste fermentation into biogas know takes 15-20 days.
5. After that, tap on the biogas outlet pipe so the reactor is opened to supply biogas to the biogas reservoir tube
6. Once it was full, closed the tap and biogas from the reservoir ready to be distributed to the cooking stove or tofu furnace.
7. Furthermore, every day the reactor could be filled as much as 1/3 beginning volume, the residue of fermentation process could be come out automatically and can be processed to be compost fertiliser.

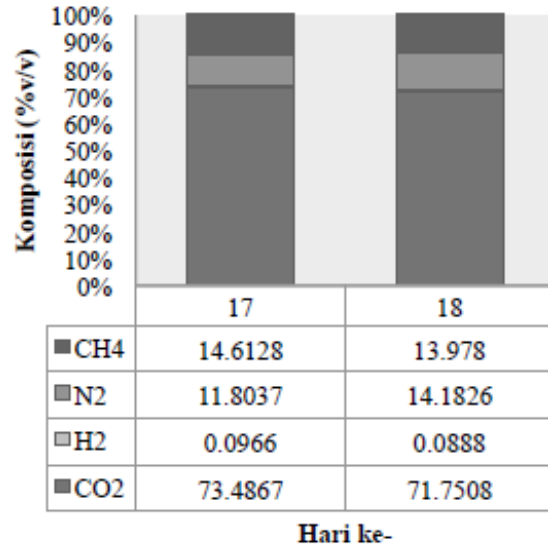


Figure 7 : Whey-Based Biogas Content Analysis Result

### 4.3 The Biogas' Content from Whey

To understand the content of whey-derived biogas could be done by doing gas analysing using gas chromatograph. This measurement was done at the time when whey is in the state of steady in the reactor at 17<sup>th</sup> day and 18<sup>th</sup> day . Below was the result of whey-based biogas content measurement (Putri, Myrasandri. 2009).

### 4.4 The Making of *Rumah Tahu Mandiri Energi* Model

Modelling *Rumah Tahu Mandiri Energi* was performed by some appropriate stages according to the research flowchart. The first plan was to make the design and installation of biogas reactor. Previously, the team conducted a survey of places that supply the necessary tools. After that, the tool began to be designed and built according to the engineering drawings that have been made. Here are the stages of making the Model of *Rumah Tahu Mandiri Energi*. To make exterior and interior design of *Rumah Tahu Mandiri Energi* were created using the Autodesk Inventor software. This was because this software allowed for 3-dimensional design according to the needs of the author. Here is the picture of the design of the *Rumah Tahu Mandiri Energi* Model.

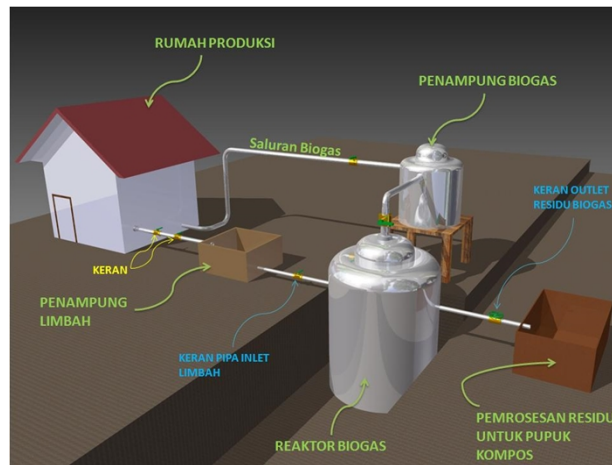


Figure 8 : The *Rumah Tahu Mandiri Energi* Exterior's Model

*Tahu Mandiri Energi*

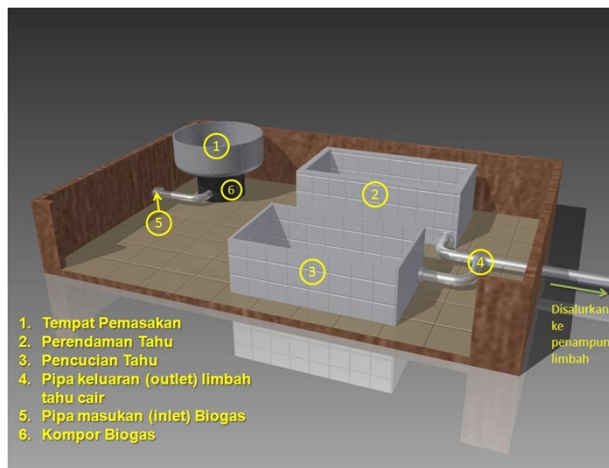


Figure 9 : The *Rumah Tahu Mandiri Energi* Interior's Model

### 4.5 Community Response at Sentra Tahu Cibuntu Bandung on *Rumah Tahu Mandiri Energi* Model



In general, people in Sentra Tahu Cibuntu, Bandung welcomed the prototype of *Rumah Tahu Mandiri Energi*. This was due as if RTME actually implemented, then the tofu-makers were able to save the cost of tofu production which minimize fuel purchases. Slowly but surely, by reducing the production costs will increase their profits and ultimately increase their productivity and well-being.

## 5. CONCLUSION

Continuity of tofu production in Indonesia hardly-relied on fossil fuels. Hence we need alternative energy resources to substitute fuel in tofu production process. Based on an intensive study and experimental research, they could potentially be used as raw material for biogas. Biogas from whey could be directly used as fuel in the tofu production process, so by more researches and experiments tofu industrial is no longer dependent on fossil fuels.

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