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Potential Utilization of Waste Cooking Oil in Sri Lanka: Policy Implementation

Udara S.P.R. Arachchige*, K.I. Achintha Wijenayake, K.A. Viraj Miyuranga, Danushka Thilakarathne, Nuwan A. Weerasekara, Randika A. Jayasinghe
Faculty of Technology, University of Sri Jayewardenepura, Sri Lanka
Email address: *udara(at)sjp.ac.lk

Abstract— *Sri Lankan energy policy depends on hydropower, coal power, and fossil fuel, contributing to the transportation sector. Implementing renewable energy is a time-required necessity to minimize the dependency on imported fossil fuels. Biodiesel produced by waste cooking oil seems a promising technique as it minimizes waste handling costs as well. However, in Sri Lanka, waste cooking oil is reselling for the food industry after purification, making several health issues to the general public. There are no proper policies to avoid waste cooking oil reselling. Therefore, immediate policy implementation is necessary to minimize health issues and implement biodiesel production based on waste cooking oil. That will introduce waste cooking oil collecting bins to restaurant chains and hotels to utilize waste cooking oil for biodiesel production.*

Keywords— *Biodiesel, Cooking Oil, Energy, Policy Implementation, Sri Lanka, Waste Utilization.*

I. INTRODUCTION

The global energy demand exponentially increased over the decades, hoping the trend will continue to be in the same way for several decades [1]. This is mainly due to population growth, the limitless needs of human satisfaction, and the industrial revolution of developing countries such as India, China, and Brazil [2]. Increasing energy demand is necessary and desirable since energy services are essential to sustain economic growth and improve lifestyle standards. To achieve sustainable development goals, moving to renewable energies are vital. Renewable energies are supporting for reduction of greenhouse gas emissions [3]. As renewable energies, wind, solar, geothermal, hydro, biomass, biodiesel, and bioethanol play a vital role in reducing greenhouse gas emissions [4]. However, biodiesel and bioethanol are taking a critical position as they are essential for lowering petroleum in the transportation sector.

II. ENERGY DEMAND IN SRI LANKA

Around 50% of energy in Sri Lanka is fossil fuel-based power generation in 2015 [5]. It has been estimated that Sri Lanka used 12.8 million tons of oil equivalent energy in 2017 [6]. A significant part of the foreign expenditure is allocated for imports of fossil fuel annually [5].

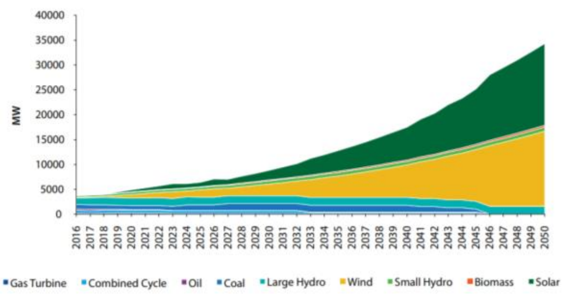

Fig. 1. Energy generation forecasting for year 2015 in Sri Lanka

If Sri Lanka achieves the target of 100% renewable energy in the year 2050, it can potentially support saving US$18-US$19 billion on imported coal as compared with the current power generation scenario [5]. However, to implement renewable energy, it has to be done investments worth US$54-US$56 billion near future [5]. With the current economic situation with the Corona pandemic, this will be a devastating period of investments for energy generation. Therefore, 100% renewable energy generation in the year 2050 would be a critical challenge without investments. According to the discussions, it has been proposed to implement and target Solar, wind, small hydro, and biomass as primary renewable energy sources to achieve the goal (Figure 1). Biofuel generation was completely ignored or eliminated due to the high production cost originally coming with the raw material cost. The electricity generation by Solar and wind are quality sources for a tropical island like Sri Lanka. However, capital investment of the project will not be easily handled by the economic situation. Therefore, biofuel such as biodiesel and bioethanol can be the best alternative to replace the fossil fuel requirements in the transport sector. The renewable energy drive has taken place against a background of growing social awareness and resistance to second coal-fired power plant installation in Sampur, an eastern coastal city in Sri Lanka.

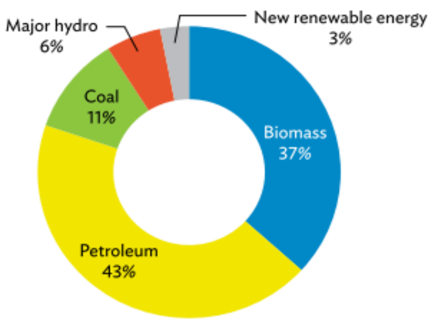

Fig. 2. Sri Lanka's power consumption by different sources [7]

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The energy consumption in Sri Lanka in the year 2017 is given in Figure 2 [7]. According to Fig.2, it can be seen that 37% of biomass usage is already taken a significant part of the energy usage. However, the substitute of 43% of the petroleum is necessary to achieve the 2050 renewable energy goal. The petroleum substitution can be achieved with biofuel increments such as biodiesel and bioethanol to replace the petroleum used for transportation and power generation.

III. BIOFUEL IN SRI LANKA

An increase in biofuel will eventually support the expansion of crops everywhere. To reach the production capacity, raw material supply is necessary. Therefore, non-arable lands or lands that were not used before for agricultural purposes can be used to cultivate biofuel crops. However, it suggests non-edible oil sources and wastes cooking oil for biodiesel production and the waste fruits and vegetables as the raw material for bioethanol production. Biofuel is a severe replacement to reduce the fossil fuel requirement as that is already well-established technology. Due to several factors, the production of biodiesel and bioethanol for commercial scale is not happening in Sri Lanka. To establish successful liquid biofuel production in Sri Lanka, Technical, Social, and Financial challenges should be addressed appropriately.

According to the national energy policy of Sri Lanka, achieving carbon neutrality and the complete transition of all the energy value chains by 2050 has been highlighted [8]. However, it has been planned to reach this level only by solar, wind, and biomass, which will not reduce fossil fuel consumption in the transportation sector. Therefore, implementing biodiesel and bioethanol is essential to reduce fossil fuel consumption, which depends on foreign expenditure.

IV. BIOFUEL

Biodiesel production from waste cooking oil has been practiced for several decades [9]. The generic way to produce biodiesel is by transesterification, which refers to a catalyzed chemical reaction involving oil sources and alcohol to yield fatty acid alkyl esters (biodiesel) and glycerol, as seen in Figure 3 [10, 11].

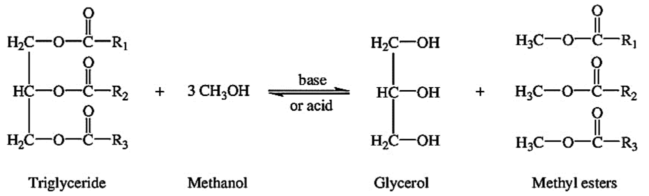

Fig. 3. A schematic representation of the transesterification reaction [10].

According to the literature, it has been proven that the production cost of the biodiesel is mainly dominated by raw material prices, especially the price of the oil source [12]. The raw material price can be reduced with the production of biodiesel with waste cooking oil. However, waste cooking oil has a market value due to the lack of rules and regulations. There is no such policy to control waste cooking oil re-selling as a cooking oil source for the food industry in Sri Lanka. Therefore, it has been a serious health issue with the re-using of waste cooking oil unknowingly due to the small vendors operating the business now. Even the main franchise is selling the waste cooking oil instead of discarding it. To solve that issue, immediate policy implementation is necessary to avoid waste cooking oil re-selling for cooking purposes.

V. WASTE COOKING OIL AS A FEEDSTOCK

The term "waste cooking oil" (WCO) refers to oil formerly used for frying in restaurants and hotels but is no longer in use. Most hotels, restaurants, and other food establishments illegally discharge WCO into rivers or land, resulting in pollution [13]. This has tremendous implications for society's environmental, social, economic, and health issues [14, 15]. When WCO is released into bodies of water incorrectly or inefficiently, the concentration of organic contaminants increases. As a result, fish and aquatic life populations and the surrounding community suffer detrimental effects [15]. Therefore, it is more advantageous to exclude WCO as a raw material for a valuable product. Producing biodiesel from waste vegetable oils decreases the biodiesel prices and will provide raw material source continuously [16].

Contrary to common assumption, land devoted to biodiesel feedstock production competes with food agriculture for food security concerns. WCO can be utilized in place of virgin vegetable oil as a raw material for biodiesel synthesis. WCO's biodiesel manufacturing benefits the environment by reusing WCO while providing clean, renewable energy with decreased pollution. Petro-diesel is more affordable than edible vegetable and plant oils. However, utilizing WCO as a biodiesel feedstock reduces manufacturing costs since feedstock expenses contribute to between 70% and 95% of total manufacturing costs [17]. Research into WCO-based biodiesel production is an economic field that contributes to addressing the global challenge of insufficient energy resources with the goals of reducing greenhouse gas emissions [18], promoting sustainable economic growth [19], and addressing food safety concerns associated with the illegal reuse of WCO [20]. Because generating biodiesel from WCO has economic, environmental, and waste management benefits, it should take precedence over food oils as a feedstock for biodiesel [21, 22].

VI. WASTE COOKING OIL UTILIZATION

Used cooking oils constitute waste included in the group of urban or municipal waste (as other *domestic/commercial waste*), which has been increased in their quantity of generation in the last few decades. The liquid nature of the waste cooking oil prevents the disposal in landfills and contributes to the reselling as the available option. Most of the restaurants and hotels are in the moment of reselling the used cooking oil at the price range of 50-70 LKR. The used cooking oil purchasing vendors are filtered the cooking oil and remove sediments to distribute to small-scale restaurants and street restaurants, and cafes for further use as a cooking oil source.

It is important to assess the consumer safety demands of how the entire food chain should be continuously controlled

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(traceability) to prevent public health risks. Traceability is a fundamental aspect that establishes the essential inter-relationship and collaboration between all the agents. A break in this traceability, at any level, dramatically increases the risk of possible accidents with repercussions on public health since complete control of the process is lost. The present study analyzes risks derived from all the agents involved in using recycled cooking oils: primary sources producing cooking oils, collectors of oils for recycling (reselling), recycling industry, and other food preparation industries and small vendors.

Reusing used cooking oil is a huge problem today. Reusing is happening due to a lack of understanding about the impact of waste cooking oil consumption on human health in domestic and the economic benefits for restaurants and hotels. The health issues with reusing waste cooking oil can be listed below [23].

1. It makes oil more carcinogenic

Anything that is carcinogenic has the possibility of causing cancer. More and more research is showing how aldehydes - toxic elements - are produced when you reheat oil. Cooking food by reusing cooking oil can also increase free radicals in the body, which can cause inflammation - the root cause of most diseases, including obesity, heart disease, and diabetes. High inflammation in the body can also reduce immunity and make you prone to infections.

2. It increases LDL cholesterol

Food cooked in black, smoked oil used and reheated throughout the day can increase the level of LDL or bad cholesterol in the body. High levels of LDL cholesterol can increase the risks of heart disease, stroke, and chest pain. Avoid reusing cooking oil to avoid cholesterol-related problems.

3. More acidity

If that burning sensation in your stomach and throat has become more frequent than ever, then reheated cooking oil may be the culprit behind it. Avoid eating roadside junk and deep-fried food if you experience more acidity than usual.

Other health risks involved with eating food in reheated cooking oil are:

- Obesity
- Weight gain
- Diabetes
- Heart disease

When waste cooking oil reusing for cooking purposes, its percentage of free fatty acid is gradually increasing. Based on the experiments FFA% variation with the reusing attempts is given in Figure 4 for coconut oil sample. According to Figure 4, it can be clearly seen that, only fresh cooking oil and the one time reusing of oil falling within the standard limits (FFA% <1) given in the FOOD ACT [24]. Therefore, necessary actions should be taken to avoid reusing waste cooking oil or reselling waste cooking oil into other restaurants and hotels [24].

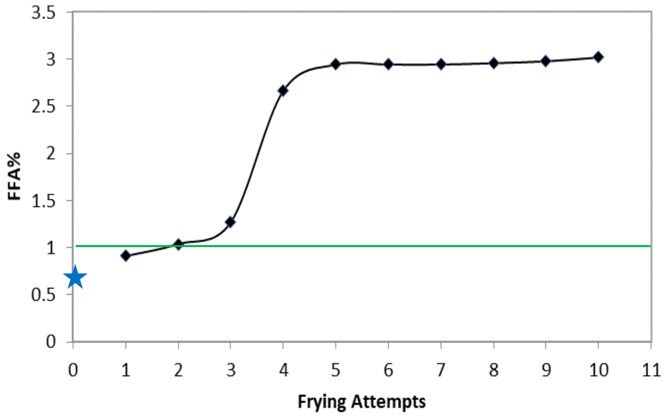

Fig. 4. FFA% variation with frying attempts for coconut oil sample [24].

VII. Policy Implementation

The following policies have to be implemented to effectively utilize the waste cooking oil for biodiesel production in Sri Lanka. Some of them do not consume considerable time as they are partially practicing for a more extended period. Most of the policies should be implemented together with the Ministry of Environment, Ministry of Health, Ministry of Power and Energy as they are correlated.

- Prohibit the reuse of used cooking oils for food applications.
- Prohibit the discharging of waste cooking oil into wastewater discharging lines.
- Promote the updating and maintaining of the statistics on the production and importation of cooking oils by the different industries.
- Encourage the voluntary collection of waste cooking oils as an agreement or contract basis between the waste cooking oil producers such as restaurants and hotels and collectors of cooking oils. The failure to comply with the quality control system requirements would lead to the termination of the contract without prior notice.
- Establish a certification system and encourage cooking oil collection companies and reusing companies to produce biodiesel.
- Ensure that only the established contracts (voluntary agreements) for collection by certificated collection companies will handle the waste cooking oils collection and transportation.
- Establish minimum quality specifications for fresh cooking oils delivered for restaurants and used cooking oils that collect for biofuel production.
- Promote education/information campaigns to improve usage in cooking at the different establishments which produce waste.
- Studies to establish the content of PCBs (polychlorinated biphenyls), dioxins and dioxin-like compounds and PAHs (Polycyclic aromatic hydrocarbons) before and after the use of oils and fats in the cooking of food. It is recommended to carry out in line with the origin and composition of the oil used.

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- Promote the self-participation of catering companies in waste minimization and eco-management programs or schemes.
- Regulate the procedures authorized for recycling cooking oils for biodiesel production.
- Together with research centres, institutions and companies, implement and promote advisory programs to establish priorities for research and development in this field.
- Establish the institute to promote studies on the description and classification of cooking oils for recycling (reference values of various parameters).
- Establish registered trademarks for recycled oils and their blends with other fats as raw materials in biodiesel production.
- Implementation of control systems for the whole process of handling of these waste oils to provide a simplified system that ensures the traceability of the whole process.
- Research and development to implement and establish rapid analysis tests to improve quality control of discarded oils maintain the waste cooking oil quality.
- Research studies and different toxicity studies of oils cyclic monomers, dimers, secondary oxidation compounds and sterol oxides originated during frying, in particular, to understand the relationship between chemical structure and toxic effect.
- Promotional campaigns for improving consumer knowledge on waste oils, risk and handling the waste oil.
- Revise the school syllabus to introduce these subjects in school education to upgrade the young generation's knowledge.
- Promote actions aimed at improving knowledge in this specific field via the media.
- Distribute advanced knowledge to promote the use of continuous frying systems in large catering establishments.
- Improve medical and health knowledge to improve the understanding of the migration level of liposoluble contaminants from the food item to the frying medium and its level of accumulation and persistence.
- Improve studies on frying processes under commercial conditions to assess the capability for forming different harmful degradation compounds. The primary importance is studies on the fatty acid composition of oils used and its relationship with different antioxidants.
- Promote studies on optimizing certain frying conditions concerning the formation of harmful degradation products, especially temperature.
- Promote technology upgrading and transfer programs to extend the results of previous studies to catering companies as much as possible.
- Promote studies to establish and standardize simple and rapid new methods of analyzing the degradation of oils during cooking concerning the product's safety.
- Suitable containers should be used for the waste cooking oils storing to maintain hygiene.
- A record must be maintained for the dates when waste oil is collected and of the approximate quantities.
- A separate area must be used for the collection containers with controlled access to avoid possible contamination.
- Awareness programs should emphasize the benefit that may result from recycling these waste oils and producing biodiesel to reduce the amount of fossil fuel requirements.
- Apart from increasing awareness, collecting and transporting these waste oils must also be facilitated to maintain the process of waste cooking oil entering for biodiesel production.

VIII. CONCLUSION

Biodiesel produced from waste cooking oil is one of the promising renewable energy sources to reduce the dependency on fossil fuels in Sri Lanka. However, waste cooking oil is not available as waste in Sri Lanka due to the secondary market, purifying and reselling for cooking purposes at a lower cost. However, the lack of policies in waste cooking oil reselling has been addressed in the present research. Immediate policy changes are necessary to ban the waste cooking oil reselling for the food industry.

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