Glycerin LCA Summary Report

Global Green Chemical Public Company Limited

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Full Life Cycle Assessment (LCA) Approach

In 2017, GGC in collaboration with experts from the Department of Chemical Engineering, Faculty of Engineering, Kasetsart University conducted a life cycle assessment of glycerin production in the new plant by applying a ReCiPe method using SimaPro 8.0 (calculation tool) that covers the impacts of 1-Kg refined glycerin (produced from crude glycerin 80-85%) resulting from the acquisition of raw materials production process, transportation, distribution, use, and disposal of product after use in order to show the overall environmental impact assessment throughout the Life cycle of glycerin products in alignment with ISO14040: 2006. The assessment result showed that refined glycerin products from palm oil raw materials have the highest proportion of environmental impacts affecting the ecosystem. However, compared to substituted glycerin produced from epichlorohydrin, refined glycerin products from palm oil have relatively low environmental impacts.

KASETSART UNIVERSITY

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Introduction

Project Background

The Thailand Board of Investment (BOI) funded GGC with the condition of minimizing environmental impact. GGC must use certified or renewable raw materials, implement sustainable green chemistry, produce biodegradable products, and align with international standards for environmental impact reduction, such as the Environmental Management Life Cycle Assessment - Principle and Performance outlined in ISO14040.

Therefore, the Company has collaborated with life cycle assessment specialists from the Department of Chemical Engineering, Faculty of Engineering at Kasetsart University to **evaluate the life cycle of glycerin production at Plant 2** located in in Chonburi Province, Thailand. The aim is to provide an overall environmental impact assessment for glycerin products, which are classified as environmentally friendly in the Chemical category as per the Board of Investment (BOI) requirements.

Goal of Project

1) To evaluate and examine the environmental effects associated with refined glycerin production across its life cycle;
2) To seek investment support from the Board of Investment for producing eco-friendly chemicals.

Methodology: Scope of Project

Product System

Product system: from Cradle-to-Gate including palm plantation, crude palm oil production, methyl ester production, and glycerin production as shown in Figure 1.

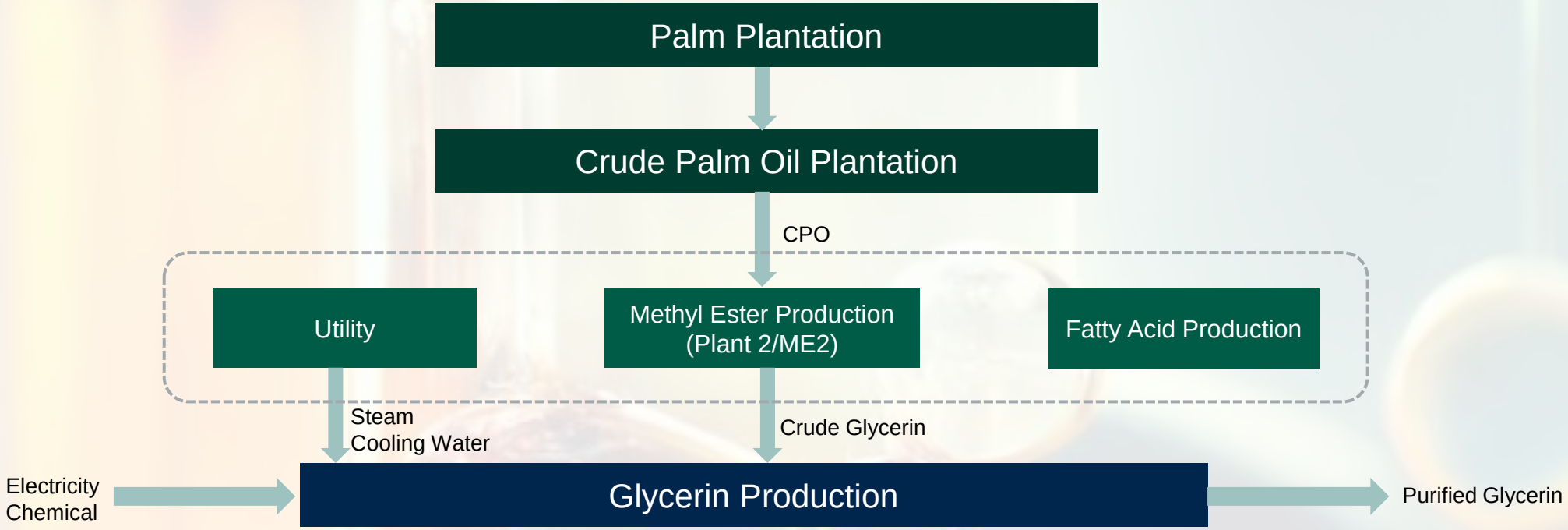

Figure 1: Refined glycerin production process within Cradle-to-Gate scope

Methodology: Scope of Project

Functional unit:

1 kg of refined glycerin

System boundary:

Refined glycerin production at Plant 2 (ME2) which derives input and output substances data from Design Specification data of 80-86 concentrated crude glycerin, Mineral Oil, electrical energy, steam, cooling water, waste, and refined glycerin as shown in Figure 2 and Figure 3

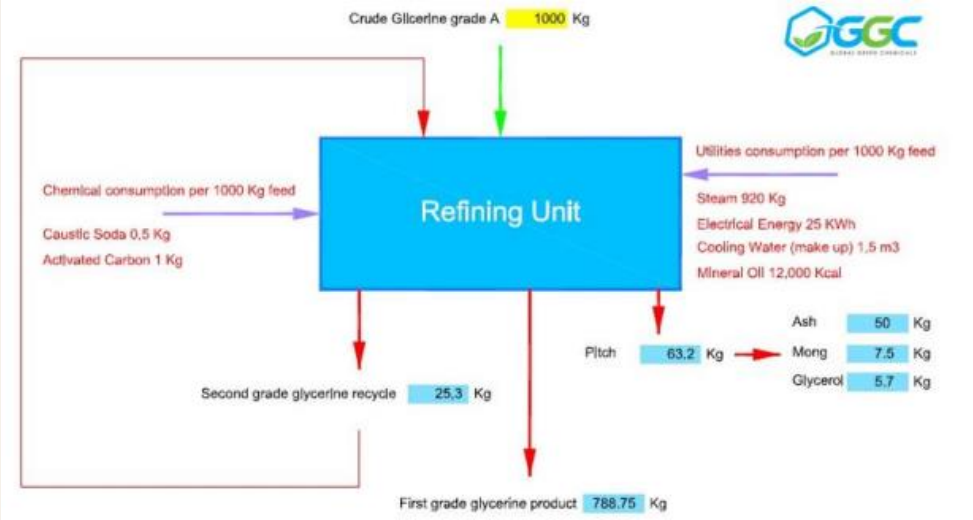

Figure 2: Input and output chemicals according to design specifications of Plant 2 for 80% concentrated crude glycerin.

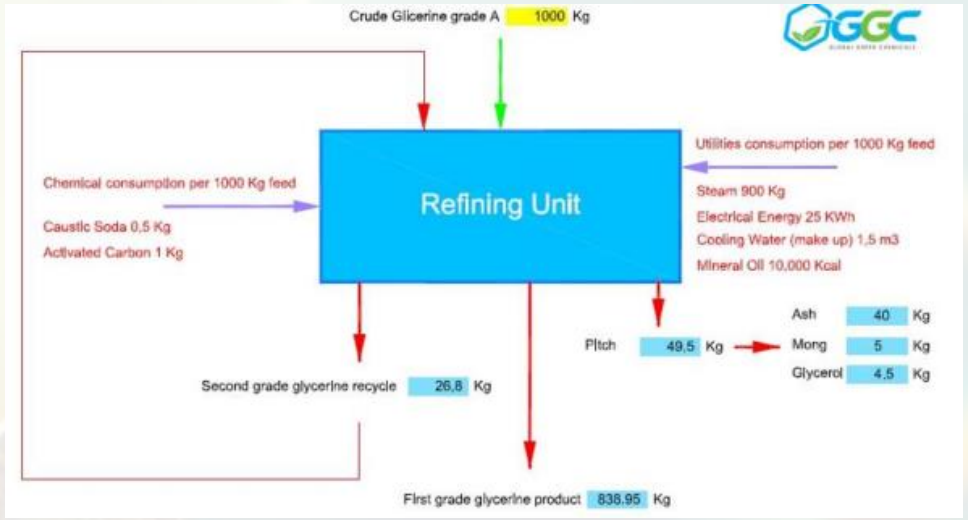

Figure 3: Input and output chemicals according to design specifications of Plant 2 for 85% concentrated crude glycerin.

Methodology: Scope of Project

Allocation method:

There is no need for allocation as refined glycerin production only generates a single product.

Assumption:

As of 2017, the operation in Chonburi Province has yet to begin. Therefore, the assessment relies on plant designs and international databases, such as Ecoinvent, for information. The SimaPro 8.0 program calculates the environmental impact assessment throughout the life cycle.

Data Requirement:

Type and quantity of chemicals used in the process are determined by plant design specifications, while the raw material sourcing data is sourced from reliable international databases like Ecoinvent.

Reporting:

Report regarding the environmental impact assessment outcomes of refined glycerin products and compare them with conventional glycerin production as well as apply for funding from the Board of Investment in the category of environmentally friendly chemical production.

Methodology: Inventory Analysis

1. **Material acquisition** is based on Ecoinvent 3.3, as shown in Figure 4.

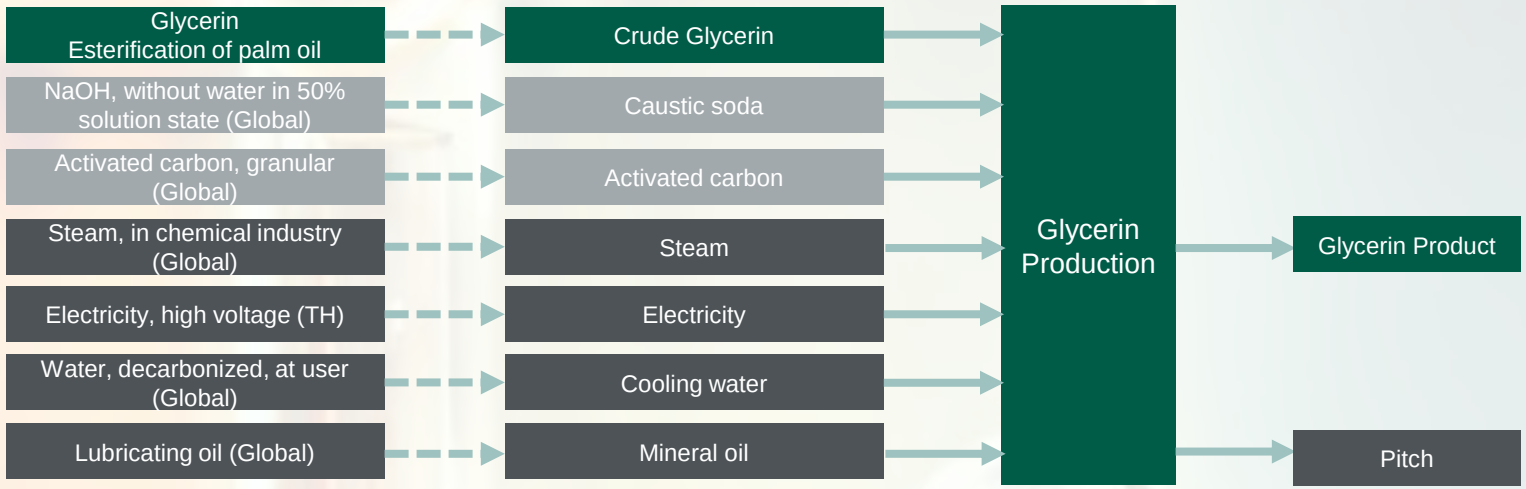

Figure 4: References for raw materials acquisition

2. **Process** is considered types and quantities of input and output chemicals, as shown in Figure 2 and Figure 3.
3. **Transport** is determined by calculating the average transport from raw materials acquisition.
4. **End of life** focuses on the waste generated during production rather than the disposal of the product itself. This waste includes Pitch or Glycerin residue, which consists of sodium salt (Ash), Glycerol residue, and other non-glycerol organic matter (Matter organics non-glycerol, mong). This waste can be repurposed as an alternative fuel for cement factories and a feedstock.

Methodology: Life Cycle Impact Assessment

The life cycle impact assessment is performed by analyzing data from inventory analysis applying ReCiPe methodology and SimaPro 8.0 calculation software, which can be used to assess 18 Midpoint environmental impacts and 3 Endpoint environmental impacts, which are Human health, Ecosystems, Resources. This evaluation methodology can be assessed individually or as a whole of impacts. Figure 5 displays the evaluation of all impacts in the Point unit (Pt).

18 Midpoint environmental impacts, including:

1. Climate change
2. Ozone depletion
3. Terrestrial acidification
4. Freshwater eutrophication
5. Marine eutrophication
6. Human toxicity
7. Photochemical oxidant formation
8. Particulate matter formation
9. Terrestrial ecotoxicity
10. Freshwater ecotoxicity
11. Marine ecotoxicity
12. Ionizing radiation
13. Agricultural land occupation
14. Urban land occupation
15. Natural land transformation
16. Water depletion
17. Mineral resource depletion
18. Fossil fuel depletion

3 Endpoint environmental impacts, including:

1. Human health
2. Ecosystem
3. Resources

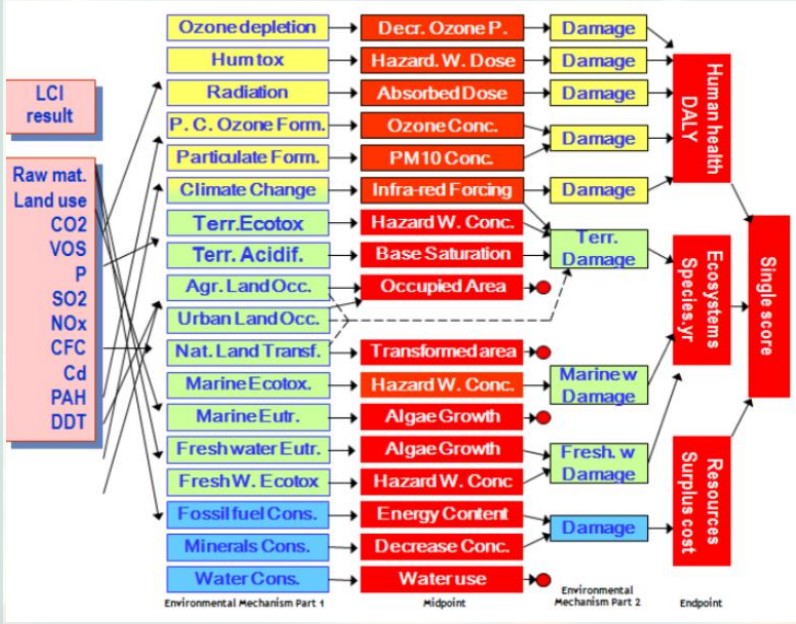

Figure 5. Relationship between Midpoint and Endpoint impacts considered in ReCiPe methodology.

Result and Discussion

Based on the environmental impact assessment of producing refined glycerin from crude glycerin, it has been discovered that purified glycerin made from palm oil has the most negative impact on the ecosystem. However, compared to glycerin made from epichlorohydrin, purified glycerin from palm oil has a lower environmental impact. **The environmental impact of refined glycerin is caused by the acquisition of various raw materials used in production**. To address this issue, our company supports groups of farmers in the northeastern and southern regions to **adopt sustainable agriculture in palm plantations, in accordance with The Roundtable Standards on Sustainable Palm Oil (RSPO).** This helps promote sustainable business from upstream to downstream and adds value to raw materials in the world market.

Thank you