

**LIFE CYCLE ASSESSMENT STUDY OF BIOFUEL PRODUCTION FROM
MICROALGAE IN THAILAND: A FOCUS ON ENERGY EFFICIENCY AND
GLOBAL WARMING IMPACT REDUCTION**

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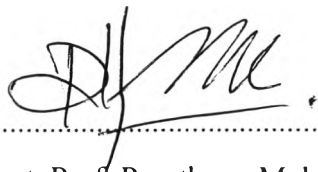
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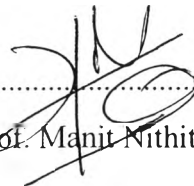


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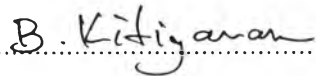
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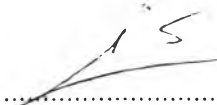
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บทคัดย่อ

ภาวะวิ วิบูลย์ : การศึกษาการประเมินวัฏจักรชีวิตของการผลิตเชื้อเพลิงชีวภาพจากสาหร่ายขนาดเล็กในประเทศไทย: ความคุ้มค่าทางพลังงานและการลดผลกระทบต่อภาวะโลกร้อน (Life Cycle Assessment Study of Biofuel Production from Microalgae in Thailand: A Focus on Energy Efficiency and Global Warming Impact Reduction) อ. ที่ปรึกษา: ผศ. ดร. ปมทอง มาลากุล ณ อยุธยา และ ผศ. ดร. มานิตย์ นิธิธนากุล 115 หน้า

งานวิจัยนี้ทำการประเมินการผลิตไบโอดีเซลจากสาหร่ายน้ำจืดขนาดเล็ก *Scenedesmus armatus* ด้วยเทคนิคการประเมินวัฏจักรชีวิตตามมาตรฐาน ISO 14040 โดยเน้นถึงความคุ้มค่าทางพลังงาน (อัตราส่วนพลังงานสุทธิ) และผลกระทบต่อภาวะโลกร้อน (ศักยภาพการเกิดภาวะโลกร้อน) ขอบเขตการศึกษาครอบคลุมวงจรชีวิตทั้งหมดของไบโอดีเซลจากสาหร่ายขนาดเล็กซึ่งแบ่งออกเป็น 4 ขั้นตอน คือ การเพาะเลี้ยง การเก็บเกี่ยว การสกัดน้ำมัน และกระบวนการทรานส์เอสเตอริฟิเคชัน จากการวิเคราะห์โดยมีหน่วยการศึกษาคือ ไบโอดีเซล 1 เมกะจูล พบว่าอัตราส่วนพลังงานสุทธิมีค่าเท่ากับ 0.34 สำหรับวิธีการปั่นส่วนเชิงมวล และมีค่าเท่ากับ 0.19 สำหรับวิธีการปั่นส่วนเชิงพลังงาน อัตราส่วนพลังงานสุทธิที่น้อยกว่า 1 ของทั้งสองวิธีแสดงให้เห็นถึงการขาดดุลพลังงานที่มีสาเหตุมาจากความต้องการทางพลังงานที่สูงในช่วงการเพาะเลี้ยงสาหร่าย อย่างไรก็ตาม การศึกษาพบว่า การดูดซับก๊าซคาร์บอนไดออกไซด์ในกระบวนการเพาะเลี้ยงสาหร่ายสามารถช่วยลดผลกระทบต่อภาวะโลกร้อนของไบโอดีเซลจากสาหร่ายได้ เมื่อเปรียบเทียบกับน้ำมันดีเซลปกติและไบโอดีเซลที่ผลิตจากเรพซิดและถั่วเหลือง ซึ่งเป็นผลมาจากการที่สาหร่ายสามารถกักเก็บก๊าซเรือนกระจกสุทธิได้สูงถึง 25 เปอร์เซ็นต์ (กิโลกรัมของก๊าซคาร์บอนไดออกไซด์เทียบเท่า) และจากการวิเคราะห์ความไวต่อตัวแปรพบว่าวิธีการปั่นส่วนมีอิทธิพลอย่างมีนัยสำคัญต่อวงจรชีวิตของการผลิตไบโอดีเซลทั้งในด้านพลังงานและด้านสิ่งแวดล้อม

ABSTRACT

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In this study, a life cycle assessment (LCA) technique based on ISO 14040 series was performed to evaluate the biodiesel production from freshwater microalgae *Scenedesmus armatus* in terms of energy efficiency (Net Energy Ratio or NER) and environmental impact (Global Warming Potential or GWP). The system boundary covered the entire life cycle of microalgae-based biodiesel which was divided into four distinct steps: cultivation, harvesting, oil extraction, and transesterification. Based on a functional unit of 1 MJ biodiesel, NER was found to be 0.34 and 0.19 for mass allocation and energy allocation, respectively. This energy deficit (NER<1) for both allocation methods was due to high energy input required to culture microalgae. However, CO₂ uptake in biomass agriculture leads to better performance in global warming potential (GWP) when compared to conventional diesel and biodiesel produced from rapeseed and soybean. This is a result of the cultivation process in which microalgae can fix up to 25 % of net greenhouse gas emissions (kg CO₂ equivalent). Sensitivity analysis showed that the allocation method had a significant influence on the life cycle energy and environmental performance of biodiesel production.

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