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# Selection and optimisation of algae for photosynthetic biogas upgrading in temperate regions: A circular bioeconomy approach

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## Abstract

Ireland plans to achieve 5.7 TWh of biomethane production by 2030 to replace 10% of natural gas grid use and in so doing increase its energy security. Biomethane is primarily generated via upgrading (CO<sub>2</sub>-removal) of biogas from anaerobic digestion (AD) of organic materials. In contrast to conventional energy and cost-intensive biogas upgrading techniques, photosynthetic biogas upgrading using microalgae offers significant economic and environmental benefits by co-generating biomethane, high-value compounds, and biofertilisers in a circular bioeconomy. However, a critical challenge lies in the selection of the optimal microalgae strain, which, besides being able to grow in mixotrophic conditions, and being tolerant to high pH and CO<sub>2</sub> concentrations, should also grow optimally under Irish climatic conditions. For example, although *Spirulina platensis* was previously assessed at laboratory scale for this purpose, due to its tropical origins, would require energy-intensive cultivation techniques in temperate climates, reducing the process benefits. The current study focuses on the bioprospecting of algae for photosynthetic biogas upgrading from local waterbodies in Ireland including isolation, purification, optimisation and its genetic identification. Following purification, the selected isolates are being cultivated under stress conditions; reflective of real-world photosynthetic biogas upgrading systems, including at alkaline pH (9.0-10.0), elevated bicarbonate concentrations (above 1.5 grams Inorganic Carbon (IC)/L), and low temperatures (less than 20 °C). A key component of this research includes the investigation of the metabolic and energy pathways of microalgae under high pH and bicarbonate stress, enabling tailoring algae production to maximise growth and production of high-value metabolites.

**Keywords:** Anaerobic digestion, microalgae, biomethane, biogas upgrading, microalgae biorefinery.

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