



The use of marine microalgae in microbial fuel cells, photosynthetic microbial fuel cells and biophotovoltaic platforms for bioelectricity generation

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Abstract

Algal green energy has emerged as an alternative to conventional energy production using fossil fuels. Microbial fuel cells (MFCs), photosynthetic microbial fuel cells (PMFCs) and biophotovoltaic (BPV) platforms have been developed to utilize microalgae for bioelectricity generation, wastewater treatment and biomass production. There remains a lack of research on marine microalgae in these systems, so to the best of our knowledge, all information on their integration in these systems have been gathered in this review, and are used to compare with the interesting studies on freshwater microalgae. The performance of the systems is extremely reliant on the microalgae species and/or microbial community used, the size of the bio-electrochemical cell, and electrode material and distance used. The mean was calculated for each system, PMFC has the highest average maximum power density of 344 mW/m², followed by MFC (179 mW/m²) and BPV (58.9 mW/m²). In addition, the advantages and disadvantages of each system are highlighted. Although all three systems face the issue of low power outputs, the integration of a suitable energy harvester could potentially increase power efficiency and make them applicable for lower power applications.

Keywords Algal biotechnology · Bioelectricity · Biophotovoltaic platform · Microbial fuel cells · Renewable energy

Introduction

Fossil fuels (oil, gas, and coal) remain as the chief contributor to global energy production, producing 79.9 EJ of energy in 2020 (US Energy Information Administration (EIA) (2021)). However, they are a depleting resource (Bach 1981; Droege 2002). Besides this, burning of fossil fuels results in several detrimental impacts, including global greenhouse gas (GHG) emissions, global warming and climate change (Mikhaylov et al. 2020). Therefore, focus has shifted from non-renewable energy to renewable alternatives such as solar, wind, geothermal energy, hydropower and biofuels over recent decades (Kammen 2006; Gielen et al. 2019). According to US Energy Information Administration (EIA) (2021), biomass led as the biggest global contributor to renewable energy production, with approximately 4.98 EJ in 2020.

One reason fossil fuels persists as a popular energy source is its price volatility. Foster et al. (2017) reasoned that the penetration of renewable energy technology into the power market to decrease demand for fossil fuel use can cause a price drop of fossil fuels, which would then

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