Life Cycle Assessment and Life Cycle Cost Analysis of a cracked ammonia fueled alkaline fuel cell for powering remote base transceiver stations

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Abstract

This work contains an analysis of an alkaline fuel cell (AFC) powered by cracked ammonia in the novel application of providing power to a remote, off-grid telecommunication Base Transceiver Station (BTS). Remote BTS are typically powered by diesel generators, which are characterized by high fuel consumption, significant direct local emissions and high maintenance requirements. AFCs are well suited to powering remote BTS because of their higher efficiency compared to diesel generators and relative site independence compared to renewable energy technologies. Cracked ammonia is favorable as a fuel source for AFCs because of its high volumetric hydrogen content, transportability, global availability, and chemical compatibility with AFCs.

The Alkammonia fuel cell is examined using Life Cycle Assessment (LCA), with ReCiPe- midpoints, and Life Cycle Cost analysis (LCC), using detailed primary data from project Alkammonia[3] partners. The costs and environmental impacts of ammonia production based both on fossil fuels and renewable energies, namely hydroelectricity and biomass, are also examined using models built from literature review taking both feedstock costs and plant size economies of scale into account. The fuel cell parameters that most affect system cost and environmental impact potential are electrode power density, lifetime and production costs and system efficiency. Recycling of nickel electrode substrate and palladium anode catalyst material is found to have large impacts on environmental performance, though without large cost incentives.

In the application of powering a remote off-grid BTS in India, the Alkammonia system with fossil ammonia and expected 2016 performance is calculated to produce electricity at a cost of 0.746 \$/kWh with a lifetime climate change impact potential of 0.96 kg CO_2 equivalent. Compared to a diesel generator in the same application, this climate change impact potential is 30% lower with a cost increase of only 7%. However, the results vary strongly depending on the impact category examined; for example, the metal depletion impact potential of the Alkammonia system is more than 6 times worse than all other systems examined. When renewable ammonia is used in the Alkammonia system, the climate change impact potential can be reduced by over 80%, with cost increases between 20-40% compared to the diesel generator system. Power systems that include solar photovoltaics are able to provide similar improvements to environmental performance with a lower cost penalty but are strongly dependant on the quality of the local solar resources. The Alkammonia system is best suited to very remote locations with poor solar resources and high fuel and labour costs.

[3] www.alkammonia.eu