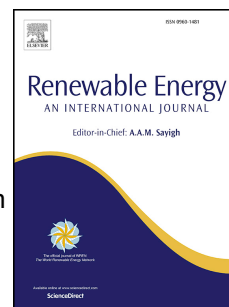


Accepted Manuscript

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PII: S0960-1481(17)30667-5

DOI: [10.1016/j.renene.2017.07.053](https://doi.org/10.1016/j.renene.2017.07.053)

Reference: RENE 9028

To appear in: *Renewable Energy*

Received Date: 22 February 2017

Revised Date: 9 June 2017

Accepted Date: 11 July 2017

Please cite this article as: Hackl R, Hansson J, Norén F, Stenberg O, Olshammar M, Cultivating *Ciona intestinalis* to counteract marine eutrophication: Environmental assessment of a marine biomass based bioenergy and biofertilizer production system, *Renewable Energy* (2017), doi: 10.1016/j.renene.2017.07.053.

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Cultivating *Ciona Intestinalis* to counteract marine eutrophication: Environmental assessment of a marine biomass based bioenergy and biofertilizer production system

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ABSTRACT: Eutrophication in the North and Baltic Seas is a major problem to the marine environment and the communities depending on it. To counteract this, the Swedish Marine and Water Authority suggested financial support for measures that increase the uptake of nutrients from the water by e.g. marine organisms and support for the utilization of these organisms as value added products. In Sweden the use of biogas to replace fossil transportation fuels is widely adopted. The domestic biogas production corresponded to approx. 1.95 TWh (approx. 7010 TJ) in 2015 of which approx. 63 % were upgraded for use as e.g. transportation fuel. Other uses are heat and electricity generation as well as industrial applications. To expand production, the biogas industry is searching for new substrates.

In this paper the utilisation of the marine invertebrate organism *Ciona intestinalis* (tunicata), cultivated in the North Sea and used as feedstock for biogas and biofertilizer production is suggested and assessed. The greenhouse gas (GHG) emissions performance of the concept and its consequences on marine eutrophication are investigated applying life cycle assessment. Results show that at full scale biogas production from *C. intestinalis* reduces GHG emissions by more than 65 % compared to fossil transportation fuels. In addition, the results show that accounting for the system consequences of other products and services such as biofertilizer replacing mineral fertilizers and decreased marine eutrophication largely increase the environmental benefits provided by the concept. Approx. 3.7 g-N_{eq}/MJ_{biogas} of nitrogen are removed from the marine environment during the cultivation of *C. intestinalis*.

KEYWORDS: biogas; biofertilizer; marine biomass; renewable energy; eutrophication; bioenergy

Nomenclature

<i>C. intestinalis</i>	<i>Ciona intestinalis</i>
CH ₄	Methane
CO ₂	Carbon Dioxide
CO _{2eq}	CO ₂ equivalents
DM	Dry Mass
GHG	GreenHouse Gases
LCA	Life Cycle Assessment
LCI	Life Cycle Inventory
N	Nitrogen
N ₂ O	Nitrous oxide
N _{eq}	Nitrogen equivalents
NH ₃ -N	Ammoniacal nitrogen
NH ₄ -N	Ammonium as N
P	Phosphorous

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