Fall 2018

IMRAD Content Structure for Research Papers, Literary Reviews, and Abstracts for Science Writing

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***Exercise*: Carefully read abstract A and abstract B, and respond to the following IMRD questions.**

Introduction Section
What was the study's motivating research issue?
Why was the study worth conducting?
What was novel and unique about the study?
What hypotheses guided the study?
What were the specific purposes of the study?

Methods Section
What key characteristics describe the study's subjects and materials?
How was the study designed?
What were the study's main procedures and analysis?
What were the independent variables and how were they measured?

Results Section
What are the study's key data?
What were the outcomes of the statistical analyses that the researchers performed?

Discussion Section
What were the author's main conclusions and arguments for them?
How did the author relate the study's outcomes to those from previous studies on the issue?
What methodological limitations and strengths did the author address?
What suggestions for future research were offered?

Abstract A:

Potential of biofuels from algae: Comparison with fossil fuels, ethanol and biodiesel in Europe and Brazil through life cycle assessment (LCA). Renewable and Sustainable Energy Reviews. *ScienceDirect*

Maria Luisa N.M. Carneiro, Florian Pradelle, Sergio L. Braga, Marcos Sebastião P. Gomes, Ana Rosa F.A. Martins, Franck Turkovics, Renata N.C. Pradelle

Abstract: Despite a substantial literature using life cycle assessment (LCA) approach, the extent to which second and third generation biofuels are more sustainable than the first generation remains a subject of debate. Although the existence of limitations due to LCA variability and uncertainty, this paper intends to determine global tendencies based on a statistic and critical interpretation of previously published study results, reviewing 61 recent papers addressing an environmental evaluation of microalgae biofuels. Such information is compared to the same impact indicators for fossil fuels and for ethanol and biodiesel from terrestrial crops in Europe and Brazil. For each case, the system boundaries and the methodological choices were precisely described. The sustainability potential of all biofuels was evaluated by the Global Warming Potential (GWP), the Energy Ratio (ER) and the Land Use (LU), allowing a broad estimation of the biofuels' contribution to climate change mitigation, their net energy efficiency and their competitiveness with food production chain. The results highlight that algae-derived biodiesel is, by far, the most efficient alternative in terms of land use compared to other biofuels, avoiding competition with food crops. Some biodiesel pathways can also satisfactorily perform in terms of greenhouse gases emissions reduction, but some others can be even worst than fossil diesel. Nevertheless, in terms of energy efficiency, algae biofuels cannot compete with other biofuels or fossil fuels. They present very low performances, even demanding more energy for its production then the energy they can deliver. Moreover, no pathway can be conclusively selected as preferable between the two main technologies available for microalgae biodiesel due to high uncertainties. However, open raceway pounds technology seems to be preferable as it looks less GHG intensive, requiring lower energy input and land use. Energetic and GWP performances can be improved if production pathways are carefully chosen and optimized.

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Abstract B:
Methane and the greenhouse-gas footprint of natural gas from shale formations. Climatic Change. *Open access at Springerlink.com*
Robert W. Howarth · Renee Santoro · Anthony Ingraffea

Abstract We evaluate the greenhouse gas footprint of natural gas obtained by high- volume hydraulic fracturing from shale formations, focusing on methane emissions. Natural gas is composed largely of methane, and 3.6% to 7.9% of the methane from shale-gas production escapes to the atmosphere in venting and leaks over the life- time of a well. These methane emissions are at least 30% more than and perhaps more than twice as great as those from conventional gas. The higher emissions from shale gas occur at the time wells are hydraulically fractured—as methane escapes from flow-back return fluids—and during drill out following the fracturing. Methane is a powerful greenhouse gas, with a global warming potential that is far greater than that of carbon dioxide, particularly over the time horizon of the first few decades following emission. Methane contributes substantially to the greenhouse gas footprint of shale gas on shorter time scales, dominating it on a 20-year time horizon. The footprint for shale gas is greater than that for conventional gas or oil when viewed on any time horizon, but particularly so over 20 years. Compared to coal, the footprint of shale gas is at least 20% greater and perhaps more than twice as great on the 20-year horizon and is comparable when compared over 100 years.