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Green hydrogen from hydropower: A non-cooperative open-source modeling approach assessing the profitability gap and future business cases

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Corresponding Author:	Sebastian Zwickl-Bernhard Energy Economics Group (EEG) Vienna, Austria AUSTRIA
First Author:	Sebastian Zwickl-Bernhard
Order of Authors:	Sebastian Zwickl-Bernhard
	Hans Auer
Abstract:	This paper investigates a possible future business case for green hydrogen production from hydropower. The main research question is to find the tradeoffs for a run-of-river hydropower plant owner between the currently prevailing business model of wholesale electricity trading and, alternatively, production of green hydrogen. Hence, a bi-level optimization framework between a hydropower plant owner (H2 producer and price setter) and a transportation firm (H2 consumer) is developed. The empirical scaling of the numerical example describes Central Western European wholesale electricity market settings. Results indicate that the current market environment and price setup do not allow for profitable green hydrogen production as yet. However, an increasing CO2 price as the key determining parameter leads to improved competitiveness and expected profitability of the business case studied in this work. In the numerical example examined, a CO2 price above 245EUR/t triggers profitability.
Suggested Reviewers:	Julian Hunt hunt@iiasa.ac.at
	Manfred Hafner manfred.hafner@feem.it
	Felix Frischmuth felix.frischmuth@iee.fraunhofer.de

Title. *Green hydrogen from hydropower: A non-cooperative modeling approach assessing the profitability gap and future business cases*

Author names and affiliations. Sebastian Zwickl-Bernhard, Hans Auer; Energy Economics Group (EEG), Technische Universität Wien

Corresponding author. Sebastian Zwickl-Bernhard (zwickl@eeg.tuwien.ac.at)

Permanent address. Gusshausstrasse 25-29/E370-3, 1040 Wien, Austria

SEBASTIAN ZWICKL-BERNHARD

Technische Universität Wien
Institute of Energy Systems and Electrical Drives
Energy Economics Group (EEG)
Gusshausstrasse 25-29/E370-3, A-1040 Vienna

Phone: +43 660 40 40 933
E-mail: zwickl@eeg.tuwien.ac.at

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Dear Reviewers, dear Associate Editors,

Please find attached our manuscript *"Green hydrogen from hydropower: A non-cooperative modeling approach assessing the profitability gap and future business cases"*, which we would like to submit for publication in your journal *Energy Strategy Reviews*.

The core objective of this research paper is to investigate a possible future business case for green hydrogen production from hydropower. In particular, the main research question is to find the trade-offs for a run-of-river hydropower plant owner between the currently prevailing business model of wholesale electricity trading and, alternatively, production of green hydrogen. The results indicate that the current market environment and price setup do not allow for profitable green hydrogen production as yet. However, an increasing CO2 price as the key determining parameter leads to improved competitiveness and expected profitability of the business case studied in this work.

We believe that with this work we can contribute for your journal's agenda, as our focus lies on hydropower-based green hydrogen production, future business cases, strategic-based (open-source) modeling, and optimal renewable energy resource allocation.

The manuscript is original; no part of this work has been published before nor is it under consideration for publication in another journal. An earlier version has been submitted to *Applied Energy* and rejected; a fundamentally revised and extended version is now submitted here. The authors declare that there are no conflicts of interest regarding the publication of this paper. The paper has been professionally proofread.

The corresponding author is Sebastian Zwickl-Bernhard. The contact details can be found above.

I am looking forward to your reply and thank you in advance for your consideration.

Yours sincerely,

Sebastian Zwickl-Bernhard

Highlights

- Future business case of green hydrogen production from hydropower
- Non-cooperative game between a hydropower plant owner and a transportation firm
- Trade-offs between electricity trading and hydrogen production
- Numerical example of the Central Western European wholesale electricity market
- CO_2 price above 245EUR/t triggers profitability

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Sebastian Zwickl-Bernhard[a,*], Hans Auer[a]

[a]Energy Economics Group (EEG), Technische Universit¨at Wien, Gusshausstrasse 25-29/E370-3, 1040 Wien, Austria

Abstract

This paper investigates a possible future business case for green hydrogen production from hydropower. The main research question is to find the trade-offs for a run-of-river hydropower plant owner between the currently prevailing business model of wholesale electricity trading and, alternatively, production of green hydrogen. Hence, a bi-level optimization framework between a hydropower plant owner (H_2 producer and price setter) and a transportation firm (H_2 consumer) is developed. The empirical scaling of the numerical example describes Central Western European wholesale electricity market settings. Results indicate that the current market environment and price setup do not allow for profitable green hydrogen production as yet. However, an increasing CO_2 price as the key determining parameter leads to improved competitiveness and expected profitability of the business case studied in this work. In the numerical example examined, a CO_2 price above 245 EUR/t triggers profitability.

Keywords: Green hydrogen, Hydropower, Non-cooperative game, Resource allocation, Profitability, CO_2 price

*Corresponding author
Email address: zwickl@eeg.tuwien.ac.at (Sebastian Zwickl-Bernhard)

Declaration of interests

☒ The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

☐The authors declare the following financial interests/personal relationships which may be considered as potential competing interests: