Application to ENLENS: Energy Transition Through the Lens of SDGs

1. Title: Risk Networks of Renewable Energy Markets

2. Applicants:

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3. Societal Case:

The provision of affordable and sustainable energy to households and businesses (SDG 7) is challenging for the Netherlands. The affordability aspect has become increasingly difficult following the energy supply crisis triggered by the Ukraine war [1]. This crisis caused significant price increases in power wholesale markets, which were passed on to consumers. This price shock has accelerated the adoption of renewable energy sources, particularly photovoltaic and wind. Energy producers charge consumers a price comprising of the production costs and compensation for supply risks. The marginal costs of wind and solar power are lower than those of gas, coal, or nuclear power, especially when accounting for the true costs associated with carbon emissions and environmental damage (SDG 13, 15). However, renewable energy sources are intermittent and non-dispatchable, resulting in supply risks contributing to higher prices. Two key mechanisms will ultimately lower the cost of sustainable energy: (1) Enhanced Understanding of Risks: Improved understanding of energy supply risk will lead to reduced prices, as the risks can be more accurately quantified and managed. (2) Renewable Energy Investments: A deeper comprehension of the risks associated with renewable energy markets will provide developers with greater certainty, encouraging more substantial investments in renewable energy and thus increasing supply (SDG 7, 9).

4. Scientific Case:

This research aims to map the network structure of European power markets to manage supply risk to ensure affordable energy prices during the transition to a sustainable and resilient energy future. Our interdisciplinary approach combines expertise from stochastic modeling, finance, and data science. By integrating econometric modeling with stochastic modeling and network analysis, we seek to uncover the underlying structures and dependencies within power markets. The methodologies will include vector autoregression models [3] and network analysis [2] to map and analyze the interactions between power prices across EU countries. The intended output includes a joint proof-of-concept paper detailing the autoregressive structures and dependencies within renewable energy networks. This study goes beyond commonly applied approaches focusing on networks spanned between energy companies' stock prices [4]. The network map will allow us to understand the cross-European power dependency structure and find solutions to mitigate risk spillovers between different European markets. This project addresses the societal need for stable and resilient renewable energy markets, which are crucial for achieving sustainable development goals. By understanding financial dependencies and risk propagation in power markets, we aim to mitigate supply risks, and ensure the stability of the electricity grid, thereby promoting a sustainable and secure energy future.

5. Contribution to the Aims and Success Indicators of ENLENS:
A. Project Evolution: This project aims to lay the foundation for future research by developing a comprehensive grant proposal for NWO or EU funding to further explore the dependency structure between financial and non-financial renewable energy networks. The long-term goal is to contribute to the stability and resilience of renewable energy markets.
B. Contribution to UvA-Community and ENLENS: This project promotes interdisciplinary research, contributing to the UvA goal to promote interdisciplinary collaborations. We will present our projects results to each other's groups at Faculty of Economics and Business and Institute of Informatics and Korteweg-de Vries Institute for Mathematics. Each Faculty/Institute by itself focuses upon sustainability research and our project will bring researchers from both groups together, setting the ground for further collaborations.

C. Broadening the Community:C1. Collaboration with External Stakeholders: We plan to engage policymakers, financial regulators, energy companies, and grid operators to refine our analysis and gather feedback, ensuring that our findings are relevant and impactful. We intend to do so by presenting our research at conferences attended regularly by these stakeholders and inviting them to our group seminars.

C2. Links with Education: The project will involve students as Research Assistants, giving them the opportunity to participate in interdisciplinary research and we offer theses that allow master students to directly contribute to research relevant for the sustainable transformation our energy systems.

C3. Outreach and Dissemination: We will contribute to the outreach of ENLENS and UvA-Sustainability by presenting our findings at relevant conferences and workshops, ensuring broad dissemination of our research outcomes. Further we will send our joint paper to relevant journals, ensuring that the research will be widely read within the academic community. 6. Budget: Conferences and Research Travel: Attendance at relevant conferences and workshops for dissemination, networking and short research stay: Conferences in our field commonly charge a conference fee (€250 - €800), and hotel and travel expenses are to be covered by the attendees themselves. We plan 3 European Conferences each (€2000 * 3 *2 = €12000), one international conference each (€6000), one research stays each (€6000). General Research Expenses (Research Assistant, Publication Fees, Others): €6000
Data acquisition: Data will be acquired from EPEX. We require the data for Netherlands and Germany for 5 years, which costs €5000. Total Budget Requested: €35,000.

Why can this project not be paid by normal budgets? For the required data and hiring of research assistants, no funding is available within our groups and is to be obtained via funding opportunities as by our group's policies.

References:

[1] IEA (2022). World Energy Outlook 2022. https://www.iea.org/reports/world-energy-outlook-2022/executive-summary#abstract

[2] Zhang, K., & Trimborn, S. (2023). Influential assets in Large-Scale Vector AutoRegressive Models. Available at SSRN 4619531.

[3] Benth, F.E. & Karbach, S. (2023). Multivariate continuous-time autoregressive moving-average processes on cones. Stochastic Processes and their Applications, **162, p.**299-337. https://doi.org/10.1016/j.spa.2023.05.003

[4] Uddin, G. S., Luo, T., Yahya, M., Jayasekera, R., Rahman, M. L., & Okhrin, Y. (2023). Risk network of global energy markets. Energy Economics, **125**, 106882. https://doi.org/10.1016/j.eneco.2023.106882