Master Thesis

The future cost of green electricity?

The costs of energy production consist of capital expenditures, fixed operational expenditures, and variable operational expenditures. Fixed operational expenditures are mostly labor and maintenance. Variable operational expenditures are generally costs for fuel or feedstock. The composition of power generation costs between renewable and fossil power plants is very different. While the power generation costs of fossil power plants consist largely of operational expenditures for fuel, most renewable power plants such as wind turbines or photovoltaics do not require fuel. Thus, their power generation costs are defined by fixed operational and capital expenditures. In literature, the investment costs of wind turbines and photovoltaics are projected to decline significantly in the future (Tsiropoulos et al. 2017). The underlying assumptions for decreasing costs are often learning rates and effects of economy of scale (Goldschmidt et al. 2021). By concept, such approaches assume that general economic conditions such as energy prices also hold in the future. This might not be the case for energy costs, as the observable historic learning rates are based on low-cost energy from fossil fuels. In the future, photovoltaics and wind turbines should be produced using renewable energy, which might be considerably more costly than fossil energy.

Key tasks and objectives of the thesis

In your thesis you should firstly review existing approaches for cost projections of investment costs for photovoltaics and wind turbines. Subsequently, you should investigate the effect of energy costs on the cost degression of photovoltaics and wind turbines. You should estimate the sensitivity of the cost degression found in the literature towards the costs of energy. By making a life cycle analysis, you should also consider energy costs of the supply chain and primary resources. The life cycle analysis should not only cover energy but all relevant in- and outputs. You should determine a spread in the investment costs depending on the basket of energy carriers used for production. For benchmarking, you should make a literature review on the historical spread between RES and fossil power generation costs and their influence on the investment costs for PV and wind turbines. Subsequently, you should compare your results with assumptions on future power generation costs and cost degressions for wind turbines and PV in the literature, e.g. in studies on the transformation of the German energy system (Energiewirtschaftliches Institut an der Universität zu Köln 2021; Kopernikus Projekt Ariadne 2021; Prognos, Öko-Institut, Wuppertal-Institut 2021; Sensfuß et al. 2021).

Your profile

- Student of economics, best with focus on energy
- First knowledge or interest in learning the concept of life cycle analysis

Literature

- Energiewirtschaftliches Institut an der Universität zu Köln (2021): dena-Leitstudie Aufbruch Klimaneutralität. Klimaneutralität 2045 - Transformation der Verbrauchssektoren und des Energiesystems. Herausgegeben von der Deutschen Energie-Agentur GmbH (dena)Verbrauchssektoren und des Energiesystems.
- Goldschmidt, Jan Christoph; Wagner, Lukas; Pietzcker, Robert; Friedrich, Lorenz (2021): Technological learning for resource efficient terawatt scale photovoltaics. In Energy Environ. Sci. 14 (10), pp. 5147–5160. DOI: 10.1039/D1EE02497C.
- Kopernikus Projekt Ariadne (2021): Ariadne-Report. Deutschland auf dem Weg zur Klimaneutralität 2045 - Szenarien und Pfade im Modellvergleich: Potsdam Institute for Climate Impact Research.
- Prognos, Öko-Institut, Wuppertal-Institut (2021): Klimaneutrales Deutschland 2045. Wie Deutschland seine Klimaziele schon vor 2050 erreichen kann Langfassung im Auftrag von Stiftung Klimaneutralität, Agora Energiewende und Agora Verkehrswende.

- Sensfuß, Frank; Lux, Benjamin; Bernath, Christiane; Kiefer, Christoph; Pfluger, Benjamin; Kleinschmitt, Christoph et al. (2021): Langfristszenarien für die Transformation des Energiesystems in Deutschland 3. Kurzbericht: 3 Hauptszenarien.
- Tsiropoulos, I.; Tarvydas, D.; Zucker, A. (2017): Cost development of low carbon energy technologies. Scenario-based cost trajectories to 2050. Edited by European Commission, Joint Research Centre (JRC technical reports).

Contact

Michael Moritz

Tel.: +49 (0)221 277 29-202
E-Mail: michael.moritz@ewi-uni-koeln.de

Topics

- Wind & PV energy
- cost degression

Methods

- Life cycle analysis
- Literature review