Lehrstuhl für Wirtschaftliche Staatswissenschaften, insbesondere Energiewirtschaftslehre

Master Thesis

Empirical Estimation of Learning Effects for Heat Pumps

For the energy transition to be successful, clean technologies must become economically competitive. For some technologies, such as wind and solar power, costs have fallen sharply over the past decades (Grubb et al., 2021). This cost decline has been attributed to technological progress, but also to increasing market penetration (Economies of Scale). For heat pumps, learning effects have been less investigated.

Energy system studies that describe the transformation of the energy economy to a climate-neutral energy system are based on assumptions about cost degression for the next 20 – 30 years. The underlying models attempt to optimize the best economic investment options using these assumptions. In those cases where possible recent trends, in their speed of development, were over- or often underestimated for such above mentioned technologies, there are significant distortions in the validity of climate policy on the energy system (Grant et al., 2020; Trancik, 2021). For the example of solar photovoltaics, it has been shown that cost assumptions in many energy system models were already outdated after five years (Grubb et al.).

In a study by Way et al. (2022), future energy system costs assumptions for solar and wind energy, batteries and electrolyzers were analyzed. The aim was to apply probabilistic cost forecasting methods based on historical cost data. The authors' study confirmed that most cost assumptions in energy system models, being expert estimates, regularly turn out to be wrong. Hence updating the cost assumptions in recent models could accelerate the whole energy transition pathway.

In this thesis, the focus lies on heat pump cost estimates for households. For this purpose, different approaches, such as Way et al. (2022), should be investigated and applied to estimate the underlying "learning rate" of heat pumps.

Key tasks and objectives of the thesis

- Identification of a suitable method for determining the learning rate
- Collection, selection and preparation of empirical data on heat pumps
- Estimating a learning curve based on historical observations
- Optional: application of the estimated learning curve for future cost estimation
- Discussion of the findings in the overall context of the energy transition

Your profile

- Student in economics, focus and interest in energy and techno-economic analysis

Literature

- Grant, N.; Hawkes, A.; Napp, T. et al. (2020): The appropriate use of reference scenarios in mitigation analysis. Nat. Clim. Chang. 10, 605–610
- Grubb, Michael; Wieners, Claudia; Yang, Pu (2021): Modeling myths: On DICE and dynamic realism in integrated assessment models of climate change mitigation. WIREs Clim Change.
- Trancik, Jesika E. (2021): Testing and improving technology forecasts for better climate policy. PNAS Vol. 118 No.35
- Way, B.; Ives, Matthew C.; Mealy, Penny; Farmer, J. Doyne (2022): Empirically grounded technology forecasts and the energy transition. Joule 6, 2057-2082

Contact

Stephan Terhorst

E-Mail: stephan.terhorst@ewi.uni-koeln.de

Topics

- Energy Systems
- Heat Pumps
- Learning Rates

Methods

- Literature Review
- Data / Regression Analysis