Master's thesis topics 2023-2024 - Professor Lion Hirth

Research & Advising Profile

The closer your research topic aligns to my own research interest, the more detailed and more helpful my advice will be. If your topic is only remotely to my own expertise, I will only be able to support you in very general forms.

I am an energy economist, and I primarily work quantitatively. I have detailed knowledge of energy policy and regulation in Europe, but not beyond. Please have a look at my publications, my course offerings and my Twitter feed to get a better idea of what I do. In particular, I am familiar with the following areas:

- Electricity markets, including topics such as electricity market design, energy-only markets, balancing systems, the European integration of electricity markets, prosumers and behind-the-meter storage
- Commodity markets, in particular power and gas markets
- Power grids, in particular nodal pricing, re-dispatch, locational markets for flexibility and locational investment incentives
- The economics of renewable energy, such as the market value of wind and solar energy, system integration, and impacts on electricity markets and prices
- Energy policy, in particular carbon pricing, support schemes for renewable energy, auction design for renewables, revenue and price caps, and to a lesser degree heating and transport policies
- Electricity system modeling, in particular numerical power market modeling such as EMMA

Proposed Topics

Below you find a list of ideas for master thesis topics. Some are pretty specific and well thought-through, others are mere fields or topics that I find interesting.

Proposed Topics
Price elasticity of energy demand: How responsive are energy consumers to prices changes? What is the price elasticity of demand? A thesis could be a review of all sectors or focus on a fuel (gasoline, natural gas, electricity) and/or a sector (transport, industry, buildings). It could be a literature review or a new econometric estimate of demand elasticity.
Electricity demand response at different time scales: Following up on Hirth, Khanna, and Ruhnau (2022). How does electricity demand responds to price shocks at different time scales (hours, weeks, months, years)? More recent data from the current European energy crisis may be used; discussion whether fuel prices can be used as an (additional) instrument in the instrumental variable regression.
Capacity credits in highly renewable electricity systems: With a numerical model, calculate capacity credits of single production and storage technologies, or de-rating factors in capacity mechanisms. Discuss how the complementarity of renewables and storage can(not) be reflected in capacity credits as well as implications for capacity remuneration mechanisms.

Granular distribution grid tariffs: A review of the use and the learnings from time-variant and location-specific tariffs for electricity distribution grids. How do European countries use such tariffs and what are the results?
Balancing energy prices: A review and descriptive statistical assessment of prices for balancing services (reservation and activation) across European countries. How have prices developed over longer periods, how have they been affected by the 2022 crisis, and how well correlated are they across countries?
The impact of batteries on balancing. Review of battery expansion in Germany plus a few additional European countries. Empirical analysis of balancing reserve prices in DE. Discussion of possible effects of reserve prices with a focus on the impact of the expansion of batteries on capacity prices. (literature review + data analysis).
Demand response in power models: What are the various demand response options available in power systems? How are these options modeled in power systems? What are the comparative benefits and disadvantages of the different approaches?
Peak shaving product. The EU is introducing a new "peak shaving product" on electricity markets. What is that, why is it introduced, and how could it be implemented?
Estimating emissions intensity of power systems: Emissions intensity of electricity generation is needed for estimating impact of all forms of demand side interventions, electric vehicles, life-time emission calculations, storage, etc. How can such numbers be derived, and what are pros and cons? What are practical implications of marginal vs. average emissions intensity and short-term vs. long-term emissions intensity?
Contracts for differences. European policy-makers would like to expand the role of CfDs, but many different contract designs are used. Review of proposed and existing CfD designs and a discussion of their implications on incentives and risk.
The "downstream" side of CfDs. Long-term contracts between governments and power generators, such as contracts for differences, need to be passed on to consumers in some way: Costs need to be recovered and/or proceeds distributed. Which options exist and what are implications on consumer risk, tax burden, industrial policy, energy savings incentives, and demand-side flexibility?
Power purchasing agreements. Review of the European market for PPAs and interviews with industrial uptakers to understand the potential and limitations of PPAs.
The value of the solar PV learning curve. Germany has spent about EUR 250bn in solar PV deployment. The main benefit, it is sometimes argued, lies in reduction of future costs due to learning-by-doing, a phenomenon often represented as a learning curve. What is the economic value of this learning and which actors/countries/generations are the one benefitting? (theory & quantifications)

Recent electricity market liberalization. Comparative case study of two recent cases of electricity market liberalization; review of crucial design choices. (literature review & interviews)
Smart meter and retail pricing review. Review of the status quo of electronic meter globally; overview of purpose (electricity theft vs. price-elastic demand); review of corresponding retail pricing (time-of-use pricing, dynamic pricing, invariant prices, etc.). (literature review)
Dynamic retail tariffs. How prevalent are variable tariffs across Europe and across different consumer segments? What are the policy, regulatory, economic and technological drivers behind these? (literature review & interviews)
Hedged retail tariffs. How can dynamic retail tariffs be combined with price hedging? Are the proposals by Severin Borenstein and Frank Wolak applicable to Europe?
Wholesale market participation of electricity demand. How can (flexible) electricity demand participate in European wholesale electricity markets (day-ahead & intraday)? What are the country differences? What are the pros and cons of the different currently implemented options? How should regulation be developed further? (literature review & interviews)
Economic value of subsidized loans for renewable energy. Estimate the (global) economic value of below-interest rate loans issues to renewable energy project developers by state-owned banks such as EIB, EBRD, KfW and World Bank. (methodological review & quantification)
Network tariff design. A theoretical discussion of efficient / sensible / feasible design of (distribution) network charges, possibly complemented with some data-based assessment. Focus should be the multiple objectives (energy conservation, climate policy, distribution and fairness, risk), the various options (capacity vs. volumetric charges, time-of-use and critical peak pricing).
Storage vs. transmission. How does the location of storage effect the need for transmission infrastructure? How do the market design and other regulatory incentives affect this outcome? (Literature review and time series analysis)
Future dispatchable capacity mix. What is the role of different dispatchable (almost) carbon-free technologies (nuclear, hydrogen, carbon capture and storage) in future electricity systems with (more or less) variable renewable energy sources? An adaptation of the screening curve model to future technologies, including a sensitivity analysis on uncertain input parameters (literature review & screening curve model)
Balancing market in the Netherlands. How do balancing responsible parties (BRPs) respond to changes in the imbalance price? Applying the instrumental variable approach presented in Eicke, Ruhnau and Hirth (2021) on the Dutch power market. How much larger is the price responsiveness in this market compared to Germany? (econometrics)
Predicting network congestion. In electricity systems, it is often relevant to predict the occurrence of line overload (grid congestion) a few hours or days before they occur. In this work, econometric methods are used to predict congestion based on variables such as wind and solar generation, imports and exports of electricity, load levels, among other regressors. Prediction could be made at the national level (redispatch volumes), individual lines, regional curtailment of renewables, or redispatch of individual power plants. (econometrics)
Redispatch and curtailment in Germany. Analyse redispatch and curtailment data in Germany to learn more when and why the feed in of renewable energy sources is reduced. In which hours does redispatch occur? How significant is the welfare loss?

Revenue cap. Capping power generators' revenues was one of the major EU responses to the 2022 energy crisis. This thesis is an ex-post evaluation of the policy: how it was implemented in (a few) European countries and what the outcome was in terms of market effects and public revenues.