Challenges in Designing Technology-neutral Auctions for Renewable Energy Support

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Overview

The expansion of renewable energy (RE) sources is a cornerstone of the energy transition in order to achieve the global greenhouse gas emission reduction targets. However, the costs of electricity from RE sources has not yet achieved grid-parity with conventional energy sources and thus RE sources need support in order to achieve the expansion targets. The global trend regarding the promotion of RE sources is to determine the support payments through competitive bidding processes. Such auctions for RE support are, as of today, deployed in many countries around the globe particularly in Latin America and in Europe. Moreover, since 2017 the European Commission requires its member states to deploy auctions in order to promote RE (European Commission, 2014).

There is a large variety of auction designs in the different countries, yet, there is a general development to open up the auction formats. The most recent openings were so-called cross-border auctions, where participants from different countries could participate, e.g., in Denmark and Germany (Kitzing & Wendring, 2016), and technology-neutral auctions, where bidders participate with different technologies. Examples include the Netherlands (Minister van Economische Zaken, 2015) and Mexico (IRENA, 2017). With a more open auction format and thus a larger variety in participating bidders, the complexity of designing an auction increases as well. We analyze the main challenges when designing a technology-neutral auction. We focus on the general differences between different RE technologies and the resulting implications for the bidders and the auctioneer.

Methods

We deploy a three-way approach in order to analyse the specific challenge to design a technology-neutral auction. First, we abstract the technological differences between different RE technologies, especially of wind on- and offshore and photovoltaics (PV). Those differences include construction and planning times, investment and operation costs and cost uncertainties. We listed the most important characteristics of RE which differ across technologies in Table 1. It also provides some examples regarding the differences among technologies.

Second, we empirically analyse the design of already conducted or planned technology-neutral auctions for RE support. Auctions where multiple technologies could participate were conducted in Germany, Mexico, The Netherlands, Slovenia, Spain and the UK among others. The main design characteristics of those auctions are summarized in Table 2. We focus on design elements that address the individual characteristics of the participating technologies and how they impacted the

Cost structure:	Investment costs	High for PV, low for biomass
	Operation costs	High for biomass, low for PV (fuel costs or not)
	Cost uncertainties	High for wind offshore, low for PV (also depending on planning times and remuneration scheme)
Project preparation:	Planning and construction time	Much for wind offshore, less for PV
	Prequalification costs	High for wind, low for PV
	Prequalification benefit	A positive feasibility study for wind does not guarantee the practicability
Generation profile:	Dispatchability	Not for wind/PV but for biomass
	Full-load-hours	Biomass > wind offshore > wind onshore > PV
	Integration costs	Different for technologies but depending on location and country
	Market value	
Project structure:	Typical project size	Wind offshore much bigger than e.g., PV
	Ownership structure	Wind offshore big utilities, while other technologies also community projects
Long-term development		Unclear future cost reduction potential for different technologies

Table 1 Different RE Technology Characteristics

	Germany	Mexico	Netherlands	Slovenia	Spain	United Kingdom
Technologies	Wind onshore, PV	Wind onshore, PV, Geothermal, Hydro	Wind onshore, PV, Biomass, Geothermal, Biogas, Hydro	Wind onshore, PV, Geothermal, Biogas, Hydro, Biomass	Wind onshore, PV, (biomass)	Wind onshore, PV, Hydro, landfill gas, Wind offshore, biomass, ACT, anaerobic digestion, geothermal
Prequalification	Different PQ and realization periods	Same PQ and realization period	Different PQ and realization periods	Same PQ and realization period	Same PQ and realization period	Same PQ and realization period
Discrimination	Regional quota, Technology-specific maximum prices, Price correction factor	Price correction factor, Regional factor	Technology-specific maximum prices	Technology pots	Generation factor	Technology pots, Technology-specific maximum prices
Results	Only PV awarded (3 auctions)	Mainly PV and wind awarded, regional concentration	Mixed results, depending on year biomass, PV or wind predominant	Different technologies awarded; wind predominant	1 auction almost entirely wind, 1 auction PV predominant	Mixed results (depending on pot), focus on offshore wind

Table 2: Overview of technology-neutral auctions in different countries

outcome.

Moreover, we include the findings of previous studies on technology-neutral auctions. Most research of technology-neutral RE auctions is based on more general considerations of technology-neutral support (Aghion, et al., 2009; Azar & Sandén, 2011). This research shows that technology-neutral policies also have set-backs with respect to dynamic efficiency and a desired technology mix. Applied on the actual topic of RE auctions there is research to quantify the monetary effect of technology-neutral auctions (Jägemann, et al., 2013; Jägemann, 2014). Further research does not only quantify the costs of technology-neutral and technology-specific auctions but also considers other effects like integration costs and market failures (de Mello Santana, 2016; Gawel, et al., 2017). Other researchers focus on the cost-effectiveness of technology-neutral auctions (Lehmann & Söderholm, 2017; del Rio & Cerdá, 2014; Kreiss, et al., 2019). That is, are technology-neutral auctions the best choice with respect to support costs.

Third, we apply auction-theoretic concepts on the present data. We deploy the concept of asymmetric auctions (Maskin & Riley, 2000) which corresponds to the different characteristics of the different technologies. Furthermore, the auction-theoretical analyses includes discriminatory auctions (McAfee & McMillan, 1989), integration costs (Joskow, 2011) and common values (Kagel & Levin, 1986).

Results

The results of our analyses show that actual technology-neutrality has never been achieved in the past and is in general hard to achieve. A further question is whether this should be achieved at all. First, there are arguments which speak against multi-technology auctions in general. Deploying technology-specific auctions reduces the uncertainty for both the auctioneer and the bidders. That has two main advantages. On the one hand, less uncertainty reduces the capital costs for investors and thus the costs for the economy. On the other hand, technological predictability helps the government to plan the grid infrastructure in line with the RE expansion and thus reduces integration costs (Hirth, 2013). Furthermore, technology-specific might be sensible with regards to dynamic efficiency (de Mello Santana, 2016), i.e., the technology development could change the costs differently for different technologies and thus their order with respect to the generation costs.

Those arguments are confronted with the biggest advantage of technology-neutral auctions, the (static) efficiency. That is, the bidders with the lowest generation costs are awarded and thus the welfare is maximized. However, it is not clear what technology-neutral actually means. For example, does it mean that all technologies have the same realization period or different periods that account for the different planning and construction times. There are various similar examples to be found. Furthermore, due to the different characteristics of different technologies it would be hard to impossible to conduct an actual technology-neutral auction even if this technology-neutral could be defined. For example, the different number of full load hours, different upfront costs to achieve the permits and different lead times cannot all be taken into account with full compensation. Upfront costs are auction-theoretically considered as sunk costs and influence the bidding behaviour depending on the amount (Levin & Smith, 1994). Additionally, different planning and construction times alter the possibilities to consider technology cost development, e.g., PV module or wind turbine prices, and thus also influence the bidding behaviour (Kreiss, et al., 2017).

Finally, there is the question whether the auctioneer wants a technology-neutral auction. Even though such an auction theoretically results in the welfare optimum, this might not be the outcome with the lowest costs for the auctioneer. The different cost structures of different technologies lead to windfall profits which could be reduced through a discriminatory multi-technology auction (Kreiss, et al., 2019).

Conclusions

The ongoing development of auctions for RE support leads towards open auction formats where bidders from either different countries or with different technologies can participate. However, this development increases complexity and is one of the key challenges for the upcoming years. Although there are reasons to maintain technology-specific auctions, the advantages of multi-technology auctions will prevail. Yet, it is still questionable if such an auction will be designed technology-neutral. Firstly, the term technology-neutral is hard to define. It is ambiguous what "neutral" means in that context. Secondly, even if technology-neutrality is well defined it remains hard to impossible to design such an auction. And finally, it remains unclear whether an auctioneer would actually prefer a technology-neutral auction.

This debate proves once again that a good auction design starts with clear objectives and requires commitment to these goals. Thus, our recommendation is to design an auction with best respect to the actual auction targets. That may lead to a technology-specific, multi-technology or technology-neutral design but technology-neutrality cannot and should not be a target itself. In any case, the special technology characteristics have to be considered.

Acknowledgments

This work is based on an abstract and presentation given at the 41st IAEE International Conference in Groningen. We would like to thank for all the valuable feedback we received at this and other occasions.

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