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Editorial

Economic analysis of recent energy challenges: Technologies, markets, and policies

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ABSTRACT

The electricity sectors around the world continue on a slow but certain transformative path. Since the 1990s, market-oriented reform models and economic regulation have reshaped the structure and organisational environment of this industry. The increasing focus on the environmental sustainability requiring the addition of new measures and policies into the sector has added to the challenges facing the sector. In addition, in response to these strong trends, technological progress has brought significant cost reductions in some technologies and innovative technical possibilities. However, these changes are increasingly challenging the existing market designs, regulatory framework, and policies—while giving rise to new ones. This means that the sector's transition path constantly creates a diverse range of new issues and options that are in need of sound economic analysis. This also poses significant challenges to the sub-discipline of energy economics and policy analysis to play an important role in the coming years. The papers in this special issue are organised around economic analysis of the central questions of technology, market design, regulation and policy. The selected topics covered here are by no means exhaustive but are indicative of the extent of the challenges ahead. The hope is that this special issue will be followed by more similar initiatives.

1. Introduction: Economic analysis of recent energy challenges – technologies, markets, and policies

Climate change and environmental concerns are transforming the operation and organisation of the energy sectors at an increasing pace. Technological progress is a dynamic force and constantly offers lower cost solutions and new possibilities for achieving objectives of sustainability. The recent reductions in, for instance, the cost of deploying renewable energy sources and storage technologies has led to a renewed optimism about the possibility achieving these objectives. As a consequence, many energy sectors around the world are at a critical juncture and on a likely transition path to a sustainable future. Technological progress and large-scale adoption of renewable energy sources also challenge conventional liberalised market designs, regulatory frameworks, and policies developed over the past two-three decades.

Even prior to the strong emergence of the sustainability drive, the electricity sectors in Europe, the US and elsewhere had periodically modified their markets and regulation in response to issues other than sustainability and affordability, such as wholesale and retail market power and incentive regulation of networks (Borenstein, 2003; Bigerna et al., 2016). The trilemma of secure, affordable, and sustainable energy has increasingly become the focus of energy policy objectives. Achieving these three objectives and balancing their trade-offs has not been easy and has constantly challenged the liberalised energy market models and have periodically required reform and a rethinking of the market design and regulatory framework such as in the case of the Electricity Market Reform in the UK (Newbery, 2012).

The cost reductions in onshore and offshore wind power and solar power in recent auctions in both developed and developing countries are likely to increase the share of renewable resources in the electricity systems around the world. In addition, progress is being made in smart grids, distributed generation, and demand response technologies, although the efforts to develop suitable incentives and regulatory frameworks to realise their full potential is ongoing. The European Commission is also following a zero-subsidy plan for the electricity sector in the long run (Newbery, 2016). Cost parity between renewables and conventional energy sources may then shift some focus from cost of different resources to their relative value in the system. Some scholars have pointed out that the conventional cost comparison of energy technologies may not be sufficient when assessing the cost as well as the value of renewable energy sources and comparing them with conventional generation sources (Joskow, 2011).

The new developments in the energy sectors offer many new challenges, options, and possibilities for decision makers. At the same time, policies still need to make economic sense to be useful. While new technologies and possibilities are emerging in a rapid pace, there is a need for economic analysis of them in order to gauge their economic

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costs and benefits (see, e.g., Sidhu et al., 2018). Economic analysis is increasingly the currency of energy policy making—as in various other public policy making areas. Taking advantage of the new developments and tackling their associated challenges requires economic analysis of the technologies, market, and regulatory policy issues and options. However, economic analysis of these changing circumstances often tends to lag behind the actual developments. This Special Issues is motivated by the constantly evolving dynamics in the interplay of new energy technologies, market design, and regulation and policy in the energy sector. The coverage of these topics is by no means exhaustive. However, the hope is to signify the role of economic analysis by addressing selected topics within this realm.

Large-scale adoption of new technologies will also have implications for the design of future auctions and subsidy programs. More importantly, the arrival of larger amounts of renewables with very low marginal cost will require a rethink of market design. The experience to date shows that relatively large amounts of renewables can be managed, although some questions remain. This new operating framework is still work in progress, and there is scope for learning from experience in different markets (Pollitt and Anaya, 2016). This trend will also have implications for future investments in conventional technologies such as coal and gas power, as well as nuclear, given that their traditional role in the market may need to be recast. The changing energy sector will also affect the business strategies and models of energy utilities as new market, technologies, and entrants will appear (MIT, 2016).

The aim of the present special issue is to assess policy practices and help improve the design and economic analysis of energy policies. The selected papers contribute to a diverse set of energy policy areas that have emerged in recent years. As noted, economic approach to energy policy analysis can shed important light on the efficiency, cost effectiveness, environmental and distributional aspects of these issues and options. The topics covered here are by no means exhaustive. Rather they represent only some of the areas of energy policy making in need of economic analysis. The contributions are broadly organised under the broad headings of technology, market, and regulation and policy.

1.1. Technology

Technology is a key driver of the transition to a low carbon energy sector and much effort is vested in promoting innovation and technology progress. However, developing theoretical and empirical frameworks to understand and manage the process of induced technical change has by and large remains a difficult task (see Popp, 2017 for a notable recent effort).

An emerging and promising technology that can potentially integrate and bridge the different non-renewable and renewable sources is electric energy storage. The technology represents a broad range of solutions differing in scale and offering different services in different parts of electricity system (Jamasb, 2017). The technology can remove many of the spatial and temporal barriers arising production of energy from different sources and consumption by the users. However, the technology can be costly and the net economic benefits of it need to be established.

A prospective technology for which the adoption and market uptake is highly dependent on establishing a price for carbon emissions is carbon capture and storage (CCS). Economic modelling can help estimating the critical carbon price for the technology to be economically viable. In addition, the pipelines for transportation of the CO_2 require a regulatory framework a subject that has received relatively little attention in the literature. This can be done by economic modelling of alternative regulatory regimes of CCS pipelines.

Carbon emissions trading markets such as the EU ETS have broad theoretical appeal for efficient internalization and mitigation of the external effects and damages of climate change. Carbon trading can change the dispatch order of electricity generation plants towards the low carbon sources. However, a lesser discussed aspect of the emissions trading markets is their role and effect as instruments of technology and innovation policy. Stringent emissions policies seem to increase the innovative activities while an oversupply of emissions permits, as experienced in the earlier allocation rounds, can result in less innovative activities in low carbon technologies.

1.2. Energy markets

The increased penetration of renewable sources in the electricity sector also gives rise to managing the implications of intermittent supplies. Flexible demand is a key feature of smart market design and can facilitate adaption to supply fluctuations. However, the literature has mostly focused on aggregation and managing the household segment of demand. The potential in large industrial production units can play a significant role in demand management but has received less attention in the literature. Research presented here analyses flexible industrial demand and shows that it can lead to lower investments in conventional generation and grid investments, thus achieving a reduction in economic welfare.

An increasingly relevant policy question is whether the increased deployment of renewable energy technologies is substituting for conventional energy sources or indeed they increase the reliance of the electricity systems on the latter technologies to provide back-up capacity. Part of the answer lies in the technical characteristics of individual renewable technologies. The research presented here indicates that while solar power is complementary to fossil fuel technologies, wind power can be a substitute.

In recent years, there is a gradual but persistent progress in the development of the concept of smart electricity networks. Technological progress in network and ICT domains increasingly offer new commercial and practical possibilities. However, in order to benefit from these developments, new business models and suitable regulatory and policy measures need to be in place. The developments in smart grids can offer developing countries with new possibilities. These countries face supply shortages and unreliable service and small networks offer them the opportunity to combine small scale sources to bypass some of the bureaucratic and institutional constraints posed by the conventional industry structure.

1.3. Regulation and policy

Ambitious renewable energy promotion in some countries has resulted in significant uptakes of the renewables. However, the cost of the support policies tends to create a trade-off between sustainability and affordability objectives. Higher electricity prices arising from subsidies can have negative on both households and industrial consumers, affecting social welfare and industrial competitiveness. Therefore, a comparison and cost-effectiveness analysis of alternative arrangements can help decision makers reduce the undesirable effects of the subsidies.

Electricity is consumed by a variety of sectors and for a wide range of purposes. The consumption behaviour of productive sectors differs from those of the household sector. As a result, electricity consumption is subject to changes in the underlying drivers for demand. It is therefore important to identify the underlying the drivers of demand in order to design effective demand-side related policies. The results of research show that rising living standards tend to increase the household demand for electricity, while improvements in labour productivity in the industrial sectors tend to reduce their demand.

Finally, it is useful for purpose of energy policy making that the relationship between energy consumption and economic growth is revisited in the context of increased renewable and network costs. An empirical study of 22 European countries shows that reduced energy consumption has a negative effect on economic growth. It then follows from the findings that further decoupling of carbon emission and economic growth needs to be achieved by replacing conventional energy sources with renewable sources.