Chapter 13
Toward Competitive and Innovative Energy Service Markets: How to Establish a Level Playing Field for New Entrants and Established Players?*

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Introduction

Alfred Kahn famously (1970, pp. xxxvii) said that the *central, continuing responsibility of commissions and legislatures* is to *find the best possible mix of inevitably imperfect competition and inevitably imperfect regulation*. Accordingly, regulation's central goal is to establish a solid and appropriate framework for balancing public interest and entrepreneurial freedom (Picot and Landgrebe 2009). In many economic sectors, the transition from monopoly to competition has been successful. The energy markets' reform to a competitive market has been the exception to the successful transition rule (Glachant and Finon 2003; Jamasb and Pollitt 2005; Joskow 2003). Especially countries that deviated from liberalization's "textbook model" (see Joskow and Schmalensee 1983), such as the US, Japan, and much of continental Europe, failed in developing efficient competition in the potentially competitive electricity value chain segments (Joskow 2006, 2008).

A major future challenge for electricity grids is the growing addition of intermittent—often distributed—renewable energy sources (RESs). This challenge is exacerbated by the traditionally low degree of automation, monitoring, and communication within the electricity supply system, especially within distribution networks. Without fundamentally modernizing the grid's infrastructure, RESs' increasing penetration

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will result in a decline of the power grid's reliability, resilience, efficiency, and environmental sustainability.

Owing to recognizing the need for improved communication and coordination, the "smart grid" concept emerged. A smart grid can be best understood as a communication layer's virtual overlay on the existing power grid. This overlay allows all actors and components within the electricity supply chain to exchange information which facilitates improved coordination of supply and demand (NIST 2009). To close the communications gap between consumers' premises and the remaining energy network, an advanced metering infrastructure (AMI) is required. In analogy to the telecommunications industry, the AMI including smart meters can be viewed as the "last mile" of smart grids as it ultimately connects utilities with consumers (Leeds 2009). In the telecommunications sector, the last mile is represented by the "local loop." International regulators treated the local loop as a monopolistic bottleneck, since no alternative infrastructure was available and potential replication was not viable. New entrants in the telecommunications market needed access to the last mile facility to offer complementary services, such as Internet services. Consequently, incumbents were mandated to grant unbundled access which allowed competitive downstream markets to be established (Cave 2010).

Similarly, competitors who seek to entry complementary markets in a smart grid need non-discriminatory access and control rights to essential facilities. Most of these innovative complementary services, applications, and products which will help improve energy efficiency depend on seamless and reliable data exchange. Literature thus postulates to identify potential technological and regulatory bottlenecks at an early stage and find remedies to overcome them (ERGEG 2010; Hempling 2011; Pérez-Arriaga 2009). This is the aim of our paper. Our study therefore draws on the normative theory of regulation and applies insights from diverse literature streams. We investigate bottlenecks within a smart grid's communication layer and discuss regulatory instruments that are adequate to relieve these. The following research questions guided this study:

RQ1: Are there bottlenecks within a smart grid's communication layer?
RQ2: Do these bottlenecks obstruct the development of competitive and innovative complementary markets?
RQ3: If so, which regulatory instruments can remove these bottlenecks?

The remainder of the paper is structured into five sections. Section "Background" provides the theoretical background on bottleneck regulation and briefly delineates liberalized electricity market's functional pattern. Section "Smart Grid Architecture" describes the smart grids' architecture and section "Potential Bottlenecks" identifies potential bottlenecks therein. In section "Potential Regulatory Instruments", we propose regulatory remedies to remove the bottlenecks. In the final section, we discuss the findings and implications and provide suggestions for future research.

Background

Bottleneck Regulation

Business models in network economies substantially depend on particular networks' availability and functioning. The irreversible costs and economies of bundling make duplicating such networks unfeasible (Joskow 2005; Picot 2009; Viscusi et al. 2005). Hence, a core element in the liberalization of any network industry is the network access' regulation for independent market entrants (Schmidtchen and Bier 2005). Without access regulation, potential entrants to these markets would face substantial entry barriers, such as long-term cost asymmetries, that discriminate in favor of the incumbent (Stigler 1968, p. 67). An incumbent might own a facility that cannot realistically be economically and technically substituted. This facility might be essential for reaching customers, and/or for competition to emerge in downstream markets. If the facility has these characteristics, it is identified as a "monopolistic bottleneck" or an "essential facility" (Blankart et al. 2007; European Commission 1998; Knieps 1997). A facility is always labeled as such whenever there is a natural monopoly. If this is the case, a firm can provide a facility more cost-effectively than several firms can (subadditivity), and the costs for the facility are irreversible (Lipsky and Sidak 1999). As competition in these markets is not feasible, they are regarded as incontestable (Baumol et al. 1982). Consequently, an essential facility's owner has stable market power (Blankart et al. 2007).

Owing to an essential facility's owner transferring the market power from the primary (upstream) market to a secondary (downstream) market in which the facility provides an essential input (Salinger 1989), the firm can take unfair advantage of its dominant position, for example, refusing to deal with certain consumers or by implementing predatory pricing practices. The firm can also impede competitors' access to large markets, and negatively affect the emergence of innovative services and products.

Thus, in order to avoid deadweight losses, to promote maximum efficiency, and allow active competition in complementary markets, non-discriminatory access to essential facilities is subject to ex-ante regulation, i.e., before market power can be abused (Blankart et al. 2007; Lipsky and Sidak 1999). The access problem is closely linked to the essential facilities doctrine (EFD), which was originally a US antitrust law instrument (Renda 2010). Today, the EFD's reasoning helps identifying situations in which regulatory interventions are required, since *any solution to the problems of economic inefficiency is inherently regulatory* (Lipsky and Sidak 1999). In this respect, competition law is insufficient to neutralize an owner's network-specific market power. Furthermore, ex post interventions involve significant time lags (Gabelmann 2001).

Most facilities that were regarded as essential in the past (e.g., see Lipsky and Sidak 1999) were "tangible" in nature, such as the local loop's single twisted pair cable. However, there are also "intangible" bottlenecks based on intellectual property rights, such as proprietary standards, protocols, or interfaces. These could hinder competition in downstream markets, as argued by the US Department of Justice (2002) and the European Commission (2004) in two antitrust cases against Microsoft. In these lawsuits, Microsoft was alleged to abuse the dominance of its Windows platform to discriminate against competitors in complementary markets by means of the non-disclosure of interoperability information (see Renda 2004). The prevalence of intangible bottlenecks is likely to increase in evermore *digitally renewed* economies (Davis 2000).

Liberalized Electricity Markets' Operating Principle

This section provides a brief overview of liberalized electricity market's regulatory, organizational, and technical structure. Within the electricity industry, three major areas of activity can be identified: generation, transport, and consumption. Since electricity markets' deregulation, the generation and retail markets have been organized competitively. Conversely, the transport functions—transmission and distribution—continue to be treated as natural monopolies because of sunk costs, as well as economies of scale and scope in electricity delivery (Joskow and Schmalensee 1983). In order to avoid monopolistic exploitation of these natural monopolies, third party network access and revenues for network usage are regulated (Wilson 2002; Woo et al. 2003).

Distribution system operators (DSOs) deliver power to end-consumers and are responsible for power quality and supply security in their local distribution areas. Besides planning, operating, and maintaining distribution grids, DSOs are legally obliged to procure the information required for electricity suppliers' (ESs) energy accounting tasks.

ESs procure power for their consumers and charge them for the electricity that they use as well as for the network usage costs, the costs of balancing power, and the costs for metering services. The latter involve various tasks. To the most essential tasks pertain *purchase, installment and maintenance of the meter, meter data collection, management and provision of meter data to other market players* (ERGEG 2007). Traditionally, metering services were operated by DSOs acting as regulated monopolists. In many electricity markets, however, the metering market has recently been liberalized to increase competition and to promote innovation. Regardless of whether metering markets are liberalized or regulated incumbent DSOs are likely to dominate the metering service market and continue to act as "metering providers" (MPs) for several reasons: In regulated markets, DSOs will probably be in charge of the smart meter roll-out. For example, this is what happens in the Netherlands and Sweden. In these countries, DSOs continue to earn regulated returns. In competitive markets, DSOs will also almost certainly play a dominant role in the metering market because otherwise they would face various disadvantages. On the one hand, they would lose not only dependable revenue sources to a competing MP but also long-established customer relationships which are valuable business assets. Moreover, as long as consumers do not actively choose another MP, DSOs already acting as MPs

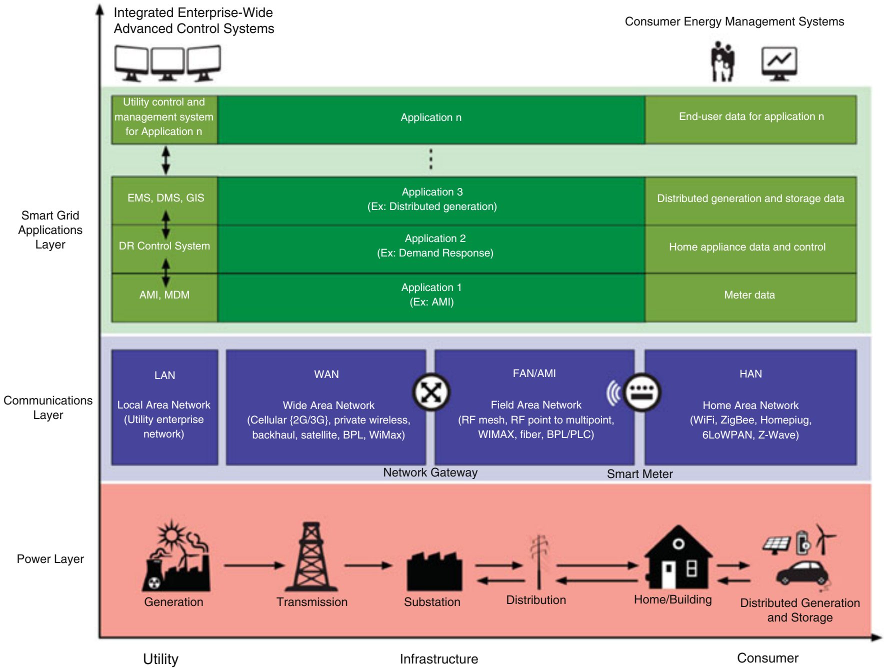

Fig. 13.1 Smart grid architecture (based on Leeds 2009)

will remain responsible for providing metering services. This is very likely as to date there is very little consumer demand for metering services. Consequently, new competitors from outside the industry are reluctant to enter the market, which results in DSOs continuing to act as regulated MPs. Thus, given the characteristics of electricity and metering service markets in most countries or regions, DSOs will act as regulated monopolists in the metering market.

Smart Grid Architecture

From a technical perspective, a smart grid is comprised of three layers. Each of these layers integrates a multitude of digital and non-digital technologies and systems from the realms of telecommunication, information, and energy technology (see Fig. 13.1). From an architectural point of view, a smart grid can be best understood as an additional communication layer that is virtually overlaid on to the existing power grid and on which an application layer is built.

By employing a layered approach of this kind, the design problem's complexity is reduced, because the functionality is modularized in components and subcomponents (van Schewick 2010, pp. 50). By interconnecting formerly isolated components,

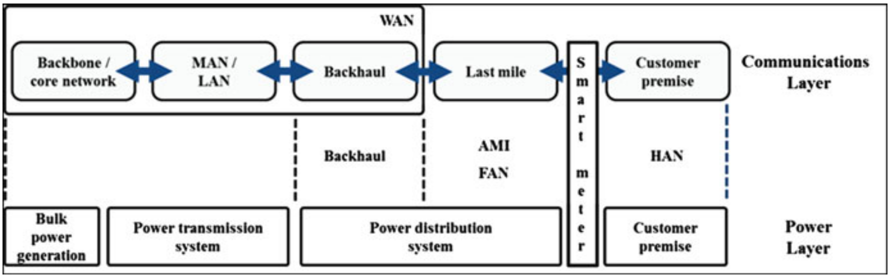

Fig. 13.2 Smart grid communications architecture mapping (based on NIST 2009)

actors, networks, and technologies, a smart grid facilitates the creation of a system of systems (NIST 2009). Hence, a smart grid can be conceived as a *system product*. By definition, this requires the components to be compatible. The different systems must function seamlessly with each other to produce the desired outputs. Each layer's components perform specific functions and have well-defined interfaces for the upper layer in order to make their services available. Simultaneously, they make use of the lower layer's services. A smart grid therefore emulates the Internet's original design principle by employing an "end-to-end" architectural approach. Within this architecture, application-specific functionalities are implemented at higher layers at the network's end-hosts or endpoints, while lower layers are kept as general and application independent as possible (Saltzer et al. 1981).

In an end-to-end network, components and actors can send and receive data without knowing the network's structure (Economides and Tåg 2009). The network itself therefore remains neutral. This encourages innovations at the network's end (Cerf 2006a, b) which is widely regarded as the key driver for the Internet's rapid development. The Internet's fast development is also characterized by low entry barriers and non-discriminatory access for innovators (van Schewick 2007). Similarly, in a smart grid, the innovation is expected to come from the network's end (FCC 2010). While there might be some innovation at the network's core, the innovative applications and services at higher layers will provide the literal "smartness."

Hence, our work focuses on identifying bottlenecks that require regulatory interventions within the communications layer. The ultimate goal is to ensure a "neutral" smart grid that promotes entrepreneurship and grants non-discriminatory access and low entry barriers for new market entrants.

Potential Bottlenecks

Utilities have already deployed communication networks that connect parts of their infrastructure (almost solely transmission grids) with supervisory control and data acquisition systems (SCADA) to manage grid operations. By linking the existing utilities' communication networks with smart meters, the AMI facilitates end-to-end networks. The AMI allows data to be transported back and forth between consumers and other market actors (see Fig. 13.2). In buildings, smart meters serve as central gateways to in-house devices such as home appliances, consumer electronics, water heaters, lighting systems, and programmable thermostats connected via Home Area Networks (HAN). Thus, to enable innovative applications such as demand response or microgrids, authorized market actors like independent energy service providers need access and control rights for the meter data and the meter itself, for instance to send price signals, control appliances, or change tariffs. Thus, the AMI including smart meters and the meter data serve as essential inputs which can be deemed as synonymous with the last mile in telecommunications, as it acts *as the final leg delivering connectivity from a utility to a consumer* (Leeds 2009, pp. 11). Also the AMI cannot be substituted or replicated within a reasonable time and/or cost frame due to substantial sunk costs and economies of bundling. Once DSOs deployed the new metering infrastructure, these sunk costs create a long-term cost asymmetry between DSOs "inside" the market and potential entrants "outside" the market and the replication of the infrastructure is practically and economically not feasible for competitors.

The data retrieved from smart meters can also be regarded as essential inputs for authorized actors. The data aid them to provide services for improving grid management and monitoring, streamlining business processes, and enabling innovative energy efficiency measures and value-added services (ERGEG 2007; FCC 2010; OFGEM 2010). Hence, it is crucial that MPs who are in charge of collecting and administrating the meter data provide authorized parties with non-discriminatory and efficient access to the meter data in compliance with national security and privacy requirements.

To ensure an efficient data provision also standardized data formats are necessary. Ultimately, the goal of smart grids is to enable actors and components to communicate end to end. Currently, only very limited information exchange is possible in power systems due to specialized rules for data exchange. For example, the core utilities' information systems (SCADA) typically use their own communications protocols. These protocols only enable communication within subsystems, but impede communication between subsystems. Therefore, to achieve end-to-end interoperability, it is crucial to establish a smart grid's communication network on a consistent set of open and non-proprietary communication protocols and standards (DKE 2010; ERGEG 2010; NIST 2010).

Overall, we identified three critical bottleneck areas: Rights to access and control the AMI and the meter data as well as interoperability. Given the current electricity markets' characteristics, DSOs are likely to be in control of the access to the AMI and the meter data as well as to considerably influence interoperability requirements for their respective distribution areas. They will therefore have manifold opportunities to discriminate against independent third parties in the complementary market. Several new smart grid applications and services such as demand response or virtual power plants will place DSOs and affiliated firms' revenues in jeopardy. Thus DSOs have incentives to capitalize on their market power and control over the identified bottlenecks. Therefore, without appropriate regulatory provisions in place, potential competitors will likely be deterred from entering the market. Local incumbent DSOs can raise rivals' costs through practices like exclusive dealing, refusals to deal, or defining proprietary protocols. They can also abuse standards to increase competitors' transaction costs and consumers' switching costs (see Krattenmaker and Salop 1986; Salop and Scheffman 1987). Therefore, as DSOs have both incentives and opportunities to exploit essential facilities in an anti-competitive way ex ante regulation is justified because

1. Once DSOs have rolled out the AMI, high and non-transitory entry barriers for new market entrants exist (Stigler 1968).
2. Liberalization in many electricity markets is still insufficient and thus will not tend toward effective competition in an acceptable time horizon.
3. The application of competition law alone will not suffice to address market failures to guarantee rivals' reliable, efficient, and non-discriminatory access to the facilities without a significant time lag.

Potential Regulatory Instruments

Regulators often develop intermediate regulatory approaches that fall somewhere between "quarantine" and "vertical laissez-faire" (Farrell and Weiser 2003). Quarantining is a classic structural remedy. It prohibits the monopolist from engaging in vertical integration by enforcing ownership unbundling. However, the bottlenecks' owner often has the best opportunities and greatest economic interest in a vibrant complementary applications and service market (Farrell 2003). Structural remedies preclude any of these integrative efficiencies (Joskow and Noll 1999). Regulators therefore seek to develop compromise approaches to have the *best of both worlds* (Farrell and Weiser 2003). On the one hand, they allow vertical integration. On the other hand, through conduct remedies, they aim to ensure that bottlenecks are not abused. In the following, we present and discuss remedies that may prevent critical bottlenecks' emergence and assure non-discriminatory access to these facilities.

Meter Data and Interoperability

Meter data are an essential input for facilitating numerous business processes and the seamless functioning of new services. Hence, the data access mode should enable any authorized market actor to compete on a level playing field. Traditionally, DSOs provided metering services and the meter data. DSOs therefore had exclusive access to the data. Other authorized actors were only granted access upon request or on a pre-scheduled basis. In an end-to-end smart grid, however, meter data's reliable and close to real-time 24-h availability is crucial to enable new business models' emergence. To prevent the emergence of efficient complementary markets, DSOs could, for instance, distort competition by leveraging their control over the data to increase rivals' transaction costs, define incompatible data formats or interfaces for each distribution area, or intentionally delay data access and provision. Hence, to enable efficient complementary markets in future smart grids, all authorized parties have to be guaranteed equal access to an online data platform to recall data in (1) as close to real time as possible, (2) a standardized and machine-readable format, and (3) the same granularity in which it is collected (ERGEG 2007).

Today, data's availability for independent third parties is still unsatisfactory, due to incomplete unbundling (ERGEG 2007). Several regulatory agencies have hence recommended establishing an independent data platform accessible to third parties, or have already established such a platform like that in the UK, Texas, and Ontario. Others have suggested that the function of data collection, management, and access should be completely decoupled by establishing an independent and neutral data service provider (ERGEG 2010; FCC 2010; OFGEM 2010). Either approach could be effective to guarantee efficient and non-discriminatory access to meter data. An independent single platform provider may be moreover able to provide the data more cost-effectively owing to economies of scale. This provider can also perform tasks such as meter registration and consumer switching (OFGEM 2010).

Data's seamless exchange requires open and non-proprietary standards and communication protocols that allow each component and actor within the smart grid to communicate end to end. As mentioned before, protocols and standards can resemble essential inputs (Renda 2004, 2010). Whenever standards are regarded as essential, they point to a market with intra-system competition. In such markets, firms compete with each other on the level of components within a particular system. Dependent on the degree of interface information availability, systems are distinguished as either open or closed. Open systems benefit modular innovation, competitors' market entry, and market dynamics (Langlois 2001; Nelson and Winter 1977). If intra-system competition is to work efficiently, it requires at least some degree of openness and modularity (Langlois 2001). In respect of the research context, DSOs may use protocols and standards as "strategic weapons" to build closed systems in which they safeguard interface information. In order to prevent this threat ex ante, there is a wide consensus among policy makers, regulators, and scholars that smart grids should be open and modular (Brown et al. 2010; ERGEG 2010; NIST 2010).

Hence, governments around the globe are fostering the emergence of open smart grid standards to ensure interoperability between components. These efforts are mostly coordinated by standard developing organizations in an attempt to identify or develop open and non-proprietary standards and protocols (see DKE 2010; ENSG 2010; METI 2010; NIST 2009, 2010). The majority of these standardization processes rely on a consensus-driven approach. The aim is for various stakeholders, such as experts from industry, academia, governments, and associations to agree on standards and protocols (Brown et al. 2010). While these attempts and standardization in general are contentious issues within the literature (Farrell and Saloner 1986; Picot et al. 2008, pp. 54), the social benefits are very likely to outweigh the costs as far as smart grids are concerned (ERGEG 2010). Hence, government and regulatory bodies should support and monitor these cooperative standardization efforts.

AMI

Once the AMI is rolled out, it becomes an essential facility that competitors cannot replicate practically nor reasonably within an acceptable time frame. This will result in a lack of competitive entry which will negatively affect investments in smart grids. High entry barriers (as a result of economies of scale and scope and high irreversible costs) as well as DSOs' non-transitory and substantial market power erode the prospects of a sufficient number of new entrants developing new markets for novel services and products.

Thus, leaving access to the AMI unregulated (which would result in negotiated access) runs the serious risk of discrimination or inefficient investment (Cave and Vogelsang 2003). Hence, regulatory intervention, in the form of open (or mandated) access is needed to secure transparent and non-discriminatory third party access to the AMI. The telecommunications sector's experience suggests that the primary focus with regard to the smart grid's last mile should be on attracting a reasonable number of entrants in the applications market to promote service-based competition. Open access implies competition based on services since several companies offer their services using a single infrastructure (van Gorp and Middleton 2010). There is a broad consensus in the literature that potential entrants should initially be granted favorable access conditions to the bottleneck infrastructures. But these conditions should be gradually adjusted over time contingent on the degree of replicability which depends on how technologies evolve and their costs develop (van Gorp and Middleton 2010). Open access policies thus have to balance carefully between encouraging investment and innovation on the infrastructure level in the long run and promoting service-based competition and application level innovation in the short run.

Discussion and Conclusion

Seamless end-to-end communication is a prerequisite for an improved coordination of electricity generation, transmission, distribution, and consumption as well as for the emergence of new business models. This paper sought to identify facilities that can be classified as essential for smart grids (RQ 1). We examined whether these bottlenecks obstruct the development of competitive and innovative complementary markets (RQ 2). Our analysis was based on theoretical arguments and empirical observations. Furthermore, we presented and discussed the applicability of regulatory instruments which might help establishing equal access to the bottleneck facilities and prevent discrimination (RQ 3).

We identified three critical bottleneck areas within the communication layer that can serve as essential inputs for competitors in the downstream market and may be used anti-competitively. However, one could argue that ex ante regulation is not indispensable. With respect to data access and the definition of a consistent set of open and non-proprietary interface standards and data protocols, competition law might suffice to correct possible market failures. However, an excessive emphasis on competition distracts from the aim to rapidly increase energy efficiency and environmental sustainability (Hertin 2004; Kemfert 2004). One can raise similar objections with regard to entry barriers' non-transitoriness. As replicability is generally not a binary variable (Cave 2006), one can argue that the AMI can be replicated if entrants find technical ways to bypass the facility. However, similar to telecommunications (Picot 2009; Renda 2010), DSOs' market power alone already justifies (asymmetric) regulatory intervention.

According to the public interest theory (Christensen 2010), the paramount societal interest is to realize the environmental benefits that can be gained from AMI's widespread adoption. Therefore, we argue that new market entrants have to be guaranteed a transparent and stable regulatory environment. Access rules regarding essential inputs are important elements of such a regulatory framework which also facilitates the emergence of intra-system competition (de Bijl 2005). If there are no effective regulatory provisions in place, DSOs might discriminate against complementary products' unaffiliated producers or even prevent them from gaining access to the bottleneck facilities. The absence of complementary applications would then negatively affect the amount of independent innovation at the application level, since independent third parties would face

1. Significant uncertainty about the future competitive environment.
2. Threats of discrimination, which will reduce profits.
3. The risk of DSOs imitating third parties' innovations (van Schewick 2007).

From a social welfare perspective, a decrease in independent applications is only relevant if this reduction cannot be offset. Owing to a smaller number of innovators, the amount and quality of innovations are also likely to be reduced (van Schewick 2007). Furthermore, DSOs have no economic interest in developing applications that decrease traditional and dependable revenues. However, for independent innovators, such applications would be very compelling. Application level innovations would also spur intra-system competition which is crucial for increasing consumers' interest in adopting and using green technologies.

A sufficient condition for justifying regulatory intervention is met if societal benefits outweigh the costs. Thus, regulators have to trade off regulatory interventions' benefits and the associated costs. As already outlined, the benefits gained from regulatory intervention include increased competition and application level innovation. From a public interest perspective, this increase in competition and innovation is only relevant if it increases social welfare. While this relationship is theoretically ambiguous (Katz 2002; Tirole 1988), in the study's research context, the presence of uncertainty and uncompensated spillovers is likely to result in a supply level below the social optimum. Furthermore, a smart grid can be considered a general purpose technology that will be required to drive future economic growth (Bresnahan and Greenstein 2001; Larsson 2009). Regarding the costs, regulatory intervention is associated with a distortion of incentives to invest and innovate in smart grid's communication infrastructures. Furthermore, regulation itself incurs costs. While the latter may be negligible, the former needs regulatory agencies' particular attention.

A few limitations have to be considered when interpreting the study's findings. Although the analysis is grounded in an extensive literature review and is based on empirical evidence from various scientific domains, the normative research approach can only establish the basis for future research. Our analysis built upon the public interest theory of regulation. Therefore, our aim was to produce a positive theory based on a normative analysis. Accordingly, we proposed regulatory measures that can correct market failures and prevent discrimination in future smart grids. Some scholars, however, criticize public interest theory because it claims that *regulation occurs when it should occur because the potential for a net social welfare gain generates a public demand for regulation* (Viscusi et al. 2005). However, in contrast to other theories of regulation (e.g., capture theory or credible commitment theory), the shortcomings of a normatively oriented research approach based on public interest theory can in terms of validity be addressed by involving a broad range of insights and stakeholder interests as done in our study. Nevertheless, further studies are needed to apply other theoretical and methodical approaches to generalize the results and to further develop the propositions.

Despite these limitations, our study provides an in-depth analysis of potential bottlenecks that can reduce the socially optimal amount of innovations at the smart grid's application level from where—similar to the Internet—innovations are expected to come. This study thus contributes to the political and scientific discussion on whether regulatory actions are required to facilitate competition and innovation in smart grids and the instruments required to help address market failures (ERGEG 2010; Hempling 2011; Pérez-Arriaga 2009).

Based on the study's findings, future energy regulation should reconsider current regulatory regimes to remove barriers that stem from misaligned incentives. Especially, DSOs which are the most affected parties in energy supply systems' transition should be provided with appropriate economic incentives to promote the upgrading to smart grids. DSOs should also be incentivized by decoupling revenues from the amount of electricity delivered to consumers. Also a more efficient systemic and commercial integration of decentralized energy resources should be fostered by more extensively including measures for energy losses and quality of service in regulated grid charges than is currently done (Cossent et al. 2009; Langniß et al. 2009; Niesten 2010). Moreover, in order to encourage more R&D and risk taking with new smart grid approaches, national regulatory authorities should consider following OFGEM's example by creating an "Innovation Funding Incentive" that allows DSOs in the UK to spend .05 % of their regulated return on R&D projects, of which 80 % can be passed on to consumers (Bauknecht et al. 2007; OFGEM 2009).

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