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Distribution Networks Tariff Design in the Era of Decentralization:
A Business Model Approach

Rolando Fuentes

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Key Points

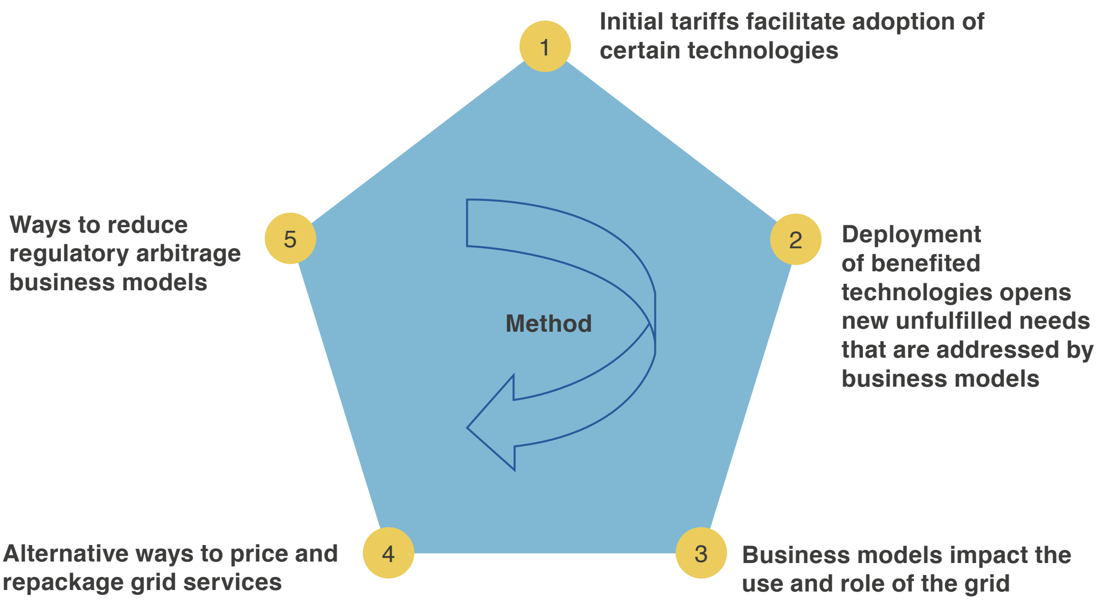
This paper addresses the question of how distribution networks can best be priced in the context of technological disruptions in the power sector. We suggest a framework for analyzing the unexplored two-way relationship between distribution network tariff design and the emergence of new business models in the power sector (Figure 1). This paper provides a novel approach that links the deployment of new technologies, new business models in the power sector, and pricing mechanisms for the reinvention of the grid. The key findings are:

The increased penetration of distributed generation opens up opportunities for aggregation. Distribution networks can be priced based on more granular cost components while allowing competition in new segments of the value chain, where possible. This is essentially the same idea that gave birth to the electricity standard reform model taken, but more granular.

If, in addition to distributed generation, households install digital technologies, the distribution network can be transformed into a platform business model. To get the full benefits of a platform through network effects, a distribution network could be operated as a subscription model, as such a model can reduce the transaction costs of digital platforms.

If in addition to the two measures above, households install batteries, there are 'behind-the-meter' business opportunities. Distribution networks would need to find a way of monetizing the standing value the grid has for consumers, based on the decoupling of the industry's value creation from its energy component.

Figure 1. Tariffs and business models are mutually interdependent.



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Summary

In this paper we discuss the unexplored two-way relationship between distribution network tariff design and the emergence of new business models in the power sector. Distribution network tariffs have traditionally used a cost accounting method. We suggest, instead, the use of a business model framework to analyze the extent to which emerging business models in the power sector change the way electricity distribution network services are priced and packaged. This approach will help us to move away from trying to ascertain whether consumers pay the right amount for what they receive (from the distribution network) to the question, Are they paying for what they want? (Lehr 2013).

Distribution network tariffs are the second-best constructs. Due to their cost structure, marginal cost pricing, the criteria for efficient pricing, does not lead to cost recovery. Tariffs have been designed to allocate costs across different types of customers based on their electricity use. Tariffs are then designed based on the combination of different cost components (energy, demand, capacity, time variance). This ends up being a combination of fixed charges and increased volumetric prices, for which regulators balance trade-offs between efficiency, cost recovery and fairness.

Theoretically, for any second-best solutions, some inputs will be overcompensated and will therefore be overused (the Averch-Johnson effect). There will be overinvestments in technologies that perform better in these overcompensated inputs. For example, photovoltaic (PV) solar generation provides energy but not back up capacity. If the energy component is overcompensated, this technology will have a higher penetration than others that mainly serve as back up. The penetration of some technologies will crack a previously monolithic, vertically integrated power sector. These cracks will open up new customer needs and therefore new business opportunities. Each resulting business opportunity will use the grid differently to how it was originally conceived. We provide an analytical framework for how to price the services the distribution networks provide.

Introduction

The pricing of distribution network services is a challenging task, given the grid's economic characteristics and competing objectives for tariff design. The issue becomes even more complicated when one considers the changing environment of the grid due to emerging business models and the growth of distributed resources. Emerging business models affect the cost recovery of the grid, under its existing tariff design, and its future costs. A plethora of literature in recent years has focused on how to develop a distribution network tariff in the presence of distributed energy resources (DERs), the combination of local generation technologies, such as solar photovoltaic (PV) generation, storage and digitalization (for a review see Burger [2019]). This research investigates the traditional cost causation logic and proposes that DER owners should be compensated according to future avoided costs. This means that DER penetration, location, concentration, and the size of their impact on network costs can be either negative or positive, depending on the technology deployed (Picciariello et al. 2015; Abdelmotteleb et al. 2018). As such, the distribution firm decides whether to build capacity or buy energy from households, while households decide whether to purchase power from the utility or install DERs (Ros et al. 2018).

Our approach departs from the cost accounting logic of previous research. Instead, we use a business model (revenue) logic to propose pricing mechanisms for distribution networks. A business model describes the way an organization delivers value to customers, encourages customers to pay for value and converts those payments into profit (Teece 2010; Casadesus-Masanell and Ricart 2009; Chesbrough 2010). Business models start by identifying opportunities for satisfying customers' needs. After their needs are identified, companies find ways to fulfill them while generating a profit. This business model approach helps us to move away from the question of whether consumers pay the right amount for what they receive from the distribution network, to whether they are paying for what they want (Lehr 2013).

The introduction of a business model framework helps us understand the economic consequences of technological development on the use of the distribution grid. Two key questions that we try to address are, 1) Does technological progress cancel the natural monopoly status of power grids? And, 2) if so, would they no longer have to abide by the pricing rules for natural monopolies? While distribution networks would continue to have the cost structures of natural monopolies, the services they provide might not. For example, while it would not make sense to install another parallel grid, it is possible for consumers to obtain services, such as reliability, through other means.

We first discuss how tariff structures can facilitate the adoption of certain technologies. We then elaborate on how different combinations of DER penetration can lead to a diversity of business opportunities. To do the latter, we decompose potential scenarios and analyze business opportunities with the penetration of individual technologies and those that arise when multiple technologies are deployed. We then assess the impact of the resulting business model on the grid and examine what role the grid plays in that model. Based on the results of that assessment, we suggest ways to package the resulting grid services, as if they were separate business models.

Throughout the paper, a constant argument will be that disruptive technologies change the nature of the energy industry. This calls for new ways of understanding the industry's products, with services decoupled from the energy component, and a shift from pricing inputs to pricing outputs. This allows us to depart from cost pricing and, instead, to price services based on values. Since services are intangible, instantaneous, and unrepeatable, the actual cost of production is less relevant for price setting than the valuation of this service. This approach will necessitate looking at tariffs in a more comprehensive way.

Tariffs can facilitate the adoption of new technologies by removing barriers that prevent adoption. If tariffs were set at the efficient point, where price equals the marginal costs – the necessary and sufficient condition for efficient pricing – the resulting technology mix would also be optimal. But because of the cost structure of distribution networks, the marginal cost of distribution network service provision is below the average cost, and, therefore, investments are not recovered. How to solve this conundrum is still an unresolved question (Ortega et al. 2008), and tariffs are consequentially second-best approaches.

Second-best tariffs often lead to a situation that some inputs are overpriced (e.g., energy) and some are underpriced (e.g., capacity). This increases the tendency for opportunistic behavior. When this happens, the resulting behavior is not welfare enhancing if some users' actions lower their costs but raise other users' bills. For example, households may decide to install certain technologies if that helps them to reduce their bills, for example by avoiding some parts of the retail tariff. This does not necessarily reduce the total system cost, however. Distribution tariffs should not therefore encourage opportunistic models. They should be conceived in such a way that only those models that create system value and are in line with wider energy policy can survive.

Setting the Common Ground

In this section, we discuss why the pricing of distribution networks is still an unresolved issue. We provide an overview of the different cost accounting components of distribution networks and argue how tariffs can combine these components to facilitate the adoption of certain technologies over others.

It is useful to establish the difference between electricity prices and network tariffs. Usually, in many jurisdictions, end users are not directly exposed to network tariffs. Under most existing arrangements, retail suppliers, not end users, are exposed to network tariffs. However, large consumers and those providing power to distribution networks are exposed to these tariffs. The expectation is that retailers will design their tariffs to account for the network costs.

The economics of networks has traditionally been a challenge for economists because of their cost structure (a fixed/sunk cost) (Borenstein, 2016). First, it is not possible to establish efficient network pricing. When average costs decline with production but are always higher than the constant and negligible marginal costs, then this is the definition of a natural monopoly. Setting prices equal to marginal costs, i.e., efficient pricing, would lead to a non-recovery of costs.

A second complication is that a network's 'supply' does not respond to price changes. By definition, supply is fixed and cannot adjust to short-term price increases or decreases resulting from changes in demand. In other markets, if prices go up due to increased demand, producers would increase market supply and take advantage of high prices. Grids are therefore reactive, not proactive.

These complexities have led producers to focus their tariffs more on cost recovery by adopting a cost-plus tariff approach instead of complying with the efficiency criteria (Demsetz 1968; Hogan 2008). This practice is similar in other industries with large sunk fixed costs that also lead to natural monopolies.

The cost accounting of the grid is not as straightforward as cost recovery, given that it serves different purposes, including delivering energy, assuring reliability or meeting peak demand and providing spare capacity for contingencies. Costs are usually broken down into the categories detailed below.

Energy charges: volumetric charges based on the consumption (i.e., kilwatthours [kWh]). The assumption is that increases in grid utilization raise the cost of maintaining and operating the grid. The volumetric charge can be flat, or it can change over time to reflect network conditions at different times.

Capacity charges: a charge on peak demand (i.e., kilowatts [kW]) during the billing period. Investment in networks is primarily driven by capacity magnitudes rather than energy magnitudes. Capacity is a better proxy for customers' contributions to network costs. Individual peak consumption may not necessarily coincide with the system's peak. This is why capacity charges need to be peak-coincident to encourage users to avoid times of network constraints. It is inefficient to signal to customers to reduce consumption when the network is underutilized.

Fixed charges: not a function of customers' load or energy consumption. They are levied regularly on different temporal bases to cover expenses such as the cost of connecting the user to the grid; they are not intended to alter consumption. They can also be applied when volumetric charges yield insufficient revenues.

There might be other charges in addition to the above categories. For example, the network operator may wish to apply demand charges based on a level of contracted capacity. This is to incentivize users to choose their contracted capacity in an efficient way and thus avoid significant unutilized network capacity.

A tariff is a formula that assigns different weights (or prices) to each of these components. These tariff categories then affect the investment and operation incentives for grid users in different ways. Depending on how these components (capacity, energy and fixed components) are combined, tariffs can benefit the adoption of some technologies by removing their barriers, or they can prevent their adoption by increasing the cost of some technologies. Overall, some technologies perform better than others in any of these categories. In extreme cases, disruptive technologies can also make some of these functions altogether obsolete.

For example, King and Datta (2018) discuss how tariffs can minimize the total cost of electric vehicle (EV) ownership by reducing refueling and grid reinforcement costs. Tariffs can also incentivize certain technologies by overcompensating for some of their characteristics. For example, storage could be used to mitigate demand charges, stabilize grid frequency, shift or improve control on renewable power, or store energy from residential solar installation (Aprile et al. 2016). A tariff designed with more granular elements can help to better compensate these stack values. Faerber et al. (2018) discuss how different network pricing can help deploy smart grid technologies. They highlight the importance of data sharing and the reduction of privacy settings to reduce the cost to consumers. Glass et al. (2018) discuss ways to incentivize the deployment of 'mini grids,' while Gilliam and Yozwiak (2018) argue that time-sensitive dynamic pricing is an essential component of a decentralized energy system, as it provides price signals for customers.

Table 1 synthesizes these options and categorizes the main messages of this section.

Table 1

Component	What does it price?	Aim	Metric	How?	Benefits/ incentives	Cost	Which technologies are benefited/ deterred?
Fixed	Operations	Cover costs exogenous to consumers	$/period	Billing	Guarantees a level of revenue for utilities, despite DER adoption	Ignores the potential benefits of DERs	Exogenous to consumers
Capacity	Peak demand	Recover network reinforcement costs	$/kW	Non-coincidental	Reduce individual peaks	Can reduce consumption when network is underutilized, and can negatively affect low-income consumers	EVs: if tariffs focus on pricing distribution network peaks and not entire system peaks. Can incentivize storage by reducing bill savings.
				Coincidental	Reduce individual peaks that coincide with system peaks	Can affect inflexible consumers	
Demand charge	Maximum contracted capacity	Recover the cost of user capacity and reduce idle capacity in the network	$/kW	One-off charge as part of connection costs	To incentivize users to choose their contracted capacity efficiently	Consumers might misjudge their future demand	Batteries
Energy	Consumption	Cover variable costs	kWh/t	TOU	Shift peak to low price periods	Equity: poorer consumers pay higher tariffs due to the higher consumption of well-off consumers	Benefits EVs if owners have separate bills. Encourages the use of storage to avoid peak period charges.

Source: Author.

A Business Model Framework

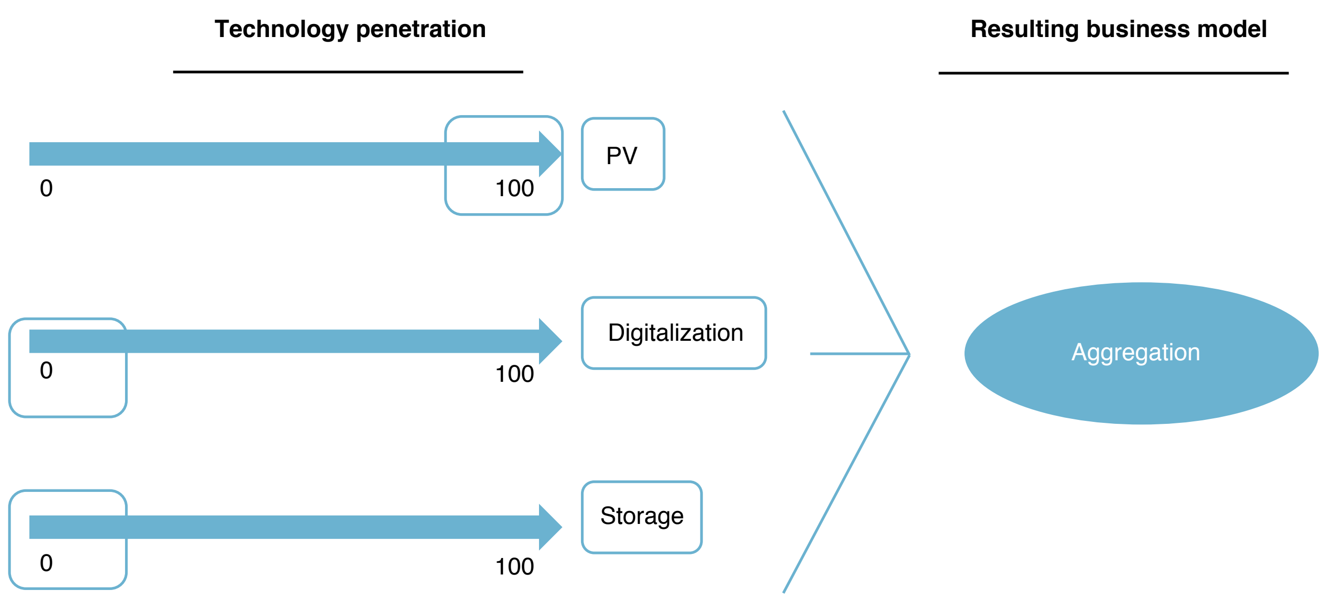
In this section we show how a business model framework is a useful approach for designing network tariffs in the era of decentralization. A business model has two important components. The first is the customer value proposition: A business can create value for its customers by giving them a solution to a fundamental problem. In economics, value is created as long as the price paid by consumers is below their willingness to pay for that product. The second key element is the profit formula, or how the company creates value for itself. The profit formula chooses the right combination of price and quantities, and the cost structure, i.e., the key resources required in the business model. The value proposition and the profit formula define value for the customer and the company (Johnson et al. 2008; Osterwalder et al. 2005).

New business models in the power sector do not appear unexpectedly. Emerging business models are often an afterthought for both incumbent and new entrant firms, and result from the introduction of DERs into the previously monolithic, vertically integrated power sector. The deployment of new technologies on top of the traditional electricity sector structure provides new services for consumers and opportunities for firms.
DERs, which comprise PV panels, batteries and demand response devices, have the potential to be disruptive because they allow a household to become independent from the grid. Depending on to what extent DERs are deployed and their internal capacity mix (PV, PV and storage, PV and storage and digitalization), they could elicit new roles for the grid and new business opportunities in the power sector (Glachant 2019).

Distributed generation leads to aggregation

We assume that distributed generation is owned by households. The growth of household generation, such as solar PV, provides an opportunity to bridge demand and wholesale trade through aggregation.

Figure 2. Penetration of distributed generation can enhance the aggregation business model.



Source: Author.

By combining the load, distributed generation, and storage capacities of many participants, an aggregator can optimize the performance of the entire portfolio in ways that would not be practical or cost effective for individuals, thereby participating as another player in the wholesale markets.

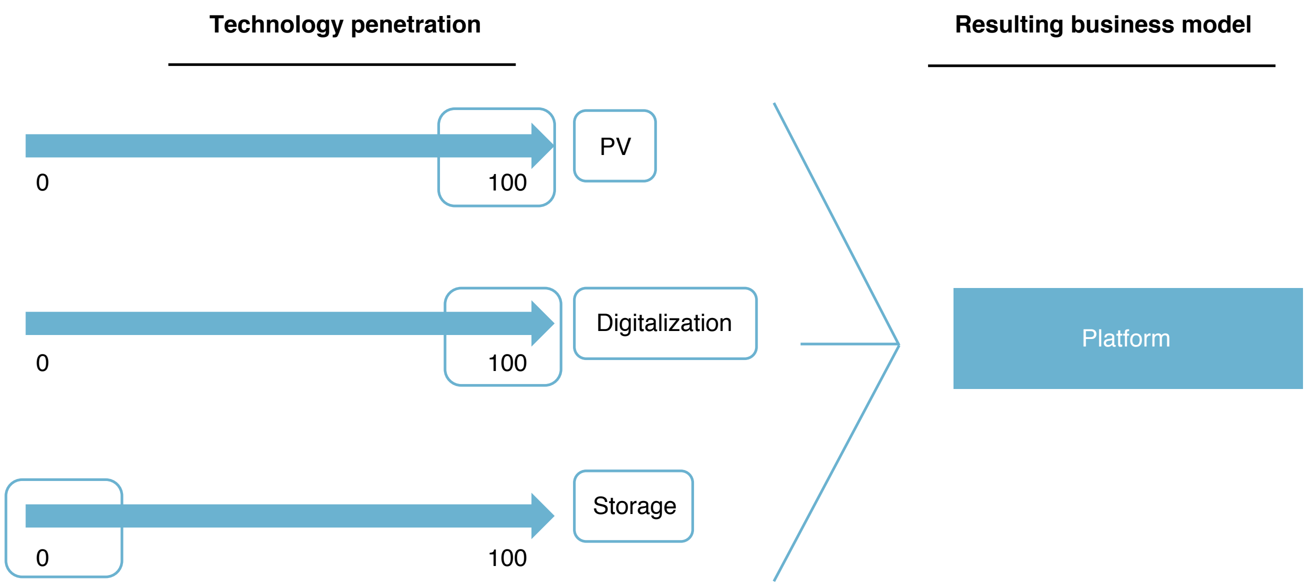
Aggregation reduces transaction costs and opens up trade in new types of products targeted at specific customers. Aggregators build portfolios of private clients and have exclusive reselling franchises. In the past, wholesale demand participation was confined to big interruptible customers. However, aggregation changes this to include retail consumers in wholesale demand participation.

Digitalization leads to platforms

Digitalization would facilitate direct peer-to-peer trading between small units, with the large number of transactions managed by blockchain. Peer-to-peer trade facilitates direct interactions between individuals and does not require them to have close proximity to one another.

Peer-to-peer trade bypasses the control of traditional utilities and could change the role of networks from grids to platforms. The costs of establishing a platform business are mainly centered around software, consumer enrolment, database and process management. As it creates a low transaction environment, a platform business can be quite small. The products, platform characteristics and the rules for the operation of platforms need to be defined, along with the characteristics of the product and the trade process, including delivery and settlement.

Figure 3. Coupling distributed generation and digitalization can transform distribution networks into platform business models.

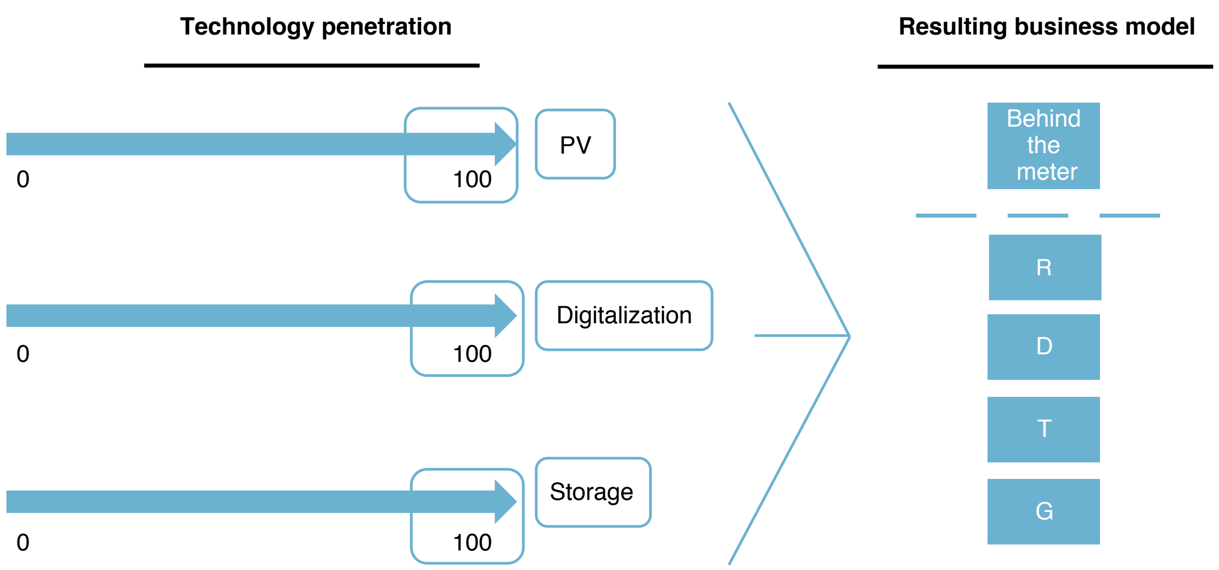


Source: Author.

Full DER deployment leads to behind-the-meter business opportunities

'Behind-the-meter' business opportunities may arise if, in addition to installing distributed generation and digitalization devices, households install behind-the-meter storage. This is a departure from the unilateral control that electricity grids and system operators have had on exchange schemes by virtue of the fact that their infrastructure supports unavoidable delivery loops (Sionshansi 2017, 2019). Behind-the-meter storage bypasses the traditional electricity system, including its grids and the energy regulators, enabling innovation and experimentation while not requiring a regulatory sandbox.

Figure 4. Full DER penetration can open up unexplored behind-the-meter business models.



Source: Author.

Impact on Grids

The grid is the quintessential example of infrastructure: an asset that underpins the way society works. As infrastructure enables modes of production, when the latter change, so does the underlying infrastructure (Haskel and Westlake 2018). In this section we discuss how the use and the role of the grid are affected by the three scenarios described in the previous section, and the unfulfilled household needs that emerge. We devise potential ways to monetize services the grid would provide in each scenario. For each scenario, the grid would be used for roles it was not initially conceived for, and under some scenarios, it would be used less than it is now. Given that the network would be used less, the average cost of the grid would increase. While the marginal cost of operating the grid does not change, having new roles for the grid could also mean that the relevant marginal costs would lie elsewhere in the system.

Aggregation: a bi-flow use of the grid

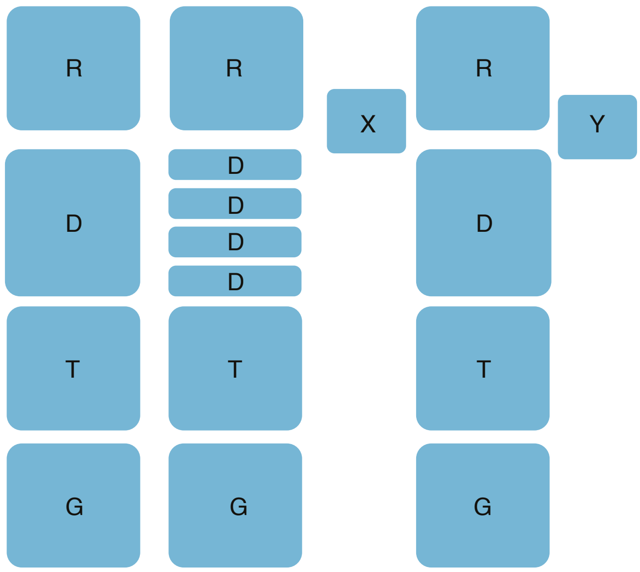
In this section we discuss the conceptual process of establishing prices for the distribution network if the business model is aggregation. Aggregation puts the upstream sections of the value chain in closer proximity to the wholesale market, including the downstream market and retail, as it allows households to participate more in that market.

This would potentially help to solve a long-standing problem. In the standard reform model, competitive price signals from generation and retail are distorted in the transmission and distribution segments, which remain monopolies. This clouds the two-way price signals that should exist between generation and retail, and may explain why liberalization has had negligible or mixed efficiency impacts. Some authors estimate the gains from market liberalization to be around 5% of costs (Pollit 2012). In our view, the role of the distribution network in this scenario is similar to the traditional use of the grid, with the difference that energy flows both ways.

To find ways of pricing the distribution network's new role, we rely on the basic idea of the standard reform model, which is that not all components of the electricity sector are best suited to a natural monopoly. There are segments for which competition can be allowed in order to achieve competitive pricing. We will therefore try to determine whether there are any new areas of the value chain suitable for competition, and whether this can be solved by having a better, more accurate or more granular application of the traditional cost accounting paradigm.

Returning to this subsection's question, Has technology opened up new sections of the value chain that are more prone to competition? As we have argued, new business results from the deployment of DERs on top of the previously monolithic, vertically integrated power sector. Figure 5 shows another schematic of the power sector, where G is generation, T is transmission, D is distribution and R is retail. Are there new functions to be costed that are adjacent to the formal value chain (described below as X or Y)?

Figure 5. The value chain in electricity can become more granular.



Source: Author.

Take, for example, storage as one of the 'new' building blocks of the value chain. Storage is neither part of distribution nor of retail. It could either be treated as part of the network or as a generator. We can therefore think of more granular tariffs in terms of space and time, volume, time of day, and so forth. The new tariff building blocks can be built around storage uses. For example, 1) to meet instantaneous discrepancies between generation and load, 2) to firm renewable power, 3) to store energy from residential installations, 4) regulate frequency, or 5) to shave the peak (demand charge management). Each one of these activities can be regulated or opened up to competition.

Platform: network effects/ matchmaking

The deployment of solar PV and digitization technologies could transform the power markets into a series of nested markets. These markets could be connected through different platforms as if they were 'multiple-sided' markets. A multiple-sided market is a meeting place for a number of agents who interact through an intermediary or platform (Rochet and Tirole 2004). This can lead to indirect network externalities, whereby complementary goods become more plentiful and cheaper as the number of users of a product increases (Katz and Shapiro 1985).

In this scenario, flat volumetric electricity rates with small fixed charges would be insufficient to align consumer incentives with the costs that electric utilities face. Utilities might not be able to recover their costs as the rate components do not reflect their costs to the system. This is because utilities make capital investments in expectation of cost recovery from assumed consumer patterns of network use. In contrast, products or services traded on platforms would be more likely to be successful in this scenario. The platform business model relies on charging small

Table 2. Hypothetical electricity subscription packages.

Attribute	Unlimited savings	Unlimited choice	Unlimited premium +EV
Fixed monthly price based on household profile usage (the current average bill is $115/ month)	$115 per month for 36 months	$125 per month for 36 months	$145 per month for 36 months
30% clean energy with energy portal app	✓	✓	✓
100% clean energy	×	×	✓
Free smart thermostat	✓	✓	✓
Access to free or discounted energy efficiency upgrades	✓	✓	✓
Unlimited EV charging at home and in community	×	×	✓
Maximum number of control days	30	15	7
Free control day overrides per year	3	5	7

Source: Trabish (2019).

commissions for matching suppliers with demand. To reduce the transaction costs of potentially numerous transactions, it makes sense to bundle several services in a subscription package. This subscription model has also been proposed by other authors (Huber and Bachmeier 2018; Lo et al. 2019; Farouqi 2019). Table 2 details hypothetical electricity subscription packages.

Subscription pricing should be designed so it can signal to utilities the amount and type of infrastructure that needs to be developed (Lo et al. 2019). In such an efficient pricing scheme, prices need to be able to signal scarcity. Since fixed costs are becoming a larger fraction of customers' bills, it is tempting to think that marginal costs are close to zero. But having zero marginal costs does not make economic sense. As we know, there is no free lunch. Often the ultimate impact of technological progress is in alleviating resource constraints, only to push them somewhere else in the value chain. The task then is to design subscriptions that reflect the scarcity of a given resource. Firms that are able to figure out which resource this is are more likely to succeed in this environment.

The example of Netflix, a company with large sunk costs and operating as a network, can illustrate this. The marginal cost of adding each additional user to Netflix's platform is close to zero. The price of adding each additional user would equal its marginal costs. We know that a subscription to Netflix costs around US$10 per month. The question then is, What is US$10 the marginal cost of? At first sight, Netflix membership could resemble an all you can eat buffet, just all you can watch. But looking closer at Netflix, one can see that not all shows and movies are available at any given time and every location. This is an indication of a scarce resource, not abundance. We also know that Netflix invests large sums of money in television and cinema production. Why would they invest so heavily in these areas when they have a zero-marginal cost in their production function? One explanation is that Netflix needs to keep its customers engaged and logged into its platform. It can therefore be argued that the relevant marginal cost of Netflix is the cost incurred in keeping (as opposed to adding) the customer base plus one for one more month. This example illustrates the type of analysis electricity firms could employ when trying to develop business models and deliver value for a subscription scenario.

Behind the meter: making the invisible visible.

In this subsection, we discuss how to price the services the distribution network can provide when households install technologies that allow them to bypass the grid and utility services. While the electricity industry's business domain typically stops at the customer's meter, these technologies open new possibilities beyond that point.

This section focuses on decoupling the grid's value creation from its energy component. It argues that new value would not come from the physical use of the network, but from its existing value, i.e., the value that people attribute to it based on it being readily available. The grid's value therefore cannot be derived from the sum of the sum of its parts (energy, capacity, reliability) but from the (whole) service it still provides. As of now, the grid is either an intermediary good or part of the production function in delivering electricity services. By moving from pricing inputs to pricing outputs we are able to suggest more comprehensive ways to design electricity tariffs.

If the grid is bypassed more often than not, consumer expenditure on it would be close to zero. Theoretically, consumers spend close to nothing on goods when the marginal utility they obtain from them is negligible (or when they cannot afford them). In a world where DERs are a perfect substitute for the distribution network, in the absence of uncertainty, close to zero expenditure on an item might imply that there is a low marginal utility derived from this good. However, there is some uncertainty around DERs as they might fail. In such a scenario, consumers would want to revert back to the grid. Therefore, as long as grids and DERs are imperfect substitutes, there is room for alternative ways of pricing the grid and rethinking the grid's business model. A new business model might transform the grid from an intermediary good – a complement to capital – to part of the demand function for reliability.

To arrive at an alternative business model, we need to locate where the economic value of the new grid lies, and how to repackage this value and find mechanisms to allocate it. The field of environmental economics has well-established methodologies to deal with existing values. Economists measure individual preferences for the conservation of the natural environment (in our case, the maintenance of the unused grid), or the consumer's loss of wellbeing from losing natural resources (in this case, maintaining access to infrastructure). These methodologies can be used to estimate the economic value of the grid based on consumer preferences as opposed to the cost of the grid.

However, just knowing the standing value of the grid does not solve our problem of decoupling the grid from its energy component. The network's role becomes a service, and as a service, it is intangible. This service needs to be standardized in order to facilitate trade. In other words, they need to make the invisible visible. Business opportunities would arise for firms able to monetize the standing value of the grid, and those that are able to reinvent their business models, i.e., the servitization of commodities.

An example from the business literature might help clarify the challenge discussed in this subsection. Johnson (2009) discusses the reinvention of tool-manufacturer Hilti. Rather than selling tools, Hiti turned to sell a service, “the tool you need when you need it, no repairs or storage hassles” (Johnson 2009, page 2). They moved from a profit formula based on low margins and high inventory turnover to higher-margin rents and monthly payments to repairmen. As such, Hiti’s value proposition moved from selling commodities to selling a service.

There is a problem of people potentially freeriding on other people paying to maintain the grid. To avoid this problem, we propose internalizing this externality by creating a market. Markets would define who gets what and at what price. Another example can help to illustrate this point. It has been argued that the distribution network would be comparable to the reinsurance business. Distribution network firms would be paid to ensure reliable supply to ‘prosumers’ (consumers who also generate electricity and sell it back to the grid) when their own generation is too low, or their consumption is too high. Fuentes et al. (2019) provide a microeconomic framework for a reliability insurance business model of electricity, an intangible service in the power sector. The intangible service is “risk,” the repackaging of the service is an insurance contract, and the price formation is found through the interaction between demand for and the supply of this product.

Summary

Price based on tariff/incentive	Drives high penetration of:	Business opportunity	Product/service	Impact on the grid	Pricing mechanism network
Net metering	PV	Participation in wholesale markets	Aggregation	Same use/bi flow	Find more granular elements in the value chain. Or find more granular implementation of combined tariffs.
Time-based tariffs	PV and digitalization	Peer-to-peer trade	Platforms	Less distance traveled/more use of local networks	Platform commissions lead to subscriptions that reduce transaction costs
Multiple-part tariffs	PV and digitalization and storage (including EVs)	Unexplored behind-the-meter opportunities	Intangible services	Less network expenditure but economic value stands	Monetize the standing value of the grid

Source: Author.

Policy Implications

In this section we discuss four insights from this paper that policymakers should be aware of:

Path dependency. We have shown there is a relationship between tariff design and technology deployment business models, where the starting point determines the result. Policymakers need to know that their actions today have far-reaching effects, and that these effects are difficult to undo. Focusing on short-term issues leads to suboptimal outcomes.

If globally efficient tariffs are not possible, try locally efficient tariffs. If tariffs were set at the efficient point, where price equals their marginal costs – the necessary and sufficient condition for efficient pricing – the resulting technology mix would also be optimal. Because this is not possible, policymakers must pursue second-best solutions. If a globally optimal tariff is not possible, locally optimal tariffs, within additional layers of restrictions, must be pursued. These additional restrictions could be environmental constraints and/or equity constraints. Network service pricing can be designed in a way that achieves an optimal outcome with respect to the most important energy policy objective, and accepts sub-optimal outcomes with respect to other objectives.

No arbitrage. The goal of setting prices to align cost minimization for the consumer with reduced system costs and increased system benefits is not new. Distribution tariffs should be designed in a way that only those models that create system value and are in line with wider energy policy emerge and survive (i.e., opportunistic models become unprofitable).

Policy outcomes. Distribution network services pricing is not independent from energy policy objectives, even in a changing business and technological environment. The different technology mixes that result from tariff design and new business models have different policy outcomes in terms of efficiency, environment and equity. Thus, an alternative way of looking at this problem is to rank design criteria in order of importance, according to the particular policy context. Jurisdictions that have strong decarbonization policies would probably rank sustainability above all other criteria; countries in which affordability and access to electricity are considered the most important objectives would probably rank efficiency as the most important objective. The latter would be the case in most developing countries.

Conclusion

In this paper we discuss the extent to which emerging business models in the power sector change the way electricity distribution network services are priced and packaged. The emergence of new business models could affect the design of distribution tariffs. However, tariffs can also trigger new business models as they can nudge consumers to adopt certain technologies. We propose a framework of analysis based on the business opportunities that arise when new technologies are deployed in the formerly monolithic, vertically integrated power sector. These business opportunities result from the physical deployment of these technologies and their impact on grid use. We propose different ways to monetize the resulting new role the grid would have in each of the scenarios we analyze. Future research could focus on developing some of the ideas proposed in this paper.

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About the Author

Dr. Rolando Fuentes

Dr. Rolando Fuentes is a visiting fellow at KAPSARC, where he researches business and regulatory models in the Innovation in Electricity Transitions program. He has extensive experience in the energy and environmental sectors as an academic and policymaker. Rolando holds a B.A. (Hons) from Tec de Monterrey, an M.Sc. from University College London and a Ph.D. from the London School of Economics. He was awarded a United Kingdom government Chevening Scholarship in 2001.

About the Project

Saudi Arabia's policymakers aim to transform the electricity sector by pursuing a dual agenda of electricity reform and decarbonization, supported by an ambitious deployment of renewable technologies. The Kingdom is pursuing this agenda in the context of a rapidly changing electricity sector worldwide, where emerging renewable and distributed technologies are testing the limits of existing market, business and regulatory frameworks.

To this end, this project investigates the innovative market designs, business models and regulatory frameworks that could embrace new technologies to enable competition in a less carbon-intensive power sector.

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