

A Design Perspective on Networked Business Models: A Study of Distributed Generation in the Power Industry Sector

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Abstract. Value chain deconstruction and reconfiguration into new value constellations is a phenomenon impacting many industry sectors. An important strategic issue therefore is the creation and analysis of new networked business models that cut across a variety of enterprise and market actors. In this paper we take up this issue from a design perspective, and consider the construction of networked business models for the emerging case of distributed power generation in the utility industry. We elucidate the role of regulation here: feasibility of new business models in this industry sector appears to be critically dependent on the nature of future regulations even in a so-called 'deregulated' open competitive market. We discuss how our value network modeling approach provides benefits already in a non-quantitative analysis in that (1) it offers a capability to map out new business ideas graphically in a clear and communicable fashion, (2) it clarifies the position of the individual stakeholders in innovative value constellations, and (3) it gives some qualitative directions where critical points and possible opportunities for new business models are to be expected.

Keywords: e-strategy, value chain reengineering, power industry sector, liberalization and deregulation.

1 Introduction

Value chain deconstruction and reconfiguration into new value constellations is a development impacting many industry sectors. An important strategic issue therefore is the creation and analysis of new networked business models that cut across a variety of enterprise and market actors. In this paper we take up this issue from a design perspective, and consider the construction of networked business models for the emerging case of distributed power generation in the utility industry.

The electricity sector in Europe and elsewhere is rapidly changing due to business as well as technology drivers. Traditionally, this sector is characterized by a few producers of electricity exploiting large power plants in a country, a transportation company that operates a high-voltage long-distance electricity transmission network, regional companies exploiting a medium and low voltage distribution grid, and numerous industrial

and residential end consumers. These enterprises have in common that they operate(d) in a monopolistic way in their region.

As a result of government motivated market liberalization and deregulation, the electricity sector is changing substantially. For example, many countries now allow end consumers to freely choose their electricity supplier. An important reason for this is to stimulate competition, thereby hoping to increase the overall efficiency of the electricity industry. Another general policy is to increase the sustainability and reduce the environmental impact of electricity generation, whereby renewable, and often small-scale energy sources (such as solar, wind, hydro-power, bio-mass) are stimulated. This development is known as distributed power generation, and it leads to a more decentralized electrical grid in which many more actors play a role in new value constellations that are still insufficiently understood.

It is important to note that these changes in the electricity industry are in part enabled by advances in ICT. For instance, the new electrical grid calls for new forms of distributed monitoring and control that exploit the current advances in communication technologies, large-scale information management, and opportunities for embedded distributed intelligence that are now available. Moreover, electronic markets are now used to trade energy and negotiate electricity prices between many electricity producers. So, information technology plays a definite enabling role in the transition from a regional monopolistic industry sector to an international market with many different large and small players.

In sum, deregulation, new ways of generating electricity, and information technology changes the way of doing business in the electricity sector. New players emerge (e.g. wholesalers of electricity) as well as new services (real-time pricing, home services, building management, IP over the electricity grid, demand-side management). A key question for players in the electricity sector is to find corresponding new, competitive business models. Actually, competition is quite new to electricity companies, since they were used to a monopolistic market.

In earlier work, we have studied the *design* of new business models for other industries, e.g. the digital content industry, and we have developed for this a business modeling approach called *e³-value* [7]. Like the electricity sector, the music industry has been facing dramatic changes in the way of doing business for several years now, as a result of the wide acceptance of the Internet.

This paper introduces the *e³-value* approach in the context of the electricity sector to develop new networked, collaborative ways of doing business. Key to this approach is that it takes a *design* perspective on business development. This implies that we develop a business model, represent it graphically in an unambiguous way, so that all stakeholders involved have a common understanding of the model, and that we evaluate the model, e.g. with respect to potential profitability. Section 2 gives a brief overview of this *e³-value* methodology. Then, section 3 discusses networked business models for the electricity sector, given on-going deregulation, use of environment-friendly energy sources, and the expected substantial increase and variety of the players in the electricity market. We will present how the *e³-value* methodology contributes to finding and explaining these new business models, summarized in the concluding Section 4.

2 The e^3 -value methodology

The e^3 -value methodology provides modeling concepts for showing which parties exchange things of *economic* value with whom, and expect *what* in return. These concepts are based on recent economics and business science literature on e-business [13], [8], [12] combined with a formal ontology of systems theory [1]. The conceptualization of an e-business idea can be graphically represented (see for example Fig. 1) in a rigorous and structured way. For diagramming purposes, the reader can download a VISIO tool stencil from our website at <http://www.cs.vu.nl/~gordijn/research.htm>. What follows is a summary of the most important concepts.

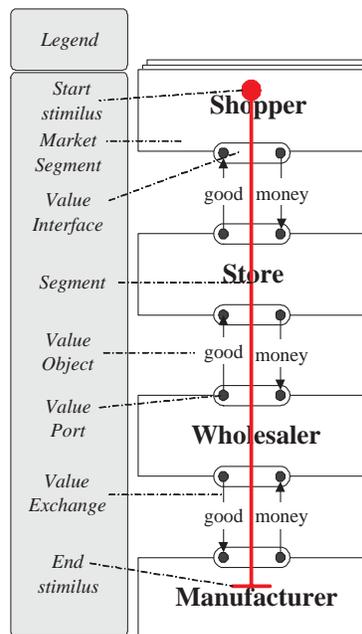


Fig. 1. A shopper obtains a good from a store and offers money in return. So do the other actors. The scenario path shows that in reaction to a start stimulus (a consumer need), the store needs to buy a good also, and so does the wholesaler.

Actor. An actor is perceived by its environment as an independent economic (and often also legal) entity. An actor makes a profit or increases its utility. In a sound, sustainable, e-business model *each* actor should be capable of making a profit.

Value Object. Actors exchange value objects, which are services, products, money, or even consumer experiences. The important point here is that a value object is *of value* for one or more actors.

Value Port. An actor uses a value port to show to its environment that it wants to provide or request value objects. The concept of port enables us to abstract away from

the internal business processes, and to focus only on how external actors and other components of the e-business model can be ‘plugged in’.

Value Offering. A value offering models what an actor offers to or requests from his/her environment. The closely related concept *value interface* (see below) models an offering to the actor’s environment *and* the reciprocal incoming offering, while the value offering models a set of equally directed value ports exchanging value ports. It is used to model e.g. bundling: the situation that some objects are only of value in combination for an actor.

Value Interface. Actors have one or more value interfaces, grouping individual value offerings. A value interface shows the value object an actor is willing to exchange *in return for* another value object via its ports. The exchange of value objects is atomic at the level of the value interface.

Value Exchange. A value exchange is used to connect two value ports with each other. It represents one or more *potential* trades of value objects between value ports.

Market segment. A market segment is a concept that breaks a market (consisting of actors) into segments that share common properties [9]. Accordingly, our concept *market segment* shows a set of actors that for one or more of their value interfaces, value objects equally from an economic perspective.

The concepts above allow us to model who wants to do business with whom, but can not represent *all* value exchanges needed to satisfy a particular end-consumer need. It occurs often that, to satisfy an end consumer need, several other actors have to exchange objects of value with each other. As an example think of a store that exchanges economic values with an end consumer: as a result, the store must also exchange values with a wholesaler. It is our experience that showing all such value exchanges to satisfy an end consumer need contributes largely to a common understanding of an e-business idea. To that purpose we use an existing scenario technique called Use Case Maps (UCMs) [2]). UCMs show which value exchanges should occur as a result of a consumer need (which we call a start stimulus), or as a result of other value exchanges. Below, the main UCM modeling constructs are briefly discussed.

Scenario path. A scenario path consists of one or more segments, related by connection elements and start and stop stimuli. A path indicates via *which* value interfaces objects of value must be exchanged, as a result of a start stimulus, *or* as result of exchanges via *other* value interfaces.

Stimulus. A scenario path starts with a **start stimulus**, which represents a consumer need. The last segment(s) of a scenario path is connected to a **stop stimulus**. A stop stimulus indicates that the scenario path ends.

Segment. A scenario path has one or more segments. Segments are used to relate value interfaces with each other (e.g. via connection elements) to show that an exchange on one value interface causes an exchange on another value interface.

Connection. Connections are used to relate individual segments. An **AND fork** splits a scenario path into two or more sub paths, while the **AND join** collapses sub paths

into a single path. An **OR fork** models a continuation of the scenario path into one direction that is to be chosen from a number of alternatives. The **OR join** merges two or more paths into one path. Finally, the **direct** connection interconnects two individual segments.

3 New networked business models for the electricity sector

3.1 Trends in the electricity sector

Traditionally, the generation segment of the electricity sector was a monopoly, where large power plants delivered lower average production costs and, therefore, had an efficiency advantage over small-scale generation units. Currently, the electricity sector in many countries faces considerable changes for a number of reasons.

First, government re-regulates the industry. An important motivation for re-regulation is to increase efficiency of the entire electricity industry. In the European Union, for example, a white paper published in 1995, providing guidelines for the electricity sector policies of Member States, considers the reorganization of the whole energy sector (see EU, 1995). As a result, the once monopolistic market occupied by big utilities is becoming a more horizontally integrated electricity sector (see [5], [3]). An additional motivation for re-regulation is a world-wide agreed goal to decrease CO_2 emission, for instance by subsidizing energy sources with no associated CO_2 emission.

Second, industry changes are caused by technological advances. It is now possible to have efficient small scale electricity generation units (e.g. solar and hydro systems, but also Combined Heat Power (CHP) devices, which generate electricity as a by-product of heat). Because such units can be located anywhere in the power grid, and there are many of them needed to generate substantial power, they are often referred to as distributed generation (DG) (see [10],[11]). DG is further enabled by computer-networked information technology; the control of energy generation by such units and pricing and billing requires far more complex information systems, compared to systems needed to control and manage only a few, centralized big power plants.

3.2 Players in the electricity sector

Industry re-regulation and new technological possibilities such as distributed generation require the electricity industry to develop new business models. In other words, the power electricity industry has to re-invent itself, just as for example the music industry is doing right now. In this paper, we will demonstrate how our *design*-oriented approach can be used to explore various new business models for the energy sector, using technological advances in distributed generation technology, and taking into account government motivated re-regulation. We also use our e^3 -value methodology to analyze and evaluate these models.

A first step in business model design is to understand and list the actors involved. This section discusses these actors, whereas the next sections explain how these actors exchange objects of economic value with each other. The actors and the business models are based on an elicitation process done with two main electricity companies in Spain and Norway [5].

The electricity sector performs several activities, namely: generation, transmission, distribution, supply, coordination of sales and system operation. The deregulation of the electricity sector removes price regulation from the generation and supply levels only, allowing the price to be formed by competition; the transmission, distribution, system operation, and coordination of sales remain regulated activities in order to ensure safe market functioning.

In order to make the generation segment self-regulating, the generation is obliged to be unbundled from the distribution and transmission levels, thus making the generation, distribution and transmission into activities performed by separate actors (although in some countries transmission and distribution are managed by one company). The electricity supply from a commercial perspective (actually selling electricity to end-consumers) also becomes the separate activity and is performed by a supplier. Coordination of supply and demand of electricity can be done by an intermediate party, or via bilateral contracts between a supplier and generator. Finally, system operation, which ensures the continuity and security of the electricity supply in the whole electricity sector, is done by the independent system operator.

In sum, deregulation reforms change the number of participants in the sector, consequently enabling new generators and new suppliers to enter the market. These generators potentially can be smaller in scale and can be distributed over a geographical region. As a consequence, new business models are possible, of which we design and discuss three possibilities in the next sections: (1) renewable, distributed generation of energy, but in a highly regulated world, (2) generation of energy, but in a deregulated world, and (3) distributed generation of energy to solve shortage in distribution capacity.

3.3 Business model: Renewable energy in a highly regulated world

In this section, we apply the e^3 -value business modeling methodology to illustrate how distributed generation of renewable energy changes the business model of the electricity sector. We do not focus on any particular distributed generation technology and consider a renewable producer that complies with the “special rules” of the Spanish electricity law: electricity generation plants of less than 50 MW capacity, which generate electricity using cogeneration systems or renewable energy sources. The Spanish government currently subsidizes these “special rules” generators.

The model (see Fig. 2) represents generation of electricity by a renewable generator, which is installed into the distribution grid. We follow the scenario path to explain the business model.

The final customer is any legal or natural person buying electricity for its own use. The scenario starts when a final customer wants to purchase electricity in return for a fee.

The distribution company performs the transportation of electricity on medium-voltage and low-voltage distribution systems, and the physical delivery of electricity to the customers. In addition to that, the distribution company performs sale and procurement functions (electricity purchasing and selling). The distribution company is a natural monopolist that serves one geographic region. There are a number of these companies in a country, each serving their own region, so Fig. 2 shows an additional shaded distribution company. Note that both distribution companies can not be seen as a market

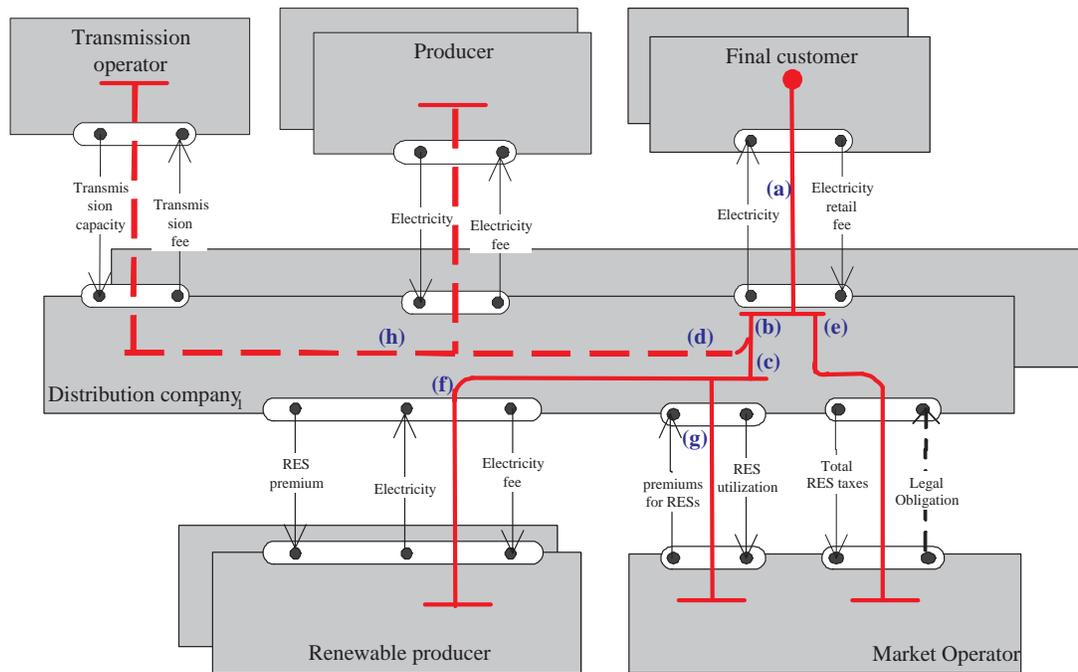


Fig. 2. In this scenario the distribution company is forced to buy all the electricity generated by renewable producers, resulting in a situation where the amount of electricity generated is always equal to the amount of electricity sold. Moreover, the price of electricity bought from the renewable producer is also fixed. The abolishment of the fixed electricity price and obligation to buy all the electricity from renewable sources can render the renewable production business unprofitable.

segment, because otherwise the customer could select a specific distribution company, which is not the case. The distribution company delivers electricity to the final customer, and it directly receives the electricity retail fee in return (see Fig. 2, annotation (a)).

Following the scenario path, we can see that the path splits into two sub-paths (see Fig. 2, annotation (b)). The left sub-path presents that energy must be obtained, either from a renewable producer (Fig. 2, annotation (c)), or from a traditional producer (exploiting non-renewable energy, (Fig. 2, annotation (d))). The right sub-path shows that for *all* energy exchanged between customer and the distribution company, a Renewable Energy Source (RES) tax has to be paid to the market operator (Fig. 2, annotation (e)). The market operator is in charge of managing the wholesale energy market including coordination of sales. He builds a fund that can be used to pay producers of renewable energy a premium for generating such energy. If we assume that the distribution company decides to obtain renewable energy, the scenario continues in the direction of annotation (c), and again splits into two sub-paths. The leftmost sub-path, (Fig. 2, annotation (f)) models that renewable energy is bought, and the renewable energy producer receives a fee and premium for the energy. The distribution company obtains the premium fee to be paid from the market operator, as can be seen from the sub-path annotated (g). In sum, Fig. 2 clearly shows that *all* energy funds renewable energy, so that the in principal more expensive renewable energy can be offered for the same price as traditional energy. It is important to stress that the energy company in this specific case was not able to articulate and explain this business model without our graphical technique, let alone to reason about the model.

From Fig. 2, it can also be seen that a renewable producer does not require access to the energy transportation network, whereas traditional producers do. To understand this, it is important to know that distribution of electricity involves a long-distance high-voltage network, called the transportation network, and a short distance medium voltage network, typically serving a limited geographical area, and called the distribution grid. Renewable producers operate small scale generators, which are plugged into the distribution network directly, and do not need a long distance electricity transportation network. Consequently, for renewable generators no transportation services (for which a fee is to be paid) need to be obtained from a transmission operator. This is also shown by the scenario path (Fig. 2, annotation (g)), which clearly shows that in the case of traditional energy both electricity *and* transmission capacity needs to be obtained. This makes renewable energy more attractive for the distribution company since the company is no transmission fees obliged.

The distribution company is *forced* by law to first exhaust all renewable energy connected to its distribution grid, and once exhausted, it is allowed to buy other types of energy from regular producers. This is suggested by dashed lines, implying that first all scenario paths with solid lines should be executed.

The renewable producer's profitability is strongly dependent on regulation, which establishes the RES tax for final customers and forces the distribution company to accept DG. If the RES premium is withdrawn, the distribution company will no longer pay premiums for renewables and the cost of "green" electricity will be equal to the cost of the electricity produced by the ordinary generator minus transportation fees. This will

harm the business of the renewable producer, because its initial investments are usually high. Although this finding is consistent with that in many literature sources, our model provides a clear graphical picture of the situation.

3.4 Business model: Energy in a deregulated world

The model presented in Fig. 2 neglects the introduction of a resale role in many European countries. The reseller will supply energy to final customers, and in turn buys energy from others. To understand this situation, we built the model shown in Fig. 3. It shows a wholesale electricity market managed by the market operator (MO), where producers sell electricity via a pool to suppliers of electricity. This model does not show elements of distributed generation yet.

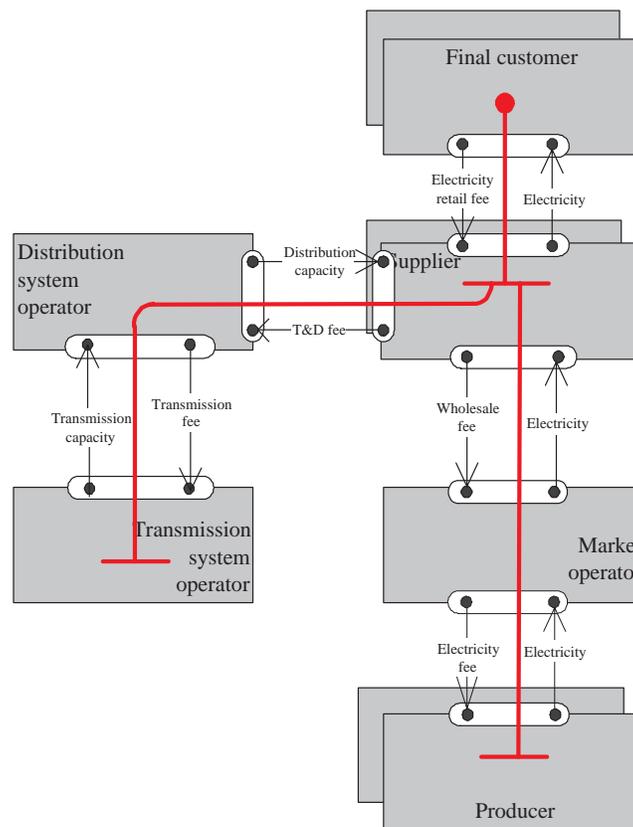


Fig. 3. The model of the deregulated market. The electricity is sold via the pool, organized by the market operator. Final customers have a possibility to choose a supplier. Note that the model shows only the exchange of economic valuable objects between actors, and *not* the physical flow of electricity. Physically, the producer is placed into the transmission grid, represented by TSO.

The model shows deregulation by introducing supplier actors. Final customers can choose an electricity supplier, whereas the business model explained in Sec. 3.3 contains no choice for a specific supplier. An important consequence of deregulation is that the party who normally would distribute the electricity to the final customer (the distribution company in Fig. 2), does not *sell* the electricity anymore to the final customer, but rather provides a physical distribution service only (see the distribution system operator in Fig. 3). Selling is now done by a supplier, whose main role is to buy electricity as cheaply as possible and to sell that energy to final customers.

The business model in Fig. 3 makes no exceptions for renewable energy. Producers are treated equally. Since renewable producers are not able to compete on costs with the big power plants, (because usually the technology requires significant investments, and even high maintenance costs), alternative business models for renewables must be explored. One such a business model we introduce in the next section.

3.5 Business model: Distributed generation to solve shortage in distribution capacity

It is difficult to say when DG will become economically attractive. As a number of works state, see [10], [5], DG may be economically attractive as a replacement for centralized power plants only in scenarios with system constraints, such as lack in the capacity in the distribution network. In such a case, there are insufficient means to transport electricity from the long distance transportation network to final customers via a short distance distribution network.

The idea of the business model presented in Figs. 4 and 5 is to delay a necessary distribution grid upgrade by installing a renewable generator, which delivers electricity directly to final customers. If the physical location of the generator is strategically chosen (in practice close to a substantial amount of consumers), parts of the distribution grid can be avoided for transportation of electricity, and consequently an upgrade of this grid can be postponed.

By following the scenario path, we can see how this idea works. The scenario starts with a final customer who wants to obtain electricity in return for a fee, and continues into alternative directions. First, if there is *sufficient* distribution grid capacity, the scenario path goes as presented in Fig. 4. Electricity is obtained from a market operator, who in turn obtains electricity from a producer. Additionally, the supplier buys distribution capacity from an operator and pays a fee for this. In this model, we assume this producer is a not-renewable electricity producer because the scenario path stops at the producer. There are variations on this model possible, but this is matter of design. To highlight such design choices is one of the goals of using our e^3 -value description technique.

Second, if there is *insufficient* grid capacity, the scenario path is as stated in Fig. 5. The supplier buys distribution capacity from an operator, but now the operator is not capable of delivering this capacity. There is however a renewable energy producer whose site is physically located near the final customers who need the electricity. This producer can deliver the electricity by using only a portion of the distribution grid. Moreover, we assume that this specific portion has no capacity problems. This situation is modeled by stating that the renewable producer delivers to the distribution operator virtual grid

capacity (or the avoidance of a need for grid capacity). At the same time, the regular electricity producer can not deliver its electricity anymore (at least the part that now will be provided by the renewable electricity producer). In this specific model the producer agrees not to generate the electricity, but to buy electricity from the renewable producer: he buys the DG electricity and pays the DG electricity fee in return. There are other solutions for this, but again this is a matter of business design choices, which we want to represent and reason about.

There are several conditions key to the success of this scenario. First, the producer has to agree to buy electricity from the renewable producer in case of distribution grid capacity problems. If the producer agrees, all the amount of the DG electricity has to be traded. If not, then the surplus of renewable electricity (which is not needed for solving distribution capacity problems) will flow into the transportation (long distance) grid. This requires some agreement to be arranged between the distribution system operator and each producer about the guarantee that the renewable electricity will be sold. Furthermore, if the electricity fee is lower than a renewable electricity fee, the producer trades at a loss and its losses have to be recovered. Finally, only sustainable technology can be deployed in this scenario. For example, wind turbine systems, which “rely upon the variable and somewhat unpredictable wind”, are unsustainable for continuous power needs (see [4]), and therefore, they cannot be exploited in geographical regions with a too low probability of wind.

4 Conclusions and discussion

Initially the e^3 -value business modeling methodology was utilized for exploring innovative e-commerce ideas, and it revealed itself as a useful and effective approach to analyze e-commerce applications [6], [7]. In this work it has been proposed to use the e-business modeling methodology for exploration of the electricity sector, which is facing considerable changes. This study, of course, cannot be viewed nor is presented as conclusive. Further study has to be done to evaluate the applicability of the methodology for exploring business cases of this kind. However, some interesting conclusions on the creation of networked business models are possible.

One of the strong points of the e^3 -value methodology lies, firstly, in the enabling the common understanding of the business case by stakeholders. The common understanding of the business case is crucial for the electricity sector, especially when the stakeholders are the representatives of different countries: as it came out from a series of international meetings, different regulation, languages and problems result in complete misunderstanding between people. The e^3 -value methodology provides a structured approach to enhance the common understanding between people, and business and consultancy experience has shown that this is difficult to achieve in a purely informal verbal way.

The models presented in the paper were based on a document analysis and a number of interviews with the business department of one of the biggest Spanish utilities. After interviewing domain experts, we independently developed the business models, and made conclusions about feasibility of business scenarios. As a result, our findings corroborate other electricity market studies (see [10], [11]).

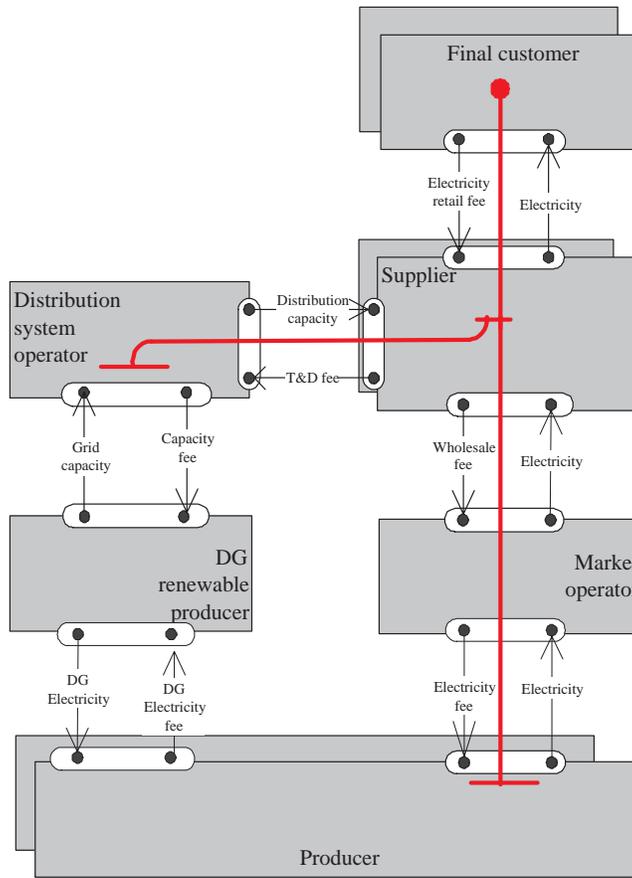


Fig. 4. The situation without distribution grid capacity problems.

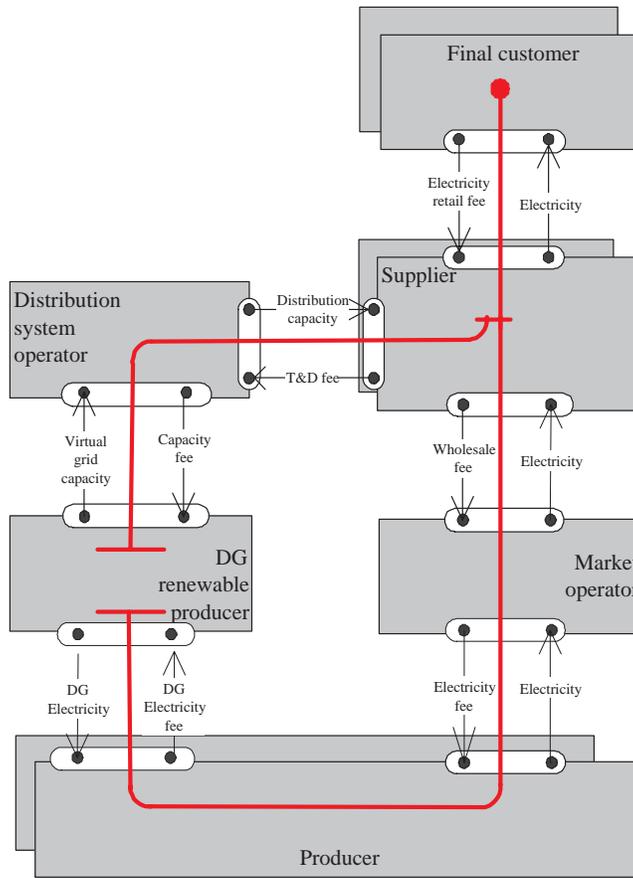


Fig. 5. The situation with distribution grid capacity problems.

From our models several conclusions can be drawn. Concerning the business case for renewable generation in Spain we can say that:

- Renewable producer's profitability is strongly dependent on regulation;
- Renewables are sponsored by taxes, paid by all customers, including those who consume non-renewable energy.

Concerning the business case for distributed generation we can conclude that:

- Distributed generation is strongly dependent on the underlying technology;
- Distributed generation is dependent on regulation;
- Distributed generation solutions as a substitute of the big utility business seems to be feasible only when some network limitations are present, e.g. grid capacity problems.

These conclusions follow from a qualitative analysis, by constructing and analyzing the graphical models only. Of interest from a general policy point of view is the conclusion that the feasibility of new business models in this industry sector critically depends on the nature of future regulations even in a so-called 'deregulated' open competitive market.

Thus, our value network modeling approach provides benefits already in that (1) it offers a capability to map out new business ideas graphically in a clear and communicable fashion, (2) it clarifies the position of the individual stakeholders in innovative value constellations, and (3) it gives some qualitative directions where critical points and possible opportunities for new business models are to be expected. The next step will be to carry out a thorough profitability analysis in a quantitative way, which is also part of the e^3 -value methodology.

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