Market Success: The Quest for the Objectives and Success Factors of Markets

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Abstract Markets are an essential tool to coordinate complex systems. Engineering markets requires the consideration of numerous objectives and factors that will eventually determine the market's success. These objectives and factors are frequently not well defined or elaborated. Hence, this chapter aims to support market design through a perspective on what determines market success. To this end, we review the literature, consider examples of market success and failure, and reflect on our ongoing work regarding future electricity market design. We provide a framework for market objectives and success factors with a focus on electricity markets. The framework could spur the identification of objectives and success factors of markets in other domains, and inform the engineering of future electricity markets.

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1 Introduction

> Science is concerned with what is possible while engineering is concerned with choosing, from among the many possible ways, one that meets a number of often poorly stated economic and practical objectives.—Richard Hamming (1969)[1]

Rising global temperatures and natural catastrophes call for active policy interventions in terms of CO_2 reductions and sustainable use of natural resources. The energy sector plays a vital role in addressing climate change because many CO_2 emissions are energy related (IPCC 2014). Stressing the need to tackle this issue globally, the United Nations has included the provision of sustainable, reliable, and affordable energy in their 2030 agenda for sustainable development (SDG7) (Fuso Nerini et al. 2018). On a national basis, Germany is adopting similar plans, including increasing the share of renewable energies, phasing out coal power plants, and reducing greenhouse gas emissions by 2030 by 55% compared to 1990 (Deutscher Bundestag 2019). Under the European Commission's Green Deal, Germany further strives for climate neutrality by 2050.

In facilitating the transition toward clean energy, energy markets—and, more specifically, electricity markets—serve a critical enabling function. This function can be explained by the potential of markets to promote allocation and information efficiencies. Moreover, markets may also steer individual behavior to efficient market outcomes via price signals. In some cases, however, prices may not accurately reflect reality, which results in market failures due to, for example, negative externalities or abuse of market power (Andrew 2008). These concerns also apply to electricity markets since these are inherently characterized by high entry barriers, imperfect information, social and environmental costs, transmission and storage constraints, as well as inelastic demand, which may all lead to incorrect price signals (Cramton 2017; Wilson 2002). The increasing share of renewable energy production further underlines the need for well-functioning markets, as the resulting generation decentralization and price volatilities require enhanced market coordination and information flows (Lösch and Schneider 2016).

Setting up well-functioning electricity markets is not a trivial task, as it usually involves a complex set of (conflicting) market objectives. Moreover, a given market's overall success can be evaluated only by assessing market structure and outcomes against the backdrop of various economic, social, legal, technological, and physical factors. Further, "market success factors" may contribute to successfully achieving the objectives. Disentangling these market success factors allows for describing, explaining, monitoring, and predicting the success of different market designs and contributing to choosing a satisfying or even the best design.

Therefore, this chapter's aim is as follows:

[1] Richard W. Hamming was an American mathematician who received the Turing Award in 1968. The quote is from his Turing Award lecture (Hamming 1969, p. 5).

> Identify and structure the multitude of market objectives and their corresponding success factors to support scholarly and practical approaches to designing and engineering electricity markets.

By understanding the critical determinants of market success, this chapter is a step toward a future-proof and sustainable electricity market design that complies with the overarching goal of delivering reliable electricity at the least cost to consumers (Cramton 2017). While we focus on electricity markets, we believe that most of the objectives and success factors can also be applied to other markets.

This chapter provides a comprehensive framework to achieve its aim, which allows for discussion of market objectives and market success factors beyond the traditional mechanism design of economic theory. Moreover, our framework contributes to existing work by mapping market objectives and market success factors. The framework is derived from an interdisciplinary literature review in the fields of—among others—economics, social sciences, information systems, operations research, computer science, and law. Moreover, the framework comprises insights from exemplary electricity markets and interdisciplinary market design workshops within the German Kopernikus project SynErgie (Sauer et al. 2019).

The remainder of this chapter is structured as follows: Section 2 lays out theoretical concepts. Section 3 presents the core artifact of this work, the market success framework. Section 4 discusses our framework's practical usage, limitations, and perspectives for future research. Section 5 concludes.

2 Theoretical Background

2.1 Market Design and Market Engineering

Markets are designed and engineered. "A market is a set of humanly devised rules that structure the interaction and exchange of information by self-interested participants in order to carry out exchange transactions at a relatively low cost. As such, markets are constrained by a sociocultural and legal framework" (Gimpel et al. 2008). Markets are information processing systems and services that support equating supply and demand, finding prices, and deciding on allocations and transactions. Markets are also entrepreneurial activities, and they may compete with other markets unless the regulatory framework ensures a monopoly position. Markets are the outcome of both evolutionary, emergent phenomena and purposeful design. Market design thus requires attention to all of a market's complications and details (Roth 2002). Therefore, "market design calls for an engineering approach" (Roth 2002, p. 1341). Others go even further and require a detail-focused "plumbing mindset." "The economist-plumber stands on the shoulder of scientists and engineers, but does not have the safety net of a bounded set of assumptions" (Duflo 2017, p. 3).

Market design and market engineering are closely related concepts. One can understand market design as an object (the design artifact) or as an activity (the process of designing). As an activity, market design is the art of designing institutions so that the behavioral incentives for individual market participants are in line with the market architect's overarching objectives (Ockenfels 2018). Market engineering is "the use of legal frameworks, economic mechanisms, management science models as well as information and communication technologies for the purpose of: (1) designing and constructing places where goods and services can be bought and sold; and (2) providing services associated with buying and selling" (Gimpel et al. 2008, p. 3). Market engineering is a process that produces (among other things) a market design artifact. As such, market engineering is close to the activity of market design. Both concepts also originate from an interdisciplinary background (Roth 2002; Wilson 2002). Market design was initially rooted in micro-economics but was soon extended to a broad range of other research areas such as computer science and operations research (Baliga and Vohra 2003; Roth 2008). Market engineering was coined by Christof Weinhardt and his team in the early 2000s (Weinhardt et al. 2003, 2006; Neumann 2004; Holtmann 2004; Weinhardt and Gimpel 2007; Gimpel et al. 2008). Christof and his team had a background in economics and information systems and leveraged the respective literature. They added multiple perspectives from their interdisciplinary work and collaboration with researchers from various disciplines, along with economics and information systems including management, finance, operations research, computer science, and law, to name but a few. The engineering perspective stresses the holistic view of markets, the notion that details matter, the need for an interdisciplinary approach, and the use of multiple methodologies (Gimpel et al. 2008; Roth 2002; Weinhardt et al. 2003). In sum, market engineering offers a broader and more holistic perspective on designing and engineering markets. In contrast, market design is used for a longer time, more widely, and (within its scope) more deeply.

2.2 Market Structure and Success

The object being analyzed and designed in market engineering is a market. A market involves multiple elements, as shown in Fig. 1. This perspective originates from Smith's (2003) micro-economic system framework, extensions offered by Weinhardt et al. (2003) and Gimpel et al. (2008), and further extensions suggested here. The market is embedded in the *socioeconomic, legal, technological, and physical environment*. A specifically relevant part of that environment might be a *regulatory authority* surveilling the market structure, participants' behavior, and outcomes to enforce or adjust the regulation.

The *market structure* resides within the environment. It contains the definition of the *transaction objects* which might be offered, sought, or traded via the market (e.g., block contracts for consecutive hours of energy supply one day ahead). Further, *participation rules* define who is allowed to enter the market or

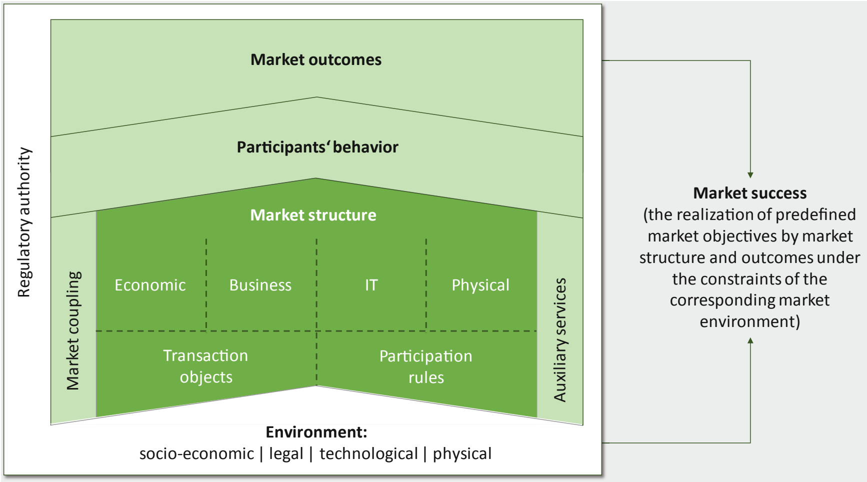

Fig. 1 Framework for market engineering (extension of Weinhardt et al. [2003] and Gimpel et al. [2008])

not (e.g., prequalification requirements for entering a balancing power market). The market structure has four further sub-structures: the *economic structure*, the *business structure*, the *IT structure*, and the additional *physical infrastructure*. The economic structure (also referred to as market microstructure) includes the bidding language, transparency rules, allocation rules, and price determination. The business structure focuses on the market as an entrepreneurial endeavor. It provides for the market institution's financing, the cost structure, revenue streams, personnel recruitment, development, dispatch, etc. The IT structure includes all the IT software and hardware belonging to an electronic market. The additional physical infrastructure includes any other physical assets (beyond IT hardware) that belong to the market (e.g., buildings for displaying goods being offered, for fiduciary storage, for facilitating the in-person exchange of traders, or for settlement). The relative importance of these structures might vary across markets. The market structure is flanked by *market coupling* (e.g., the markets for electric power being linked to markets for fossil fuels) and by *auxiliary services* that are not at the core of the market process but support participants (e.g., weather or price forecasting services).

On top of all this, there is the *market participants' behavior*. This behavior will typically result from the environment; the actors' options, values, and preferences; and the market structure. Behavior and structure jointly determine *market outcomes* (e.g., allocation or prices). A key challenge in market engineering is designing the market structure so that—given the environment—the behavior of the participants outside the control of the market designer and engineer results in the desired outcome and market success.

3 Market Success Framework

3.1 Market Objectives

Market success is the realization of predefined market objectives by market structure and outcomes under the constraints of the corresponding market environment. *Market objectives* are the aims of a market; they are the ends to which the market is engineered and operated. For electricity markets, the market objectives reflect the underlying electricity system and society's objectives as a whole, and thus exceed the scope of pure economic efficiency (Kominers et al. 2017). Market objectives need to be chosen with great care since the whole market is designed around them. For instance, regulatory changes or fiscal instruments (e.g., taxes or public debt) are introduced in accordance with market objectives. The lack of a concise definition of these objectives may result in unintended and unforeseen market outcomes.

Objectives can conflict with one another, and trade-offs need to be considered when deciding on the overall objectives. For instance, electricity markets typically face a trade-off between short-run and long-run efficiency (Biggar and Hesamzadeh 2014). Even if efficient electricity production with existing plants is achieved in the short term, concerns may arise in the long term over which investments in new plants and technologies and retirement of existing plants are necessary for efficiency. However, whether one or multiple market objectives are attainable in practice hinges on various conditions that we refer to as success factors. *Market success factors* are elements of a market's structure, auxiliary services, coupling, environment, or participants' behavior that directly influence the attainment of market objectives, thereby marking the difference between market success and market failure.

Figure 2 provides an overview of the market success framework. It lists the objectives and success factors, which are further detailed in the chapter.

Table 1 provides a list of common market objectives. The list comprises traditional economic criteria (e.g., short-run and long-run efficiency) and complements these with other essential perspectives relating to, for example, social well-being (support of the broader economy and society), sustainability (environmental/human health protection), or fairness (distributive justice). The list addresses electricity markets explicitly and captures the essential commodity aspect of electricity (security of supply). While we believe that each of the objectives listed may be a legitimate objective for an electricity market, we do not claim that the list is exhaustive. The list of objectives expands and complements traditional economic design desiderata such as allocative efficiency, individual rationality, budget balance, incentive compatibility, and core stability (Mas-Colell et al. 1995). In particular, the latter might often be challenging to achieve in a strict sense in complex real-world electricity markets. In contrast, the list of objectives in this chapter focuses on long-term-oriented objectives from a broad social perspective.

Fig. 2 Overview of the market success framework

3.1.1 Short-Run Efficiency

In economic terms, the objective of short-run efficiency is achieving allocative (or Pareto) efficiency (Dierker 1986). In the context of electricity, a market is allocatively efficient when the market price approaches the cost of supplying an additional unit of electricity (Green 2000; Munoz et al. 2018). Thereby, price signals are essential for steering supply and demand toward allocatively efficient outcomes. For prices to perform this function—and thus to serve as a reliable indicator of current market conditions—they need to reflect all relevant information available in a given market. For instance, prices need to reflect the costs of different power plants or local grid constraints. Marginal costs, on the other hand, comprise important supply-side information and may include, for example, the costs of fuel needed to arrive at an additional unit of energy (Munoz et al. 2018). Allocative efficiency may be achieved by maximizing gains from trade, which can be defined as the

Table 1 Electricity market objectives

Market objectives	Key aspects
Short-run efficiency	• Timeframe: Short run • Maximization of welfare or gains from trade • Minimization of costs • Requires inclusion of all affected parties and costs
Long-run efficiency	• Timeframe: Long run • Maximization of welfare • Requires incentivizing efficient investments in assets and network, as well as for decommissioning • Efficient allocation of risk
Support of the broader economy and society	• International competitiveness • Low financial burden on consumers • Innovativeness of the energy sector • High employment in the energy sector
Security of supply	• Reliability: Security of supply and energy system security • Robustness: Ability of the energy system to cope with disruptions and operate under unusual circumstances such as outages or IT security leaks • Resilience: Ability of the energy system to maintain services under stress and in turbulent environments
Distributive justice	• Different distributive rules such as egalitarian, merit, or utilitarian • Distribution by region, origin, income, age, etc. • Justice such as procedural or cosmopolitan justice
Environmental protection	• Protection of natural resources in quantity and quality, as well as of natural ecosystems • Sustainable use of natural resources • Climate neutrality • CO_2 reduction
Human health and flourishing protection	• Promote health, for example, by avoiding noise emissions, radiation, or toxic substances along the whole energy lifecycle • Promote well-being, happiness, life satisfaction, virtue, and close personal relationships

"improvement in consumer incomes and producer revenues that arise from the increased exchange of goods and services" (Sauma and Oren 2007, p. 1397).

To reach efficient market outcomes, electricity markets need to aggregate all information and reliably consider all available assets and network constraints. This rule implies that market mechanisms successfully avoid costly ex-post adjustments in the form of redispatch. Thus, redispatch refers to rearranging the schedule of (conventional) power plants such that all transmission constraints are respected, and demand is met (van den Bergh et al. 2015). Since efficient markets already consider the actual value or cost of electricity, externalities such as fossil fuel combustion are fully captured by market mechanisms and thus internalized (Andrew 2008). If externalities are internalized, short-run efficiency can align nicely with market objectives in the sustainability domain, such as environmental protection.

3.1.2 Long-Run Efficiency

The objective of long-run efficiency is "ensuring the market provides the proper incentives for efficient long-run investment" (Cramton 2017, p. 591). For electricity markets, the term "proper" refers to at least three aspects of long-run investment. First, investments need to be made in the "right" technologies. For example, for the German Energiewende, investments should be made in renewables instead of fossil power plants. Second, investments should be made in optimal asset capacities and network capacities. Third, investments need to be made in the right locations of the system (Cramton 2017). Another critical aspect of the objective of long-run efficiency relates to market power. No market participant or coalition should be able to manipulate the market outcomes to their advantage. Instead, it is essential that free competition is possible and that barriers to market entry and exit are low. Free competition also includes support for new market players or small-scale entrants such as prosumers.

Moreover, long-run efficiency also addresses the "missing money problem," which captures the idea that electricity prices do not fully reflect the value of investment needed to meet customers' expectations for reliable electric services (Hogan 2017). Hence, conventional power plants, which mostly perform as base load or back-up generators, may not recover their fixed costs due to low returns. Low returns may stem from a drop in prices, which is usually explained by high feed-in from renewable energy sources and low(er) demand linked to increasing energy efficiency (Hogan 2017). Lastly, long-run efficiency also comprises the co-existence of markets with different timescales (e.g., futures, day-ahead, or intraday) that allow for hedging against risks.

3.1.3 Support of the Broader Economy and Society

As discussed in Sect. 2.1, every market operates in a broader environment. Similarly, the electricity market operates within the context of the broader economy and, ultimately, society. There are multiple links and possible feedback channels between the broader economy (and society) and the electricity market (Brown and Spiegel 2019). Interaction effects may occur, for example, via market prices, employment rates, innovations, or the abuse of market power. For instance, as a significant production cost component, electricity prices may influence the (international) competitiveness of the manufacturing industry (Kwon et al. 2016; Moreno et al. 2014). In this case, electricity prices influence the competitive environment of non-electricity markets and bear consequences for the whole society via employment rates and tax income. Similar effects arise concerning market power, where monopoly electricity providers may also extend their powerful position to other markets (or society), for example, by controlling electricity prices (or outputs). On the retail level, electricity prices further have an essential impact on consumer rent and individual households' economic and social well-being (Brennan 2007). Lastly, it is essential to note that prices guide market participants on both the wholesale and retail level. This guidance implies that price components need to be understood by all relevant players so that economic decisions can be based on "true" market signals (Vucetie et al. 2001). Hence, this objective seeks to reduce the complexity of electricity prices, which is frequently introduced by additional levies and taxes, so that informed decision-making is possible. Informed decisions not only influence social participation but also positively affect short-run efficiency. Increased transparency may generally contribute to efficient allocation and pricing (Francis et al. 2009).

3.1.4 Security of Supply

From a short-term perspective, supply security refers to the readiness of existing capacities to meet the current load. Markets require proper incentives for the provision of reserves (Creti and Fabra 2007). From a long-run perspective, supply security involves performance attributes that stimulate investment in generation, transmission, distribution, metering, and control capacities to ensure stable system operation (Creti and Fabra 2007). More generally, the objective of security of supply refers to the market design supporting the reliable operation of the whole electricity system. Reliability in the electricity sector may be defined using two components: adequacy and security. First, "adequacy refers to the ability of the system to supply customer requirements under normal operating conditions" (McCarthy et al. 2007, p. 2153). Second, security includes the system's dynamic response to unexpected disturbances and relates to its ability to tolerate them (McCarthy et al. 2007). In sum, reliability can broadly be described as the system's ability to supply the electricity desired by consumers when and where it is demanded. Subcategories of reliability are resilience and robustness. Thus, resilience is traditionally used in an interdisciplinary context and provides a measure of stability related to objects' ability to promptly recover from an exogenous shock and promptly return to the equilibrium state (Mola et al. 2018). Within the power industry, resilience is defined as the system's ability to maintain or recover quickly to a stable state, allowing it to continue operations in the presence of significant mishaps or continuous stress (Ibanez et al. 2016). Common elements of resilient electricity systems are, for example, continuous feedback and monitoring of critical systems and consistent planning of communications and IT services to minimize human error (Carvalho et al. 2006). A system is robust if it is resilient for given events under all defined states (Ibanez et al. 2016).

To achieve reliability in practice, electricity markets need to allow for adjustments in the very short term in the case of instabilities. The existence of well-functioning balancing markets as well as redispatch activities can contribute to such adjustments. To mitigate the need for these costly short-term measures, electricity markets must account for available flexibilities already early on. Flexibilities can be provided through electricity generation or demand, storage technologies, transmission line expansions, or sector coupling (Heffron et al. 2020). In order to trade flexibility, separate flexibility markets may be needed that complement wholesale electricity markets (Hirth and Schlecht 2019). Objectives relating to economic efficiency need to create appropriate incentives for flexibility investments. Hence, the security of supply and long-run efficiency are closely interlinked objectives (Jamasb and Pollitt 2008).

3.1.5 Distributive Justice

The outcome of every market will produce both benefits and costs. Distributive justice as a market objective refers to how these benefits and costs are distributed among the market participants. The answer to the question of what justice means in such a context is highly critical. Nevertheless, market design and engineering need to consider the distributive effects resulting from how the market is organized (Traber 2017). There are different rules according to which the benefits and costs can be distributed. For instance, an egalitarian rule assigns everyone identical benefits and costs; a merit-based rule assigns benefits and costs in proportion to the contribution that market participants have made to the market outcome; a utilitarian rule assigns benefits and costs such that the greatest overall utility is achieved (with the notion of utility itself being subject to debate). Further, an inequitable distribution can also show itself according to, for example, region, origin, income, or age.

For electricity markets, distributive concerns often evolve around zonal or nodal pricing schemes (Ding and Fuller 2005). Smaller bidding zones usually involve price heterogeneity between different regions and favor one region over another (Egerer et al. 2016). Regional disparities may then have a considerable impact on the economy (or society) as a whole and the corresponding market objective. However, the growing decentralization of electricity systems and high shares of renewable energy sources may demand regionally differentiated prices in terms of economic efficiency (Neuhoff 2011). Uniform pricing may run counter to the objective of short-run efficiency. Further issues arise concerning how countries finance their energy transitions, such as the German Energiewende, as the related costs and benefits are typically distributed over different generations (Healy and Barry 2017). More precisely, the (economic) costs are mainly borne by today's generation to not further destroy the next generations' natural environment. Cross-generational settings often lead to underestimating long-run costs and thus underinvestment (Winkler 2009). Distributive justice, under certain circumstances, falls short of long-run efficiency objectives. Distributive justice may further be concerned with issues around energy poverty. Energy poverty relates to (un)equal access to modern energy services and the underlying pre-conditions for electricity usage (González-Eguino 2015; Sovacool 2012). For instance, poorer households may have to face higher electricity bills due to less energy-efficient buildings and devices (Reames 2016). In this case, distributive justice is again closely linked to objectives relating to economic and social development.

3.1.6 Environmental Protection

In essence, the market objective of environmental protection relates to the protection of natural resources in quantity and quality and the protection of ecosystems (including wildlife). This objective does not exclude the use of natural resources per se but calls for doing so sustainably, that is, in such a way that resources can be renewed. In the context of electricity, environmental protection translates into climate neutrality of electricity generation and avoidance of negative externalities for the environment (Capros et al. 2019). This shift is captured by the German Energiewende, for instance, which strives to increasingly replace conventional power plants with renewables to generate "clean" energy. Note that environmental protection is closely linked to short-run and long-run economic efficiency since externalities need to be reflected in prices (short run), and "green" investments need to be stipulated (long run). Furthermore, environmental protection may influence the broader economy and society.

3.1.7 Human Health and Flourishing Protection

Generating, transmitting, and consuming electricity comes with by-products such as noise emissions, radiation, or toxic substances. These by-products may negatively affect human health and flourishing (Treyer et al. 2014). For instance, the combustion of fossil fuels such as coal produces particulate matter, which—when it occurs in high concentrations—settles in the human lung and causes lasting damage. Therefore, the objective of human health and flourishing protection calls for electricity markets in which such adverse impacts are minimized. The installation of air filtration systems in coal power plants and, more generally, a shift toward renewable electricity production are measures supporting this objective (Akella et al. 2009). Beyond health, a possible objective could be that a market does not interfere with or even promote factors related to human flourishing such as well-being, happiness, life satisfaction, virtue, and close personal relationships. Analogous to the previous objective—environmental protection—human health and flourishing are also closely related to short-run and long-run efficiency and the broader economy and society. Additionally, human health also strongly depends on the previous objective of environmental protection.

In summary, we identify seven different market objectives that are distinguishable but also interrelated. The market objectives may be conducive to or inhibit one another, requiring trade-offs. However, whether one or several of the above objectives are achieved depends on success factors. In the following, we outline different success factors that directly impact market objectives and thereby foster or inhibit a market design's overall success.

3.2 Market Success Factors

3.2.1 Objective Orientation

While it may sound trivial that market design should be aligned with the market's objectives, it is somewhat challenging to determine what this means in practice. First, objective orientation implies that the market designer and engineer have determined the market's objectives. Second, objective orientation implies that the market design is catered to the market objectives. Third, effectivity means that a given market design is well suited to achieve the chosen market objectives (Cramton 2017). Market design provides instruments that effectively guide the individual behavior of the market participants.

Linking this success factor to the previously outlined market objectives, it becomes clear that all objectives are somehow affected by the degree of "objective orientation." Hence, all the above objectives may more likely be reached if market design directly addresses them.

3.2.2 Participation

Whether market design finally contributes to achieving the chosen objectives crucially hinges on market participation. Only if market players transact in a given market, the market can achieve its objectives. Hence, (potential) market participants should not be excluded from the marketplace, and market entry barriers should be low (Pavić et al. 2017). In addition, markets have to create the appropriate short- and long-term incentives to use them and not rely on agreements and transactions outside the market. In other words, no market participant should be able to do better by transacting outside the marketplace (Roth 2012). Fluctuating prices may incentivize market players to participate in local markets for flexibility in the short term. In contrast, in the long term, market players may be encouraged to invest in sufficient capacity to profit from price peaks (Graßl and Reinhart 2014).

Concerning market objectives, market participation may be closely linked to both short-run and long-run efficiency. In particular, markets may operate efficiently only if sufficient information and all stakeholders are considered. Goods are allocated to the participant with the highest valuation, or contracts to the participant with the lowest costs.

3.2.3 Incentives for Market-Conducive Behavior

Market designers and engineers need to create incentives that induce behavior conducive to the efficient functioning of the respective market. Market participants need to be incentivized to support market objectives and act following market rules and institutions. More precisely, no market participant or coalition should be able to manipulate market mechanisms, to engage in tacit collusion, or to bid or game strategically (Kominers et al. 2017; Kumar and Wen 2001). Market designers and engineers therefore need to create a market in which it is safe for market participants to reveal information and in which the market outcome is stable such that no market player or coalition can gain an advantage by deviating from it. If achieving the market objective depends on the participants' disclosure of information, it must be in the market participant's best interest to do so (e.g., due to dominant strategy or Bayesian incentive compatibility) (Roth 2007, 2012; Wolak 2019).

Considering the link between this success factor and the market objectives, incentivizing market-conducive behavior may support short-run and long-run efficiency and contribute to a market's support of the broader economy and society. For instance, the disclosure of private information and the resolution of conflicting interests fosters efficient market allocations as well as "true" price signals; the lack of opportunities to exploit market power and form strategic coalitions positively contributes to the objective of long-run efficiency; installing market incentives that foster technological innovations and adoptions may cause positive spill-overs to the broader economy and society because research and development activities need to be conducted and innovations can be used for applications outside the electricity domain.

3.2.4 Integration and Interconnection

Markets are typically interconnected with "neighboring" markets. For example, there is not just one energy market, but rather many neighboring submarkets on which different energy resources and services are traded, for example, the gas market, oil market, and electricity market. Moreover, markets are typically integrated into the broader market environment. For instance, the markets for different energy resources and services are influenced by numerous other markets whose transaction object is not energy but, for example, consumer goods, tourism, or labor (Heffron et al. 2020). Further, the electricity market itself comprises several submarkets, for example sequential markets for the same final good such as forward markets and real-time markets for energy. Therefore, market designers and engineers must be aware of possible feedbacks between neighboring and larger markets. In particular, they must ensure that neighboring markets are aligned with one another. Each market is efficiently integrated into the broader market environment to reduce or completely prevent friction between the various (sub)markets.

By linking this success factor with the market objectives, integrating markets into the broader market environment may significantly contribute to the market's support of the broader economy and society; interconnecting a market with its adjacent markets can notably contribute to short- and long-run efficiency.

3.2.5 Coordinated Timing

Within a given market, coordinated timing refers to the absence of time lags and sufficient time for market participants to reflect and make a decision. Market participants have sufficient time to (re)consider and evaluate different alternatives and make informed decisions (Roth 2007). Moreover, market designers and engineers need to consider possible interactions with different (sub)markets to ensure that no market participant is excluded from market interactions due to incompatible timing and the speed with which changes can be implemented in the existing market design.

Concerning the market objectives, coordinated timing predominantly influences the objectives of short-run and long-run efficiency. For instance, sufficient decision time allows market participants to consider and aggregate all available pieces of information in the short run. In the long run, coordinated timing enables participation in different (sub)markets and does not structurally exclude participants from market interactions.

3.2.6 Realizability in IT Systems

Electricity markets are complex markets whose functioning today largely depends on IT systems. For example, the market outcomes on power exchanges are calculated using algorithms, bids of suppliers and buyers are transmitted digitally, and network operators rely on computers to manage their network. Accordingly, market success depends heavily on the speed of the computations, the quality of their outcomes, and the security of the IT systems. Further, changes in the market design must ultimately be represented by the IT system and implemented in the existing structure.

Concerning the market objectives, this success factor mainly contributes to short- and long-run efficiency and supply security. Among the market objectives, these three objectives are most strongly affected when IT systems do not function properly.

3.2.7 Legitimacy

The concept of legitimacy is frequently discussed from an interdisciplinary perspective including, for example, important studies in political science (Lipset 1959), philosophy (Habermas 1975), psychology (Tyler 2006), and sociology (Johnson et al. 2006). More recently, legitimacy also extends to further domains, including, for example, electricity systems (Fuchs 2019; Renner and Giampietro 2020). In the electricity context, legitimacy is understood from an organizational (or managerial) perspective, referring to the "generalized perception that the actions of an entity are desirable, proper, and appropriate" (Suchman 1995, p. 574). The rights and identity of a regulator are publicly agreed on. Questions of legitimacy nowadays mainly relate to market design issues involving, for example, legitimacy of market operators, market participants, and institutional changes (Fuchs 2019). Thus, creating a broad social consensus on decision rights and relevant institutions constitutes a major success factor for market design. Consensus can usually be achieved if market incentives and institutions are aligned with socially accepted market objectives.

As indicated by the Fukushima incident, legitimacy can positively impact the objectives of environmental protection and human health. Environmental and human health protection are prerequisites for legitimate market design and thus already imply objective compatibility. Moreover, legitimacy is closely linked to distributive justice. If markets involve an unequal distribution of resources and outcomes are perceived as "unfair," market success is inhibited due to legitimacy concerns.

3.2.8 Legality

Another important driver of market success is legality, meaning that market design aligns with current law and jurisprudence. Legality requires decision-makers, in our case market designers and engineers, to resolve disputes by applying legal rules that have been declared beforehand, and not to alter the legal situation retrospectively at their discretion (Robinson 2005). One exemplary legal aspect that needs to be considered in market design is the protection of business secrets. Making the protection of confidential information enforceable by law allows market participants to truthfully reveal their valuation (or cost) to the market operator when engaging in market interactions, which is also an essential prerequisite for overall market success.

Considering market objectives, legality is connected to all of the above objectives in one way or another. First and foremost, legality impacts short-run efficiency via trust formation and the protection of business secrets. Moreover, flexible law amendments may positively contribute to short-run efficiency via swift adaptations to changes in the market environment, for example, an increasing share of renewable energies. However, note that a flexible legal framework may increase uncertainty of future expectations and negatively impact long-run efficiency, possibly leading to a conflict between short-run and long-run objectives. Further, the legal framework in electricity markets may impact the broader economy and society, as it significantly influences electricity prices and thus the financial burden of electricity on the household and industry level.

3.2.9 Technological Factors

Markets rely on various technologies, both analog and digital. Market designers and engineers must ensure that markets are designed to be technology-neutral for markets to select the "right" technologies (in the sense of being efficient, effective, cost-effective, etc.). Technology neutrality of markets is the only way to make sure that the technologies prevail in open competition. However, some objectives may require the privileged treatment of specific technologies, such as renewable energy generation in electricity markets, to achieve environmental objectives (Gawel et al. 2017). Moreover, market designers and engineers should anticipate technological developments in the short term, midterm, and long term and consider such possible developments when implementing new market rules.

Linking this success factor to the market objectives may contribute to short- and long-run efficiency, the security of supply, environmental protection, and human health and flourishing protection, for example, if more power plants are built that emit fewer pollutants into the environment.

3.2.10 Transparency

Another essential success factor for markets is transparency (Cramton 2017). Transparency implies that the market's rules, particularly how the participants' behavior translates into market outcomes, are unambiguously specified and communicated to the market participants. Common knowledge of the rules allows market participants to anticipate other participants' behavior and consequences and act accordingly. Transparency about the market outcome, if not in conflict with information confidentiality, may increase trust in the market. Moreover, market rules need to be connected to a transparent period of validity, enabling foresighted decision-making and long-term planning. This also implies that market participants can make reliable predictions for the future with intertemporal planning being a possibility. Focusing on market rules, it becomes clear that they need to be designed clearly and unambiguously.

Linking transparency to market objectives, this success factor impacts both short-run and long-run efficiency. Market participants can easily understand existing market rules, including price formation, and correctly anticipate others' behavior in a transparent environment. This knowledge and understanding allows market participants to base their decisions on all available information correctly and is necessary for short-run efficient market outcomes. Transparency further fosters security of supply, as important market information may be exchanged more easily between system-relevant stakeholders (e.g., electricity providers or grid operators), and congestion problems can be anticipated with higher accuracy through market indicators.

3.2.11 Simplicity

Simplicity can be regarded as a necessary extension of transparency (Cramton 2017). Provided that market participants' valuations (or costs) are made transparent, it is further crucial that these preferences can be expressed simply and effectively. Hence, market participants face minimum transaction costs when placing their bids. Since markets operate simply and predictably, distorting interventions by the regulator are minimized. The absence of ex-post adjustments allows market participants to gain experience with a given market design, and learning effects are possible. Another aspect of simplicity is the ease with which market designs are practically implemented. A given market design easily fits into the existing social, legal, technological, and economic environment and can be implemented via existing infrastructure.

Simplicity affects the objectives of short-run and long-run efficiency, as it contributes to reducing implementation hurdles and false expectations. More precisely, the unambiguous and straightforward disclosure of preferences and comprehensible market rules supports short-run efficient outcomes. The reduced need for ex-post adjustments and market interventions further enhances efficient market operation in the long run, creating a stable investment environment. Simplicity also positively impacts the objective of security of supply since unintended miscoordinations are limited due to a consistent understanding of market rules.

4 Intended Usage and Limitations of the Market Success Framework

The proposed framework of market objectives and success factors provides a holistic overview of functional market design requirements and serves as practical guidance for researchers, policymakers, and practitioners. It may be used along the whole lifecycle of markets from their initial conception up to the operation and eventual shutdown (Weinhardt et al. 2003; Neumann 2004; Gimpel et al. 2008). Thereby, our framework may assist all relevant stakeholders and decision-makers throughout the process of designing, evaluating, and monitoring markets. In this context, relevant user groups are regulators, market designers and engineers, and researchers from various fields, including economics, operations research, information systems, computer science, and law. Specifically, we see at least four possible ways to use the market success framework:

1. The framework, most notably the objectives, may serve as a starting point for eliciting needs and requirements for a market. Further, it may serve as a reference frame for structuring various perspectives, needs, and requirements. While the framework presented in this chapter might be a starting point, we assume that the framework is adapted to fit the specific market to be designed.
2. The market success framework may be used in the design phase. The objectives will serve as guiding principles for market designers and engineers, and the success factors offer more specific guidance on which aspects to consider. Again, we assume that the framework serves as a starting point from which the list of success factors and their interrelations with the objectives need to be tailored for a specific market.
3. Once one or multiple potential market designs are developed, they should be evaluated and refined to the point where a single satisfying design is selected. In this evaluation, the objectives—adapted to the specific market—are the

dimensions to be considered for judging the likely market success. On a more operational level, the success factors—adapted to the specific market—provide a list of factors to consider for evaluating the market.

4. Once the market is in operation, it should be monitored and re-evaluated based on its structure and outcomes in the field. Similar to the evaluation during the design phase, for an evaluation in the operation phase, the market success framework provides both the objectives and the success factors to consider. It is likely that the market operators, regulators, and competition authorities will, over time, reconsider objectives and success factors and gradually evolve them.

The market success framework may be used from two different perspectives. First, it may be used descriptively as an analytical framework to support market design. Second, it may be used to normatively judge the quality of market designs and derive recommendations on how markets ought to be designed. No matter which perspective is ultimately adopted, the market success framework seeks to structure existing market engineering processes and provides a common ground for future work.

Quite naturally, our work has limitations. The proposed list of market objectives and success factors is not exhaustive and is explicitly tailored to electricity markets. Hence, market designers, engineers, and researchers may extend our framework to other fields of application and add more objectives and success factors to the list. Moreover, our framework does not include suggestions concerning the operationalization and measurement of the proposed success factors. Therefore, future work may aim to establish objective criteria to state the degree of success factor achievement reliably. In addition, our framework does not provide information on the relative importance of the objectives and success factors. Possible extensions in this field may include a selection and weighting process to distinguish between primary (obligatory) and secondary (optional) market success factors.

5 Conclusion

Societal and technological changes call for active and detailed engineering of markets to cope with and manage increased market complexity. The emergence of new market participants, technological innovations, and the plurality of social values and constructs open up a complex field in which market designers and engineers need to make decisions regarding possibly conflicting market objectives and specific measures they want to implement. Hence, this work provides a structured overview of different market objectives and the corresponding factors that contribute to achieving these objectives and ultimately determine market success. This work's focus mainly lies in electricity markets. The ongoing energy transition poses various new challenges to market designers, engineers, and regulators, which will most likely increase in the coming years. More precisely, the energy transition brings about fundamental changes in the market environment and therefore calls for market design adaptations. Against this background, the energy transition will only realize its full potential if changes in the market environment are effectively addressed by market design. Even though this work is mainly centered around electricity markets, our framework may also be extended to other application fields. Further research may tailor this framework to a range of other markets in which market design interventions are required due to market failures, malfunctioning, or changes in the overall market environment. Hence, our framework provides an essential basis for understanding market performance (or quality) and, ultimately, market success.

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