Taking Stock of Economic Regulation of Power Utilities in the Developing World

A Literature Review

Martín Rodríguez Pardina
Julieta Schiro

World Bank Group
Energy and Extractives Global Practice
May 2018
Abstract

The model of power sector reform that emerged during the 1990s placed considerable emphasis on the creation of an independent regulatory agency, with a strong orientation toward technically-driven tariff-setting procedures. Despite widespread uptake of regulation, implementation has proved to be challenging in the developing world. Regulators were seldom as independent as originally envisaged, with widespread divergence between the formal regulatory framework and the day-to-day practice of regulation. In practice, many developing countries operate with “advisory regulators” whose main role is to provide technical support to the ultimate political decision makers. Nevertheless, there is some evidence that regulation has had a positive performance impact, particularly where utilities are privatized and in middle-income settings. But the impact is more questionable in cases where regulation is primarily directed toward state-owned enterprises, which lack the commercial incentives to respond to regulatory instruments.

On the choice of regulatory regimes, the ongoing debate between price cap and rate of return regulation suggests that the latter may be better suited to developing country environments where the priority is to provide predictable returns to support large capital investment programs. Furthermore, the advent of technological disruption in the power sector demands an adaptation of the way in which regulatory instruments are designed and applied. Regulators will need to pay closer attention to providing the right incentives for utilities to innovate and become more energy efficient, and for consumers to take economically grounded decisions on distributed generation. Finally, the literature leaves many important questions unanswered, such as how regulatory design affects regulatory effectiveness and the impact of tariff regulation on cost recovery.

This paper is a product of the Energy and Extractives Global Practice. It is part of a larger effort by the World Bank to provide open access to its research and make a contribution to development policy discussions around the world. Policy Research Working Papers are also posted on the Web at http://www.worldbank.org/research. The authors may be contacted at marp@macroconsulting.net and jschiro@macroconsulting.net.
Taking Stock of Economic Regulation of Power Utilities in the Developing World: A Literature Review

Martin Rodríguez Pardina and Julieta Schiro

*Macroconsulting S.A. of Argentina

Keywords: Power sector regulation; Power sector reform; Power sector market design and regulation; Electricity pricing; Electricity tariffs; Developing countries; Emerging markets.

JEL Classification: L94

---

1 This paper is a product of the “Rethinking Power Sector Reform” knowledge program of the World Bank’s Energy & Extractives Global Practice. Any views presented here are the authors’ alone and should not be attributed to the World Bank or any other person or institution. Financial support from the Energy Services Management Assistance Program (ESMAP) and the Public Private Infrastructure Advisory Facility (PPIAF) is gratefully acknowledged. Peer review comments were provided by Vivien Foster, Katharina Gassner, Joseph Kapika, David Reinstein, and Bernard Tenenbaum. Any shortcomings are the sole responsibility of the authors.
Contents

1. Introduction
2. Regulatory Governance
   2.1 Alternative Institutional Models
   2.2 Regulatory Independence
   2.3 Regulating State-Owned Enterprises
   2.4 Regulatory Impact
3. Regulatory Substance
   3.1 Tariff-Setting Objectives
   3.2 Tariff Regimes
   3.3 Regulation of Quality
4. New Regulatory Frontiers
5. Conclusions
1. Introduction

The aim of this literature review is to take stock of the body of knowledge on economic regulation of electricity; while acknowledging that this is only one of a number of relevant forms of regulation that may also cover health, safety, technical, financial and environmental dimensions. Following Brown et al. (Brown, et al. 2006), economic regulation can be defined as:

“the combination of institutions, laws, and processes that, taken together, enable a government to exercise formal and informal control over the operating and investment decisions of enterprises that supply infrastructure services.”

Brown et al. 2006 decompose regulation into two basic elements. The first element is governance, which refers to the institutional and legal design of the regulatory system and the framework within which decisions are made. The second element of regulation is substance, which is the content of regulation, the actual decisions, whether explicit or implicit, made by the specified regulatory entity or other entities within the government, along with the rationale for the decisions. The substance of economic regulation for natural monopoly industries, such as electricity, has traditionally comprised price controls (e.g. price caps or rate of return) and service obligations (e.g. minimum quality standards). The control of market entry (e.g. exclusive rights over a certain area) can also be considered a relevant aspect of market regulation, but this will be covered in a parallel literature review dealing with the topic of competition in electricity markets. More recently, regulators have increasingly been drawn into supporting implementation of a broader array of energy policies related to universal access and the clean energy transition, and the implications of this new agenda will also be considered here.

The aim of this literature review is to provide some insight to the following questions. What constitutes good regulatory practice? To what extent have countries succeeded in creating effective regulation? When are regulatory agencies needed? What measures are useful to build regulatory capacity? In practice, is it really possible to achieve regulatory independence? Is it meaningful to regulate state-owned enterprises? What evidence is there of the beneficial impact of regulation on the power sector? How are current technological disruptions affecting the practice of regulation?

To this end, the paper is organized as follows. Section 2 covers regulatory governance, examining alternative institutional models for organizing the regulatory process, distinguishing between formal regulatory rules on paper and the informal practice of those rules, considering the feasibility of achieving regulatory independence, and documenting the impacts of regulatory frameworks on sector performance. Section 3 addresses regulatory substance focusing particularly on tariff regulation, including the regulatory objectives of tariff-setting, the choice between alternative regulatory tariff regimes, and touching upon the regulation of service quality. Section 4 takes up the issue of technological disruption in the energy sector and its impact on economic regulation,
concluding that even when regulators may not always be required to take on additional
duties related to clean energy objectives, the advent of new technologies has major
implications for the optimal practice of traditional regulatory functions. Finally, Section
5 concludes.

2. Regulatory Governance

Brown et al (2006) define regulatory governance as the institutional and legal design of
the regulatory system resulting in the framework within which decisions are made.
Regulatory governance is defined by the laws, processes, and procedures that determine:
which enterprises, actions, and parameters are regulated; the government entities that
make the regulatory decisions; and the resources and information that are available to
support these decisions.

Brown et al (2006) also identify the characteristics of good regulatory governance as:
credibility; legitimacy; and transparency. Credibility means that investors must have
confidence that the regulatory system will honor its commitments. Legitimacy means that
consumers must be convinced that the regulatory system will protect them from the
exercise of monopoly power, whether through high prices, poor service, or both.
Transparency means that the regulatory system must operate clearly and openly so that
both investors and consumers understand the basis of decisions. In order to achieve these
three characteristics, the authors propose 10 key principles that should inform the design
of regulatory systems, as described in Error! Reference source not found..
Table 1: Principles in the independent regulator governance model

| Principle                                    | Description                                                                 |
|----------------------------------------------|-----------------------------------------------------------------------------|
| 1° Independence                              | Freedom to make decisions within scope of authority. Insulation from short-term political pressure. |
| 2° Accountability                            | Accountability for actions (reporting and audit, transparency, ethical and procedural obligations) |
| 3° Transparency and Public Participation     | Availability of documents and information used for decision-making for public inspection. Publicly available procedures and criteria for decision-making. |
| 4° Predictability                            | Reasonable certainty as to the principles and rules that will be followed within the overall regulatory framework. |
| 5° Clarity of Roles                          | Careful definition of roles in law, avoiding duplication of functions, interagency conflicts, mixed signals to stakeholders, policy confusion. |
| 6° Completeness and Clarity in Rules         | Provision, to all stakeholders, of clear and complete timely advance notice of the principles, guidelines, expectations, responsibilities, consequences of misbehavior, and objectives that will be pursued in carrying out regulatory activities. |
| 7° Proportionality                           | Regulatory intervention being proportionate to the challenge being addressed. |
| 8° Requisite Powers                          | Possession of all powers required to perform functions.                      |
| 9° Appropriate Institutional Characteristics  | Ability to consistently perform professionally, competently, and thoroughly. |
| 10° Integrity                                | Existence of strict rules governing the behavior of decision makers, so as to preclude improprieties or any conduct appearing to be improper |

Source: Brown et al (2006)

2.1 Alternative Institutional Models

In designing regulatory systems, several different institutional models are possible as shown in Figure 1 (Eberhard 2006).

---

2 It must be stressed, that these terms’ definitions are the ones adopted through this review.
At one end of the spectrum, there is “regulation by government”, where no distinction is made between the policy-making and regulatory functions of the government. This is the starting point in many countries. However, this arrangement can give rise to conflicts of interest between long term policy goals (e.g. financial sustainability of the sector) and short term political interests (e.g. avoiding popular unrest resulting from tariff hikes). The need for separate regulation of some sort arises from the desire to avoid these kinds of conflict of interest, by distancising technical decisions from the political process.

At the other end of the spectrum lies “regulation by agency”, the agency is a distinct independent entity with full financial and decision-making autonomy that takes binding decisions on regulatory questions. While this squarely addresses the conflict of interest problem, it can prove difficult in practice for the political system to relinquish control of the sector and fully respect regulatory independence. One possibility is to confine regulation to the legal enforcement of contracts, in cases where the private sector is operating and/or investing in the power sector, for instance through a concession or BOT contract; this is known as “regulation by contract”. Another possibility is to create regulatory entities with technical competence, but without decision-making autonomy, and treat them as advisory bodies, the so-called “advisory regulator”. In countries where technical capacity may be limited, regulation can be outsourced to consultants.
Eberhard (2006) states that regulatory design is “essentially about the appropriate level of regulatory discretion that should be informed by the local country context”; regulatory models should be “securely located within the political, constitutional, and legal arrangements” of countries, taking into account their level of regulatory commitment (i.e. the willingness of governments to de-politicize tariff settings and service standards), of institutional development, and human resource capacity (see Figure 2). It is also suggested that if there is weak regulatory commitment and capacity, it might be better, as an initial choice, to set regulatory contracts without a regulatory agency. On the other hand, if there is strong regulatory commitment but low capacity, then the solution may be to contract regulatory functions to an expert panel.

![Figure 2: Regulatory context and choices](source: Eberhard (2006). Figure 5)

Similarly, Brown et al (2006) provide a stylized outline of how utility regulation and regulatory functions often evolve. The pattern of regulatory evolution has been observed in the development of regulation in European and Latin American countries. The authors claim that the development of regulatory arrangements for infrastructure sectors often goes through three separate stages. The first stage, which they call “Contract Enforcement”, is an institutional arrangement by which long term commercial (and franchise) contracts can be written, approved, and enforced. This can be achieved through formal oversight by impartial courts of law that are enforcing an effective commercial law system. Alternatively, the contracts might be administered by the executive or legislative branches of government, or both. In a second stage, “Monitoring and Enforcement of Contracts by Separate Entities”, institutional arrangements take place under which utility service licenses or concession contracts can be monitored and enforced on an ongoing basis by a third party (an informal arbitration entity or a formal regulatory or quasi-regulatory body). Finally, in the third stage of evolution “Separate Regulatory Entity with Tariff-Setting Authority”, a separate regulatory entity is created. This entity can act of its own volition and has the authority, in consultation with regulated companies and their
consumers, to modify existing regulatory obligations (for example, maximum tariffs and minimum quality-of-service standards) and to establish new rights and obligations.

Often, the concept of an independent regulatory entity with final decision-making authority faces resistance from the government, so a truly independent regulatory entity cannot be created at initial stages of the reform process. As an alternative, advisory regulators are commonly established. Advisory regulators are entities that provide advice on regulatory decisions to a minister or prime minister, who retains responsibility for the final decisions. There is however a risk that this supposedly “transitional” arrangement can become permanent, and the independent regulator never created. This, according to the authors, will depend on the specific features of the arrangement: whether a weak or a strong advisory regulator is in place. The main characteristics of these types of advisory regulators are shown in Table 2 and it is concluded that the weak advisory regulator rarely leads to anything useful, being just a version of the previously existing regulatory system but with a different name and, typically, with weak legal protection. On the other hand, the strong advisory regulator has considerable potential for evolving to a more effective regulatory system over time.

**Table 2: Weak and strong advisory regulator characteristics**

| Weak advisory regulator | No separate earmarked budget (depends solely on ministry budget). |
|-------------------------|------------------------------------------------------------------|
|                         | Regulator’s advice to the minister is not given publicly and is often kept confidential. |
|                         | Minister’s policy and other directives or other communications to the regulator are not made public. |
|                         | Little or no public consultation by the regulator with affected parties. |
|                         | Ministry is under no obligation to respond to the regulator’s advice within a specified period. |
|                         | If the minister rejects or modifies the regulator’s recommendations the minister is under no obligation to give any public explanation for it. |
|                         | There are no conflict-of-interest rules for the decision-makers and key staff members of the regulatory entity. |
| Strong advisory regulator | Separate and earmarked funding is outside the ministry’s budget. |
|                         | Regulator’s advice must be given in a publicly available document that provides a clear statement of the decision, a description and analysis of all evidence taken into consideration, a summary of views offered by the different parties, and a full discussion of the rationale for the recommendations. |
|                         | The minister’s policy directives and other communications to the regulator must be given in a public document. |
|                         | The regulator has public consultations with affected parties. |
|                         | The minister can reject or request reconsideration of the recommendations and must do so within a specified number of days. If the minister fails to act before the deadline, the regulator’s recommendations are deemed to have been adopted. |
|                         | If the minister rejects or modifies the regulator’s recommendations, the minister must give a written, public explanation for this action. |
|                         | Conflict-of-interest rules are in place for decision-makers and key staff of the regulator. |
2.2 Regulatory Independence

An additional important aspect when analyzing regulation and overall sectoral performance, mostly in developing countries, is to distinguish between the formal and informal aspects of the regulatory process; that is the distinction between what is written in the law and regulations, and the way in which things are actually done. Bureaucratic delegation of regulatory competencies from political decision-makers (the “principal”) to regulatory agencies (the “agent”), though backed by law and highly formalized, invariably relies upon an incomplete contract, since it is impossible to spell out in explicit detail all the precise obligations of the agent throughout the life of the contract, and the cost of monitoring the whole process would be prohibitive (Gilardi and Maggetti 2010).

Developing countries show a substantial gap between the conditions stated in the legislation and what actually happens in the real world (Rodríguez Pardina 2008). A number of studies have attempted to measure this divergence empirically.

Andres et al (2007) evaluated the performance of regulatory agencies by constructing a Regulatory Governance Index for electricity regulators in Latin America. The principles of autonomy, transparency and accountability were divided into formal (what is stated in the norms) and informal (what really happens) variables. This makes it possible to measure the divergence between them, by looking at the strength of the correlation between the formal and informal indicators for each of these three dimensions. Rodríguez Pardina (2008) undertook such an exercise and the results (Table 3) show that both the direct correlation between the indexes and the rank correlations are relatively low for the three principles included in the study.

|          | Autonomy | Transparency | Accountability |
|----------|----------|--------------|----------------|
| Index Correlation | 0.459    | 0.364        | 0.365          |
| Rank Correlation  | 0.409    | 0.330        | 0.398          |

Source: Rodríguez Pardina (2008)

A similar conclusion is reached by Correa et al (2006) in their study of Brazilian regulatory authorities, although the correlation is relatively higher (0.7). They compare an overall index, which comprises a complete set of 106 questions regarding the agency’s formal characteristics and procedures, with the “de facto” index, in which only 28 questions, designed to capture the procedures used by each regulatory agency, are included. This
gap reflects, to a certain extent, a mismatch between the regulatory system and the context in which this system has to operate, as was previously suggested.

Groom and Schlirf Rapti (2008) cite the implementation of a regulatory system imported from a different legal tradition (particularly Anglo-Saxon models implanted in Latin America and French speaking Africa) as the source of tensions between the regulatory regime and the rest of the legal system which in many cases also leads to a gap between the formal and real operation of the system. They state that until recently, concepts like the internal rate of return seemed to be absent from the analysis and jurisprudence of regulatory authorities in Latin America.³

Gilardi and Maggetti (2010) consider that independence requires the presence of two components: “self-determination” (i.e. the faculty to judge own interests and values) and “ownership of one’s actions” (i.e. the faculty to translate own interests and values into actions, without external constraints). They then distinguish between “formal” and “de-facto” independence and, based on previous work, operationalize these concepts through different dimensions (Table 4). The term “de facto independence” refers to “the extent of regulators’ effective autonomy as they manage their day-to-day regulatory actions”. De facto rests on two components: the (relative) self-determination of agencies’ preferences and the (relative) lack of restrictions when enacting their regulatory activity, both with respect to elected politicians and regulated utilities. They present this divergence between formal and de facto independence for 16 Western European regulatory agencies from different sectors (Figure 3),⁴ concluding that there is a weakly positive but statistically insignificant relationship between the two dimensions, and that in some cases regulators score higher on formal than de facto independence, while in other cases it is the other way around. They also point out that there seems to be a systematic association between regulators’ de facto independence and their institutional age or the presence of several veto players in the political system.

³ It should also be noted that many regulations talk about a “reasonable rate of return” without clearly stating the parameters or variables to measure this reasonability. This can lead to disputes and legal complaints by the regulated companies against the regulator.

⁴ Based on a previous work (Maggetti 2009).
| Measures of formal regulatory independence | Chairperson and management board | Measures of de facto regulatory independence | From politicians | From regulated utilities |
|--------------------------------------------|---------------------------------|---------------------------------------------|------------------|------------------------|
|                                            | - Term of office                | - Frequency of revolving door                | - Frequency of revolving door | - Frequency of revolving door |
|                                            | - Appointment procedure         | - Frequency of contacts                      | - Frequency of contacts | - Frequency of contacts |
|                                            | - Dismissal procedure           | - Influence on budget                        | - Influence on budget | - Influence on budget |
|                                            | - Renewability of appointment   | - Influence on internal organization         | - Influence on internal organization | - Influence on internal organization |
|                                            | - Compatibility with other offices | - Partisanship of nominations            | - Partisanship of nominations | - Partisanship of nominations |
|                                            | - Formal requirements of independence | - Political vulnerability            | - Political vulnerability | - Political vulnerability |
|                                            |                                  | - External influence on regulation          | - External influence on regulation | - External influence on regulation |

| Relationship with elected politicians      | - Independence formally stated | - Source of the budget                     | - Rule-making |
|                                            | - Formal obligations           | - Agency's internal organization            | - Monitoring |
|                                            | - Overturning of decisions     | - Control of human resources                | - Sanctioning |

| Finances and organization                  |                                  |                                             |                 |
|                                            |                                  |                                             |                 |

| Regulatory competencies                    | - Rule-making                   | - Source of the budget                      | - Rule-making |
|                                            | - Monitoring                    | - Agency's internal organization            | - Monitoring |
|                                            | - Sanctioning                   | - Control of human resources                | - Sanctioning |

Source: Gilardi and Maggetti (2010). Table 1
Hanretty and Koop (Hanretty and Koop 2010), on the other hand, do find a significant association between formal and de facto independence of regulatory agencies from Western Europe. They perform an OLS regression over data from 84 regulators from 17 countries. The dependent variable is a measure of de facto independence based on a combination of two proxies: average tenure of the chief executive of the agency and political vulnerability measured as the percentage of government changes followed within six months by a change in the regulator’s chief executive. Statistically significant explanatory variables with the expected sign include: formal independence; rule of law, veto players, and degree of coordination in the market economy. It shall be noticed that in this case variables related to the life of the agency - age and the salience of the issue area - are not statistically significant.

5 However, the interaction between formal independence and the rule of law turned out to have the opposite effect to that predicted: formal independence has a greater effect in countries with lower levels of rule of law.
In practice, it has proved difficult in the developing world to implement regulatory frameworks that meet all the good practice criteria for regulatory governance.

Eberhard (2006), who provides a summary of the challenges and problems that utility regulation faces in developing countries, and particularly Africa, highlights, among others, the “lack of regulatory commitment: political expediency and the limits of independence”. Furthermore, even when there are separate regulatory institutions with legal mandates for tariff setting and other regulatory decisions, government can still exert pressure, undermining regulatory independence. Other challenges identified are: lack of transparency, participation and accountability; institutional fragility; and lack of capacity/competency, which compromises regulatory substance. Eberhard (2006) suggests that regulatory performance can be improved through mandatory, periodic, independent reviews of regulators’ performance and impact; through building or strengthening the “demand” for regulatory transparency and participation, by consumers, investors, etc.; and through capacity building, involving experienced and qualified staff.

The World Bank’s Africa Infrastructure Country Diagnostic assesses the infrastructure institutional frameworks for 24 countries in Africa scoring the quality of governance of the regulatory agencies out of 100 (The World Bank 2010). The results show that electricity sector regulators perform relatively well compared to those in other infrastructure sectors. However, in absolute terms, the overall average score for the quality of governance of electricity sector regulators is under 50. The weakest dimension of governance was autonomy (or independence of decision-making) and the strongest transparency (captured in terms of publishing information) (Figure 4).

**Figure 4: Institutional progress on regulation - Regulatory quality**

![Figure 4](image_url)

Source: The World Bank (2010). Figure 4.3. Panel (b)
In India, the Electricity Act of 2003 aimed to turn around weak utility performance through improved sector governance (World Bank, 2014a), aiming to create an independent, unbiased, and transparent governance framework that balanced consumer and investor interests, specifically by removing regulation and tariff determination from the purview of the government. A key element of this was the creation of independent State Electricity Regulatory Commissions (SERCs) in each Indian state. In practice, however, the SERCs have not managed to achieve true autonomy from state governments. In reality, they lack the human resources and IT systems needed to carry out their functions, do not implement adequate transparency measures, do not create frameworks for meaningful public input to the regulatory process, and are not subject to any clear accountability mechanism.

The challenges of implementing sound regulatory governance in developing countries have led to calls for a more pragmatic solution, through the introduction of hybrid regulatory models (Gassner and Pushak (2014), Kessides (2012), Gratwick and Eberhard (2008)). These refer to regulatory systems that are compatible with a country's regulatory commitment and institutional and human resource endowment. Gassner and Pushak (2014) suggest that the higher risk environment in developing countries may require a regulatory regime aligned more with cost-plus principles, in particular when investors need to be reassured that their investments can be recovered. Kessides (2012) recognizes that, as full implementation of the standard reform model (especially effective regulation, vertical or horizontal unbundling, and wholesale and retail competition) has several institutional prerequisites that most developing countries lack, there are doubts about the applicability of the standard template to many of these countries, especially in Africa.

2.3 Regulating State-Owned Enterprises

Despite numerous rounds of reforms and private sector participation that have taken place in the last 20 years, State-Owned Enterprises (SOE) are still prevalent in many developing countries (Vagliasindi 2008a). Moreover, there has been what might be described as a third wave of reforms, with focus shifting back towards the improvement of SOE performance while maintaining public ownership (Vagliasindi 2008b). The rationale for this is that while SOEs may be better placed to address market failures, through the delivery of social and development objectives, they are at the same time subject to government failures, in the form of inefficiency (World Bank, 2014b). To that extent, it is often argued that SOEs - no less than private operators - should be subject to economic regulation. Nevertheless, the differing incentive structures of public and privately operated utilities greatly impacts the efficacy of regulatory incentives and needs to be well understood as a basis for adapting regulatory approaches to the context of SOEs (see Figure 5 below).
Good corporate governance⁶ is key to good performance for both SOEs and private enterprises. However, SOE governance typically faces more challenges than private enterprises, whether in developed or developing countries (Economic Insights 2015). In private enterprises, the primary goal is profit maximization, so market mechanisms (including the threat of takeovers and bankruptcy) can operate to help ensure competitive outcomes, also private enterprises have more freedom (e.g. in relation to employment) to determine their actions.

SOEs, on the other hand, often have multiple and poorly defined objectives and as a result their strategic goals are poorly defined (Economic Insights 2015). They also suffer from weak governance structures, including the absence of boards at times, the presence of numerous and sometimes conflicting social objectives, as well as multiple public sector principals with different perceptions of what the strategic goals should be (Vagliasindi, 2008b). At the same time, SOE management is typically accountable to and monitored by

---

⁶ Corporate governance refers to “the structures and processes for the direction and control of companies. It specifies the distribution of rights and responsibilities among the company’s stakeholders (including shareholders, directors, and managers) and articulates the rules and procedures for making decisions on corporate affairs (...). Corporate governance therefore provides the structure for defining, implementing, and monitoring a company’s goals and objectives and for ensuring accountability to appropriate stakeholders.” (The World Bank 2014)
a shifting coalition of interest groups (politicians, bureaucrats, labor unions, and other stakeholders).

The (common) lack of clear objectives in SOEs poses a challenge to performance assessment by regulators. If goals cannot be clearly specified and quantified, a good performance cannot be distinguished from a bad one. This in turn implies that managers of state-owned enterprises cannot be rewarded on the basis of performance (Vagliasindi 2008b). Moreover, in general SOE management does not face any credible threats for non-performance from the external environment in which it operates. This makes it difficult to successfully apply the kind of incentive mechanisms on which regulation is based.

The limited empirical evidence on the regulation of SOEs is quite consistent in demonstrating that regulation may not be the most powerful mechanism to improve the performance of public utilities. However, neither is there compelling evidence that the alternatives to regulation are any more effective.

This is not an exclusively less developed country issue. The experience of Australia provides support for the notion that incentive regulation is more effective at promoting efficient performance for network service providers that are privately owned as opposed to those that are state-owned (Mountain, 2014). Here it was found that SOEs increased their plant capacity and regulatory asset bases inefficiently compared to private companies operating in the same sector (Mirrlees-Black, 2014). Underlying these problems is the impact of government ownership in attenuating incentives to efficiency, and in undermining the independence and authority of the regulator (Mountain, 2014).

Effective regulation of SOEs depends both on the independence of the regulatory agency and on the extent to which the SOE is incentivized to respond to regulatory incentives. Evidence from Ukraine and Nigeria suggests that SOEs do not respond as effectively as private enterprises to regulatory incentives for the reduction of technical and commercial losses, nor to the investment incentives associated with rate of return regulation. Given low public sector salaries and lack of performance-related pay, public sector managers are less motivated to take actions that increase utility cash flows (Vagliasindi, 2008a).

A broader assessment of the experience of applying the UK regulatory model in the developing world concludes that it has only been partially successful in middle and low-income countries (Gassner and Pushak 2014). The authors note that new institutions (such as sector regulators) cannot operate in isolation from the institutional environment and wider governance endowment of the country. A key reason for this is the difficulty of achieving regulatory “depoliticization” of a sector characterized by extensive service

---

7 The author mentions that there is international evidence on problematic application of price cap regulation to government-owned utilities, citing the case of postal services and electricity in Guernsey (analyzed in Yarrow, G., Decker, C., 2010. Review of Guernsey’s Utility Regulatory Regime. A Report for Commerce and Employment. Regulatory Policy Institute, Oxford) and the case of electricity utilities in Europe (citing Bortolotti, B., Cambini, C., Rondi, L., 2013. Reluctant regulation. J. Comp. Econ. 41 (3), 804e828).
subsidies and state-owned utilities, which mean that efficiency improvements cannot be achieved using the same set of incentives that were designed in the UK under completely different circumstances. Without the introduction of commercial principles for the operation of utilities, including accountability and a hard budget constraint, regulation cannot be expected to dramatically change sector performance.

In view of these concerns, performance contracts are often put forward as an alternative regulatory mechanism adapted to SOEs. Performance contracts are “negotiated, written agreements that clarify objectives of governments and motivate managers”, which typically include approval of a business plan and specify a number of key performance indicators. These contracts, by introducing ex post evaluated targets, can reduce ex ante controls and provide incentives to managers to do what is necessary to achieve targets. Nevertheless, the targets are often hard for outsiders to evaluate because of the information advantage that managers enjoy over owners, nor easy for utility managers to achieve due to the constraints of operating in a public-sector environment.

Performance contracts are widely used for state-owned electric utilities in Africa. For example, Eskom (South Africa) annually aligns its performance objectives and indicators with treasury regulations under the Public Finance Management Act, in consultation with its shareholder, the Minister of Public Enterprises. In 2008, about half of the key performance indicators were not met, due to below-target financial performance and investment efficiency, both in capital and operational expenditure (Khanna 2013).

A broader review of the experience of performance contracts with state-owned utilities in Africa found that performance contracts with incentives and independent external audits have become dominant features of the governance reform process in the African electricity sector. While the application of a performance contract was not found to have any significant impact on a range of performance indicators including distribution losses, labor productivity and electricity access; the use of independent audits of those contracts did appear to make a significant difference (Vagliasindi and Nellis 2009) and The World Bank, 2010) (Table 5).

| Reform                  | Technical losses | Connection per employee | Access |
|-------------------------|------------------|-------------------------|--------|
|                         | Yes | No | Yes | No | Yes | No |
| Independent audit       | 22.9% | 28.3% | 164.3 | 92.7 | 22.0% | 9.6% |
| Performance contracts    | 24.2% | 23.3% | 176.8 | 103 | 14.6% | 28.1% |

Source: Based on The World Bank (2010). Table 4.4

When it comes to SOE performance, potentially more significant than any regulatory agency are the oversight arrangements within the government. Three different approaches are widely in use: the decentralized (or traditional) model, where state-owned enterprises are under the responsibility of relevant sector ministries; the dual model, where responsibility is shared between the sector ministry and a central ministry
or entity (for example the Ministry of Finance); and the centralized model, where responsibility for all state-owned enterprises (regardless of sector) is concentrated under such a central ministry or entity (Vagliasindi, 2008b). The choice between these models depends on balancing the advantage of greater technical expertise inherent in the decentralized model, with the greater degree of fiscal discipline and policy coherence towards state-owned enterprises inherent in the centralized model. While the dual model seeks to combine the best of both worlds, in practice responsibilities may become blurred and conflicts of interest arise between the two government entities involved.

Sector regulation, by itself, is no guarantee of performance improvements; without significant changes in the supporting institutions, the standard tools of regulation will not be effective. Equally critical is the institutional governance of the SOE itself. One means of bringing incentives of SOEs closer to those of private operators is through the adoption of corporatization reforms, which involve a range of measures designed to make the enterprise operate in a more commercial environment (Berg, 2013) (see Table 6). Nevertheless, corporatization alone is a necessary but not sufficient condition to insulate the public enterprise from political pressure that may challenge efficiency (Vagliasindi, 2008b).

Table 6: Commercialization Criteria for Utility Service Industries and Enterprises

| The relevant company or enterprise should: |
|------------------------------------------|
| 1. Have corporatized status and not operate as a government department |
| 2. Be governed by a board with a significant number of non-executive board members who should not be government officials |
| 3. Be in full compliance with internationally accepted accounting standards (including its own balance sheet) |
| 4. Pay taxes at the same rate as other companies or enterprises |
| 5. Borrow at interest rates that are market based Earn a commercial rate of return on capital or equity |
| 6. Have the autonomy to borrow within limits set by the board and regulator |
| 7. Have the autonomy to procure equipment, consultancy, and other services |
| 8. Have the autonomy to hire and fire staff |
| 9. Adopt commercial salaries and employment conditions (including total level of employees) |
| 10. Raise financing from capital market sources rather than from low-cost government fiscal sources. |

Source: Box 4.3 Commercialization Criteria for Utility Service Industries and Enterprises in Brown et al (2006).

2.4 Regulatory Impact

There is some theoretical consensus that an autonomous regulatory agency should have a positive impact on electricity sector performance. However, actually measuring the
impact of regulation on sector performance is a daunting task due to both theoretical (model formulation) and empirical (data availability) challenges. From the theoretical side, the main issue is the multi-dimensionality of sector performance. At the same time, it is difficult to isolate the characteristics of the regulatory agency that really influence sector outcomes. On the empirical side, the main problem is the lack of consistent data over time and across countries. Limits to international comparisons in econometric studies are well known. Over time, changes in rules and the way information is collected and recorded also affect the quality of the available data.

The literature contains many case studies with anecdotal evidence of improved sector performance resulting from the introduction of a regulator, generally as part of a wider sector reform (Cubbin and Stern 2004), (World Bank 2010). However, there is only a handful of rigorous cross-country studies that try to isolate the impact of regulation on sector performance econometrically, even if they differ somewhat in their focus.

The first two econometric studies are centered in Latin America - Guasch (2004) and Andrés, et al. (2008) - and share the same database of structural variables including measures of regulatory governance and regulatory substance for 1,000 infrastructure concession contracts (including electricity) in 17 Latin American countries. Regulatory governance is captured by variables depicting existence of regulatory agency, instrument used to create it (law, decree, other), autonomy (part of a ministry or autonomous body), and length of regulators’ mandate (5 years or more vs less than five years). Regulatory substance is reflected in the choice of tariff regime in place: price cap, rate of return or hybrid.

Guasch (2004) focusses on the high incidence of renegotiation of concession contracts in infrastructure sectors, and finds that - among other explanatory variables - the regulatory framework significantly influences the incidence of renegotiation in two main ways. One is through the quality of enforcement, as measured by the existence and autonomy of a regulatory agency—both decrease the probability of renegotiation. The other is through the allocation of risks, as measured by the type of regulation. Price-cap regulation—in which the operator bears the risk—increases the probability of renegotiation relative to rate-of-return regulation. Moreover, the incidence of renegotiation was much higher under price-cap regulation (42 percent) than rate of return regulation (13 percent), and when a regulatory agency was not in place (61 percent) than when one was in place (17 percent). Finally, renegotiation was more likely when the regulatory framework was embedded in the contract (40 percent) than when embedded in a decree (28 percent) or a law (17 percent).

Andres et al. (2008) center on the impact of privatization on performance in three infrastructure sectors (including electricity) by comparing performance trends (rather than absolute levels) before, during and after the privatization process. There are three main findings. First, regulatory and contract characteristics matter: the way privatizations are undertaken can generate significant performance differences. Second, each
regulatory and contract characteristic affects each performance variable differently. In other words, a certain contract characteristic could have a positive influence on one performance variable while having a negative or insignificant impact on another. Third, some regulatory and contract variables have bigger impacts than others. For instance, in some cases, the changes attributed to a fully autonomous regulatory body are much larger than changes attributed to other regulatory variables.

The third econometric study is global in scope, covering 22 countries around the world over a decade (Vagliasindi 2013), which are clustered by income level and system size. The study finds for the overall sample that the introduction of an autonomous regulatory agency is significantly positively associated with higher access, higher labor productivity, higher tariffs, and higher carbon emissions. However, results differ dramatically across country clusters. For countries with higher incomes and larger power systems, the introduction of an autonomous regulator is significantly associated with enhanced access, higher operational efficiency, lower tariffs and lower carbon intensity. By contrast, for countries with lower incomes and smaller power systems, the introduction of an autonomous regulator is significantly associated with reduced access, lower operational efficiency, higher tariffs, and lower carbon intensity. This result underscores the challenges in implementing regulatory reforms in less developed countries.

A brief overview of the main empirical results on regulatory governance reported in this section is provided in Table 7.
Table 7: Summary of Empirical Literature on Regulatory Governance for the Power Sector

| Study                                      | Period   | Countries      | Findings                                                                                                                                 |
|--------------------------------------------|----------|----------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| **Studies that compare formal and informal regulatory practice**                     |          |                |                                                                                                                                            |
| Correa et al., 2006                        | Early 2000s | Brazil         | Correlation between scores on formal attributes of the regulatory system and informal operation of the regulatory system is relatively low, at 0.7, for several infrastructure regulators in Brazil (including energy). |
| Andres et al., 2007                        | Early 2000s | Latin America (various) | Correlation between formal and informal scores for power sector regulators in several Latin American countries dimensions of regulatory autonomy, transparency and accountability are generally very low, between 0.3 and 0.4. |
| Gillardi and Maggetti, 2010                | Mid 2000s | Western Europe (various) | Weakly positive, but statistically insignificant, relationship between formal measures of regulatory independence and those that capture actual informal regulatory practice. Formal independence may be higher or lower than informal independence depending on individual cases. |
| Hanretty and Koop, 2010                    | Mid 2000s | Western Europe (various) | Find a statistically significant positive correlation between formal measures of regulatory independence and those that capture actual informal regulatory practice. |
| **Studies that measure independence of regulators**                                 |          |                |                                                                                                                                            |
| World Bank, 2010                           | Mid 2000s | Sub-Saharan Africa (various) | Electricity regulators score better than those in other infrastructure sectors on autonomy, transparency and accountability, but still only score around 50% against best practices in these areas overall. |
| Pargal et al., 2014                        | 2010s    | Indian States (various) | Most State Electricity Regulatory Commissions have not achieved true autonomy from State Governments, lack necessary resources, do not create adequate mechanisms for transparency and accountability. |
| **Studies that compare efficacy of regulation between private and state-owned utilities**  |          |                |                                                                                                                                            |
| Vagliasindi, 2013                          | 2000s    | Nigeria, Ukraine | State-owned enterprises are less responsive than private ones to regulatory incentives for loss reduction and investment. |
| Khanna, 2013                               | 2000s    | South Africa, Mozambique | Performance contracts are not effective in delivering performance improvements for state-owned utilities. |
| Mountain, 2014                             | 2000s    | Australia      | State-owned network service providers are less responsive to than privately owned companies to the efficiency incentives embodied in price cap regulation. |
| Mirrlees-Black, 2014                       | 2000s    | Australia      | State-owned network service providers tend to invest more heavily than privately owned companies under the same regulatory regime and are more likely to end-up with excess capacity. |
| The World Bank, 2010                       | 2000s    | 24 Sub-Saharan African countries | Based on cross-country analysis, state-owned utilities with performance contracts do not perform any better than those without, unless independent auditing is included in the contractual framework. |
| Study                  | Period   | Countries                      | Findings                                                                                                                                                                                                 |
|------------------------|----------|--------------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Studies that measure impact of regulation on sector performance |          |                                |                                                                                                                                                                                                          |
| Guasch, 2004           | 1985-2000| 17 Latin American nations (1,000 contracts) | Regulatory framework affects occurrence of renegotiation of infrastructure contracts in two ways. Presence of a regulatory agency decreases the probability of contract renegotiation. Adoption of price cap regulation, by allocating more risk to the contractor, raises the probability of contract renegotiation. |
| Andres et al., 2008    | 1985-2000| 17 Latin American nations (1,000 contracts) | A regulatory framework enhances the performance impact of privatization, particularly when there is an autonomous regulatory agency. However, specific characteristics of the regulatory framework affect different dimensions of performance differently; sometimes positively, and sometimes negatively. |
| Vagliasindi, 2013      | 1989-2009| 22 developing countries        | Econometric results show that a regulatory agency is associated with higher electricity access, higher labor productivity, lower tariffs and lower carbon intensity in larger middle income countries. However, these results are largely reversed in the case of smaller and lower income countries. |
| Gassner and Pushak, 2014 | 2000s   | 70 developing countries       | The UK model of incentive-base regulation (price cap) has only been partially successful in low and middle income countries due to the major differences in the institutional and political context. |
3. Regulatory Substance

Brown et al (2006) define regulatory substance as the content of regulation. It is the actual decisions, whether explicit or implicit, made by regulators along with the rationale for those decisions.

3.1 Tariff-Setting Objectives

Given that electricity tariffs can be set in numerous ways, a critical starting point is to define (and prioritize) the objectives of tariff-setting, ideally this should be explicit in the legal framework. Without clarity of objectives, it is impossible to evaluate outcomes. The economic regulation of tariffs potentially has up to four conflicting objectives: financial sustainability, allocative efficiency, productive efficiency and social equity.

Financial sustainability is the ability of the firm to achieve full cost recovery through the revenues generated by its regulated activities plus fiscal transfers, if any. As a goal, it entails tariffs that generate enough revenues to cover the economic costs of the service. This allows the attraction of new capital resources to the industry, so as to guarantee the future provision of the service while minimizing potential fiscal contributions.

Allocative efficiency is concerned, in a context of scarce resources and alternative uses for such resources, with tariffs reflecting the services’ production costs, i.e. having tariffs equal marginal costs. When tariffs reflect costs they serve as efficient signals for the allocation of resources in the economy. From the demand side promoting efficient consumption and from the supply side giving signals on investment needs.

Productive efficiency has to do with the minimization of costs at a given output level or, alternatively, the maximization of output with a given level of inputs. For a long time now, both the regulatory literature and actual experience have demonstrated that the creation of incentives for companies to be productively efficient is one of the greatest challenges faced by regulators (Laffont and Tirole 1994).

Lastly, regulation must also provide for certain basic aspects of distributive efficiency or social equity. This, in turn, is a two-fold aspect involving access and affordability. Access has to do with universal service goals. Affordability has to do with keeping tariffs commensurate with ability to pay, particularly for the poorer strata of the population.

At the heart of the regulatory problem is the existence of strong trade-offs among these objectives (see Table 8). The existence of trade-offs implies that many regulatory

---

8 Meaning efficient costs directly related to the provision of the regulated service.
9 See Estache, Foster and Wodon for an analysis of the relationship between infrastructure reform and poverty in Latin America (Estache, Foster and Wodon 2002).
10 The existence and strength of the trade-offs will vary across countries, sector and time.
actions will improve the situation in terms of one objective while at the same time worsening it in terms of others. This means that it is necessary to give weights or priorities to the different objectives to be able to choose optimal (or at least efficient) instruments; and these inevitably vary across countries, sectors and time.

### Table 8: Objectives Tradeoffs

| Objective Tradeoff                              | Description                                                                 |
|------------------------------------------------|------------------------------------------------------------------------------|
| Allocative Efficiency vs. Financial Sustainability | Under a natural monopoly, marginal costs are lower than average costs        |
| Allocative Efficiency vs. Productive Efficiency  | The leveling of tariffs and costs can reduce incentives to minimize costs    |
| Allocative Efficiency vs. Social Equity          | Price discrimination is efficient but can be unfair, and may slow down the rate of new connections if it penalizes new or small consumers |
| Financial Sustainability vs. Social Equity       | Cost recovery tariffs may not be affordable to the poorest households.        |

Source: Own elaboration

The main instruments that can be used to achieve these objectives are: tariff level, tariff structure and tariff regime. These are summarized in Table 9. The institution responsible for each of these three instruments varies. In general, the tariff regime is defined in the regulatory framework (typically the sector law), while establishing and approving the tariff level (in each regulatory period the length of which will depend of the tariff regime) is the main task of the regulator. Defining the tariff structure can also be part of the regulator’s task or in some cases it can be left to the utility (for example, in the UK the regulator defines a cap on the average tariff for a basket of services and the companies are allowed to define the particular charges for each service subject to this overall cap).

### Table 9: Regulatory Instruments

| Instrument   | Definition                                                                                                                                 |
|--------------|-------------------------------------------------------------------------------------------------------------------------------------------|
| Tariff level | Average tariff that allows the operator to break even under an allowed rate of return.                                                      |
| Tariff Structure        | Multidimensional combination of charges (fixed, variable), user types (res, ind, etc.), services (HV, MV), etc. which define the tariff grid. |
| Tariff regime          | Set of rules and procedures by which tariffs are updated and changed over time.                                                            |

Source: Own elaboration

The interplay of these instruments will be crucial for attaining the different objectives. There is a reasonably close relation between the various objectives and instruments which is summarized in Table 10.
Table 10: Regulatory Objectives and Instruments

| Objective                | Instrument                                                                 |
|-------------------------|-----------------------------------------------------------------------------|
| Financial Sustainability| Tariff levels and, where needed, subsidies                                 |
| Allocative efficiency   | Tariff structure                                                            |
| Social Equity           | Tariff level reflects current efficiency, and tariff regime incentivizes future efficiency gains. |

Source: Own elaboration

The economic sustainability of the operator is driven mainly by the tariff level (or in other words the average tariff), which should allow an efficient firm enough revenue to cover its economic cost including a reasonable rate of return on its capital. In addition to this reasonable rate of return, it accounts for the invested capital assessed at reasonable values and for reasonable expected efficiency gains all of which are the responsibility of the regulator. If the tariff level does not cover costs, subsidies will be a complementary option. Their design may however have an impact on allocative efficiency.

Allocative efficiency and equity are influenced essentially by the tariff structure. To achieve allocative efficiency, charges should reflect the long-run marginal cost of supplying each consumer. However, to meet the objective of financial sustainability, charges will need to be higher than long-run marginal cost. To minimize the behavioral response associated with tariffs above long-run marginal cost, and so to maximize the utility’s revenues, the necessary mark-up should be inversely proportional to demand elasticity. However, this may often result in relatively higher charges to residential consumers who tend to have lower price elasticities of demand, raising concerns about social equity, which is the other objective that needs to be met through the design of the tariff structure. The trade-off becomes evident, as does the level of challenge involved in designing a good tariff structure.

In practice, the structure may be differentiated in many dimensions: across clients, regions, between fixed and variable charges, according to the consumption level, etc. An optimal structure will depend on both: demand and supply considerations. From the demand side price and income elasticities for different types of users, willingness and ability to pay, costs of substitutes, consumptions patterns over time (day, season), etc., are all elements that need to be taken into account. From the supply side costs of serving different types of users, cost patterns over time (day, season), fixed vs. variable costs, and the allocation of common and joint costs are among the main elements affecting the tariff structure.

In general, the service provider will have better information than the regulator on these variables, and this is why in many cases decisions on the tariff structure are left with the operator. But, with social concerns in mind, the regulator often issues some guidelines because an operator concerned only with maximizing revenues may end up charging tariffs that are socially inequitable.

---

11 This is known as the Ramsey principle.
At the start of the regulatory period, tariffs are set at levels that reflect efficient performance to achieve productive efficiency. However, there is always scope to make additional efficiency improvements over time. The incentive for continued cost minimization is essentially determined by the design of the regulatory regime. The tariff regime is the set of rules by which tariffs are updated and modified over time. This is the key to the incentives the firm faces for productive efficiency.

3.2 Tariff Regimes

The need to choose between two types of tariff regimes is commonly portrayed as one of the first decision points when a regulatory regime is being established: rate-of-return regulation dominated utility regulation until the 1980s; then, in the 1990s price-cap regulation emerged as a new regime in the UK and gained many followers due to its greater power to incentivize performance improvements.

According to Jamison (Jamison n.d.) “Rate of return regulation adjusts overall price levels according to the operator’s accounting costs and cost of capital. In most cases, the regulator reviews the operator’s overall price level in response to a claim by the operator that the rate of return that it is receiving is less than its cost of capital, or in response to a suspicion of the regulator or claim by a consumer group that the actual rate of return is greater than the cost of capital.” In practice, under rate of return regulation (also known as cost-of-service regulation), prices are adjusted on an annual basis (Lewis and Garmon, 1997).

Price cap regulation became an integral part of the new institutional model for infrastructure reform introduced in the 1990s (Joskow 2008, 2014). Although some authors (Vogelsang, 2004) acknowledge earlier references (Baumol, 1967), it has become inextricably linked with the landmark Littlechild Report (Littlechild, 1983). According to Stern, the Littlechild Report “… was and remains a crucial landmark document. After its publication, the world of utility regulation economics and policy-making would never be the same again” (Stern 2014).

Rather than undergoing annual adjustments of tariffs, under price cap regulation, the company is required to keep the weighted increase in a basket of its prices to less than the increase in a specified price index, less X percent, so that the prices decline by X percent a year in real terms. Multi-year review periods allow the company to outperform the target set by the regulator and retain the associated cost savings as profits, thereby creating a strong incentive for improvements in performance.

In practice, price cap mechanisms are more complex than the simple version usually presented as there is a need to apply elements of cost-of-service regulation, yardstick
competition, and high-powered “fixed price” incentives, plus a ratchet\(^{12}\) (Joskow 2014). Once all these complexities are taken into account, some have argued that the price cap regime is in practice not much different to the rate-of-return regime (Liston 1993), and this has even given rise to legal disputes (Ergas and Small, Price Caps and Rate of Return Regulation 2001).

The differences between these two regulatory mechanisms have been analyzed from different perspectives.

A first element to consider is regulatory risk (Ergas, Hornby, et al. 2001). In a seminal paper, Alexander, Mayer and Weed (Alexander, Mayer and Weed 1996) measure the difference in risk allocation of the different regimes by comparing the betas of infrastructure companies under different regulatory mechanisms. The study shows that investors bear the greatest non-diversifiable risk with price caps and the least with rate-of-return regulation. Although the risk differential seems theoretically sound, other authors have not found this difference to be statistically significant [ (Gaggero 2012), (Competition Economists Group 2013)].

Second, the forward-looking nature of price caps versus the backward looking one of rate of return has also been pointed out as one of the key differences between the two regimes. In general, rate-of-return is based on actual historic accounting costs, while in principle price caps are based on projected efficient costs, that is, costs that the utility should be able to achieve (possibly after some reorganization) if it were efficient (Newbery 2003). Along these lines, Stern (2014) states that “The central feature of price regulation in the British utility model is the periodic resetting of regulated prices in the light of forward looking efficiency gains and investment requirements.”

Third, the length of the review period is another way of looking at the differences between price cap and rate of return regulation [ (Ofgem 2010), (Northumbrian Water 2015), (Regulated Industries Commission 2011)]. Joskow (2014) points out that “As the review period gets longer the power of the incentive mechanism increases and vice versa”. At one extreme, a very short period - less than a year - would turn the price cap mechanism into one of rate of return, while at the other extreme, a permanent cap with no reviews would maximize the incentives for productive efficiency. Neither of these two extremes are feasible, and given the need to ensure financial sustainability there will always be the need for periodic review of the price. According to Newbery (2003) “many of the apparent differences between the two forms of regulation disappear when the price controls are reset at the first regulatory review.”

Fourth, the more capital intensive the industry the less the opportunity for short-term efficiency gains, and the less material the difference between the regulatory regimes. Thus, Stern (2014) indicates that “A lot of time and effort is spent on designing strong

\(^{12}\) The term “ratchet” refers to the cost-cutting dynamic that is meant to result from a price cap regime, whereby the utility cuts costs steeply to exceed the efficiency target and retain profits, while the regulator claws these efficiency gains back by reducing the tariff baseline at the next review.
incentives to improve the efficiency of regulated companies, but within a framework where cost of capital (and Regulatory Asset Base maintenance issues) have become increasingly important.”

Fifth, the differing information needs of the two regimes has also been analyzed. Joskow (2014) mentions that “..., the sound implementation of incentive regulation mechanisms depends in part on information gathering, auditing, and accounting institutions that are commonly associated with traditional cost- of-service or rate- of-return regulation”. Laffont analyzes the relationship between information availability and appropriate regulatory regime, concluding that price caps may be the only option when the regulatory information base is weak, rate of return regulation may become possible as regulatory accounting standards are implemented, and more high-powered incentives may be considered when there is sufficient information to make reasonable regulatory projections regarding the future evolution of costs (Laffont 2005).

The choice of price caps during the reform process in many developing countries seems to be due to the lack of accounting and auditing Laffont (2005). The problem in most of these countries is that little if any efforts were devoted during this stage in developing the needed information to move on to rate-of-return regulation within a reasonable time frame.

However, price cap has other potential disadvantages in a developing country setting. In the UK, where the price cap regime was first applied, utility companies are serving mature markets with relatively small investment needs making efficiency gains the central concern. While inefficiency remains a major issue in the developing world, there are also huge investment needs to keep pace with rapidly growing electricity demand, improve deficient service quality and reach universal electrification (Kessides, 2012). Furthermore, developing countries may lack the institutional, legal and financial sophistication needed to apply this model (Alexander, 2014). In that context, rate-of-return regulation may provide a more predictable basis for remunerating and incentivizing investment.

Indeed, Newbery (2003) reflects the trade-offs in choosing between regimes and how these differ across sectors: “While it is clear that price regulation is superior for telecoms where it may only be needed in the transition to deregulation, it is less clear that permanent price regulation with periodic reviews is superior for core network monopolies like water, gas and electric distribution, balancing the better incentives of price regulation against the lower perceived investor risk and cost of capital of rate-of-return regulation.”

Even in the UK context, the merits of price cap versus rate of return regulation continue to be debated among leading thinkers. Wolak (Wolak 1998) criticizes the use of price cap in newly privatized utilities: “The failure of price-cap regulation to control adequately the profits of the Regional Electricity Companies and many newly privatized companies in the UK is largely due to the use of a regulatory scheme that is poorly suited to account for the uncertain productive efficiency gains possible under a privatized, competitive market
structure.” Green (1997) on the other hand, while recognizing the initial problems of price caps in the UK has a much more positive view about its usefulness as regulatory mechanism: “The high profits of the early 1990s were due largely to unanticipated, one-time productivity gains following privatization, which are unlikely to be repeated. The established method for resetting price controls makes further “mistakes” unlikely. In the future, price controls can be expected to give companies an incentive for efficiency without allowing them to earn excessive profits”.

3.3 Regulation of Service Quality

In addition to setting tariff levels, another critical (but often neglected) area of economic regulation is quality of service. The implementation of a sound regulatory framework for quality of service is essential in any regulatory regime, but becomes particularly critical when a price cap regime is in place.

Incentive regulation mechanisms that provide incentives only for cost reduction, simultaneously create an incentive to reduce service quality, since cost and quality are closely related. It is therefore essential to complement price regulation with performance standards and associated penalties and rewards for the regulated firm that falls above or below these performance norms. These mechanisms are used by several U.S. states and in other countries that have liberalized their electricity sectors, such as New Zealand and the Netherlands (Joskow, Incentive Regulation and Its Application to Electricity Networks 2008), (Joskow 2014).13

The UK regulator (Ofgem) has developed several incentive mechanisms targeted at various dimensions of distribution network service quality. Ofgem uses statistical and engineering benchmarking studies and forecasts of planned maintenance outages to develop targets for the number of customer outages and the average number of minutes per outage for each distribution company. These Quality of Service Guaranteed Standards must be met by each distribution company and have been set to guarantee a level of service that is reasonable to expect companies to deliver in all cases. If a distribution company fails to meet the level of service required, it must make a payment to the customer to compensate for the inconvenience caused by loss of supply (subject to certain exemptions). (Ofgem n.d.)

Similarly, the Australian Energy Regulator established the Service Target Performance Incentive Scheme (STPIS) to incentivize businesses to maintain or improve the quality of their services. The STPIS counterbalances incentive-based regulation and the expenditure incentive schemes in place, which encourage businesses to become more efficient by spending less. The goal is to avoid cost reductions coming at the expense of service quality. Different schemes exist for distribution and transmission networks. Penalties and rewards under the distribution STPIS are calibrated to how willing consumers are to pay

---

13 [http://www.nber.org/chapters/c12566.pdf](http://www.nber.org/chapters/c12566.pdf)
for improved service. This aligns the distributors’ incentives towards efficient price and non-price outcomes with the long-term interests of consumers (Australian Energy Regulator 2014).

Quality of service is gaining importance across Europe (Adam 2011). This is due to the emergence of a more decentralized electricity distribution system with significant generation by consumers, which can negatively affect network stability. Even if regulations do not explicitly address quality of service, they do so implicitly to the extent that regulators grant utilities compensation for their capital and operational expenditure plans, which already embody quality-enhancing measures. This may justify closer regulatory involvement in the development of utility investment plans. Building on the analysis of European regulators, Adam offers some policy recommendations that consist of creating differentiated quality targets or incentives and carefully balanced capital expenditure recovery schemes (see Figure 6).

Figure 6: Quality of Service policy framework

| Recommendation                                                                 | Good Practice |
|-------------------------------------------------------------------------------|---------------|
| **Level of Incentive Rate**                                                   | United Kingdom, Netherlands |
| • Base incentive rates on customer’s cost of cutage, including “energy not served” (ENS) |               |
| **Differientiation**                                                         | Norway        |
| • Differentiate incentive rates based on customer’s factual cutage costs       |               |
| • Value network types with different cost structure separately               |               |
| **Target-Setting**                                                           | United Kingdom |
| • Set targets independent of DSO’s past performance                           |               |
| • Provide long-term security on target development                           |               |
| **CapEx Pass-Through**                                                        | Norway        |
| • Allow additional partial CapEx recovery, if quality incentives are insufficiently foreseeable |               |
| • Limit CapEx pass-through as much as possible to attract efficient investment |               |

Source: Adam (2011). Figure 2

In the US, where both incentive and cost of service regulation schemes can be found, these are often supplemented by reliability or quality-of-service targets with penalties and rewards as performance incentives (MIT, 2011). By 2005, 16 states had a form of performance-based regulation that included explicit penalties or rewards based on performance in reliability and/or quality of service, and two of these even allowed an adjustment of the regulatory rate of return based on performance. Another 23 states set service targets or required utilities to report performance, but without any associated financial consequences. The main finding of the analysis is that greater performance-
based regulation can improve the efficiency of the distribution system and the quality of utility investments. Utility outcomes should be tied to performance metrics that allow for comparisons across utilities and over time, for this purpose, state regulators should develop and publish a consistent set of cost and performance metrics that allow these comparisons.

In addition to safeguarding the technical quality of service, regulators often also monitor the quality of customer service provided by utilities. This includes timeliness and efficacy of response to consumer complaints, and efficiency of administrative process such as billing and (re-)connection. Regulators also handle disputes that may arise between utilities and their customers.

4. New Regulatory Frontiers

The advent of new technologies has created many new challenges for regulators, affecting both the governance and substance of regulation. This final section explores the regulatory implications of emerging technologies such as renewable energy, energy efficiency and demand side management, energy storage, smart grids, and distributed generation. It also considers the impact of climate change on power systems, and particularly the increased occurrence of extreme weather events, necessitating both risk mitigation investments as well as increased and less predictable maintenance and rehabilitation expenditures to recover from natural disasters.

This is a very dynamic field and the full implications both for the governance and substance of regulation are still being worked out. However, what is already clear is that these emerging trends will substantially affect and reshape the delicate balance between the competing regulatory objectives of achieving financial sustainability, allocative efficiency, productive efficiency and social equity.

The advent of new technologies requires clarification of the roles and responsibilities of existing sector actors with respect to the new issues raised (Berg and Brown, 2012). Regulators’ specific role in the adoption and promotion of emerging technologies is often established in the broader legal sectorial framework. In general, these policies are designed by policy makers rather than by regulators, but policy makers may choose to (explicitly or implicitly) delegate all or some of these to regulators, which will in turn result in a greater or smaller degree of regulatory power to exercise discretion in the design (Berg and Brown 2012). Regardless of regulators’ role in the design of policies, they will generally play a significant role in implementation (Berg, 2013).

As is the case with more traditional regulatory functions, the internal practices followed by the regulator need to provide legitimacy for regulatory rulings on these areas, building on expertise, transparency, evidence-based decision-making, public participation, etc.,
Berg (2013), (Energy Regulators Regional Association 2013). Berg also argues that it is important for the regulator to have credibility with investors (and others funding investments) and legitimacy in the eyes of utility customers (Berg 2015).

Consistency is needed to avoid policy shifts (which increase the cost of capital and de-incentivize investments); nevertheless, technological change, which is inherent to the sector, requires a certain degree of flexibility in the regulatory framework. This is a trade-off that must be carefully dealt with. Also, the regulatory framework must provide incentives to actors to adapt to the new environment and to changing users’ needs. This is patently the case for network operators, whose roles and responsibilities will likely change. Efficient price signals must be provided for the increasingly diverse set of network users (O’Sullivan 2015).

Irrespective of whether technological change brings additional areas of responsibility for the regulator, the new environment will inevitably affect the way in which existing regulatory functions should ideally be performed. In particular, the advent of new technologies will substantially affect both the pattern of demand for electricity, as well as the structure of costs; both of which are fundamental inputs to tariff regulation.

Turning first to the demand side, emerging trends can be expected to dampen the growth of demand for grid electricity, or even reduce it, particularly in more mature systems. The two key factors shaping future demand trends are energy efficiency and distributed generation.

Many countries are adopting energy efficiency targets and plans, involving actions by a wide variety of players on the demand and supply side. Power utilities potentially have a significant role to play in the drive for greater energy efficiency, given their central position both as producers and suppliers of energy. This ranges from supply-side efficiency measures, such as loss reduction, to demand-side management through pricing, appliance replacement programs, and load control through smart grids. Utilities may even be well-placed to provide on-bill financing for household investments in energy efficiency.

Nevertheless, a utility’s incentive to take any of these measures depends on the regulatory regime for tariffs as well as the tariff structure. Conventional tariff regimes set overall price controls in such a way as to make revenues proportional to sales, and apply tariff structures that recover most costs through variable charges on energy consumption. These arrangements mean that energy efficiency measures will lead to a decline in revenues, creating a direct conflict of interest for the utility.

As the price of solar PV systems continues to fall, rising uptake of distributed generation among utility customers will lead to declining demand on the local network posing challenges for the recovery of costs associated with network infrastructure (Rocky Mountain Institute and Homer Energy 2015). Whether these customers fully opt out of the grid, or simply reduce their demand for grid electricity, will depend among other things
on the cost and performance of battery storage, which is changing rapidly (Australian Energy Market Commission, 2015). At current storage costs, most consumers will continue to benefit from grid connection both as a source to cover peak supply, a market for excess power production, and a back-up when solar resources are inadequate. As long as they remain connected to the grid, these customers could potentially provide value to the distribution grid, by allowing deferral of upgrades, relieving network congestion, and providing other ancillary services.

Incentives to adopt distributed generation depend critically on retail tariff structures as well as the design of net metering or feed-in-tariff arrangements as well as any compensation for ancillary services. The higher the share of variable charges in retail energy bills, the greater the extent of cross-subsidy among customer groups, and the more generous the provisions for resale of power into the network, the stronger will be the incentive for retail customers to invest in distributed generation. Without careful design of these pricing structures, there is a risk that distributed generation could undermine the basis for recovery of the fixed costs of the local distribution network. It is also likely that over time distributed generation may undermine the basis for cross-subsidy in retail electricity tariffs, which have long been a mainstay of social policy in the sector.

Turning next to the structure of costs, the general direction of all the recent technology and climatic trends is towards increasing the capital intensity of the energy sector.

The transition to a clean energy future will involve higher levels of investment in the sector, increasing the level of capital intensity. Enhancing energy efficiency, including through the adoption of smart grid infrastructure, invariably involves upfront capital investments that reduce the running costs of the system over time. Renewable energy is more capital intensive than conventional alternatives, but avoids the major operating expenditures associated with fuel purchase. Moreover, the dispersed character of renewable energy resources calls for substantial transmission upgrades that need to be carefully coordinated with investments in generation. At the same time, the growing threat posed by extreme weather events arising from climate change may require significant investments to upgrade power infrastructure or make new infrastructure more resilient (for example by burying overhead cables), particularly in the most vulnerable geographies. Responding to the impact of disasters will also create the need for unpredictable and lumpy investments in rehabilitation of damaged infrastructure (Alexander and Harris 2005). Finally, the rapid pace of technological change risks creating stranded assets as conventional technologies become redundant before the end of their useful lives.

Historical experience highlights that capital expenditure poses much greater challenges for regulation than operating expenditure. In particular, information asymmetries between regulators and utilities are much greater in the case of capital expenditures, due to the site specific and customized nature of investments. At the same time, the context described above indicates that investments could be unpredictable and not always in the
direct control of the utility management (Benitez and Rodriguez Pardina 2010). The growing capital intensity of the sector will also shift the cost structure substantially towards fixed costs.

Accommodating and optimizing all these major shifts in the structure of demand and cost have significant implications for the practice of regulation, and point towards a number of changes that will likely need to be adopted over time.

First, it will be increasingly desirable to decouple utility revenues from utility sales by shifting from price cap regimes to revenue cap regimes. Under a price cap, the regulator determines the level of the average tariff and utility revenues are then determined by sale volumes. This creates perverse incentives for utilities to sell more energy, and prevents them from becoming active champions for energy efficiency, owing to the resulting volume reduction (Termini, 2014). At the same time, price cap regimes can leave utilities highly exposed to the volatility associated with climate change (Termini, 2014). A shift toward revenue controls, where the regulator sets a target revenue and prices adjust in an offsetting manner to sales volumes to ensure that utility revenue targets are met, can effectively address these incentive issues.

Second, it will be increasingly important for tariff structures to more accurately reflect the balance of fixed and variable costs on the power system to provide correct economic signals for distributed generation and demand-side management (Council of European Utility Regulators, 2014). New technologies, such as distributed generation, require a revision of cost allocation mechanisms among users and also among types of charges (energy versus capacity charges), in order to achieve allocative efficiency (Pérez-Arriaga and Bharatkumar 2014). “The development of behind-the-meter generation depends on retail prices, not wholesale electricity prices” (International Energy Agency 2016). This implies that regulators have a major role in the development of distributed generation resources. Another important matter is the coordination of price signals between retail and wholesale markets (real-time price, dynamic pricing), so as to balance the contribution of centralized and decentralized resources.

Despite the fact that a high percentage of power system costs are fixed in relation to peak demand, historically there has been a preference for tariff structures that primarily vary according to energy consumption. With the upswing of distributed generation, tariff structures that are heavily skewed towards variable charges can create perverse incentives for grid defection and erode utility revenue bases; particularly when these are embedded in net metering schemes allowing decentralized generators to sell power back to the grid at the retail price. Incentives for supplying decentralized solar power to the grid should reflect the avoided cost of power generation, whereas the retail tariff captures the full fixed cost of the grid. As a result, distributed generators under net metering schemes fail to contribute to the fixed cost of the grid from which they are benefiting as back-up supply during periods when their own production is inadequate. To continue to cover the fixed costs of the power network, which provides a public good platform for
exchange and back-up of power supply, there will be a need to shift the recovery of costs from energy-related charges to fixed or capacity-related charges of various kinds.

Third, an increase in distributed generation is also expected to raise technical challenges in terms of reliability and quality of supply. Traditionally, distribution grids have been designed to support a unidirectional power flow. While volumes of distributed generation remain small, they can be regarded simply as a reduction in load. However, as volumes increase and consumers become net producers, distribution grids will need to be able to accommodate the flow of power in two directions (MIT, 2011). This will raise challenges for quality of service regulation.

Fourth, the rapid pace of innovation makes it difficult for regulators to estimate future cost of service or even how services will be delivered. This calls for the design and implementation of regulatory mechanisms that are technologically neutral (for example, as regards the balance between operating and capital expenditure), and that give the proper incentives to invest under uncertainty (Benitez and Rodriguez Pardina, 2010). It is often difficult to predict the factors that drive the need for a specific investment and its costs, both for the regulator and the utility (Alexander and Harris, 2005). Consequently, it is important when assessing investments to examine their predictability (or ease with which they can be forecast) and controllability (or ability of the utility to influence either the volume or unit cost of investment). The additional uncertainty brought up by new technologies and climate change related issues will probably provoke that a greater share of overall investment plans is composed of lesser predictable and controllable projects. A number of regulatory approaches are emerging to deal with these issues.

Regulators, when setting CAPEX allowances at price reviews, have several options to deal with the phenomenon of uncertainty, according to OXERA (Oxera 2016), they can move to a total expenditure (TOTEX) approach (versus the traditional CAPEX and OPEX approach) and implement contingency margins.

One approach is the so-called TOTEX approach, which looks at the sum of capital and operating expenditure rather than considering each of these separately as has been typical in the past (Oxera 2016). While not tackling the uncertainty problem directly, this avoids the need to undertake a detailed review of cost forecasts for individual projects, and may reduce the bias towards capital solutions. Additionally, TOTEX may, in some instances, be more stable over time and more comparable between companies than capital expenditure alone.

Another approach is the so-called RIIO approach, which builds-up the regulatory revenue allowance in terms of “Incentives”, “Innovation” and “Outputs” (Ofgem, 2013). This departs from traditional cash-flow analysis, valuing more optionality and flexibility, and incorporating output-based regulation (Figure 7). In order to ensure that there is sufficient incentive for innovation under conditions of uncertainty, tariff review periods are lengthened beyond the traditional three to five year cycle. According to Ofgem (Ofgem,
RIIO Incentive Framework. 2013) the first implementation of RIIO, is proving successful, fundamentally changing behavior and Board discussions at companies, and significantly enhancing stakeholder engagement to present well thought-out, detailed and better justified business plans.

**Figure 7: RIIO framework**

Fifth, the expansion of renewable energy depends critically on the timely availability of transmission infrastructure to evacuate power often from remote locations requiring expansion to the grid. Often incentives for investment in generation are simpler and faster to develop and regulators are left to handle the challenge of developing the accompanying transmission infrastructure. A number of different regulatory responses are possible. Generation developers may be provided with an unconstrained connection right to the grid, or connection capacity limits to the grid can be established together with evaluation and selection methodology to grant scarce development and connection rights (known as queue management). Ultimately, the regulatory design of transmission connection charges will be important in determining incentives for grid investment to keep pace with the evolving needs of renewable generators.

Sixth, new technologies are making possible the rapid expansion of off-grid electrification in developing countries still far removed from universal electrification. The parallel expansion of electricity grids often driven by national public utilities and off-grid systems often driven by decentralized private sector actors poses a series of regulatory challenges of its own. A key issue is how the development of both types of systems can be coordinated, and how the investments made by off-grid actors will be treated upon the arrival of grid infrastructure into the locality (Tenenbaum, 2014). Regulators also need to consider the need for and nature of price and quality regulation governing off-grid systems, and the potential equity issues associated with these (for instance, if poor rural households face a higher price for electricity than that available to richer urban households on the national grid) (Rocky Mountain Institute and Homer Energy 2015).
5. Conclusions

The model of power sector reform that emerged during the 1990s placed considerable emphasis on the creation of a regulatory framework, often centered on an independent regulatory agency. The purpose of regulation was to minimize political interference in tariff-setting through a technical determination of prices that cover efficient costs so as to safeguard the financial viability of the sector. The agency would also protect consumers from abuse of monopoly power and hold utilities accountable for providing the stipulated quality of service. In exercising its functions, the regulator could draw upon regulatory innovations for tariff-setting, such as price caps, which had been newly developed at that time.

While there was widespread uptake of regulation, with some 70 percent of developing countries creating regulatory agencies between 1990 and 2015 (Foster et al., 2017), the implementation of the full regulatory vision proved to be challenging in the developing country context. Some of the main conclusions to emerge from this literature review are as follows.

First, even where regulators were created they were seldom as independent as had been envisaged. The design of the regulatory governance framework often fell short on many dimensions of independence. For example, a survey of African electricity regulators found that they scored less than 50 out of 100 on an index of good practice institutional design features (World Bank, 2010). Moreover, even when institutions were well designed on paper, the day-to-day practice of regulation often belied a different reality (Rodriguez Pardina, 2008). A number of studies highlight the divergence between formal and informal regulatory practice in Latin America (Correa et al., 2006; Andres et al., 2007) and even to some extent in Western Europe (Gillardi and Maggetti, 2010).

Second, this has led to a recognition that regulators in developing countries are often operating under various intermediate models. Many developing country regulators function primarily as “advisory regulators” meaning that their main role is to provide technical support to the ultimate political decision-makers, who may or may not act on their advice (Brown et al., 2006). Where the requisite capacity and commitment for independent regulation are lacking, it may be more realistic for developing countries to adopt such intermediate models, including advisory regulators, regulation by contract, or expert panels (Eberhard, 2006).

Third, there is some evidence that regulation has had a positive performance impact particularly in the context of privatized utilities and middle income countries. Despite the limitations noted above, there is empirical evidence to the effect that the presence of a regulator has helped to support more stable privatization contracts (Guasch, 2004) and led to a larger performance impact, particularly in Latin America (Andres et al., 2008), and in larger middle income countries (Vagliasindi, 2013).
Fourth, the impact of regulation in developing countries has been limited by the fact that much of it continues to be directed towards state-owned enterprises. The creation of a regulatory agency was originally conceived as a prerequisite for private sector participation in the sector. Yet, in many developing countries, the uptake of private sector participation in electricity distribution was limited, and regulators are primarily concerned with regulating state-owned enterprises. Since regulation is premised on the existence of commercial incentives that can be harnessed by the regulator through a variety of regulatory instruments, the efficacy of regulation has proved to be more limited when directed towards state-owned enterprises (Khanna, 2013; Vagliasindi, 2013; Gassner and Pushak, 2014). Similar conclusions regarding the relative efficacy of regulation for private and public utilities have been reached in the context of OECD countries, notably Australia (Mirrlees-Black, 2014; Mountain 2014).

Fifth, rate of return regulation may be better suited to the challenges of price regulation in developing countries. Much of the debate on regulatory substance has centered on the choice between price cap and rate of return regulatory regimes; even if it is also acknowledged that the differences between the two approaches are not as substantial as they may at first sight appear. The literature suggests that price cap regimes, which are most effective at driving operating efficiency gains in mature systems, may be less suitable in developing country environments where there is a need to provide predictable returns to support large capital investment programs (Kessides, 2012). Furthermore, developing countries may lack the institutional, legal and financial sophistication needed for the application of the price cap approach (Alexander, 2014), while the prevalence of state-owned enterprises makes the incentive aspects of price cap regulation less relevant.

Sixth, the advent of technological disruption in the power sector demands an adaptation of the way in which regulatory instruments are designed and applied. The opportunities posed by new technologies, combined with the challenges posed by climate change, are creating a dynamic environment of innovation, competition and investment in the sector. As a result, regulators need to pay closer attention than ever before to allocative efficiency and careful alignment of incentives. One example is the growing need to decouple utility revenues from sale volumes, so as to create incentives for utilities to pursue energy efficiency (via revenue caps), or avoid incentives for uneconomic grid defection (via tariff structures that better reflect the fixed cost structure of the grid). Another example is the need for traditional tariff regulatory regimes to provide the greater flexibility needed to support innovation, for instance through the TOTEX (total expenditure) approach (Oxera, 2016), or the RIIO (Revenue=Incentives+Innovation+Output) approach (Ofgem, 2013).

Finally, the literature review has also highlighted that the evidence base on regulation in developing countries continues to contain many gaps. As noted above, while there is some empirical literature on the impact of regulatory institutions on sector performance, it remains relatively small and limited in geographical coverage (with a strong Latin America focus). Neither is the literature able to shed much light on
how the efficacy of regulation is affected by various aspects of the institutional design or the degree of effective regulatory independence. As regards regulatory substance, although there is a strong conceptual literature on tariff regulation, there is no real empirical evidence regarding the impact of tariff regulation on the cost recovery and financial viability of power utilities. There has also been little analysis of the functioning and impact of regulation on the technical quality of electricity and the customer service experience.
BIBLIOGRAPHY

Adam, R. 2011. *Establishing Regulatory Incentives To Raise Service Quality in Electricity Networks.* Cisco Internet Business Solutions Group (IBSG).

Alexander, I. 2014. *Developing countries experience and outlook: Getting the framework right.*

Alexander, I., and C. Harris. 2005. *The Regulation of Investment in Utilities Concepts and Applications.* Washington D.C.: The World Bank.

Alexander, I., C. Mayer, and H. Weed. 1996. "Regulatory Structure and Risk and Infrastructure Firms: An International Comparison." Policy research working paper.

Andres, L., J. Guasch, M. Diop, and S. Lopez Azumendi. 2007. *Assessing the Governance of Electricity Regulatory Agencies in the Latin American and Caribbean Region: A Benchmarking Analysis.* Washington D.C.: The World Bank.

Andrés, L., J. Guasch, T. Thomas, and V. Foster. 2008. *The impact of private sector participation in infrastructure.* Washington D.C.: The World Bank.

Antmann, P. 2015. *Reform of the Electricity Sector in Latin American Countries: Main Characteristics and Emerging Lessons.*

Australia Energy Market Commission. 2015. "Integration Of Energy Storage. Regulatory Implications. Final Report."

Australian Energy Regulator. 2014. "Australian Energy Regulator." *Overview of the Better Regulation reform packag.* Accessed 2016. https://www.aer.gov.au.

Baumol, W. 1967. "Reasonable Rules for Rate Regulation: Plausible Polices for an Imperfect World." In *Prices: Issues in theory, practice and public policy*, by Phillips and Williamson, 108 - 123. Philadelphia: Phillips and Williamson.

Benitez, D., and M. Rodriguez Pardina. 2010. "How Infrastructure Regulation Is Adapting to Climate Change: A Review of Recent Changes in Electricity and Water Regulation."

Berg, S. 2013. "Best practices in regulating State-owned and municipal water utilities." *ECLAC.*

Berg, S. 2015. "Energy Efficiency in Developing Countries: Roles for Sector Regulators."

—. 2013. *Regulatory Functions Affecting Renewable Energy in Developing Countries.*

—. 2013. "The Challenge of Renewables." *Body of Knowledge on Infrastructure Regulation.*

Berg, S., and A. Brown. 2012. "Response to the FAQ “What should be the involvement and mandate of the energy regulator in connection with promotion of Renewable Energy and
what are the main challenges associated from a regulatory perspective?". "Body of Knowledge on Infrastructure Regulation. http://regulationbodyofknowledge.org/.

Brown, A., J. Stern, B. Tenenbaum, and D. Gencer. 2006. Handbook for Evaluating Infrastructure Regulatory Systems. Washington D.C.: The World Bank.

Competition Economists Group. 2013. «Information on equity beta from US companies.»

Correa, P., C. Pereira, and B. Mueller. 2006. "Regulatory Governance in Infrastructure Industries Assessment and Measurement of Brazilian Regulators." Trends and Policy Options N° 3. Washington D.C.: The World Bank, PPIAF.

Council of European Energy Regulators. 2014. «The Impact of Distributed Generation on Electricity Infrastructure - Regulatory Dilemmas in Promoting the Future Role of DSOs.»

Cubbin, J., and J. Stern. 2004. "Regulatory Effectiveness: The Impact of Good Regulatory Governance on Electricity Industry Capacity and Efficiency in Developing Countries." City University, Department of Economics, Discussion Paper Series.

Eberhard, A. 2006. Infrastructure regulation in developing countries: an exploration of hybrid and transitional models.

Eberhard, A., J. Kolker, and J. Leigland. 2014. South Africa’s Renewable Energy IPP Procurement Program: Success Factors and Lessons. Washington D.C.: PPIAF - World Bank Group.

Economic Insights. 2015. "State Owned Enterprises in Papua New Guinea: Public Policies and Performance Final Report."

Energy Regulators Regional Association. 2013. "Regulatory Practices Supporting Deployment of Renewable Generators through Enhanced Network Connection."

—. 2016. «System Effects of Intermittent Renewable Generators (Wind, Solar) – Balancing.»

Ergas, H., and J. Small. 2001. Price Caps and Rate of Return Regulation. Network Economic Consulting Group.

Ergas, H., J. Hornby, I. Little, and J. Small. 2001. "Regulatory Risk - A paper prepared for the ACCC Regulation and Investment Conference." Manly.

Estache, A., V. Foster, and Q. Wodon. 2002. Accounting for Poverty in Infrastructure Reform: Learning from Latin America's Experience. Washington D.C.: World Bank Institute.

Gaggero, A. 2012. "Regulation and Risk: A Cross-Country Survey of Regulated Companies." Bulletin of Economic Research, Blackwell Publishing Ltd.

Gassner, K., and N. Pushak. 2014. 30 years of British utility regulation: Developing country experience and outlook.
Gilardi, F., and M. Maggetti. 2010. *The independence of regulatory authorities*.

Gratwick, K., and A. Eberhard. 2008. "Demise of the Standard Model for Power Sector Reform and the Emergence of Hybrid Power Markets." *Energy Policy* 36: 3948–60.

Green. 1997. *Has Price Cap Regulation of U.K. Utilities Been a Success?* Viewpoint Note 132, Washington D.C.: The World Bank.

Guasch, J. 2004. *Granting and Renegotiating Infrastructure Concessions Doing it Right*. Washington D.C.: The World Bank.

Hanretty, C., and C. Koop. 2010. "Shall the Law Set Them Free? The Formal and Actual Independence of Regulatory Agencies."

International Energy Agency. 2016. «RE-POWERING MARKETS Market design and regulation during the transition to low-carbon power systems.»

IRENA. 2015. "Energías Renovables en América Latina en 2015: Sumario de Políticas." Abu Dhabi.

Jamison, M. n.d. *Rate of return regulation*. Gainesville: Public Utility Research Center University of Florida.

Joskow, P. 2008. "Incentive Regulation and Its Application to Electricity Networks." *Review of Network Economics* 7 (4).

Joskow, P. 2014. "Incentive Regulation in Theory and Practice: Electricity Distribution and Transmission Networks." In *Economic Regulation and Its Reform: What Have We Learned?*, by Nancy L. Rose, 291 - 344. University of Chicago Press.

Kessides, I-. 2012. *Electricity Reforms - What Some Countries Did Right and Others Can Do Better*.

Khanna, A. 2013. *Assessing the effectiveness of Regulatory Performance*. The World Bank. Washington D.C.: The World Bank.

Laffont, J-J. 2005. *Regulation and development*. Cambridge.

Laffont, J-J., and J. Tirole. 1994. *A Theory of Incentives in Procurement and Regulation*.

Lewis, T., and C. Garmon. 1997. "Fundamentals of Incentive Regulation." PURC/World Bank International Training.

Liston, C. 1993. "Price-cap versus rate-of-return regulation." *Journal of Regulatory Economics* 25 - 48.

Littlechild, S. 1983. *Regulation of British Telecommunications' Profitability*. London: HMSO.

Maggetti, M. 2009. «The Role of Independent Regulatory Agencies in Policy-Making: A Comparative Analysis.» *Journal of European Public Policy* 16: 445-465.
Miller, M., and S. Cox. 2014. *Overview of Variable Renewable Energy Regulatory Issues.* National Renewable Energy Laboratory, U.S. Department of Energy.

Mirrlees-Black, J. 2014. "Reflections on RPI-X regulation in OECD countries." *Utilities Policy* 31: 197-202.

MIT. 2011. «The Future of the Electric Grid - An interdisciplinary MIT study.»

Mountain, B. 2014. «Independent regulation of government-owned monopolies: An oxymoron? The case of electricity distribution in Australia.» *Utility Policy (Utilities Policy).*

Newbery, D. 2003. "Rate-of-return regulation versus price regulation for public utilities."

Northumbrian Water. 2015. "The duration of price controls: to change or not to change?"

O'Sullivan, F. 2015. «The solar revolution—Its Scale, the Benefit and Challenges.» *Seminar "The Future of Energy: Latin America's Path to Sustainability" - ECLAC.* Santiago.

Ofgem. n.d. *Ofgem.* Accessed 06 15, 2016. https://www.ofgem.gov.uk.

—. n.d. *Ofgem.* Accessed June 16, 2016. https://www.ofgem.gov.uk.

Ofgem. 2010. "Regulating energy networks for the future: RPI-X@20. Current thinking working paper: The length of the price control period." London.

—. 2013. «RIIO Incentive Framework.» *10th EU-US Energy Regulators Roundtable.*

Oxera. 2016. "The CAPEX factor—part 1: dealing with uncertainty in setting CAPEX allowances."

Pérez-Arriaga, I., and A. Bharatkumar. 2014. "A Framework for Redesigning Distribution Network Use of System Charges Under High Penetration of Distributed Energy Resources: New Principles for New Problems." MIT.

Regulated Industries Commission. 2011. "Determining the Length of the Regulatory Control Period." Trinidad.

REKK. 2013. "Regulatory Practices Supporting Deployment of Renewable Generators through Enhanced Network Connection."

Rocky Mountain Institute and Homer Energy. 2015. «The Economics of Load Defection - How grid-connected solar-plus battery systems will compete with traditional electric service, why it matters, and possible paths forward.»

Rodríguez Pardina, M.. 2008. *Infrastructure Regulation: Taking Stock and Emerging Issues.*

Stern, J. 2014. *The British utility regulation model: its recent history and future prospects.* Working paper, London: Centre for Competition and Regulatory Policy (CCRP).
Termini, V. 2014. «The impact of distributed generation on electricity infrastructure - Regulatory Dilemmas in Promoting the Future Role of DSOs .» NARUC - 11th Annual EU-US Energy Regulators Roundtable.

The World Bank. 2010. Africa’s Infrastructure. A Time for Transformation. Washington D.C.: Vivien Foster and Cecilia Briceño-Garmendia Editors.

—. 2014. "Corporate Governance of State-Owned Enterprises."

—. 2014. Republic of India. India Power Sector Diagnostic Review More Power to India: The Challenge of Distribution. Washington D.C.: The World Bank.

UNIDO, and REEEP. 2006. "Sustainable Energy Regulation and Policymaking for Africa."

URSEA. 2012. Regulación de Energía y Agua 2011/2012. Montevideo.

Vagliasindi, M. 2008b. "Governance Arrangements for State Owned Enterprises." Policy Research Working Paper 4542. The World Bank Sustainable Development Network.

—. 2013. Power Market Structure: Revisiting Policy Options. Washington D.C.: The World Bank.

—. 2008a. "State Owned Enterprises and Hybrid PPPs: Is Economic Regulation Equally Effective?" Brown Bag Lunch on Regulatory Issues sponsored by FEU Economics Team and PPIAF.

Vagliasindi, M., and J. Nellis. 2009. "Evaluating Africa’s Experience with Institutional Reform for the Infrastructure Sectors." Working Paper 23, Africa Infrastructure Sector Diagnostic, The World Bank.

Vogelsang, I. 2004. Electricity transmission pricing and performance-based regulation. Boston: Boston University.

Wolak, F. 1998. Price-Cap Regulation and Its Use in Newly Privatized Industries. Palo Alto: Department of Economics, Stanford University.