Energy 36 (2011) 4340–4352

Contents lists available at ScienceDirect

Energy

journal homepage: www.elsevier.com/locate/energy

Conceptualizing and evaluating best practices in electricity and water regulatory governance

Darryl S.L. Jarvis, Benjamin K. Sovacool*

Lee Kuan Yew School of Public Policy, National University of Singapore, 469C Bukit Timah Road, Singapore 259772, Singapore

ARTICLE INFO

Article history:
Received 1 September 2010
Received in revised form
29 March 2011
Accepted 2 April 2011
Available online 4 May 2011

Keywords:
Energy governance
Electricity restructuring
Water reforms

ABSTRACT

This article presents a preliminary conceptual framework that scholars and analysts can use to evaluate regulatory systems in the provision of water and electricity services. We propose an integrative evaluative framework combining regulatory governance and regulatory substance metrics to assess regulatory effectiveness in relation to performance based outcomes in water and energy services provision. We identify eight structural based elements as necessary for effective governance in addition to two output attributes. We then identify twelve components that comprise regulatory substance for the energy and water sectors. We lastly suggest quantitative and qualitative metrics for assessing specific sector outcomes. While we recognize that issues associated with outcomes are ubiquitous to both the water and energy sectors, the metrics necessary to evaluate performance and outcomes are sectorally specific. The novelty of our study is that it does not exempt issues of sustainability and equity from notions of effective regulation. Our framework simultaneously looks at regulatory outcomes and governance at micro (industry), meso (provincial/state) and macro (national) levels. Lastly, it highlights the importance of a mixed methods approach that combines quantitative and qualitative metrics.

1. Introduction

This article presents a preliminary conceptual framework to evaluate regulatory systems in the provision of water and energy services. There is now a voluminous literature addressing the attributes of regulatory systems and best practice in regulatory design [1–10]. Relatively less literature, however, has evolved in relation to regulatory evaluation and much of this literature has focused on regulatory outcomes in terms of incentives, tariffs, rate of return, and other financial metrics. While questions about the appropriate models to incentivize utility operators of course remain important, effective regulation is equally a function of the governance mechanisms that surround, and give rise to, sound regulations and policies. The focus on governance, as opposed to mere regulation, has generated a substantial body of research, much of it identifying the "meta-principles" of credibility, legitimacy, transparency, autonomy and accountability, as essential attributes necessary for the effective long-term provision of energy and water services [11–14].

These two literatures have tended to coexist as two sides of the regulatory coin but not always treated holistically. Approaches to regulatory evaluation have thus emphasized either the outcomes of contending incentive based models *or* outcomes associated with different governance models (regulation by contract versus regulation by agency, for example). Further, broader questions about equity and sustainability have fallen outside of the methodological purview of these frameworks. As a consequence, the literature on regulatory evaluation has gaps in both its explanatory power and ability to evaluate outcomes.

In this study, we propose an integrative conceptual framework that combines regulatory governance *and* regulatory substance metrics to assess regulatory effectiveness in relation to performance based outcomes in water and energy services provision. We suggest a series of fundamental attributes for assessing the quality of *regulatory governance*. We identify eight elements as necessary for effective regulatory governance systems in addition to two output attributes. We then identify twelve components that comprise *regulatory substance* for the energy and water sectors. We lastly suggest quantitative and qualitative metrics for assessing specific sector outcomes. While we recognize that issues associated with outcomes are ubiquitous to both the water and energy sectors, the metrics necessary to evaluate performance and outcomes are sectorally specific. We thus develop specific metrics for the energy and water sectors. Our study has four advantages over previous models.

* Corresponding author. Tel.: +65 6516 7501; fax: +65 6468 4186.
E-mail address: bsovacool@nus.edu.sg (B.K. Sovacool).

0360-5442/$ – see front matter © 2011 Elsevier Ltd. All rights reserved.
doi:10.1016/j.energy.2011.04.007

First, our framework does not exempt issues of sustainability and equity from notions of effective regulation. Instead, it treats financial, managerial and political considerations as important attributes, along with technical standards and efficient operating procedures, only insofar as they also enhance social equity and environmental sustainability and improve a set of specific sectoral outcomes. In other words, effectiveness is viewed as multi-dimensional and outcome oriented. It involves a "seamless web" of economic, political, social, technical, and environmental criteria that cannot be investigated in isolation, and it necessitates measuring real outcomes, rather than the absence or presence of structural attributes associated with regulatory governance and substance [15–18].

Second, our framework simultaneously looks at regulatory outcomes and governance at micro (industry), meso (provincial/state) and macro (national) levels. This is because systemic elements at one particular level interact with the other levels, meaning that major elements of effective governance include not just national forms of regulation but also consumer needs and preferences, market structures and the entire set of actors and institutions involved with electricity supply and water prevision [19–21].

Third, we use a mixed methods approach that combines quantitative and qualitative metrics. This provides rigor in evaluating sector outcomes and allows for meaningful quantitative comparisons but supplements this with qualitative assessments that investigate process and practice based performance and outcomes.

Fourth, our framework has a high degree of specificity that distinguishes between the electricity and water sectors, recognizing that regulatory governance and substance articulates in different ways across these sectors because of the nature of each industry. Attitudes toward access issues associated with energy and water, for example, consumer tolerance of service quality and interruptions, or consumer attitudes toward entitlements, pricing and tariffs, differ across these two sectors and reflect different demand elasticity and access requirements.

2. The need for a conceptual framework

Regulation, or the setting and enforcement of rules based in law, is central to cost effective, efficient, just, and environmentally sustainable provision of energy and water services. The rules may simply impose constraints and define penalties, or may seek to alter the incentives faced by providers. Regulatory systems are comprised of:

- institutional responsibilities and processes for setting and enforcing rules, formal and informal (the "how" of regulation, known as "regulatory governance"); and
- the content and rationale of actual rules and enforcement decisions (the "what" of regulation, or "regulatory substance").

For regulation to be "effective," the elements of regulatory governance and the decisions that constitute regulatory substance should satisfy certain parameters.

Over the past three decades most developing countries have initiated regulatory reform in their energy and water sectors with the aim of improving the delivery of service, increasing investment in the sectors, and reducing government budget burdens. Such reforms followed worldwide ideational shifts commencing in the 1980s and 1990s in the United Kingdom, the United States and Chile. These efforts deregulated and unbundled state-owned electricity utilities, introduced private sector competition, established electricity markets, and strengthened independent regulators.

Since the late 1980s an increasing number of developed, transition and developing economies have instigated energy and water sector reform measures, but none of these have yet resulted in an optimal framework. By the turn of the millennium, for example, 70 developing and transition economies and the majority of OECD countries had taken steps to reform their energy sectors while an increasing number of OECD and developing countries had similarly explored reform in the water and sanitation sector [22,23]. These trends reflect a board paradigm shift in approaches to infrastructure provision related to:

- Ideational changes about the role of the state in the provision of public goods;
- Dissatisfaction and concerns about the performance, efficiencies and standards of service quality provided by traditional state controlled utilities and monopolies;
- The desire to reduce the fiscal burden on the state in the provision of public utilities and thus increase fiscal discretion;
- The development of new management and theoretical approaches premised on market and incentive based regulation.

As Jamasb *et al* observes [23], however, the driving force behind reform differs markedly between developed and developing economies: In developing and transition countries the burden of subsidies, low service quality, non-collection rates, high network losses and poor service coverage have meant that governments are no longer willing or able to support existing arrangements.

By the 1980s, emergent patterns among public utilities in developing countries indicated reduced financial performance, revenue reductions through declining average real power tariffs in the energy sector, deteriorating service quality in both water and energy, and inadequate billing, collection and metering practices. Together these trends compromised financial sustainability and increased the requirement for state subsidies across both sectors. While infrastructure costs continued to rise along with demand for energy and water, the rates of return on public sector capital expenditures continued to deteriorate [24].

These dynamics highlighted the problem of insufficient commercial operations in public utilities throughout Asia and the Pacific. More particularly, they bring into focus broader problems associated with the ownership, management and accountability mechanisms that had emerged with the centralized state provision of public utilities. As Saunders et al. observe [24], "opaque command and control management" structures combined with "poorly defined objectives, government interference in daily affairs, and a lack of financial autonomy" detracted from "productive efficiency and institutional performance." By the time of Asia's first financial crisis in the early 1980s and again in the late 1990s, it was increasingly evident that models premised on the state-centered provision of energy and water infrastructure would require reengineering. The spate of reforms that followed thus broadly coalesced around sector liberalization, allowing private sector participation as a means of mobilizing private capital and reducing the fiscal burden on the state. Liberalization, it was assumed, would increase efficiencies through market based incentives, positively impacting sector performance and outcomes. At the same time, governments around the world commenced a series of reforms aimed at constructing regulatory frameworks as a means of facilitating and supporting private sector participation. Liberalization and the need to mobilize private capital into the utilities sector thus came to define the role, function and focus of regulatory reform and practice.

However, a number of enduring research questions remain: what attributes of regulatory governance result in effective and efficient electricity and water policies? What forms of regulatory substance should be most valued? And how can performance in these sectors best be assessed?

3. Conceptualizing regulatory governance

Unlike previous studies, in this study we distinguish between input governance attributes and output governance attributes. Input governance attributes are inherent characteristics of the structure of the regulatory system itself (for example, whether the regulator is autonomous, and whether it is transparent). Output based governance attributes are based on stakeholder perceptions of the regulatory system (i.e. whether the regulatory system is credible and legitimate). Fig. 1 illustrates how these attributes will be present in different degrees depending upon the extent the regulatory system is viewed by different stakeholders as possessing satisfactory input governance characteristics, and producing good regulatory substance. Table 1 provides definitions and brief descriptions of these eight attributes of regulatory governance; Table 2 definitions and descriptions of two output attributes. The remainder of this section discusses each attribute in detail.

Autonomy is met if the regulatory body can make decisions and take action without referring to another authority, and can carry out its regulatory functions with relative independence from political interference in a manner that satisfies its stated objectives. It is commonly understood to have three components:

- Organizational autonomy- a clearly defined formal-legal power and authority to make decisions and take action separately from government and the private sector;
- Fiscal autonomy – an adequate amount of dedicated financial resources that are not subject to arbitrary withholding or control by another institution, subject to audit; and
- Managerial autonomy – the operational ability to make decisions over resources and staff.

An example of a fully autonomous agency is the Dubai Water and Electricity Authority, which oversees everything water related throughout the country, compared to Singapore where autonomy is split between the Ministry of Environment and Water Resources (in charge of policy) and the Public Utilities Board (in charge of service).

Clarity of roles and objectives is met when roles, responsibilities of the regulatory body, and regulatory objectives, are clearly and well specified; roles and responsibilities do not overlap significantly with other departments and agencies; and sector objectives are clearly defined in authorizing legislation and transparent to all stakeholders. Hence there must be clarity and coherence between: the regulator, the sector ministry, and the utility operator; the regulator and any competition authority and consumer protection authority; the regulator and other public agencies or regulator working at the provincial, or local level, or otherwise across different levels of government; and other regulators also governing the power or water supply industry (i.e. environmental regulators). The attribute is often achieved when rule ownership and rule making are confined to a single regulator, agency or government department. In Denmark, for example, the design, permitting, environmental impact assessment, operation, and interconnection of renewable sources of electricity to the grid are handled by one agency, the Danish Energy Authority, regardless of the source or type of technology. Contrast this with the United States, where permitting for some sources, such as onshore wind and solar, is

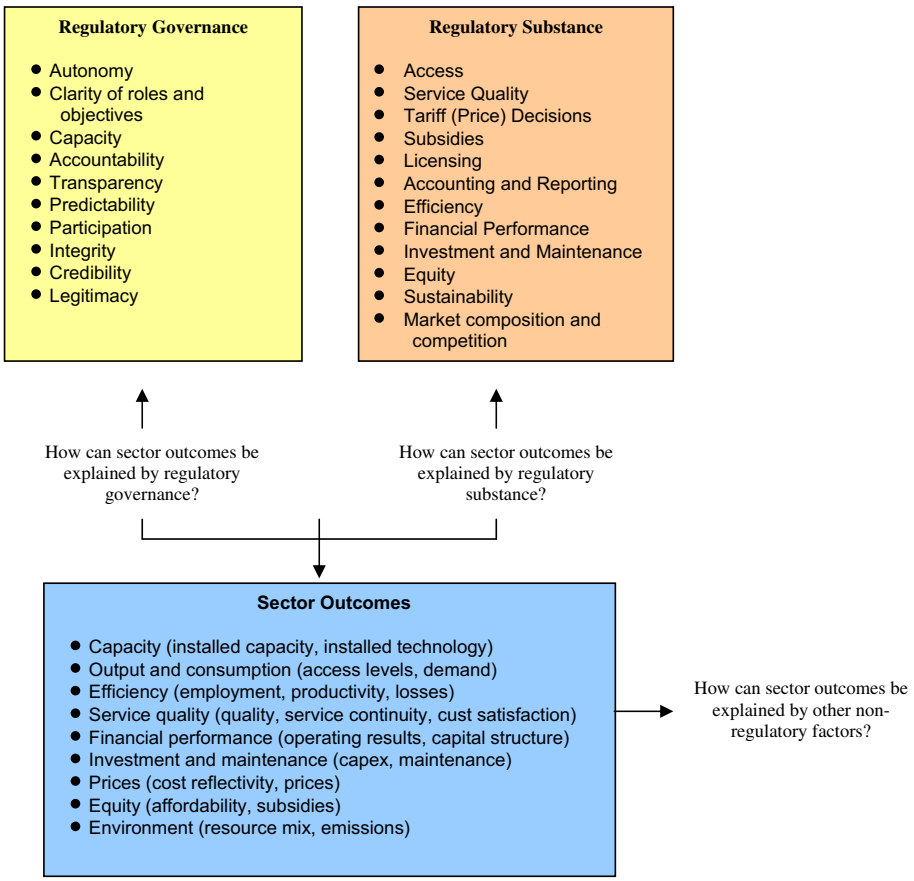

Fig. 1. Regulatory governance, substance, and sector outcomes.

Table 1
Definitions and qualitative indicators for regulatory governance input attributes.

Regulatory governance input attribute	Definition	Indicator/Questions
Clarity of roles and objectives	Refers to the clarity of the roles and responsibilities assigned to the regulating entity Refers to the specification of roles, responsibilities and regulatory objectives in the formal-legal documentation that governs the regulating entity Refers to the clarity of rule ownership and the extent to which confusion of rule ownership is avoided	We measure the clarity of roles, rules and objectives in relation to 6 indicators: Does the primary legislation or the legal instrument that governs the regulating entity clearly set out a description of its roles, functions and responsibilities? Does the primary legislation or the legal instrument that governs the regulating entity clearly set out its regulatory objectives? Are certain roles or responsibilities for rule making carried out jointly with other administrative entities, ministries or agencies? Does the regulating entity have responsibility for regulatory oversight and the commercial promotion of the sector? Does the primary legislation or the legal instrument that governs the regulating entity clearly demarcate between functions associated with oversight versus policy development? Does the primary legislation or the legal instrument that governs the regulating entity clearly specify its role and jurisdiction in relation to decision making versus an advisory role?
Capacity	Refers to the availably and sufficiency of both financial and human resources to undertake and discharge to a high level the requirements stipulated in its mandate Refers to adequate resourcing in the case of budget provisions or access to revenue streams that enable the regulating entity to act relatively free of resource constraints Refers to the ability to attain sufficient regulatory capacity in respect of regulatory staff with the appropriate technical skills, relevant knowledge and experience	We measure capacity in relation to 4 indicators: Is the regulating entity appropriately resourced relative to its mandated role(s) and responsibilities? Does the regulating entity have access to independent revenue streams that guarantee its operations? Does the regulating entity enjoy budget stability from year to year? Is the regulating entity able to attract and retain personnel with the appropriate technical skills, knowledge and experience?
Autonomy	Refers to the ability of the regulating entity to act and render objective, fair and impartial decisions in the interests of all stakeholders Refers to the ability of the regulating entity to act beyond the interests of specific constituencies Refers to the mechanisms and procedures put in place that help ensure the regulating entity is not captured by government or private sector interests	We measure autonomy in relation to 5 indicators: Does the regulating entity enjoy independence from the government (e.g., statutory authority)? Does the regulating entity enjoy budget autonomy in the discharge of its mandate? Are members of the regulating entity appointed on the basis of merit and in an open, transparent and fair appointments process? Are members of the regulating entity protected from arbitrary dismissal by the government or other constituencies? Does the regulating entity have rule and decision authority or only an advisory capacity?
Accountability	Refers to mechanisms that hold government and public/private sector actors accountable and ensure appropriate conduct Refers to the processes and procedures via which the regulating entity reports and accounts for its activities in relation to its mandate and the discharge of its duties Refers to the mechanisms for interested parties to challenge the regulating entity's decisions or rulings Refers to the mechanisms, processes and instruments available to stakeholders to seek redress or have the decisions or actions of the regulating entity reviewed by an external party	We measure accountability in relation to 5 indicators: Is there a formal set of accounting and reporting procedures in place (to government, to the public, to key stakeholders?) Can the regulator be dismissed for failing to fulfill its duties? Are formal accountability mechanisms enshrined in the mandate of the regulating entity? Are formal mechanisms for redress/dispute resolution proscribed in the mandate of the regulating entity? Is there a process for judicial review in the case of disputes?

(*continued on next page*)

Table 1 (*continued*).

Regulatory governance input attribute	Definition	Indicator/Questions
Transparency	Refers to the process of revealing the assumptions and information on which decisions and actions are made, so that outside observers can scrutinize them Attributes of transparency refer to i) how timely information is made available; ii) the processes and procedures for recording, storing and transmitting information; iii) the policies indicating what information is to be made available (disclosed); v) the extent to which the regulating entity is willing to allow external access to decision making processes/information sources	We measure transparency in relation to 6 indicators: Are major regulatory documents in the public domain? Does the regulatory entity publish major decisions? Is there a voluntary or compulsory code of disclosure in place for regulatory rulings and decisions? Does the regulating entity have a policy in place for transparency and disclosure? Does the regulating entity record and store its information sources, documentation and other external inputs on which its decisions are made? Does the regulating entity disclose/publish the information sources on which its decisions are based and the methods via which issues like tariff adjustments are determined?
Predictability	Refers to the certainty & stability of the rule and decision making environment Refers to the certainty and stability of the processes and procedures by which rules and decisions are rendered Refers to the certainty that regulatory objectives, sector composition, or regulatory substance will not be suddenly changed (i.e., that the rules of the game are relatively stable) Refers to the regularity, consistency and orderliness of decision making in relation to a consistent set of objectives and criteria	We measure predictability in relation to 5 indicators: Are regulatory objectives stable? Do rule and decision making producers demonstrate consistency? Can the regulating entity's functions, role and duties be easily changed? Are compliance requirements stable from year to year (license, authorization procedures, inspection requirements)? Does the regulating entity produce regular documentation, render regular reports, and discharge its duties in relation to a set calendar?
Participation	Refers to the ability and willingness of the regulating entity to canvas diverse opinions, integrate the opinion of multiple stakeholders into its decision making processes, and allow for mediation of different points of view in open forums, public events and through written and oral submissions	We measure participation in relation to 6 indicators: Does the regulating entity have procedures and mechanisms in place to consult widely? Does the regulating entity hold public forms/events/meetings that are open to the public/industry stakeholders? Does the regulating entity allow written and oral submissions to its decision making bodies? Does the regulating entity publish or make publicly available all submissions from the public/stakeholders? Is the regulating entity required to respond formally to public submissions? Is there any evidence that public participation and consultation processes influence the decisions or operations of the regulating entity?

Table 1 (*continued*).

Regulatory governance input attribute	Definition	Indicator/Questions
Integrity	Refers to the perceived consistency of values, methods and actions of the regulating entity in relation its mandated objectives and sectoral outcomes	We measure integrity in relation to 4 indicators:
		Are members of the regulating entity required to disclose conflicts of interest?
	Refers to degree to which stakeholders perceive the regulating entirety to adhere to its principles, display professionalism in the discharge of its mandate, observe due process, and act on the basis of impartiality and with high levels of probity	
		Are members of the regulating entity subject to ethics codes and due diligence upon appointment? Is the regulating entity perceived to be impartial by a diverse set of stakeholders? Is the regulating entity perceived to be governed by adherence to the broader principles of its mandate?

handled by the U.S. Environmental Protection Agency, those on tribal lands the Department of Interior, biomass sources the Department of Agriculture, and offshore wind and tidal sources by the Bureau of Ocean Energy Management. Furthermore, in the U.S. operation is regulated by local utility commissions and cooperatives, interconnection standards by local transmission operators, and so on. The former has a "one-stop-shop" that is clear and objective, the latter multiple competing agencies with complex and at times confusing mandates.

Capacity is the ability of people, organizations and society as a whole to manage their affairs successfully. For a regulatory body, this attribute is met if it has leadership and it can mobilize and manage resources to plan, implement, monitor, learn, and adapt to change. In the context of a utility regulatory body, it must have the financial and human resources available in sufficient quantity, predictably over time to enable it to discharge its regulatory mandate. For capacity to be present, the regulatory body needs commissioners who can demonstrate leadership; the ability to mobilize and manage adequate financial resources that are predictable and stable over time; and the ability to attract and maintain a sufficient number of regulatory staff with the right technical skill set and knowledge and experience. A prime example is the Federal Regulatory Energy Commission in the United States, founded in 1920 to oversee interstate electricity rates, hydroelectricity licensing, and natural gas and oil pipeline prices, which is comprised of four long-term commissioners appointed by the Courts as well as a Chairman.

Accountability is met if a regulatory body is subject to answerability and sanctions. Answerability is the process whereby the regulator has a duty to provide an answer regarding a decision it

Table 2
Definitions and Qualitative Indicators for Regulatory Governance Output Attributes.

Regulatory Governance output attributes	Definition	Indicator
Credibility	Refers to the extent to which stakeholders perceive the regulatory entity and government will honor its commitments, validate its contractual agreements and obligations, and otherwise honor issues associated with regulatory substance and governance	We measure integrity in relation to 5 indicators:
		To what extent do major stakeholders perceive regulatory commitments to be credible? Is there evidence of the regulating entity or government engaging in contract re-negotiation? Is there evidence of the regulating entity deviating from its mandated objectives? Has the regulating entity issued conflicting rulings or rendered decisions that are obtuse or open to interpretation? Has the regulating entity or government abided by judicial review and adhered to judicial rules in the case of disputes?
Legitimacy	Refers to the extent that multiple stakeholders perceive the regulating entity to be principled in the discharge of its mandate, fair and equitable in the treatment of all stakeholders, and acting in accord with its mandate to protect and enhance the interests of all stakeholders	We measure legitimacy in relation to 3 indicators:
	Refers to the extent to which the regulating entity enjoys the support and respect of multiple stakeholders	Is the regulating entity perceived as fair in its treatment of various stakeholders? Does the regulating entity display impartiality and even-handedness in its decision making and rule determination? Do multiple stakeholders engage with the regulating entity to prosecute their concerns and agenda?

makes or an action it carries out to a person or company who may be affected by its decision or action. It also involves the regulator being subject to sanction for revealed abuses of power or the failure to provide a satisfactory answer. This requires: external mechanisms to challenge the regulator's decisions and hold the regulator accountable and so reduce the risk that private firms or consumers are treated unfairly; processes and procedures by which the regulatory body reports and accounts for its activities in relation to its mandate and the discharge of its duties; mechanisms available to interested parties to challenge the regulatory body's decisions or rulings; and an independent and fair judiciary that reviews administrative decisions. Classic examples of *unaccountable* regulatory bodies include the Civil Aeronautics Board, Interstate Commerce Commission, and Atomic Energy Commission in the United States, organizations that all had monopoly power to make decisions related to aviation, railroads, and nuclear power plants without input from key stakeholders and without being held accountable by sanctions or external control.

Transparency is met if a regulatory body is required to provide information on regulatory actions, decision making and the assumptions and information upon which decisions and actions are made; and information, laws, rules, regulation, and decisions are clear. It requires that information is disclosed in a timely fashion; there are established processes and procedures for recording, storing and transmitting information; defined policies exist indicating what information is to be publicly disclosed; stakeholders are able to review relevant information; and outside observers are able to scrutinize the decisions and actions of the regulatory body. Examples of transparent regulatory schemes include the Toxics Release Inventory in the United States, and also the National Pollution Control Agency in Indonesia, which publicly discloses the environmental performance of manufacturing facilities [42].

Predictability is met if laws, rules, policies, and the contracts pertaining to sector regulation (i) do not suddenly change, and (ii) are applied fairly and consistently within the framework. It requires certainty and stability of the processes and procedures by which rules and decisions are rendered; certainty that regulatory objectives, sector composition, or regulatory substance will not be suddenly changed (i.e., that the rules of the game are relatively stable) and that decision making is regular, consistent and orderly in relation to a set of objectives and criteria. One example of predictability is Germany's feed-in tariff for renewable sources of electricity, on the books since 1990 for wind and solar and expanded to other sources in 2000. The law requires any changes to the scheme to be announced at least two years before they take effect. Germany's scheme can be compared to the production tax credit for renewable energy in the United States, which expired no less than four times from 1998 to 2010, sometimes with less than 3 week's notice, or support mechanisms for solar energy in Australia, which expired with less than one day's notice [15].

Participation is met if all parties affected by a regulatory decision, action or process, or interested in participating, including government, the regulated industry, consumers and unconnected citizens, have the opportunity to influence the regulation or decision before the regulator decides. It requires information disclosure sufficient to allow stakeholders to have informed participation; formal and informal opportunities for consultation of stakeholders; the ability and willingness of the regulatory body to canvas diverse opinions; the ability and willingness of the regulatory body to integrate the opinion of multiple stakeholders into its decision making processes; and the ability and willingness of the regulatory body to mediate different points of view in open forums, public events and through written and oral submissions. Participation may take many forms, but generally it refers to forums (public hearings) and or processes (the ability to make written and oral submissions, for example) that allow for the presentation of information, analyses, complaints, suggestions and concerns about regulatory processes and outcomes, and the procedures and processes via which these representations are considered and acted on by the regulating entity. One example of a relatively participatory regulatory process is the permitting and siting of hydroelectric dams in Laos, which under national law must occur in binding consultation with the communities and other affected stakeholders. This can be contrasted to the siting of nuclear waste repositories in Canada and the United States, which frequently occur without public consultation (and can be vociferously opposed by local communities) [43].

Integrity is defined by the personal integrity of individuals that are part of the system, and the institutional characteristics of the system itself. Personal integrity requires that an individual adheres to principles of honesty, is ethical, and commits to the objectives, values and principles of the regulatory system. System integrity means that the system as a whole is not undermined, impaired or diminished by external factors. It involves the degree to which stakeholders perceive the regulatory body and individuals working within it as adhering to its objectives, values and principles; displaying professionalism in the discharge of their mandate; observing due process; and acting impartially and fairly. One instance of a system with a lack of integrity is the State Oil Fund of the Azerbaijan Republic, created expressly to distribute revenues from the country's oil production to the "social and economic development" of the poor, which has instead funneled more than 90 percent of its funds into pet projects of the ruling elite, including hundreds of millions of dollars for presidential palaces, complexes, and statues [44]. One example of a person with integrity is the former Georgian Minister of Environment Nino Chkhobadze, who protested against the construction of a multi-billion dollar oil pipeline on the grounds that it would violate his country's environmental legislation at the risk of losing his job, which he did two months later [44].

These input governance attributes are interstitial, holistic, and interdependent. Transparency and access to information can in turn degrade or enhance accountability. Similarly, lack of accountability or corruption can convince citizens not to trust government information, no matter how clearly or transparently it is presented. Predictability can enhance participation, since it enables people to better plan when and how to participate in hearings and discussions. Personal and system integrity are necessary to create conditions of trust that permeate other dimensions such as capacity or autonomy. So, too, are the regulations and sectoral outputs that result from such a governance framework. Electricity tariffs are influenced by other factors such as subsidies, whether to include the costs of negative externalities, and whether to incentivize energy efficiency and demand side management programs. The point is that one cannot look at any single input attribute or outcome in isolation, they exist as part of an interconnected whole, which is why we present them as part of a comprehensive framework.

When all of our input attributes coexist harmoniously, they tend to result in two output attributes. *Credibility*, an output attribute, is defined as the extent to which stakeholders believe the regulatory body will honor its commitments. It signals the veracity of the regulatory regime and regulatory body; that its commitments are firm and ensconced within its license to operate and will be honored and adhered to. Credibility indicates the government and regulatory body will be bound by judicial processes and third party arbitration, and not unduly seek to change the parameters of regulatory substance or interfere inappropriately with the spirit and intent of agreed principals. High levels of credibility signal the presence of certain protections, certainties, and the ability to engage in long-term commitments, to sector participants.

Legitimacy, a second output attribute, is defined as the extent to which external stakeholders perceive the regulatory system to be derived from moral or legal authority and the regulatory body to be discharging its duties and exercising its authority consistent with its express and implied legal authority. It involves the perception by multiple stakeholders that the regulating entity is governed by the principals of its mandate, is fair and equitable in the treatment of all stakeholders, seeks to protect and enhance the interests of the sector and all participants, demonstrates impartiality and high levels of integrity in the discharge of its duties, and acts effectively and professionally.

4. Conceptualizing regulatory substance

The governance conditions above give rise to the substance of energy and water regulation. We define regulatory substance as the actual decisions (explicit or implicit) made by the regulatory body or other government agent, the rationale for the decisions and the enforcement and other actions taken by the regulatory body. Regulatory substance covers the design of regulatory incentives, and the models that set the rules of the game for utility providers. It encompasses the formal rules, regulations, and laws governing energy and water use, and also norms, values, and principles applied, decisions made, and actions taken, in practice. Table 3 presents the regulatory dimensions involved in electricity supply; Table 4 those for water supply. The remainder of this section elaborates on these twelve components of regulatory substance for the water and power sectors.

Access refers to regulatory decisions and actions that (a) enable citizens to be connected to and maintain connection to electricity and water supply service networks, (b) inhibit such connections, (c) facilitate access to alternative non-grid forms of energy and water supply, (d) monitor and enforce regulation on maintaining and expanding access coverage, and (e) resolve disputes related to access.

Service quality refers to the regulatory decisions and actions that set service standards for the quality of water and electricity, including whether minimum service standards exist, whether service providers are permitted to experiment with flexible standards. It covers (a) standards ensuring continuity of water or electricity supply (for example, outages based on electricity service interruptions or blackouts, and 24/7 uninterrupted water supply); (b) standards ensuring the quality of supply (i.e. frequency and voltage for electricity, and World Health Organization standards for water); (c) customer service (for example customer complaints) and service quality.

Tariff and Price Decisions refer to the regulatory decisions and actions that (a) set the tariff levels, (b) determine the tariff structure, and (c) periodically review or adjust the tariff. It includes establishing tariff objectives, structure, methodology, and review. Tariff levels need to be considered for different classes of users (such as residential, commercial, or industrial). Tariff structures need to consider whether tariffs cover full costs, whether they are fair to consumers and utilities, and whether charges are fixed and variable, as well as whether price caps, seasonal tariffs, interruptible tariffs, real time pricing, net metering, and declining block rate pricing exist.

Subsidies requires considering incentives for the electricity or water sector whether or not they are direct (the result of a regulatory decisions or action) or indirect (actions that may affect regulatory decisions or the sectors involved). These include direct financial transfer, preferential tax treatment, trade restrictions, and public funding of research related to energy and water. Evaluating subsidies involves investigating the financial value of those subsidies, whether they apply to usage or connections, whether they are targeted or applied to specific groups, and assessing their costs and benefits.

Table 3
Dimensions of Regulatory Substance for Electricity Supply.

Regulatory Dimension	Description
Access Coverage	Extent of network and off-grid provision
Service Quality	Technical safety, and customer service standards
Price (Tariffs)	Tariff levels, structure and adjustment
Accounting and Reporting	Obligation to report information about the sector
Subsidies	Nature and amount of direct and indirect subsidies
Licensing	Agencies involved in licensing, permitting, and siting new facilities
Efficiency	Extent of demand-side management programs
Financial performance	Maintaining adequate rates of return
Investment decisions and maintenance	Responsibility for maintaining, retrofitting, and upgrading infrastructure
Equity	Ensuring access, affordability and quality of service to poor
Environmental sustainability	Minimizing environmental degradation
Competition and Composition	Licensing and network access for private providers

Licensing refers to the regulatory decisions and actions that cover permitting, licensing, and re-licensing of energy and water facilities. It includes the clarity of those regulatory decisions and actions on licenses, the issued grounds for amending or suspending licenses, processes of dispute settlement or management for licenses, the information the regulatory decision or action requires for a license application, the ease of new entry into the market, and the types of obligations reflected in licenses.

Accounting and reporting refers to regulatory decisions and actions setting standards for collecting, compiling, evaluating, and distributing documentation and information related to energy and water supply, and the enforcement of those standards. It includes formal requirements, such as independent audits and mandatory information disclosure, as well as informal requirements, such as requiring documentation to be publicly available on websites and in brochures.

Efficiency refers to regulatory decisions and actions that require water and energy suppliers to deliver their services using the least energy, water, or cost necessary. It involves measures to make the supply side of energy and water sectors more efficient by improving

Table 4
Dimensions of Regulatory Substance for Water Supply.

Regulatory Dimension	Description
Access coverage	Extent of network and off-grid provision
Service Quality	Technical and customer service standards
Price (Tariffs)	Tariff levels, structure and adjustment
Subsidies	Nature and amount of direct and indirect subsidies
Licensing	Agencies involved in licensing, permitting, and siting new facilities
Accounting and Reporting	Obligation to report information about the sector
Water Efficiency	Extent of water efficiency programs
Financial performance	Maintaining adequate rates of return
Investment and maintenance	Responsibility for maintaining, retrofitting, and upgrading infrastructure
Equity	Ensuring access, affordability and quality of service to poor
Environmental sustainability	Minimizing environmental degradation
Competition and Composition	Licensing and network access for private providers

Table 5
52 Indicators for Electricity Sector Outcomes.

Sector Outcome	Proposed Indicator for electric utility
Capacity	Installed generation capacity (MW)
	% change (growth) in generation capacity per year
	Gross Generation (MWh)
	Peak Demand (MW)
	Demand growth by sector (residential, industrial, commercial)
	Generation reserve margin (MW)
Access	Number of connections to the electricity grid
	% households with access to the electricity grid
	Number of households served by off-grid energy systems and/or isolated micro-grids
	% change (growth) in new connections per year
	Number of new customers (connections) per year
	Length and duration of connection queues
Service Quality	Continuity of supply (outages measured by minutes of supply interruption per year, or number of major blackouts)
	Quality of supply (number of incidences per year where frequency and voltage variations damaged equipment)
	Quality of customer service (from existing surveys of consumer satisfaction or number of customer complaints per year)
Price (Tariffs)	Average tariff (US$ per kWh)
	Total production cost (US$ per kWh)
	Fuel cost (US$ per kWh)
	Other O&M cost (US$ per kWh)
	Stability of prices (% change per year)
Subsidies	Amount of direct and indirect subsidies per capita
	Subsidies per GDP (as a %)
	Sufficiency of targeted subsidies for the poor (amount of subsidy divided by number of poor)
Licensing	Cost of applying for a permit or license
	Average length of time needed to get a license renewed or new project approved
Efficiency	Energy intensity (Sector energy consumption/GDP)
	Demand-side management (kWh saved/year from DSM programs)
	Water intensity (thermoelectric and hydroelectric water withdraws and consumption per kWh)
	Technical losses (transmission and distribution loss)
	Network (commercial) losses (electricity theft)
	Staff productivity (staff per 1000 connections, kWh generated per employee, customers served per employee, electricity sales per employee)
Financial performance	Operating Profit Margin/Operating profits/net profits or losses
	Rate of return on capital (%)
	Rate of return on expenditure (%)
	Debt Service Coverage Ratio (%)
	Sources of finance (% domestic sources of finance, % foreign sources, % state sources, % private sources)
Investment and maintenance	Capital expenditure
	Sunk investments/infrastructure stock
	Maintenance expenditures as a % of capital expenditure
	Rate of depreciation (degradation of sunk assets)
Equity	Affordability (% household expenditure on electricity to lowest income quintile)
	Number of low income households that have high quality, reliable, continuous access as a proportion of total customers
Environmental Sustainability	Greenhouse gas emissions (GHG) and GHG intensity per kWh
	Resource mix (electricity generation by source)
	Ambient particulate matter pollution
	Nitrogen oxide emissions
	Sulfur dioxide emissions
Competition and Composition	% market share held by top three suppliers
	Number of IPPs
	Number of distributed generation/combined heat and power/cogeneration operators
	Number of public private partnerships
	Numbers and quality of bidders in bids for transmission projects, new generation, franchises, and privatizations

the efficiency of supply, transmission, and distribution (by increasing the thermal efficiency of power plants, and reducing transmission and distribution losses, and water losses). It also involves measures to reduce demand by improving end-use efficiency (by lowering energy intensity or water intensity for homes and businesses).

Financial performance refers to regulatory decisions and actions that require water and electricity suppliers to comply with financial ratios, including rates of return and debt coverage.

Investment and maintenance refers to regulatory decisions and actions that relate to expenditures needed to maintain existing infrastructure, the age of infrastructure stock, and the degradation of that infrastructure.

Equity refers to regulatory decisions and actions that concern, identify, or target poor or low income water and electricity users. It involves assessing the needs of the poor, identifying any existing obstacles to pro-poor service, targeting subsidies for the poor, and determining whether regulators offer any mechanisms to help low income users.

Environmental and social sustainability refers to regulatory decisions and actions that relate to environmental and social sustainability. It covers whether the regulator has a mandate that covers sustainability issues, including provisions to include externalities in energy or water prices, energy efficiency and water conservation, whether the regulator has made any decisions, issued any regulation or taken any action on environmental and social sustainability, including renewable energy and energy efficiency, and the types of requirements regulators have in place to minimize greenhouse gas emissions and respond to climate change.

Market composition and competition is defined as the regulatory decisions and actions on the structure of the electricity and water sector, including whether it is a monopoly, partially restructured, or fully restructured, deregulated, or liberalized. It includes regulatory decisions and actions (a) restricting investment, (b) unbundling the generation, transmission, and distribution components of the sector, (c) establishing competitive wholesale or retail markets for electricity and water, and (d) facilitating or inhibiting access and interconnections to the transmission and distribution grid.

5. Determining sector outcomes

Regulatory governance and regulatory substance can directly affect sector outcomes. As Brown et al. [14] have noted: “regulation is a means to an end, and the end is better sector performance …

Table 6
50 Indicators for Water Sector Outcomes.

Sector Outcome	Proposed metric for water utility
Capacity	Installed water supply
	% change in water supply by volume
	% demand growth by sector (residential, industrial, commercial)
	Number of annual customers served
Access	Number of connections to the water network
	% households with access to the water network
	Number of alternative households served by water vendors and tanks
	% change (growth) in new connections per year
	Number of new customers (connections) per year
	Length and duration of connection queues
Service Quality	Drinkability of water (WHO recommended standards in relation to contaminants and purification standards)
	Frequency of water supply interruptions
	Customer average duration index
	Bacterial content of water supplies
	Customer satisfaction (from existing surveys or to be collected originally)
Price (Tariffs)	Average tariff (US$ per m^3)
	Total production (US$ per m^3)
	Other O&M (US$ per m^3)
	Stability of prices (% change per year)
Subsidies	Amount of direct and indirect subsidies per capita
	Subsidies per GDP (as a %)
	Sufficiency of targeted subsidies for the poor (amount of subsidy divided by number of poor)
	Presence of flat-rate subsidies
Licensing	Cost of applying for a permit or license
	Average length of time needed to get a license renewed or new project approved
Efficiency	Energy intensity (Sector energy consumption/GDP)
	Water-use efficiency (how much water is used compared to the minimum amount needed)
	Technical losses (unaccounted for water; non-revenue water)
	Network (commercial losses) (non-revenue water)
	Staff productivity (staff per 1000 connections, water sold per employee, customers served per employee)
Financial performance	Operating Profit Margin/Operating profits/net profits or losses
	Rate of return on capital (%)
	Rate of return on expenditure (%)
	Debt Service Coverage Ratio (%)
	Debt to equity ratio
Investment and maintenance	Capital expenditure
	Sunk investments/infrastructure stock
	Maintenance expenditures as a % of capital expenditure
	Rate of depreciation (degradation of sunk assets)
Equity	Affordability (% household expenditure on water on electricity to lowest income quintile)
	Number of low income households that have high quality, reliable, continuous access as a proportion of total customers
Environmental Sustainability	GHG per liter (roughly correlated with the energy needed for water conveyance, pumping, treatment, etc.)
	Water resource by source (desalination, imports, catchment, etc.)
	Arsenic contamination of water
	Lead contamination of water
	Mercury contamination of water
Competition and Composition	% market share held by top three suppliers
	Number of water concessions
	Number of private operators
	Number of public private partnerships

(*continued on next page*)

Table 6 (*continued*).

Sector outcomes must be the ultimate benchmark for judging regulatory performance." However, sector outcomes are also driven by other events beyond the regulatory system and outside the control of the regulator. External factors include "macroeconomic conditions… currency fluctuations, interest rates… global conditions of the regulated market," natural disasters, and investor perception of overall country risk, to name a few [14]. In understanding our conceptual framework, it is important to mention that not all aspects of regulatory governance and regulatory substance will have a direct affect on sector outcomes. Understanding and looking for external factors that contribute to sector outcomes can help distill the extent to which the regulatory system is responsible for the sector outcomes, or whether it is because of some extraneous factor. This section identifies twelve key performance indicators (KPIs) and their associated metrics for assessing sector outcomes, also summarized in Tables 5 and 6.

Capacity is perhaps the most elementary sector outcome. It refers to the amount of equipment, technology, and infrastructure installed to operate a water or electricity system. For an electric utility, this would include generation, transmission, and distribution assets; for water, it would include water conveyance, treatment, storage, and distribution.

Access is also an elementary and fundamental sector outcome. It refers to (a) the number of households connected to the electricity grid or water network, (b) the percentage of total households that have such access, (c) the numbers of households that receive energy services or water from alternative suppliers, (d) how much electricity and water networks are growing per year; and (e) the length and duration of connection queues [25].

Service Quality covers the quality of energy and water services provided. It measures (a) the continuity of supply, (b) the frequency and duration of interruptions, and (c) how satisfied customers are with existing services [26].

Pricing and tariffs covers the (a) tariff levels (the actual tariffs for different customer classes and the average tariff); (b) the total production costs, fuel costs, and operation and maintenance costs in US$ per kW h; and (c) the stability of pricing [27]. This KPI is the most visible and contentious component of regulatory substance and impacts affordability, demand usage, return on investment, and the financial resources needed to sustain the sector and attract investment. Pricing and tariffs must be balanced to ensure sufficient utility revenues on the one hand, and affordability for consumers on the other hand (which we discuss below under equity).

Subsidies covers (a) the amount of direct and indirect financial payments to sector participants measured by total expenditure, and expenditure per capita; (b) subsidies as a percentage proportion of GDP; and (c) the sufficiency of targeted subsidies for the poor, equal to the amount of the subsidy divided by the number of poor). A government's provision of subsidies is not often value neutral, but

driven by political interests involved in energy and water services and the access of poor or marginalized groups to these services. Subsidies come in many varieties (direct, indirect) and can have positive or negative as well as unintended consequences. Subsidies typically include direct financial transfer, preferential tax treatment, trade restrictions, public funding and favorable regulations. Excessive subsidies can have deleterious effects on energy and water use. They can distort the market signals that consumers receive, discourage energy and water efficiency, encourage overconsumption of resources, and lead to capacity developments in excess of true needs [28–30]. Positive subsidies help protect low income families, which spend a larger proportion of their income on electricity/water, may encourage the use of energy efficiency, and facilitate renewable energy. Targeted subsidies to these households can serve as a hedge against rising prices and ensure affordability and access.

Licensing covers (a) the cost of applying for a new permit, and (b) the average length of time taken to get a new permit approved. Licensing is an integral part of the regulatory process. It serves to define market competition (access to the market), stipulate the operating parameters of utilities in the market in relation to various standards (for example, health, safety, environmental emissions, quality assurance, service obligations, financial obligations) and through the process of renewing a license, it provides an audit and check system to ensure that license holders comply to the conditions laid down in the license. Clear and transparent licensing and permitting requirements have been shown to be an instrumental part of effective utility regulation. Slow, opaque or bureaucratic licensing procedures can inhibit the uptake of needed investments in capacity, especially for renewable energy resources [31]. Non-centralized or multiple agency licensing processes (i.e., split between several agencies with specific oversight for environmental, health, safety, labor, or land use issues, for example), can create barriers or disincentives to market entry, or create delays for much needed investments [32].

Efficiency covers, for the electricity sector (a) sector energy intensity (for example, measuring energy intensity, or the amount of energy [in the form of British Thermal Units] needed to produce one U.S. dollar of Gross Domestic Product), (b) energy savings from demand side management programs, (c) sector water intensity (to measure the water used in power stations for hydroelectric and thermoelectric consumption), (d) losses due to transmission and distribution as well as theft, and (f) staff productivity, based upon staff per 1000 connections or a similar basis. For the water sector, (a) sector energy intensity, (b) water-use efficiency (how much water is used for a specific purpose compared to the minimum amount needed for the purpose); (c) water productivity (the amount of measurable output per unit of water use), (d) water conservation, most generally how to reduce water use by any means, including new technology, improving old technology, and changing behavior [33], (e) losses due to unaccounted for or non-revenue water, including theft, and (f) staff productivity, based upon staff per 1000 connections or a similar basis.

Financial performance covers (a) net profits or losses and related ratios, and (b) financial ratios, including rate of return on capital and expenditure, and debt to equity and debt service coverage ratios of the utility. It is key to ensuring that they can operate without government subsidies and sustain themselves independently over time. Financial performance can refer to the management of costs, the planning and hedging against fixed input costs (coal, LNG, or other fuel source inputs in the case of electricity generation), the allocation of resources in the management and maintenance of fixed infrastructure, revenue management, capital expenditure requirements for infrastructure provision and network expansion, among others.

Investments and maintenance expenditure covers investments in infrastructure, a ratio for maintenance expenditure to capital expenditure, and depreciation. Such expenses are needed to maintain infrastructure and keep service costs low. They are related to efficiency and financial performance, as proactive investments in maintenance and service are often less expensive than reactive costly overhauls and replacements.

Equity covers (a) affordability (a ratio of the share of monthly household income spent on energy or water services) [27], and (b) the number of low income households that have high quality, reliable, continuous access as a proportion of total customers. It seeks to measure the ability of particular end users to pay for a minimum level of certain service. Affordability always needs a threshold, something that constitutes an acceptable level [34]. Generally below 10 percent of household income spent on energy and water services per month is deemed equitable [35]. Particularly important is the equity of service for families in the lowest income quintile. Increasing access to energy to reduce poverty or broadly, to achieve millennium development goals, has been increasingly acknowledged by development organizations as central to improving living standards in emerging economies [36,37].

Environmental sustainability covers three components: climate change, resource mix and ambient pollution. Climate change is important as developing economies rely heavily on climate sensitive sectors such as agriculture, tourism, and forestry; they are affected directly and significantly by changes in temperature and precipitation and extreme weather events. Resource mix relates to diversity or diversification, an important hedge against risk and interruptions in supply [38]. High levels of ambient pollution (mercury, lead, acid rain, ozone) damage and degrade not only the natural environment but also communities and social welfare. Without minimizing environmental degradation the net negative externalities associated with utility operation and service provision may increase total costs to society, harming citizens, including consumers, and reducing economic benefits [39–41].

Market composition and competition is defined in relation to the openness of the sector to investment and the presence of competitive bidding, tendering and procurement processes, and the ease of entry into the market (including elements such as interconnections and third party access). The composition and relative levels of competition in markets are important indicators related to efficiency, investment, financial performance and sustainability. Appropriate levels of competition and the presence of commercial interests can induce sectoral reform, innovation, efficiency drives and increase sector performance outcomes. Monopolies that create barriers to entry may distort performance outcomes and result in poorer levels of efficiency and service quality.

6. Conclusion

Effective long-term provision of electricity and water services will not occur by itself, nor does it occur in a vacuum. Government opportunism and the tendency of political constituencies to demand economic concessions remains perhaps the greatest disincentive to private sector participation in utilities and infrastructure provision. For governments to mobilize private sector investment they thus need to construct credible institutional arrangements that constrain their opportunism and balance the obsolescing bargain problem. The design and operation of a regulatory regime must ameliorate political risk, constrain the opportunistic behavior of government, decrease uncertainties for the investor, and provide frameworks that set in place administrative procedures for review and revision due to changed circumstances, unforeseen externalities and disputation.

To help regulators, scholars, and energy analysts devise better forms of electricity and water policy, founded on the norms of good governance, our study has proposed a broad conceptual framework consisting of regulatory governance, regulatory substance, and sector outcomes. We have iterated eight fundamental and synergistic input elements—clarity of roles and objectives, capacity, autonomy, accountability, transparency, predictability, participation, and integrity—necessary to produce the two desired output elements of credibility and legitimacy. We have presented twelve components constituting effective regulatory substance for electricity and water utilities—access coverage, service quality, price (tariffs), subsidies, licensing, accounting and reporting, efficiency, financial performance, investment and maintenance, equity, environmental sustainability, and competition and composition—and also correlated these with 102 qualitative and quantitative indicators that can be utilized to assess sector outcomes.

Such a framework should be most useful for those seeking to better understand the relationship between governance, regulation, and sectoral performance at practically any scale, from the city and province to the country or even a region composed of many countries. Those wishing to use our framework to write case studies, for instance, could begin by asking the "indicator" questions from Table 1 and then sketching the broader governance architecture in place. Next would come documenting how these meta-level governance concerns influence specific forms of regulation and legislation dealing with energy and/or water. Lastly would come correlating regulatory designs with particular sectoral outcomes, drawing inferences from which forms of governance and regulation produce optimal results, and which do not. The point here is to be sequential and systematic: sequential in that analysis should follow our template to begin with broader governance issues before working "down" our framework to regulations and outcomes; and systematic so that all of our various components, from prices and infrastructure to sustainability and equity, are included in the research.

This article, however, leaves some questions unanswered: does our conceptual framework strike the proper balance between complexity and simplicity? That is, are the number of input and output attributes inclusive (we've covered all of the important ones) but coherent (not so broad as to include practically everything)? What is the "cause" and "effect" relationship between governance, regulatory substance, and sector outcomes? Do the outcomes shape governance norms and beliefs, do governance structures influence outcomes, or is the relationship multidirectional? For some of the qualitative elements of sound regulatory governance, how can they be measured beyond the somewhat simplistic "yes/no" dichotomy we present above? Do some elements of governance and substance, such as predictability and sustainability, tradeoff with others, such as competitiveness and cost? If so, how can these tradeoffs be minimized? Are the components and metrics we offer equal in importance, or should they be weighted somehow? If so, how? When our framework is put into practice, which countries and regulatory schemes would typify examples of success, and which would be exemplars of failure? Researchers would do well to explore these topics in the future.

Regardless, this framework reminds us that while credible and legitimate electricity and water regulation takes work, countries erecting strong regulations (substance) founded on sound principles (governance) will likely achieve improved sector outcomes that are fair, enduring, efficient, and appropriate to all.

Acknowledgements

The authors are grateful to the Asian Development Bank and especially Ms. Kala Mulqueeny from the ADB for supporting this research through TA-6424 (REG): Enhancing Effective Regulation of Water and Energy Infrastructure and Utilities Services, Asian Development Bank, Manila, Philippines, Contract No. S31381. Two anonymous reviewers from the journal also provided excellent suggestions for revisions. Nonetheless, any opinions, findings, and conclusions or recommendations expressed in this material are those of the authors and do not necessarily reflect the views of the Asian Development Bank or Ms. Mulqueeny.

References

[1] Bertelli Anthony M, Whitford Andrew B. Perceiving credible commitments: how independent regulators shape elite perceptions of regulatory quality. British Journal of Political Science 2009;39:517–37.
[2] Beasant-Jones John E. Reforming power markets in developing countries: what have we Learned? September, energy and mining sector board Discussion Paper. Paper Number 19. Washington, D.C: The World Bank; 2006.
[3] Cubbin John. Regulatory effectiveness and the Empirical impact of Variations in regulatory governance: electricity industry capacity and effectiveness in developing countries, March, world Bank policy research working Paper 3535. Washington, D.C: World Bank; 2005.
[4] Dassler Thoralf. Combining Theories of regulation: Proposing a framework for Analyzing regulatory systems worldwide, utilities policy, 14; 2006. pp. 31–43.
[5] Henisz Witold J. The institutional environment for infrastructure investment, Industrial and Corporate change, 112; 2002. pp. 355–389.
[6] North Douglas. Institutions, institutional change and economic performance. Cambridge: Cambridge University Press; 1990.
[7] Stern Jon. What makes an independent regulator independent, Business Strategy review, 82; 1997. pp. 67–74.
[8] Stern Jon. Electricity and Telecommunications regulatory institutions in Small and developing countries, utilities policy, 9; 2000. pp. 131–157.
[9] Stern Jon, Stuart Holder. Regulatory governance: criteria for assessing the performance of regulatory systems. An application to infrastructure Industries in the developing countries of Asia, utilities policy, 8; 1999. pp. 33–50.
[10] Zhang Yin-Fang, Margo Thomas. Regulatory reform and governance: a Survey of Selected developing and transition economies. Public Administration & Development; 2009. July, 294, pp. 330–339.
[11] Nakhooda Smith, Dixit Shantanu, Dubash Navroz K. Empowering people: a governance analysis of electricity – India, Indonesia, Philippines, Thailand. Washington, D.C: World Resources Institute & Prayas Energy Group; 2007.
[12] Dixit Shantanu, Dubash Navroz K, Maurer Crescencia, Nakooda Smita. The electricity governance Toolkit: Benchmarking best practice and promoting accountability in the electricity sector. June, the electricity governance Initiative. World Resources Institute & Prayas Energy Group; 2007.
[13] World Bank Institute. Social accountability in the public sector: a conceptual design and learning Module. Washington D.C: World Bank Institute; 2005.
[14] Brown Ashley C, Stern Jon, Tenebaum Bernard. Handbook for evaluating infrastructure regulatory systems. Washington, D.C.: The World Bank; 2006.
[15] Sovacool, BK. Rejecting Renewables: The Socio-technical Impediments to Renewable Electricity in the United States. Energy Policy November, 3711, pp. 4500–4513;
[16] Hughes Thomas P. Networks of power: Electrification in Western society, 1880–1930. Baltimore: Johns Hopkins University Press; 1983.
[17] Hughes Thomas P. The Evolution of Large technological systems. In: Bijker Wiebe E, Hughes, Pinch Trevor J, editors. The social construction of technological systems: new Directions in the Sociology and History of technology. Cambridge, MA: MIT Press; 1987.
[18] Bijker Wiebe, Law John. General Introduction. In: Bijker Wiebe, Law John, editors. Shaping Technology/Building society: studies in Sociotechnical change. Cambridge, MA: MIT Press; 1992.
[19] Weber Matthias, Hoogma Remco. Beyond national and technological Styles of innovation Diffusion: a dynamic Perspective on cases from the energy and Transport sectors. Technology Analysis & Strategic Management 1998;104:545–66.
[20] Kemp R, Schot J, Hoogma R. Regime shifts through processes of Niche Formation: the approach of Strategic Niche management. Technology Analysis & Strategic Management 1998;10:175–95.
[21] Olivier Coutard. The governance of Large technical systems. New York: Routledge; 1999.
[22] OECD. Private sector participation in water and sanitation infrastructure. November, OECD Directorate for financial and Enterprise affairs. Paris: Investment Division; 2007.
[23] Jamasb Tooraj, Mota Raffealla, Newbury David, Pollitt Michael. Electricity sector reform in developing countries: a Survey of Empirical Evidence on Determinants and performance. March, world Bank policy research working Paper 3549. Washington, D.C: World Bank; 2005.
[24] Saunders Robert J, Besant-Jones John, Churchill Anthony, Cordukes Peter. The world Bank's role in the electric power sector. Washington, DC: World Bank; 1993.
[25] Kemmler Andreas. Factors influencing household access to electricity in India. Energy for Sustainable Development December, 2007;94:13–20.

[26] Jansen Jaap C, Seebregts AdJ. Long-Term energy services Security: what is it and how can it Be measured and valued? Energy Policy 2010;38: 1654–64.
[27] Fankhauser Samuel, Tepic Sladjana. Can poor consumers pay for energy and water? An affordability analysis for transition countries. Energy Policy 2007; 35:1038–49.
[28] Koplow Douglas N. Federal energy subsidies: energy, environmental and fiscal impacts. April. Washington, DC: Alliance to Save Energy; 1993.
[29] Koplow Douglas N. Subsidies to energy Industries. Encyclopedia of Energy 2004;5:749–65.
[30] Koplow Douglas N, Dernbach John. Federal Fossil fuel subsidies and greenhouse gas emissions: a case study of increasing transparency for fiscal policy. Annual Review of Energy & Environment 2001;26:361–89.
[31] Coenraads R, Voogt Morotz A. Analysis of barriers for the development of electricity generation from renewable energy sources in the EU-25, Optres Report D8 report, May; 2006 [Utrecht, Netherlands].
[32] Coenraads Rogier, Reece Gemma, Voogt Monique, Ragwitz Mario, Resch Gustav, Faber Thomas, et al. Progress: Promotion and Growth of renewable energy sources and systems Ecofys, Fraunhofer Institute, energy economics group, LEI, and Seven7, Utrecht; March 5, 2008.
[33] Peter Gleick H. Water use, Annual review of environment and resources 28; 2003. 275–314.
[34] Spreng Daniel. Distribution of energy consumption and the 2000 W/capacity target. Energy Policy 2005;33:1905–11.
[35] Jacobson Arne, Milman Anita, Kammen Daniel M. Letting the energy Gini out of the Bottle: Lorenz Curves of Cumulative electricity consumption and Gini Coefficients as metrics of energy distribution and equity. Energy Policy 2005; 3314:1825–32.
[36] Pachauri S, Mueller A, Kemmler A, Spreng D. On measuring energy poverty in Indian households. World Development 2004;3212:2083–104.
[37] Modi Vijay, McDade Susan, Lallement Dominique, Saghir Jamal. Energy services for the millennium development goals Washington and New York. The International Bank for Reconstruction and Development/The World Bank and the United Nations Development Programme; 2005.
[38] Stirling Andrew. Diversity and Ignorance in electricity supply investment: addressing the Solution rather than the problem. Energy Policy 1994;223:195–216.
[39] Kemmler Andreas, Spreng Daniel. Energy indicators for Tracking sustainability in developing countries. Energy Policy 2007;35:2466–80.
[40] Lawn Philip A. A theoretical Foundation to support the Index of sustainable economic Welfare, Genuine Progress indicator, and other related Indexes. Ecological Economics 2003;44:105–18.
[41] Holdren John P, Smith Kirk R. Energy, the environment, and health. In: Kjellstrom Tord, Streets David, Wang Xiadong, editors. World energy assessment: energy and the challenge of sustainability. New York: United Nations Development Programme; 2000. p. 61–110.
[42] Tietenberg Tom. Disclosure Strategies for pollution control. Environmental and Resource Economics 1998;11(3–4):587–602.
[43] Durant Darrin. Buying Globally, acting Locally: control and Co-Option in nuclear waste management. Science & Public Policy August, 2007;34(7):515–28.
[44] Sovacool BK. “Cursed by Crude: the Corporatist resource Curse and the Baku-Tbilisi-Ceyhan (BTC) pipeline”. Environmental Policy and Governance 2011; 21(1):42–57.