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Engineers and Electricity Market Reform

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ABSTRACT

The last decade has seen a worldwide shift towards greater private participation in the infrastructure industries. Most governments are reducing their roles as owners and operators of facilities, so managers, employees, customers, government officials, and other stakeholders are confronting new issues. In particular, governments must establish sustainable regulatory arrangements. Successful agencies promote credibility with investors, are perceived as legitimate and fair in the eyes of the public, and deliver greater efficiency for the economy as a whole. The technical skills of engineers are more needed than ever--but unless the regulatory system rewards cost-containment and the creation of valued new services, the funds needed for modernization will not be forthcoming.

Issues include: (1) market structure reform; (2) financial analysis; (3) incentive regulation; (4) reliability and other non-price dimensions of performance; (5) competition *in* and *for* the market; (6) rate structure (including time of use pricing); and (7) managing the interface between regulators and firms. Both utility managers and regulators need new skills to perform new functions, increasing the demand for forums for exchanging information and on professional training.

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Firms in high income economies take a great deal for granted. They have a history of demand on which to base investment decisions, the institutional structures under which they operate are relatively stable, customers pay their bills, and investors have years of performance data on which to base their stock valuation decisions. Electricity market reform complicates the process (Joskow, 1997). How much of the aggregate demand will be supplied by rivals? How will new laws affect prices, returns, corporate structures, and public attitudes towards incumbent firms and new suppliers? Will returns become more variable, thus raising the cost of capital to firms--altering their capital intensity?

Engineers ignore these issues at their peril, because electricity market reform will alter the world in which they work. Flexibility in the reconfiguration of power systems, demand side management, voltage regulation, and the prevention of harmonics are tasks engineers take on with pleasure. Still, competitive pressures can lead to down-sizing or reduction in R&D activity by incumbent firms immune to such pressure in the past. However, electricity market reform also creates new opportunities for firms--including the availability of funds for new initiatives.

The purpose of this paper is to outline seven areas that engineers need to understand if they are to perform their own jobs well. Top management will be unconvinced about the desirability of creating intelligent electrical energy delivery systems unless the factors noted here are addressed. The framework draws upon training material developed in collaboration with the Private Participation in Infrastructure Group at the World Bank. They funded the Public Utility Research Center (PURC) at the University of Florida to develop a two-week *International Training Program on Utility Regulation and Strategy*. After the first delivery in January 1997, PURC became responsible for organizing additional programs delivered in June and January of each year. So far, over four hundred participants from eighty-five countries have attended the first five courses. Sectors covered in the sessions include electricity, gas, telecommunications, and water. About twenty-percent are from newly privatized enterprises or government firms in the process of being restructured.

Regulators and managers of infrastructure firms face significant challenges. Often these industries were under government ownership—so price structures were often designed to subsidize particular customer groups. When costs exceeded revenues, vertically integrated public enterprises sought capital from the government. Fiscal pressures often limited transfers to electric utilities, leading to declines in service quality and low penetration rates. In response to this situation, private participation in the provision of infrastructure services has increased dramatically, as developing countries restructured public enterprises. Corporatization separates enterprises from government agencies, putting them on a commercial basis. In addition, many entities have been or are in the process of being privatized. In either case, some government oversight responsibilities remain.

As will be described shortly, the basic technological and demand conditions leading to natural monopoly can justify government oversight, which requires the development of new regulatory institutions. The PURC/World Bank Training Course represents one vehicle for the sharing of experience and expertise in the creation of agencies that constrain monopoly power and promote competition where it is feasible. These sectors are important for economic development. The new regulatory agencies are important to both consumers and investors, as decisions are insulated from politicians whose time horizons only extend to the next election.

Infrastructure industries form the backbone of many economies throughout the world. Consequently, the performance of these industries in any country has profound implications for the performance of the nation's entire economy. The *PURC/World Bank Training Program on Utility Regulation and Strategy* examines seven major topics. Resolving the issues associated with these themes determines the incentives facing firms in new, competitive environments. Their relevance for engineers is described below.

1. Market Structure Reform and Regulation of Network Industries

It is unnecessary to review the rationales for market structure reform. Countries are reforming their electric utility sectors because of growing evidence that competition is feasible and desirable at the generation level. Retail competition is being implemented in the UK, California, and other areas--but most policy-makers are waiting until there is more evidence on the benefits and costs of such initiatives. Nevertheless, the search for market solutions across infrastructure sectors reflects an awareness that markets are not fragile, and that government ownership (and pricing based on politics) results in inadequate capacity investment. Decision-makers are gaining a better understanding of the constraints associated with introducing competition in network industries, such as the provision of ancillary services in the context of vertical disintegration.

Investors are worried about uncertainty, and public policy uncertainty is particularly troublesome. Countries reform utility markets to improve services and give customers better choices. Successful reforms accomplish this by encouraging business practices that increase efficiency, expand capacity where economically justified, make better use of existing plant, and make management responsive to customers. This reliance on economic business decisions means that the reform process must provide an environment in which managers can plan ahead and generate investor profits if they do their job well. Thus, policy makers need to decide industry structure prior to privatization since business valuation of the assets depends on entry conditions, pricing rules, and how efficiency will be rewarded. If market structure decisions are put off until after privatization, investors will require higher returns when estimating the present value of the net cash flows stemming from the investments.

2. Financial Analysis for Utility Regulation

Cost Effective investments in new technologies require appropriate financial analyses. An understanding of the fundamentals of cost accounting and the analysis of cash flows is essential for managers. Engineers, too, must become aware of techniques used for project analysis. Payback periods are not as good a criterion as net present value when evaluating alternative

investments. However, the use of the latter requires that a risk-adjusted weighted cost of capital be utilized. Thus, engineers must provide the risk profiles of the alternative projects—technological risks (that the prototypes can be scaled up for full implementation). In addition, in conjunction with marketing and operations personnel, engineers must quantify commercial risks (that the demand forecasts are accurate or that the market will accept new services. can be applied to the treatment of operating costs, capital expenditures, depreciation and taxes of utility companies. How can regulators determine the cost of capital and assess the projects, particularly in countries with scarce or unreliable cost information? What are the information requirements for regulators? How can regulators improve data quality and minimize information rents?

Nevertheless, energy prices tend to be political, opening up that the possibility that political opportunism will result in commitments being broken. Customers want lower prices NOW, but energy investments are long term and immobile. If businesses believe that regulators will bend to this political pressure, they will require high returns and short payback periods. These create higher prices. So when bending to political pressure, regulators ensure that customers do NOT get the very thing they are demanding.

On the other hand, businesses want compensation when profits become low. In these situations, the regulator has to decide whether the business can improve profitability on its own or at least weather the storm, whether the low returns constitute acceptable business risk, or whether the unanticipated developments threaten current or future services. If it is the latter, then the regulator needs to be flexible and make allowances to keep services and investments flowing.

3. Principles and Application of Incentive Regulation

What should be the extent of regulation? What are the trade-off between flexibility and predictability of regulatory arrangements? What has been the experience with alternative schemes of incentive regulation? What incentive rules promote competition, efficiency, and innovation? What are the strengths and limitations of alternative forms of price regulation? How does the choice of price regulation affect the system s overall credibility, efficiency, and legitimacy? What has been the experience with conducting price reviews under alternative incentive systems?

The term "incentive regulation" involves a redundancy--the rules of the game establish incentives, either to engage in cost-containment activity and introduce valued new services or to devote resources to political lobbying and to make life comfortable for managers. Businesses plan, and customers make demands, according to what each perceives to be the rules of the game. There are two basic regulatory schemes for controlling prices -- rate of return regulation and price caps -- although there are an infinite number of ways of combining the two. With rate of return regulation, regulators base price levels on what the company spends to provide service (although they cannot determine what level of outlays was truly required to provide reliable service). In pure rate of return regulation, the company has little incentive to be efficient and may even be insulated from bearing losses that would have been incurred in competitive markets. Investors may insist on rate of return regulation where credibility is low. Customers may insist upon it where legitimacy is low.

With price cap regulation, regulators base initial price levels (and future prices) on cost information (such as inflation and productivity indices) that the company cannot control. In pure price cap regulation, the company has high incentives to be efficient and bears the risk of making mistakes. Also, it has no incentive to cross-subsidize potentially competitive services (raising prices on monopoly services and limiting entry in other lines of business). International experience points to low incentives to maintain service quality, since without choices, customers continue to buy even when quality is low. Investors may insist on price cap regulation where both regulatory credibility and opportunities to improve efficiency are high (e.g., US telecommunications).

4. Non-Price Aspects of Utility Regulation

A vertically integrated monopolist can establish responsibility for reliability. More complex industry structures will call for additional information flows and new mechanisms for promoting investment in the transmission system. Again, there is a role for economists and engineers to develop corporate models that capture the complex system interactions--based on economic, not accounting, data (Hunt and Shuttleworth, 1996).

Restructuring generally involves the introduction of performance standards and incentives related to quality of service, health, and safety. In addition, environmental factors continue to come into play. Generally, a different government agency will be responsible for establishing standards (or emissions taxes) and for monitoring compliance. Engineers have much to contribute in developing alternative techniques for complying with regulations. Communicating the costs of these constraints to customers can help them understand what they are paying for and what they are getting.

Another non-price element is the universal service obligation. Historically, some rural areas might have been subsidized or some (politically powerful) customer groups given especially low prices. With restructuring and new entry, procedures need to be developed for funding supplier-of-last-resort obligations. Managers of incumbent firms cannot ignore the costs that had been rolled into the general cost structure. Potential entrants will not serve markets that have low prices and they will enter those markets that had been "taxed" in the past.

5. Managing the Introduction of Competition in and for the Market

Basic conditions facing an industry influence the number and size distribution of suppliers which are feasible in an industry. As noted earlier, the traditional features comprising the structure, behavior, and performance of public utility industries involve important linkages. Causation runs from the basic conditions to industry structure (entry conditions, number of firms, degree of vertical integration and product differentiation). Industry structure determines, in turn, the behaviors likely to be observed (prices, promotion, research and development, production process changes, and new service introductions). The market outcomes can then be described in terms of performance criteria (profitability, efficiency, innovation, and meeting other social objectives). Clearly there are feedbacks in this process--for example, high levels of R&D can lead to innovations which affect the production technologies and entry conditions.

As noted earlier, policy-makers are in the process of determining where competitive forces can be introduced or strengthened. The decisions must be based on economic reality regarding economies of scale and actual operations of the existing grid. What policies hinder competition and what policies promote competition? When should regulators intervene in market structure? What has been the experience with different types of market mechanisms for unbundled utility services? How should regulators apply competition rules and antitrust principles?

In a number of situations, competition can replace regulation as a mechanism for pressuring incumbent suppliers to bring costs down and improve service quality. Many observers contend that the burden of proof should be placed on those who would limit entry and constrain consumer choice, since competition has been shown to be a powerful stimulus for improved industry performance. Fundamental issues arise regarding how the interface between monopoly and competition should be regulated. Similarly, we need to better understand the impact of different forms of vertical separation and service unbundling on competition and incentives for efficiency.

6. Rate Structure

Rate design has a significant impact both on patterns of cash flows across customer groups and also on the timing of consumption. The load patterns affect reliability and the optimal capacity mix (base load, intermediate, and peaking). When costs where lumped together in a vertically integrated utility, they tended to be "allocated" in politically acceptable ways. However, excessively low prices are not sustainable unless taxpayers are willing to subsidize the consumption of electricity. The concern over access is better addressed by targeted subsidies rather than artificially holding a price below cost. Of course, the transition to cost-based prices represents a political problem as suppliers are placed on commercial footings.

In addition, price signals are important determinants of demand patterns, so they ought to reflect incremental costs where feasible--encouraging consumption when incremental cost is low and discouraging electricity usage during periods when the loss-of-load-probability is high or when operating costs are high (Sullivan, 1987).

Developing appropriate prices in the presence of joint and common costs of the electricity network is no simple task. Engineers can play a key role in documenting true opportunity costs of electricity. In many cases, accounting systems provide historical data that are irrelevant for the purposes of efficient price-setting. For example, the introduction of competition affects decisions about tariff re-balancing, cross-subsidization, and funding of social obligations. Price levels determine whether prices are remunerative--so that under-recovery of costs greatly dampens incentives to make long term capacity investments to modernize.

One example arises in the context of power factors (Berg, 1983). Engineers know that two loads placed on the system involving the same kilowatt demand (kW) and kilowatt-hour (kWh) energy consumption can have different implications for the electrical current requirements. Resistive loads from light bulbs or electric heat strips do not affect the relationship between the electrical current and the voltage in an alternating current power system. The current remains in phase with the voltage. If the voltage were applied to a purely inductive load (such as an unloaded

transformer), the output current would lag the output voltage. Such a circuit would "consume" only reactive power (measured in kilovolt ampere reactive--KVAR). As more reactive power is consumed, the unit generating the electricity produces less real power (measured in kW). Price schedules in the U.S. for large industrial customers price KVARs by penalizing low power factors (which imply more KVARs). A penalty trigger point of less than.85 or .90 characterized rate structures--but this is not necessarily an appropriate signal. Industrial customers with high power factors might still be able to improve the situation with appropriate equipment purchases, but they will lack an incentive to make those investments. Another issue is whether the penalty should be based on the cost of additional capacitors or additional generating capacity. The case of reactive power illustrates the importance of having engineers who understand cost-causation assist in the development of appropriate price structures.

7. Managing the Regulatory Process for efficiency, transparency, credibility, and legitimacy

Numerous issues are addressed during a transition to a new market structure (Lalor and Hernan, 1996). It is in the interest of firms to see the government establish consistent and transparent regulatory institutions. The regulatory process can promote legitimacy and credibility of decisions--reducing political risks facing investors whose capital is at risk. The various stakeholders need to have strategies to effectively manage complex and often politically sensitive negotiations involving government, investors, consumers, and other interest groups. In addition, public communication takes on greater importance, as the press interprets develops for the general public.

Given the complexity of the issues associated with partial deregulation and industry re-structuring, market participants must continue to explore alternative mechanisms adjudication. In particular, Alternative Dispute Resolution (ADR) can substitute for litigation as way of establishing rules or outcomes. ADR procedures can promote timely decisions, reduce contention, and save resources--especially when the issues are technical in nature. Timely intervention allows the process to deal with non-issues that might be thrown up as roadblocks by some parties. More important, it allows complicated issues to be addressed in a relatively non-adversarial setting. The interests of the parties may differ, but t resolution of technical issues can sometimes open up the possibility of win-win negotiations.

Barker, Tenenbaum and Woolf (1997) identify twenty-six basic market design issues for new style power pools. The various market participants (generators, power marketers, transmission grid operators, distribution systems, and final customers) all have stakes in the arrangements that affect the electricity delivery and financial settlements associated with this market. They distinguish between governance and regulation. "Governance is the process by which decisions get made, implemented and enforced—it is internal to the pools. In contrast, regulation is how governments review and change the decisions of pools—it is external to pools." (p. v) In their description of decision-making models, they note the problems associated with alternative governance mechanisms—since these involve different voting schemes, different approaches for representing stakeholder interests, and a variety of enforcement mechanisms. They note that backstops (or appeal procedures) for pool governance are inevitable.

Given the technical nature of disputes, a specialized board can have both the expertise and flexibility necessary to reach decisions in a timely manner. Barker, Tenenbaum, and Woolf conclude that a two-tier approach to governance is probably preferable to pure collective self-governance. Thus, an independent board can make a binding decision in the event of non-consensus or unreasonable delays. Such a board combines flexibility with expertise (and a detailed knowledge of the grid). It ought to have the power to ensure that disputes are not "bottled up" in a committee. The sector regulator serves as a point for the appeal of decisions by the technical board, should the need arise.

The types of issues raised by power pool governance and system operations affect the financial opportunities available to market participants as well as the economic efficiency of electricity sector. The traditional regulatory hearing process is not well designed to address (and resolve) the technical issues that are raised in the context of complex transactions in this market. New approaches to conflict resolution come to the forefront of debates over industry restructuring.

If transparency and independence from the regulated companies are absent, then customers will conclude that the regulator is not a legitimate regulator -- that the regulator has been captured by the company and is serving its interests. By the same token, investors will believe that a regulator that has been captured by the political process and/or customers will not view the system as credible either. Firms will then engage in (inefficient) behavior as they seek to maximize their short run gains rather than invest for the longer term. Without customer perceptions of a fair process or investor perceptions of credible regulatory commitments, the nation will not obtain a high level of performance from electric utility firms.

Concluding Observations

Decision-makers in government and in companies must understand the broad economic and technological forces affecting energy. The factors affecting effective regulatory policy are complicated. Figure 1 shows that key lessons can be successfully applied only if the regulator takes into account her country context. The boxes on the left show the factors regulators must consider in choosing their regulatory tools. Industry conditions (e.g., technology and market structure), general economic conditions (e.g., inflation and per capita income), stakeholder experiences (e.g., customers' service expectations and business's views of government), and institutional conditions (e.g., court systems and regulatory expertise) determine which combination of tools will achieve the desired industry performance. The dashed arrows show that these factors also directly affect industry performance. There is also a feedback loop where the actual industry performance provides learning for stakeholders. If the experience is positive, the regulator has additional flexibility to revise her combination of tools. If the experience is negative, the regulator must redouble her efforts to achieve the transparency, legitimacy, and other keys necessary for success.

As Sally Hunt has said in the context of restructuring the energy sector and creating independent regulatory agencies, "[The} Prime Minister is agreeing to give up political power in order to get electric power." The seven broad themes identified above represent the tip of an iceberg. Key lessons that are being learned in different nations need to be shared and analyzed, if we are to establish electricity infrastructures that create value for customers and reward those who take risks. Nations seeking to attract capital and expand their energy infrastructure ignore these lessons at their peril.

Many observers have emphasized the importance of sustainable regulatory frameworks. Initiatives undertaken by groups in response to this recognition include the PURC/World Bank International Training Program. In addition, multilateral lending organizations, regional banks,

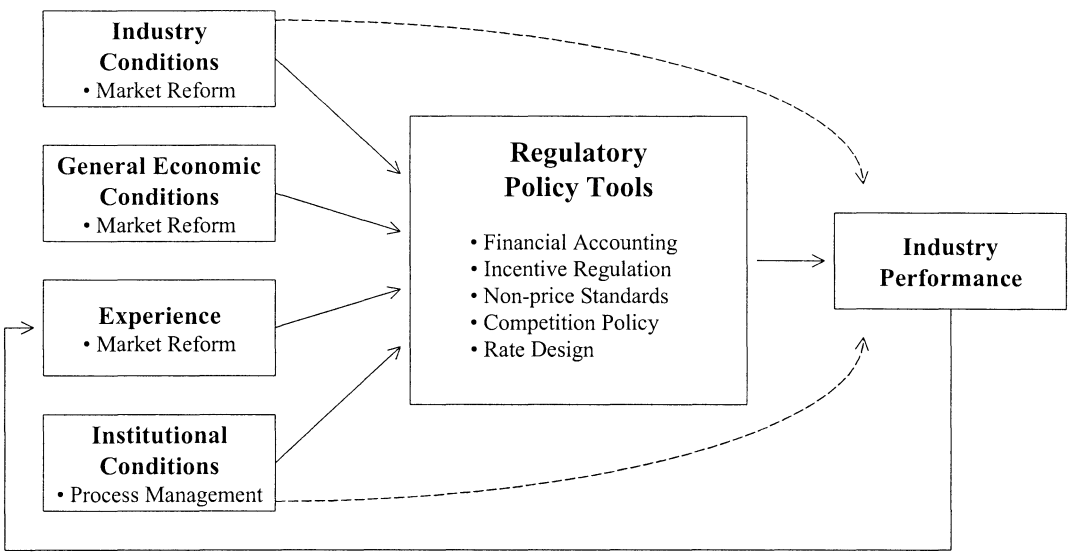

Figure 1. Country Context for Applying Regulatory Tools

and regional collaborations among commissions have resulted in venues for the sharing of ideas. For example, the Australian Competition and Consumer Commission hosted a five-day training program (November 1997)—utilizing PURC material and drawing upon expertise from a number of countries. Such activity needs to be part of the on-going educational process for commission staff and company managers in every country. No one has all the answers. What is important is that decision-makers begin asking the right questions and developing the conceptual frameworks and information required for addressing critical issues.

At the initial offering of the *PURC/World Bank* course, one attendee from a developing country was that nation's first energy regulator. He understood the pivotal role he would be playing in the years ahead, and the importance of a sound regulatory framework for capital attraction and

the sustainability of his new regulatory institution. He sat each morning in the front row, following the presentations carefully and asking intelligent questions of the speakers. Often he would comment on particular observations—sometimes supporting the generalization and sometimes qualifying the point by recognizing other trade-offs. His eloquence and insights were acknowledged by all.

Since I sat in the front with the other speakers, I noticed that he had two notebooks. Sometimes he would write a paragraph in one, and after hearing other ideas developed by the speaker, he would dig into his briefcase and write in another notebook. Near the end of the two weeks, my curiosity could not be contained. I asked him about the two notebooks. He responded: "One is for *useful ideas*. The other is for *interesting ideas*. As a professor who tries to translate principles into practice, I understood the distinction quite well. He wanted to return to his homeland with an agenda for his staff. He wanted to apply some the ideas and principles immediately. However, he also recognized that some of the ideas still needed to germinate some more. The particular conceptual framework from a session might be interesting (and show promise), but it needed more time before it could be applied. Or, the idea provided a sound intellectual basis for some development (such as incentive regulation), but that background information could not be applied in the present institutional environment.

Change induces responses by those affected. The technical issues addressed by engineers cannot be entirely separated from the managerial context in which solutions will be implemented. Nations are moving forward in the creation of legal and regulatory frameworks conducive to capital formation and sector modernization. There is much that is interesting and useful yet to be learned. As an academic involved in that learning process, I would urge that governments and private organizations continue the dialogues initiated over the past decade. Educational institutions can play a n important role in providing forums for sharing experience and exploring new ideas.

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For further information, see www.cba.ufl.edu/eco/purc.