Stalled on the Road to the Market: Analysis of Field Experience with a Project to Promote Lighting Efficiency in India

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Several factors have been recognized in the energy policy literature as constraints that have retarded the wide-scale diffusion of high-efficiency appliances. In the developing countries in particular, despite the apparent benefits of energy-efficiency as an answer to problems in both environment and development arenas, the diffusion of highly-efficient appliances has been limited. Research suggests that these appliances appear more attractive from the collective or societal perspective than from any one actor's view, and that current market and institutional arrangements do not automatically allow for an efficient sharing of costs and benefits. There is therefore little incentive for an individual or organization to promote increased energy efficiency on their own.

This paper outlines the differing perspectives of consumers, utilities, and appliance manufacturers and describes the resulting barriers that appear in the Indian electric sector. An attempt to overcome these constraints, by means of a field experiment in Bombay, is then described. The project was to lease high-efficiency lamps to households where they would reduce evening demand, thus saving or freeing up badly-needed peak power. To accomplish this, a consortium of the north Bombay utility, a lighting manufacturer, and a local research institution was convened and jointly developed the Bombay Efficient Lighting Large-scale Experiment (or BELLE).

The practical progress of BELLE and the lessons learned in attempting to get it off the ground are described. Participants learned that the purely economic constraints that BELLE was designed to address are not the only factors that can influence the diffusion of increased-efficiency appliances: the project encountered resistance from other organizations, eventually leading to the refusal by a review committee of the consortium's request for access to hard currency. The paper concludes with an assessment of factors that led to the proposal's failure and some thoughts on next steps.

Introduction

Improved end-use efficiency holds the promise of increasing the level of electrical services provided to consumers while reducing the requirements for new generation plants. Recent increases in cost-effectiveness and availability of efficient technologies are argued as evidence that improving end-use efficiency is an effective development strategy, even (or especially) for the poorest nations.

While electricity use in developing countries has grown an average of eight percent per year during the past two decades thanks to large expansions in power systems (Levine et al. 1991; Meyers et al. 1989), demand for electricity continues to outstrip supply in the developing world. Even today, the average Indian consumes about two percent of the electrical energy used by a US consumer. A large fraction of households in the developing world remains unelectrified, lacking access to the electric grid. Within electrified households in these countries, the current penetration of major electric appliances remains low; installed appliances have long life spans[1] and tend to be based on outmoded technology and therefore of poor efficiency.

The idea of leap-frogging appears to have gained currency in international development circles (see, for example, Goldemberg et al. 1987). Based on the current low levels of electrification and small penetration of appliances, developing countries are said to posses the opportunity to leap-frog the West and bypass the development stage in which low-efficiency appliances achieve wide-scale penetration, thus proceeding directly to the increased use of higher-efficiency appliances. This view, in which the low penetration of appliances is seen as an opportunity, offers promise to developing countries.

Promoting high-efficiency appliances therefore 'makes sense' from the developing-world perspective. Environmental concerns regarding carbon emissions increase the attractiveness to the industrialized countries of improved energy end-use efficiency in the developing countries. This strategy therefore provides a rare example of a cost-effective, no-regrets policy to achieve two major objectives: speeding the development process, especially for the world's poorest citizens, and simultaneously reducing the risk of potential global climate change, which could benefit everyone.

Within this context, the authors embarked on a project designed to promote highly-efficient compact fluorescent lamps in an Indian city through BELLE (the Bombay Electric Lighting Large-scale Experiment), a lighting efficiency program designed for Bombay residents. Together with colleagues from a variety of institutions, all three authors were actively involved in its development and planning. While we remain convinced that improved energy-efficiency offers many benefits to citizens of the developing and industrialized worlds, our experience also reveals that the subtle and complex challenges of implementing apparently attractive programs in developing countries are not addressed in the energy policy literature.

The project was built on prior technical-economic analyses of the cost-effectiveness of CFLs in India from the consumer, utility and societal perspectives (Gadgil and Jannuzzi 1991). We began the project with an analysis of barriers that have suppressed the adoption of high first-cost, high-efficiency end-use appliances in the developing countries. Tackling these constraints, which are fairly well-documented in the energy and development policy literature, was the aim of our field work. Through a program that would share costs, risk, and benefits among the major potential participants, we hoped to address three major barriers that we had identified.

(1) Cash-poor residential customers demonstrate high rates of discount for future savings, which differ greatly from those exhibited by utilities and governments. In India, it is common for a utility to use discount rates of 12% or less, whereas consumers may have a discount rate of 60 or 80% (Dunkerley 1990).[2] This skews the overall societal investments heavily in favor of energy supply over efficiency and results in an over-investment in supply. In addition, consumers have low levels of risk-tolerance and a very high cost of obtaining information about new technologies.

(2) Utilities are pressured into subsidizing residential and agricultural tariffs, making it difficult for unsubsidized efficiency to compete with subsidized energy. Furthermore, because utilities make large losses on these subsidies, they are reluctant to put any money into a subsidy to support increased efficiency. This is partly because such an untried strategy appears to these utilities to be far more risky than the conventional approach of building new power plants.

(3) Potential manufacturers of highly efficient appliances perceive that any local market for high-first-cost goods would be extremely limited, owing to the above two factors. Thus, there is little incentive for setting up local factories for domestic production.[3] Existing regulations discourage the importing of these appliances through customs duties that are so large that any scheme for importing them appears uneconomic.

These three barriers relate to the key constituencies--consumers, utilities, and manufacturers--that we agreed would be essential to include in any successful attempt to promote electric efficiency in India. The program we designed would provide benefits to all three groups, if it worked as planned. Its design, which represents a novel approach to the problem of promoting energy efficiency in the developing world, explicitly recognized the roles played by all three sets of actors. What we learned through the implementation process, however, is that such an approach neglects other key constituencies. In assuming that the three sets of 'market failures' constituted the only major obstacles, we underestimated other non-economic factors such as the organizational behavior of institutions whose support (or at least non-opposition) would be essential for the project to succeed.

This paper represents an attempt to combine more conventional analyses of energy efficiency programs with a reflection on our own experience. Recent work in this area (Reddy 1991) develops an integrated framework for addressing the energy-efficiency challenge in the developing countries. Our aim is to examine our experience with BELLE in light of such an approach incorporating the roles of key interest groups. We present here our own thoughts on the decision-making processes as they unfolded over the course of three years. As both participants in and observers of the phenomena we describe, we understand that our findings will inevitably reflect our own biases, mistakes, and misperceptions; nevertheless, we feel that this process of self-reflection can be valuable, both to ourselves and potentially to others who study, plan and implement energy-efficiency policy in developing countries.

An integrated approach, in which the technical and economic aspects are combined with the behavioral and institutional, is increasingly advocated by scholars, academics and policy-makers addressing energy efficiency. Yet little research has been published addressing

the institutional aspects of implementing energy efficiency; even less has been written from the perspective of particular case-studies. While there are numerous instances of efficiency and conservation programs that have succeeded in the industrialized world, we have few examples to point to in the developing nations. Consequently, we understand little about what will be required in these countries to make increased efficiency work in practice. Ironically, it may be the developing world that most needs the benefits that improved efficiency can bring.

BELLE: An Overview

Over the past several years, the authors worked with colleagues in India and the US to form a consortium in Bombay consisting of the North Bombay utility (BSES), a potential manufacturer of compact fluorescent lamps (Philips India), and a research institution (Indira Gandhi Institute of Development Research, IGIDR). We focused on the diffusion of CFLs rather than other high-efficiency, high first-cost appliance for several reasons: (1) incandescent lamps, the products that CFLs replace, have a short life, allowing the rapid penetration of CFLs; (2) the per-unit cost of CFLs is relatively low (compared to, say, a major appliance); (3) the gain in efficiency in replacing an incandescent with a CFL is unmatched in any other residential electric end-use technology; and (4) in India, CFLs would save valuable on-peak electricity, unlike the other major appliances (which have both low penetration and low peak-coincidence).

BELLE was designed to test, debug and demonstrate a novel approach to promote high first-cost, high-efficiency electric appliances in the risk-averse and cash-poor residential and small commercial markets in the developing countries. Although BELLE was a pilot project, it was planned to be cost-effective and to save or generate income for all participants. Incorporating joint research, risk-sharing and the simultaneous meeting of environment and development goals, it offered a positive model to emulate and improve upon, both in India and elsewhere. We expect that such demonstration would not only encourage domestic production and sales of CFLs, but also could be extended and tailored to other high first-cost, high-efficiency appliances elsewhere.

The BELLE design was based on three important assumptions that we believe represent an untried approach to problem-solving in developing-country utilities. First, a large difference between discount rates of major actors in an economic sector represents an opportunity to make money by bridging the gap. Thus, cost-effective--and possibly lucrative--programs could be designed that could help implement efficient technologies that involve longer payback periods than those usually supported by consumers but that represent paybacks far shorter than those conventionally seen by utilities. Second, the project was designed so as to involve the key constituencies whose support would be necessary for its success. Thus, the planning and design phase would bring together decision-makers from utilities and manufacturers, as well as potential financiers. The program would include a substantial amount of monitoring and surveying to ensure that consumers' views are fully represented. In fact, we intended to work with consumer groups and community organizations even earlier in the planning stage. Third, we agreed that participants should perceive a reward for participating and making a success of the project. From the earliest stages, we focused on the perspectives of the three key groups, asking what their potential benefits were, and designing a program that could help meet the perceived needs of each group.

For the purposes of the experiment, the CFLs were to be purchased with foreign currency obtained from a suitable supporting agency. PACER (USAID's Program to Accelerate Commercialization of Energy Research in India), with its budget of several million dollars, seemed a logical lender from which to request access to hard currency. The program is managed professionally by the Industrial Credit and Investment Corporation of India, a state-owned development bank. Officials at PACER's office in India, as well as those in the corresponding USAID office in Washington DC, were encouraging about the prospects of obtaining support through their program. We planned to return the borrowed amount with interest, in Indian rupees (abbreviated Rs), to the agency. This use of PACER's hard currency funds to obtain access to the hardware, and subsequent repayment in soft currency, was also a novel feature of the project.

According to our plans, an initial pilot phase with 2000 CFLs would provide the starting point for offering 20,000 CFLs on a lease-purchase basis to residential and small-commercial consumers. The lease-purchase program would be operated through the utility by a consortium of the utility, the lamp manufacturer, and the research institution. Lease payments would be collected by the utility along with the monthly utility bills, substantially reducing administrative costs. The lease payments were designed to be smaller than the reduction in the monthly electricity bills, and would be charged for only a fraction of the expected life of the CFL. The utility would save peak demand, and reduce subsidy payments owing to the decrease in electricity sales. The lamp manufacturer would get visibility, market experience, first entry into the market, and explore an innovative financing method, thus laying the groundwork for indigenous manufacturing.

IGIDR would gain first-hand research experience in analysis and implementation of the first demand-side management project in the country, and would serve as an institutional memory for other utilities to tap into when developing similar programs. Thus, we hoped that the BELLE plan would offer sufficient inducements to participate for all parties--we framed it as a win-win-win proposal. The next section provides more detailed information of these plans to show how they were designed to achieve this goal.

The project proposal was written in a business-plan style by the participants in Bombay and included detailed steps for each stage. On first review, it passed most of the internal tests of PACER, but was sent back from ERDAC for several changes. Yet when all of these changes were incorporated, and the project proposal resubmitted, it failed the ERDAC review in October of 1991. Naturally, the experience has prompted all those involved to ask why. We turn to this question in the final section of our paper.

The Economics of BELLE

In this section, we summarize the operational plan of BELLE, focusing on key elements of the economics of the proposal.

A CFL uses less than a quarter of the electricity to produce same quantity of light as an incandescent lamp. The BELLE consortium proposed to replace a 60-watt incandescent lamp, approximately the average wattage of such lamps installed in India (Gadgil and Natarajan 1989), with a 15-watt CFL fitted with an electronic ballast. Such a CFL delivers 900 lumens, about 25% more illumination than that provided by a 60-watt incandescent lamp (incandescents for countries with line voltage fluctuations are designed to be more robust, and hence are less efficacious, than their counterparts in OECD markets).[4]

BELLE would offer CFLs to two types of consumers: residential and commercial. In the case of residential consumers, only those incandescent lamps that are used on an average of 4 hours per day or more would be replaced with CFLs. For commercial consumers, only those incandescent lamps with a minimum daily use of 8 hours would be replaced with CFLs. Based on an assumed burning life of 8000 hours, CFLs would last for 5.7 years in the residential market segment (four hours' daily use) and 2.9 years in the commercial segment (eight hours' daily use).[5]

In the early 1991 version of the proposal, twenty-two thousand CFLs were planned to be purchased for BELLE. The purchase price, offered to the BELLE consortium via Philips India in discussions with their international counterpart, was US $12 per CFL. This price compared well with other quoted bulk prices and works out to Rs 222 per CFL (using an exchange rate of US $1 = Rs 18.50).[6] Since this is an experimental project, the consortium planned to obtain a special permit for one-time, duty-free import of CFLs from the Indian Government. The lamp manufacturer associated with the project, Philips, estimated that CFLs could be indigenously produced approximately at this price, once a manufacturing plant is set up in India. (The Monterrey factory of Philips Illuminacion of Mexico offers evidence of the feasibility of indigenous manufacturing in a developing country). While BELLE, as a one-time experiment, relies on duty free import, all consortium members agreed on a long-term goal of indigenous manufacturing of the CFLs, once the technology and financing was demonstrated.

CFLs would be leased to BELLE participants under a four-year leasing scheme for residential consumers and a two-year plan for commercial consumers. To reduce the risk borne by consumers, the lease could be terminated at any time by the consumer returning the CFL (even a failed one) to the utility. The lease arrangement was regarded as essential because most consumers, especially those in the residential segment, would not be prepared to make high initial investment for buying the CFLs.

For each CFL leased, the monthly charges would be Rs. 7.00 for residential customers, and Rs. 12.50 for commercial customers. These charges are designed to recover the cost of the lamp, including interest charges based on a 15% interest rate, and a 10% surcharge to cover distribution costs and any risk or premature failures. Residential and commercial customers would save Rs. 106 and Rs. 304 per year respectively through lower electricity bills and avoided incandescent lamp purchases for the life of each CFL installed. The savings stream is therefore larger than the lease payment stream right from the start of the project. In addition, the consortium discussed the possibility of providing the CFLs for free for the first month as a measure to raise customers' confidence in the savings and performance.

The BELLE approach also offered a range of potential benefits, listed below, to a participating utility. However, in this particular case, as we explain later, few immediate savings could be realized because BSES was not in a position to capture the financial benefits of saving power.

(i) Reduction in peak demand: in India, residential lighting load largely corresponds to peak power demand. Hence, a utility responsible for distribution alone (such as the

BELLE participant) could reduce its purchases of expensive peak power. A utility engaged in both generation and distribution (like most Indian utilities) could reduce its requirements for generation of expensive peak power.

(ii) Earnings from increased high-tariff sales: the utility could benefit financially by diverting the power saved from the residential to the industrial customers.

(iii) Reduction in capital investment: A utility responsible for power generation could save capital investment related to peak load generation through a BELLE-type scheme. Savings due to one CFL, assuming transmission and distribution losses[7] of 21% and plant availability factor[8] of 57.3%, are 99 watts of installed capacity, worth Rs. 1980. Annualizing this at 10% interest over the 30-year life of the power plant yields a savings of Rs. 192/yr.

BSES, the participating utility, could not receive immediate cost savings in this area for several reasons. Since it purchases its electricity on contract basis from a generating utility, Tata Electric, the amount of power it must pay for is already fixed by a long-term contract. Thus, there is little incentive to save power. In addition, BSES does not currently pay differential rates for peak power, and--very uncommon for an Indian utility--it does not at the moment have unmet demand from the commercial/industrial segment and, owing to regulatory constraints, is unable to sell saved power to neighboring utilities that do. Yet it does stand to gain from BELLE in the near future since peak shortages are anticipated due to a projected growth in demand.[9] Differential tariffs for peak and off-peak power are currently under discussion in different forums. In addition to this, BSES is constructing its first power plant. It therefore expects that it would greatly benefit from BELLE on all the three counts in the near future.

BELLE also offers potential benefits to society. Our calculations suggest that investment in CFL factories and full lease financing of the lamps is more than ten times cheaper than financing power plants to energize incandescent lamps. As a developing country in need of more investment resources, India would be able to invest capital saved through deferring power plants in other productive sectors where current capital shortfalls exist. Alternatively, any reduction in power shortages currently faced by all sectors of the economy could improve overall productivity. Reduced need for power also implies the postponement of new power plant construction, resulting in lower levels of pollution and fewer environmental problems in the future.

Beyond an Economic Analysis

A conventional cost-benefit analysis demonstrated that improving electric end-use efficiency with compact fluorescent lamps could 'make sense' from a societal perspective in India, and also from the points of view of the consumers, utility, and manufacturers. This finding is not inconsistent with the growing body of literature advocating increased energy efficiency.[10] The cost-benefit framework illustrated above represents one approach for designing implementation programs. In such an approach, the goal is to quantify the economic dimensions of options that have been shown to be technically feasible. Policy analysts, utility planners and other decision-makers frequently use such technical-economic evaluations as the basis for recommending implementation of a technology or program. This traditional methodology--which has been developed and used in the United States and other industrialized countries in the two decades since the oil crisis--is, we feel, not always sufficient for achieving successful implementation in a developing country. In this section, we will draw upon our experience in India to explain why, and point to the need for a wider approach.

Reflecting our own dissatisfaction with the traditional model, there is a growing recognition that technical and economic analyses alone do not account for all the factors likely to be important in planning and assessing the prospects for energy efficiency. Yet most of the research we have seen in this area focuses on the perspectives of researchers from the industrialized countries, and argues that behavioral dimensions should be added to the traditional approach (see, for example, Robinson 1991, Katzev and Johnson 1987, Stern and Aronson 1984, and Kempton and Nieman 1987). While we recognize the importance of accounting for the behavioral aspects of consumer response to policy instruments, and agree that energy-efficiency programs that are designed to be economically attractive may fail if they neglect the social, psychological and behavioral aspects of consumers' decision-making, we feel that a further dimension that recognizes institutional and organizational behavior must be added to the analysis. Existing literature addresses institutional factors through formally-recognized roles, such as regulatory mechanisms; we propose that the behavior of institutions and their objectives (often beneath the surface) is at least as important in developing countries. Thus, our view is that the roles that institutions play are defined by their behavior and actions rather than by their stated purpose. Reddy has recently argued for an approach that accomplishes this, and lays the groundwork for a model in

which seven different constituencies--each of which can comprise several types of actors--participate in the energy-efficiency decision-making process in one way or another (Reddy 1991). While in practice it appears that business enterprises, in their dealings with developing countries, have found ways to get past various institutional and regulatory obstacles,[11] and while other disciplines, such as urban planning and rural development efforts, have incorporated such institutional analyses into their research, the work on energy-efficiency implementation in such settings frequently fails to recognize the roles played by various interest groups. Before moving on to the details of such an analysis and its relevance to our experience in the field, it may be useful to ask why the institutional behavior perspective has been largely ignored to date in the energy-efficiency literature.

As our experience in the field indicates, increasing energy efficiency may entail solving problems in a wide range of areas. Depending on the researcher's own training, the problem could be defined as one of economic sub-optimality (e.g. the under-pricing of electricity; see Sioshansi 1991), market failures (e.g. asymmetric discount rates exhibited by utilities and their customers), lop-sided regulatory and market structures (e.g. the lack of competition faced by most utilities or tax incentives that disfavor efficiency), social biases (e.g. the 'invisibility' of energy), the institutional context of consumers (e.g. the degree to which decision-making in an organization is decentralized, which may affect the success of efficiency options; (Cebon 1992)), or the role of policy (Kempton and Nieman 1987, Gadgil and Jannuzzi 1991, Jannuzzi et al. 1991, Levine et al. 1991).

Given that the questions regarding energy efficiency are potentially limitless in their scope, policy analysts and energy planners must define the boundaries of the specific problem their analysis is to tackle. The choice of boundary may be motivated by many factors, among which the analyst's own background and institutional context figure prominently. Because much of the literature focusing on energy-efficiency implementation issues is written from the perspective of analysts in the industrialized countries, the traditional methodology--even when it includes the behavioral and social dimensions--embodies a set of assumptions, some of which may be inappropriate in the developing-country context. Such presuppositions are rarely stated explicitly; yet they become crucial when attempting to transfer technical and program-related knowledge between countries.

Central to those assumptions that we have found to be both pervasive and implicit in the implementation literature is the view that the larger political and economic institutions that can determine a program's success are already in place and supportive; a major exception is Reddy (1991). Thus, if the utility is ready and willing to implement conservation, then regulators, government and financiers are assumed to also be supportive. If they are not, then the efficiency implementation problem is assumed to be non-starter and would therefore, by definition, not be written about in the implementation literature. In other words, the problem of putting efficiency into practice is widely held to begin once the political and social institutions are already appropriately aligned. If they are not, then the problem moves from the realm of efficiency implementation to the national political-economic arena where it loses a program- or technology-specific focus, and instead takes on general characteristics. As a result, we see few examples both in the literature and in practice of a given energy efficiency proposal being tackled simultaneously at the technical, economic, behavioral and institutional levels. Yet we argue that it is exactly this lack of an integrated approach that has resulted in the poor record of energy-efficiency implementation in developing nations.

The Indian electric sector provides a useful example. From conversations with staff at the World Bank and other aid organizations, we learned that energy efficiency was widely believed in these circles to be an option that should be investigated only after the 'bigger' problems of the power sector were corrected, namely electricity pricing. Such changes naturally would entail fundamental shifts in the political economy of electric utilities and national and state governments. While we feel that this approach has its own merits (proper pricing is one of the elements that will support efficiency), it is a strategy that is slow and difficult to implement. More importantly, it does not guarantee implementation of any specific efficiency technology or program. In particular, it fails to explicitly address the locus of decision-making regarding efficiency options. As we found, it was only through our attempts to implement efficiency that we were able to identify the full range of actors likely to influence its success. Thus, if we are to understand which policy options work and which do not, they must be combined with a program-specific, 'hands-on' approach such as the one we attempted.

Our experience with such an approach has led us to several conclusions. As described above, we started with an assumption that a program designed with only the societal perspective in mind would not succeed, no matter how attractive for the economy as a whole, if it failed to address the concerns and perspectives of important constituencies involved. Thus, once we showed that compact fluorescent lamps were attractive from the societal viewpoint because they could save badly needed evening-peak electricity if used in Indian households (see Gadgil

et al. 1988, Gadgil and Jannuzzi 1991), we spent several months in the field investigating the barriers or constraints that might limit their penetration in India. It became clear to us that a successful efficiency implementation strategy would have to address the issues we uncovered in our field research. Few of these findings, listed below in summary form, will be surprising to researchers and practitioners in the field. Yet we found a dearth of examples of practical programs, schemes and techniques designed to overcome the obstacles. As is described in the final section of this paper, BELLE--designed to overcome key barriers--in at least one important respect also fell short of addressing the full range of real-world limiting factors. As far as we can tell, however, BELLE is one of very few efforts to deepen our understanding of the implementation issues in developing countries by attempting to put into practice what has been advocated in theory.

The Institutional Context of the BELLE Implementation Effort

While BELLE was designed to address the concerns of the three key constituencies--consumers, utility, and equipment manufacturer--as the consortium attempted to operationalize its plans we found that the perspectives and potential roles of other actors had not been adequately taken into account. To understand how these other institutions influenced the project's success, we provide some background on the institutional context within which the BELLE implementation effort took place.

In order to obtain support from PACER, the BELLE proposal had to be approved by three separate bodies of Indian officials. First, it had to pass the scrutiny of the PACER staff. The next step was an examination by the PACER-appointed Peer Review Committee (PRC). Finally, the proposal was forwarded to PACER's Energy Research and Development Advisory Committee (ERDAC) which was appointed jointly by the Indian government and USAID, and comprises mostly of senior government decision-makers, together with representatives of a few public-sector institutions and one private organization related to energy. Following the final review by ERDAC, the project would be approved for funding by PACER, once all objections were satisfactorily answered. Usually, ERDAC approval is granted to all projects supported by PRC and recommended by PACER's staff.

As mentioned in the previous section, in planning the project we did consider the potential role that various government agencies would play in the execution of BELLE. We realized that governmental support would be essential for implementing our plans, particularly for the waiver of the import duty. Several influential government officials sat on ERDAC, such as the member who also chaired a government committee that grants waivers of customs duty for energy research equipment. This overlap seemed a nice tie at that time as it could help us later in the implementation process.

Governmental organizations, of one form or another, have been central to decision-making in many walks of public life in India for decades. Like governments throughout the developing world, the Indian government perceives itself as the active promoter of change in the country, and exerts unparalleled influence in the economy both directly and through government-owned corporations and enterprises. The elites that run the institutions of the national and state governments can influence decisions in both public and private sectors, since enterprises in the latter are governed by a large number of government regulations (such as requirements for licenses and permits, quotas for scarce raw materials, connections for electricity and water, environmental restrictions, and access to loans from the large banks). While economic activity is over-regulated on paper, the actual enforcement of the regulations is erratic (Crook 1991; Bardhan 1992) and can depend on the disposition of any of a number of influential officials. It is owing to this fact of life in India that it is difficult to start up a new enterprise without having access to a member of this power elite to enable one to negotiate the myriad rules and regulations. Despite recently-initiated efforts to cut the red tape, reducing the traditional influence of the bureaucracy is a slow and difficult process (Bardhan 1992; Gargan 1992).

Two points about the role of the government officials are important to note. The first is that connections to these decision-makers can be important to anyone attempting to implement change, within the government as well as outside of it. The second is that the influence of government administrators is not necessarily malignant: bureaucrats can (and do) play a positive role both in promoting change and in reconciling perspectives of different interest groups.

The BELLE consortium consisted of organizations operating in the Indian institutional environment: naturally, they were well aware of such inter-relationships between institutions. The consortium members are large and significant entities, each with a national presence in its own field. Yet none of the three organizations considered the BELLE project as their keystone activity upon which their organization depended for survival--it was only one of many desirable activities that were being undertaken. Because any individual or organization that needs to get things done must draw on a limited stock of personal goodwill and informal connections to get around the

various bureaucratic obstacles, there is a reluctance to risk this limited capital on ventures not perceived to be major. Thus, even though consortium members were supportive of BELLE, ensuring its success required a costly, time-consuming, and risky investment of institutional resources: in the end, these demands proved to be too great when compared with other needs of the three organizations.

All three authors are Indians who have lived in Bombay; two of us have several years of working experience in India. We were therefore aware of many aspects of Indian institutions, such as the importance of cultivating broad support for the project. We also understood that, to get a new venture off the ground in India, one has to take into account the cultural aspects of decision-making. For example, criticism is usually expressed only indirectly, if at all, by Indian decision-makers. Real reasons for an action are rarely stated; the stated reasons are rarely the real ones. The most important message, if given at all, can lie somewhere below the surface level of the communication. It may be easy to obtain support for an idea in principle, but it is quite a different matter to obtain it in practice. Such factors are important to an understanding of the final outcome of our efforts as described in the next section.

While we were aware of such factors, we were confident that BELLE offered such large benefits for the Indian economy and its constituents that it would be supported--or at least unopposed--by the technocratic elite within and outside of the government. Our further belief was that, should objections to the plans be raised by critics, consortium members were influential enough that they would be able to address the criticism themselves. Thus, we saw little need to cultivate the appropriate members of the invisible power elite on our own. As it turned out, this judgment was incorrect.

Another feature of the institutional environment in India turned out to be important. Relative to the advanced industrial countries, developing countries have a low level of institutional diversity in terms of the number of organizations which may be authorized, capable and willing to carry out a given project. For example, in the US, support for a cost-effective energy-efficiency demonstration project may be obtained from one of the numerous Offices of the Department of Energy, or any of its large institutions (e.g. BPA), or the appropriate State Energy Commission, or even the US Environmental Protection Agency, within which there is a multiplicity of channels by which the project may be funded. This is rarely the case in developing countries where there are only a few opportunities for obtaining support for a given project. Another important institutional feature is that as a result of the relative paucity of 'niches' in a given area, the institutions that occupy a niche guard it jealously and, often, viciously. If an organization regards projects in a certain area as its purview, it can be very reluctant to allow others to undertake similar projects and may call on the connections it has already established as niche-occupier to block potential entrants. Consequently, there is little competition within each niche and low mobility of organizations between niches. A further characteristic of the Indian environment is that the pyramid of hierarchical authority narrows extremely fast as one goes up the institutional ladder. As a result, the personal opinions of the men (and the very few women) at or near the top have a disproportionately large influence on organizational outcomes. Thus, three factors--steeper hierarchical structure of institutions, fewer opportunities for project support, and more intense infighting for niches--make it possible for top managers to block implementation of a new idea more effectively in India than in industrial countries.

From its beginning, BELLE faced problems exacerbated by these factors: a private research organization with close links to the USAID program in India as well as to numerous Indian government officials, and which was represented on ERDAC, regarded energy efficiency as its own purview. Because BELLE involved another research institution (IGIDR), and not this one, our proposal was perceived as a threat to its near-monopoly of the national niche in energy research. Recognizing this perception, we suggested to PACER that the here-unnamed institution organize could its own program similar to BELLE in another city such as New Delhi; we offered to work together with it to present a two-city research project if it was interested. This offer went unanswered, and BELLE continued to be perceived as a threat because it would give IGIDR high visibility. The publicity that the proposal generated in the Indian and international press only heightened this jealousy and inspired more activity based on it which intensified as BELLE gathered more momentum. Things finally came to a head in late 1991, as we describe below.

The Experience in the Field

BELLE was based on the results of an earlier survey of load profiles, peak-coincidence factors for incandescent lamps, and installed lighting wattage in Bombay households. That research, summarized in Gadgil and Natarajan (1989) had been led by one of the authors while at Tata Energy Research Institute, New Delhi, over the period 1984-88. An economic analysis of CFLs was completed in 1989 as an internal report at the Lawrence Berkeley Laboratory (Gadgil and Jannuzzi 1991). As an outgrowth of this work, informal discussions had been held since 1986 with several lighting manufacturers and government

utilities regarding the need for a project to promote efficient lighting in India. Our efforts to define the BELLE project began in earnest in 1989, when one the authors spent several months meeting with managers of different Indian utilities, senior officers of the Indian government within and outside of the power sector, researchers, planners and representatives of major end-users. We decided early on locating the project in Bombay for several reasons: unlike other Indian utilities, the Bombay utilities had fully computerized records of customer billing; they were in the unique position of having installed a meter in every household in their area;[12] their billing cycles were regular; and there was very little "leakage" in the Bombay area.[13] Finally, we had worked earlier with one of the utilities, BEST, and were impressed with their efficiency and interest in such undertakings.

Because we planned the project in Bombay, a local research institute was a natural choice for the lead in the design and co-ordination of the experiment. The Indira Gandhi Institute of Development Research, an autonomous institute established by the Reserve Bank of India (roughly equivalent to the Federal Reserve in the US), and with broad strengths in social sciences, developmental economics, and technical-economic analysis, fit the bill perfectly. We initiated discussions in late 1989 with Philips and BEST officers, and prepared the first proposal to PACER with the involvement of a local management consulting firm. In May 1990, we added to further support from the Rockefeller Foundation to our grant from the C. S. Mott Foundation, both of which were through the Global Energy Efficiency Project of Rocky Mountain Institute. With this support, we were able to pay the consulting firm for their efforts, while giving them on-the-job training in planning demand management programs, in keeping with one of our objectives of developing local strengths in planning and execution of DSM programs in the private entrepreneurial sector.

Most difficult among our early steps was the identification of an interested utility. After spending several months meeting with top officers of several major utilities, we seemed to find an encouraging response from the South Bombay utility, BEST. We had earlier worked with its officers in the residential lighting survey described above. However, we never received a clear expression of interest from the highest level of its management, even after several long and arduous discussions, demonstrations, and recalculations. In retrospect, we realize that the Acting General Manager who headed BEST in late 1989 and early 1990 was perhaps reluctant to commit the utility to a high-profile experiment. The new General Manager (who may have been uncertain of his footing owing to his newness to the position) finally made clear to us in late 1990 that the utility was unwilling to be the first in the country to undertake such a project.

In the same month we approached the top management of BSES, their North Bombay neighbor, who are privately owned and not under the same political pressures as the government-controlled BEST. Fortunately, we were able to meet the Chairman and Managing Director of BSES in person immediately; he expressed enthusiasm for adopting BELLE, although BSES had little to gain financially in the near term from the project (see the section on Economics).

Owing to the perception of the major energy research institution that BELLE was a threat to its unique and unchallenged occupation of the energy niche, however, our project was burdened with politicking, not uncommon in Indian organizations. A chronological sequence of events as they unfolded follows.

The initial plans for BELLE involved 100,000 CFLs to allow adequate study of three issues: the different promotional strategies required for each market segment; the technical performance of the lamps in non-laboratory settings and their effect on the power system; and a demonstration to the lighting manufacturers and the utilities that setting up a CFL factory in India with an annual output of six million lamps for the domestic market was not a crazy idea. In discussions with senior PACER officials, we were encouraged to request for a loan in hard currency for the purchase of CFLs abroad, to be returned in rupees as the lease payments were collected. The first proposal was scaled down to 40,000 lamps in June of 1990 to limit the financing to be provided by PACER. The peer review committee (PRC) met in August to consider the proposal after an internal review by PACER staff. The PRC was not satisfied that Philips was investing sufficiently in the project and required that they raise, in rupees, half of the total investment. However, by end of September of 1990, even partial financing by PACER was ruled out. The consortium was asked to raise all the money in India on its own, and could request only access to hard currency through PACER. This led to further down-scaling of the project to a total of 22,000 CFLS (Philips India had suffered financially in 1989-90, and wanted to limit its debt exposure). At the same time, we were told informally (but very clearly and through several channels) that the proposal stood no chance of getting support from PACER if one of the authors (MAS) ever visited India again in connection with the project. The causes for this severe and personal condemnation were never explained to any of the recipients of the message, nor was any room left for a rebuttal or

discussion. (It seemed to us like a summary execution without charges and without a trial!) The vehemence of the action was too severe to be explained by sexist bias of one or two persons, and remains a mystery today. Despite our misgivings, in the interests of the project, we complied. At this point, we were ready to revise the proposal but by then BEST finally decided to back out. In the middle of all this, we later learned, the 'rival' research institution[14] got together with another lamp manufacturer and a state utility and presented to PACER a two-page proposal in October 1990 along the same lines as the sixty-page proposal submitted by the BELLE consortium. The rival institution also canvassed the PRC for support.

The BELLE consortium, now with BSES as a partner, resubmitted a scaled-down proposal to PACER in December of 1990. PRC met on the 28th of December, and approved the proposal for forwarding to ERDAC. Although PACER requested the consortium to further reduce the size of the experiment to 15,000 CFLs, we defended the proposal successfully, arguing that further reductions would trivialize the experiment.

In February of 1991, ERDAC met, but the project encountered stiff resistance, reportedly from the rival institution, which was an ERDAC member. This was, we were told, the first time that a project recommended by both the PRC and PACER staff was not approved by ERDAC. To resolve the matter, ERDAC took the unprecedented step of defining a sub-committee to examine the project; of course, the rival institution was appointed a member. This group raised several objections and requested a presentation from the senior vice-president of Philips. At this meeting it produced, without prior notification, the lighting manufacturer that had been allied with the rival research institution as a surprise witness to counter Philips, which led to an unpleasant and unexpected confrontation. The ERDAC sub-committee again raised the question of why there was only one lighting manufacturer, and a multinational[15] at that, in the consortium, and asked why BELLE involved a foreign-based expert. We had responses to these questions: in developing BELLE, we had met a wide variety of potential CFL manufacturers and, over the course of several years, the only one that had consistently expressed an interest and devoted resources to the groundwork had been Philips. Regarding the role of the foreign-based expert: we planned that the project would be increasingly controlled by indigenous institutions but saw the importance of bringing in the expertise and experience of AJG, who had carried out the earlier lighting survey and was now in touch with a variety of utilities throughout the world carrying out innovative demand management programs. The consortium members later met in AJG's absence in PACER office in response to this question and confirmed to PACER their desire to have AJG participate in the project.

ERDAC asked the consortium to include the rival lighting manufacturer in the proposal if it wanted to get support. We complied and, as a tactic to dilute expected disruptions, also invited three other lighting manufacturers to join the consortium in March 1991. Our expectations of trouble were not unfounded; the rival lighting manufacturer immediately started pushing for replacing IGIDR with the rival research institution, and also wanted to eliminate the other author (AJG) from the project. These efforts were not successful owing to the other lighting manufacturers' presence. In turn, we requested both the PACER staff and the rival research institution to consider the effect going from one lighting manufacturer to five, without increasing the size of the project. We felt that this would trivialize the project since each manufacturer would have only about 5000 CFLs tested in the market, on which it was to base its decision to set up a CFL factory with an annual output of six million CFLs for the Indian market. The experiment would be useless to the lighting manufacturers and a waste of effort. This argument was apparently unconvincing: our request for reconsideration was rejected in May 1991. This was all the more surprising since we were, after all, asking PACER only for short-term access to hard-currency, not for funding; and that too for a project that appeared to be very much in India's national interest and in line with PACER's stated objectives of accelerating the commercialization of energy research.

The new, expanded consortium was to be finalized by May 1991, but continuing internal political problems (often raised by the rival lighting manufacturer) delayed the signing of the legal documents until August 1991. Meanwhile, the Indian rupee was devalued by 20%, and the project appeared to have become uneconomic since electricity tariffs had not yet been raised. The original consortium-member lamp manufacturer was so committed to the project that it proposed to cover this loss of Rs. 2.8 million as its contribution to the project. Other lighting manufacturers, unwilling to put up money to share in this loss equally, dropped out of the consortium on their own. We had now met all the objections raised by the sub-committee and satisfied the PACER staff. The revised project proposal was resubmitted to ERDAC.

PACER's ERDAC was scheduled to meet on the 11th of October 1991, in New Delhi. One of us (AJG) was in New Delhi at that time, and offered several times to be available at the meeting to answer any questions regarding the proposal. This offer was declined by the ERDAC

chairman. ERDAC met in the afternoon of the scheduled day and decided to reject the BELLE proposal, against the recommendation of PACER staff. The rejection was based on two major points, as recorded in the ERDAC minutes and reported formally to the consortium by PACER staff. The stated reasons make it appear that the ERDAC members completely misunderstood the project objectives and potential large benefits to the Indian economy from BELLE. First, ERDAC characterized the project as a "market seeding program" that, in ERDAC's view, would take two years to carry out, much later than the time that ERDAC anticipated it would take to begin indigenous CFL production in the country. ERDAC thus felt that CFL manufacturing would somehow be undertaken very rapidly and somehow would obviate the need for testing a utility-sponsored leasing scheme for the CFLs--although our research had made it clear that, without a BELLE-type scheme, the lamps were simply uneconomic to the majority of consumers. ERDAC further suggested that market promotion be taken up with "public-sector enterprises and large commercial establishments" once CFLs were available in rupees. This ignored BELLE's objective of capturing valuable on-peak savings from improvements in residential lighting efficiency. ERDAC further advised the BELLE consortium that "a controlled scientific experiment would be sufficient to establish the energy efficiency and effectiveness of CFLs"--when it had been made clear that we were not at all interested in such a demonstration, which had already been undertaken elsewhere. We are truly amazed at ERDAC's inability to comprehend BELLE's aims and benefits, particularly in light of the extended exposure that ERDAC members had to the project proposal. It is also inconsistent with their refusal to let one of the authors be available to answer questions if any arose. Thus, we are led to believe that the real reasons, as usual, remained unstated. The pivotal role of the rival research institution in scuttling the BELLE proposal was confirmed to the authors in informal conversations both in India and abroad in the subsequent months by several of the persons involved with PACER.

Concluding Remarks

It is important to note a final irony: the BELLE proposal failed although there are no villains in the story! We did not receive any hints for kickbacks or bribes (contrary to the common Western perception of how business is conducted in developing countries). The individuals in the events described above acted sincerely to promote their institutional interests (even the 'rival' research institution could be described as following its interests, albeit rather ambitiously). Our experience therefore underscores the need for an integrated analytical framework, incorporating the role of institutional behavior, to assess both the barriers to implementation of energy efficiency in developing countries and the ways to overcome them. The BELLE proposal is based on a sound business plan, is in the societal economic interest, and saves or increases income to all participants. It failed to secure access to hard currency owing to institutional behavior that would not have been predicted based on industrial-country experience.

Despite the failure to obtain hard-currency access from PACER, BELLE did enjoy significant successes. Among our successes we count the formulation of the business plan for the project by an Indian management consultant team, the identification of consortium members and their formal formation of the consortium to execute the project, the successful facing by the consortium of the many challenges it encountered in 1990-91, and perhaps most importantly, the attention the project proposal and its progress drew in the Indian and international press. Such reports generated the interest of many potential users of the BELLE concept, and led to plans for project replication and refinement in many developing and formerly centrally-planned countries (e.g. Mexico, Hungary, Ukraine and Egypt). In fact, a large project for diffusion of CFLs in the residential sector, inspired in part by the BELLE proposal, was submitted by the central electrical federation (CFE) of Mexico and has been funded by the Global Environmental Facility of the World Bank.

What would we do differently if we were to do it all over again? The weak side in our organization of the project was that we underestimated the power of behind-the-scene caucuses against the project and the importance of identifying and energizing potential champions of BELLE in the invisible power network of the bureaucracy and politicians. This certainly would have been possible; there are large political payoffs to the politician who can promise an electric lamp in every household in the electoral district. We also overestimated the significance of the project to each of the three member organizations in the consortium. These are not our shortcomings alone; as we found, such errors of judgment were shared by others who also attempted to help launch the project, both from within the consortium and outside it.

As Amulya Reddy points out, the new way of doing things may be hard, but continuing in the old way is certain to lead to an impasse. The Indian utilities are in a financial crisis. On the one hand is the shortage of investment capital for building power plants to meet projected electricity demand; on the other, as we have seen around the world, cash-poor, risk-averse consumers will not invest in high-efficiency, high first-cost appliances. One solution seems to be for the utility to

invest in increasing the energy efficiency of consumer appliances. Thus we are confident that a BELLE-like scheme will have to be a part of the solution to this crisis.

As for the directions for the future, we continue to explore ways to obtain access to hard currency for operating BELLE, although the onus of this work is now left more on the shoulders of the consortium members. If the project does not take off in India, one based on it may succeed elsewhere. As far as the Indian context is concerned, it is entirely possible that the next major step will occur when one of the multinationals (e.g. Philips) establishes an export-oriented factory for CFLs on Indian shores, in which case some number of CFLs may become available for the project in rupee currency. Alternatively, the rupee may be made partially convertible.[16] Although several manufacturers have submitted to the government Letters of Intent to manufacture CFLs, (currently, a procedural requirement for licensing), all are apprehensive about the Indian market. It is instructive to notice that the Philips CFL plant in Mexico exports 95% of its production to the US, owing to limited market within Mexico. Thus, local production alone will not solve the problem of promoting high-cost, high-efficiency appliances in the mass market. That a large lighting manufacturer was willing to accept losses of Rs. 2.8 million in the late stages of the BELLE proposal for obtaining critical market information is evidence of the importance of finding ways to make CFLs more affordable. Thus, it is ironic that ERDAC advised the BELLE consortium that market information is not needed!

While we realize that there is no single solution that will guarantee the ultimate success of the project, any one of the above developments would allow the project to proceed to the next stage. As Steven Wiel says of the US states that are slow to adopt least-cost planning, "it takes time for people who can change, to change, and for those who can not change, to be replaced".[17] Our experience has taught us that there are likely to be more, as yet unknown, obstacles in the next step; however, it is only by facing them at that stage that we will really be able to understand and analyze them. In the meanwhile, we think it is very important to practitioners and researchers alike that we share the lessons and analyses of our successes and failures as we go.

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Endnotes

1. Thirty years for a refrigerator would not be uncommon, owing to an active secondary market in repairs and resale.

2. Results similar to Dunkerley (1990) were reached earlier by B. S. Reddy and Amulya Reddy in their unpublished study of household cooking fuels in Bangalore. Personal communication.

3. Ironically, Brazil exports all its production of high-efficiency refrigerators to the US, and Mexico exports 95% of its production of compact fluorescent lamps to the US. Absence of local manufacture is thus not a key barrier, because in these two cases local manufacture has not led to any significant penetration in the domestic market. It would appear that the real road-blocks (in technical-economic terms) are just the first two factors. However, as we describe later, the BELLE project has stumbled on the third one!

4. A 60 W incandescent lamp designed for the Indian market produces 720 lumens of light (12 lumens/watt), and a CFL produces 900 lumens (60 lumens/watt). The figures are taken from the commercial lamp catalogues of Philips India.

5. Compared to the usual claim of a 10,000-hour burning life for CFLs in the US market, manufacturers seem to be more cautions about CFL life under poorer power conditions. 8,000 hours is the quoted burning life of a 15 W electronic CFL from the Philips India catalogue.

6. In mid-1991, the Indian rupee was sharply devalued to an exchange rate of about US $1 = Rs. 25. However, electricity tariffs did not rise immediately in proportion. Demonstrating their commitment to BELLE, Philips India offered to proceed with the experiment nevertheless, and to bear the entire loss resulting from the temporary imbalance between the CFL international price and local electricity tariffs.

We show here the calculations as they stood in early 1991. As inflationary pressures on power tariffs in India are very high, we are sure that price increases are imminent and that the imbalance mentioned above will be redressed soon.

7. Average transmission and distribution losses in Indian power system during the last decade.

8. Norm adopted by the Central Electricity Authority, the central planning agency for power development in India, for the 7th Five-Year Plan of the country. This norm is a desired (and realistic) goal rather than the actual average plant availability factor, which is somewhat lower.

9. Reports in the Indian press in May 1992 predict power shortages in Bombay beginning in June 1992.

10. Since the terms 'conservation' and 'efficiency' are interchangeable in this discussion, we will use the latter to suggest both.

11. Witness the success of Bofors in selling field guns to the Indian military and of Ambanis in importing chemical feedstock for synthetic yarn.

12. A common arrangement in developing countries is for one slum-lord, who is connected to the meter, to sell electricity (often at steep rates) to a number of poor households who are 'illegal' and hence unable to get a metered connection.

13. This refers to the practice whereby a consumer bribes the meter-reader to overlook a circumvented meter, or to allow commercial activity to get power on a residential meter, or simply to 'misread' the meter.

14. While we did not consider this institution as our rival, concentrating instead on getting the proposal off the ground, it apparently saw IGIDR as its competition. Since we do not name it here, we shall call it the "rival" institution for brevity with the understanding that this is a one-way rivalry.

15. Philips India is affiliated to a multinational corporation, and also large enough to be regulated under India's Monopolies and Restrictive Trade Practices (MRTP) Act, inviting more political scrutiny. As we write this, however, the Indian government has all but dropped the MRTP act and its enforcement under the new economic policy.

16. As we write this, the Indian Government has already announced its decision to make the Indian currency partially convertible. What this means, and what impacts this has on BELLE remains to be seen.

17. Steven Wiel is the Chairman of the Conservation Committee of NARUC. Remarks during Seminar at LBL titled "The History of the Utility Industry in Demand Side Management Programs", May 26, 1992.

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