Power Sector Restructuring and Environment: Trends, Policies, and GEF Experience

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A. Introduction

Power-sector restructuring is underway or beginning in many regions and countries around the world, both developed and developing.[1] Restructuring is resulting in independent power production and competition in generation; decentralization; privatization; unbundling of generation and transmission; and even competition in distribution. Along with these changes are a broad variety of new institutional and contractual forms within the power sector. As restructuring takes place, environmental considerations are often overlooked, either because policy makers and their advisors perceive their priorities to be elsewhere, or because they assume that restructuring will automatically lead to environmental improvement (Gilbert et al. 1996; Kozloff 1998; USAID 1998e; ESMAP 1999; Bacon and Besant-Jones 2001).

This paper reviews six key trends underway in power sector restructuring and their implications for environment. It then looks at specific power-sector policies for renewable energy and energy efficiency that can accompany restructuring and recent GEF experience with supporting grid-based renewable energy. Finally, it provides some recommendations from a June 2000 workshop on power sector reform and environment sponsored by the GEF Scientific and Technical Advisory Panel.

B. The Power Sector

Total world electric power capacity stood at 3,400,000 MW in 2000, with about 1,500,000 MW (45%) of this in developing countries (see Table 1). This capacity represents a cumulative investment of perhaps $3-4 trillion and annual fuel costs of perhaps $150-250 billion. Globally, fossil fuels account for about two-thirds of generating capacity, with the remaining third being large hydro (20%), nuclear (10%), and renewable energy (3%). Electricity consumption in developing countries continues to grow rapidly with economic growth, raising concerns about how these countries will expand power generation in coming decades. According to some estimates, developing countries will need to more than double their current generation capacity by 2020 (IEA 1998, 2000; Martinot et al 2002).

[1] Other reasonably equivalent terms to "restructuring" are "liberalization" and "reform," although some might argue that there are differences. This paper uses the term "restructuring" throughout.

Traditionally, power utilities have been state-owned monopolies or privately-owned monopolies, either regulated by government agencies or "self-regulated" without much oversight. Their traditional mission has been an engineering one: expanding supply, improving technical efficiency, and ensuring or improving reliability and access. In developing countries, many utilities have been and remain are in poor financial condition and have limited borrowing ability to make investments and expand service. In developed countries, utilities had (until more recently) been considered among the safest investments available, since their profits were guaranteed by government regulation, and thus had no trouble attracting capital for expansion.

During the 1990s, waves of "restructuring" have washed over utilities worldwide, with profound effect on technologies, costs, prices, institutions, and regulatory frameworks. Restructuring has changed the traditional mission and mandates of utilities in complex ways, and has had large impacts on environmental, social, and political conditions. At the same time, new regulatory approaches are being found for reducing environmental impacts from the restructured power sector. The next section discusses some of the ways in which the environmental impacts of energy have been affected.

Table 1: Renewable Grid-Based Electricity Generation Capacity Installed as of 2000 (megawatts)

Technology	**All countries**	**Developing countries**
Small hydropower[b]	43,000	25,000
Biomass power[c]	32,000	17,000
Wind power	18,000	1,700
Geothermal power	8,500	3,900
Solar thermal power	350	0
Solar photovoltaic power (grid)	250	0
Total renewable power capacity	102,000	48,000
Large hydropower	680,000	260,000
Total world electric power capacity	3,400,000	1,500,000

Source: Martinot et al. 2002

C. Patterns of Power Sector Restructuring and Influence on Environment

Globally, there are six key trends at work in the context of power sector restructuring that are most relevant to environmental considerations. These trends are:

1. Competitive wholesale power markets and removal of price regulation on generation
2. Self-generation by end-users
3. Smaller-scale generation facilities and technologies
4. Privatization and/or commercialization of utilities
5. Unbundling of generation, transmission and distribution
6. Competitive retail power markets

These trends are described below along with the potential effects they may have on technology and fuel choices, levels of energy consumption, emissions, and consequent environmental impacts. It should be noted, however, that power sector restructuring is still in its infancy. Though almost every country in the world is involved in some phase of electricity sector restructuring, no country considers its restructuring activities complete; all are in some transitionary phase. As a result, actual data is scarce and trends are derived from preliminary information.

1. Competitive wholesale power markets and removal of price regulation on generation

Power generation is usually one of the first aspects of utility systems to be deregulated. The trend is towards situations in which utilities no longer have monopolies to produce power. "Power markets" have emerged with many buyers and sellers.[2] Distribution utilities and large industrial customers are gaining more choices in obtaining wholesale power. Where deregulation is occurring, power contracts are being concluded by players in an essentially free market for wholesale electricity (of course, producers may need to pay transmission and distribution fees to get their power to end-users). When wholesale electricity becomes a market commodity, price becomes paramount: "in a competitive market, price appears to be much more important than other factors in determining the choice of electricity supplier" said USAID (1998a).

Such a market (and other power-sector changes discussed later) may often begin with independent power-producer (IPP) frameworks, says Weinberg (2000). He hypothesizes that "perhaps IPPs are a relatively easy first step because the national government is not required to cede control of assets or jeopardize workers….But, once established, IPPs set a benchmark, and thereby drive change" (p.7). Indeed, one of the very first major markets for renewable energy in the 1980s was in California, where a new national regulatory framework enacted in 1978 (PURPA) allowed independent power producers for the first time. "The commercial response [to PURPA] resulted in most of the renewable generation that exists today," assert Rader and Short (1998).

In developing countries, independent power producer frameworks are emerging. In a recent ESMAP survey of 115 developing countries, 43 of these countries had IPPs (ESMAP 1999). In some countries, such as India and Sri Lanka, IPP frameworks have played key roles in accelerating markets for renewable energy (particularly wind power and small hydro). As happened in California and is happening in many developing countries, IPP frameworks may initially develop under a "single buyer" model, in which a competitive wholesale market does not yet exist and IPP power must be sold to monopoly utility companies at regulated prices.

The potential effects of competitive wholesale markets and independent power producers appear to be substantial.[3] They can include:

[2] Historically, regulated utilities bought and sold from one another across territories in regional power markets, but each utility typically had a monopoly over generation in a particular territory.
[3] Dubash and Rajan (2001) discuss the social and environmental impacts of IPP frameworks on the Indian power sector during the 1990s. They find that many utilities were locked into long-term unfavorable power contracts with

(a) *Older and dirtier*. Low-cost producers like older fossil-fuel power plants that have already amortized their capital costs may be placed in a strengthened position in a competitive market and may be able to sell more power than was the case in a regulated market. These plants are often the dirtiest and may be exempt from more recent pollution-control laws because of their age. During periods of demand decline, the higher-cost, newer, cleaner plants may go unused while older, dirtier plants continue to run full bore.

(b) *Greater consumption*. Competition may lower prices and raise demand. As prices fall, consumption increases, increasing the overall environmental impacts of the power sector. Greater technical efficiency is not required; price reductions may occur as previously monopoly producers make organizations leaner or must simply accept lower profit margins or returns. Evidence for this effect occurred with restructuring in Norway in the early 1990s, where price decreases of 18-26% to industrial customers led to large increases in energy consumption (Nadel 1996).

(c) *More efficient production*. Managerial incentives to improve the technical performance of existing power plants may increase as competitive price pressures occur.

(d) "*Dash for gas.*" Natural gas generation may be favored by competitive forces. For example, when the UK power sector was opened to competition, the market share of gas-fired generation went from 1 percent to 13 percent from 1990 to 1994, and is continuing to become a dominant fuel source in the UK (Woolf and Biewald 1996). This phenomenon has occurred in most countries where wholesale generation is opened to competition.

(e) *Mixed prospects for renewable energy sources*. With a few exceptions, traditional utility monopolies have avoided renewable energy sources. As wholesale power markets appear, renewables are no longer "hostage" to entrenched utility mentalities and technology biases. For example, most wind power capacity worldwide has been installed by IPPs. In general, IPP frameworks appear to be an essential pre-requisite for renewable energy development (Weinberg 2000). On the other hand, competitive power markets may lower wholesale prices, which may stifle renewable energy development. As combined-cycle gas turbines, for instance, begin to dominate new generation, renewable energy has an even more difficult time competing.

(f) *Demise of clean-energy mandates?* Elimination of mandates for power purchases from certain types of producers may also leave renewable energy behind. For example, in California, utilities will no longer be required to purchase power from independent power producers (mostly cogeneration and renewable energy producers). The state's restructuring law assesses a "competition transition charge" to electricity sales through 2002, some of

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IPPs that impaired their fiscal viability, forced higher tariffs, and resulted in surplus generation capacity while crowding out potential demand-side energy efficiency improvements. This situation is by no means limited to India but has occurred in other countries and regions. On the other extreme, a "merchant plant" market regime, in which plants do not have long-term purchase contracts but sell power on a spot market, means that capital-intensive producers, particularly renewable energy producers, face uncertain profitability and thus find it more difficult (or impossible) to obtain power project financing. The case of Sri Lanka small hydro produces discussed later in the paper points to the problem of power purchase contracts based on short-run variation in fuel costs.

which will be spent by the government on renewable energy, but only in limited amounts and only until 2002 (Hirsh and Serchuk 1999).

(g) *Demise of nuclear?* Deregulated markets spell uncertain prospects for nuclear power. Nuclear power plants in the U.S. are being retired early as competitive markets take hold because of their high operating costs. Moody's Investors Service reported that ten or more nuclear plants might be closed for economic reasons if generation is completely deregulated (Woolf and Biewald 1996, also citing Moody's Investor Service, "Moody's assesses nuclear power risks in a more competitive market," November 1996).

(h) *Economic valuation of generation reliability.* In spot and bulk markets, the reliability and dispatchability of generation sources are likely to be assigned explicit or implicit economic values that may penalize intermittent (or "non-firm") power generators like renewable energy sources.

2. Self-generation by end-users

Independent power producers need not be simply generation companies. IPPs may be the end-users themselves. With the advent of IPP frameworks, utility buy-back schemes (including "net metering" in some countries), and cogeneration technology options for commercial and industrial customers, more and more end-users, from large industrial customers to small residential users, are generating their own electricity—and either selling surplus power back to the grid or using self-generation to partly offset purchased power. This trend has a number of potential effects on the environment:

(a) *Higher efficiency from cogeneration.* Cogeneration makes overall power and heat supply more efficient (up to twice as efficient), given a large enough "system boundary" that incorporates all energy inputs to an end-user—particularly electricity and heat. Most evidence seems to indicate greater shares of cogeneration in the process of restructuring, but in Europe the cogeneration market has seen a considerable slowdown, attributed by some to legal uncertainties surrounding the implementation of 1996 EU electricity and gas directives (Cogen Europe 2000).

(b) *More natural gas.* At least in some countries, self-generation is more likely to employ natural gas and gas turbines (and perhaps natural-gas-supplied fuel cells in the future). Provided a gas supply exists, gas seems to be the fuel of choice for small self-producers because of short construction lead times, low fuel and maintenance costs, and modular technology. New "microturbines" are lowing the capacity threshold at which natural-gas-fuelled self-generation becomes viable.

(c) *Lower transmission and distribution losses per unit of load.* As generation becomes closer and closer to loads, the amount of T&D losses will not increase as rapidly as load growth.

(d) *Lower emissions*. As mentioned above, new smaller-scale generation technologies are generally cleaner and/or more efficient than large-scale technologies, because they tend to incorporate cogeneration, use natural gas, or use renewable energy sources.

(e) *Entry of renewable energy, especially solar PV, with "net metering."* As households and businesses take more interest in distributed solar PV, either by taking advantage of government subsidy programs or deciding to pay the extra costs themselves, "net metering" that allows "stored" kilowatt-hours over the utility connection and power sales at retail-tariff levels, is becoming more widespread. For example, 30 states in the U.S. now have net metering laws, and California allows users with up to 1-megawatt loads to use net metering.

3. Smaller-scale generation facilities and technologies

The economic advantages that traditional regulated monopoly utilities enjoyed from large power plants and increasing economies of scale (during an era when "big" power plants were getting bigger, cheaper and more efficient every year) are being eroded by new technologies that are cost-competitive and even more efficient at increasingly smaller scales. In fact, newer technologies actually reduce investment risks and thus costs at smaller scales by providing modular and rapid "just in time" capacity increments. Combined-cycle gas turbines are the best example. Wind power and other renewables are also in this category. A variety of other "micropower" sources are becoming commercially available, and one can even anticipate future advanced technologies such as stationary fuel cells (Dunn and Flavin 2000). An additional advantage of smaller-scale technologies is that they can be distributed and placed closer to end-uses, reducing needed transmission and distribution investments (as has happened with wind turbines in some European countries like Denmark). The effects of this trend are similar to those for "self-generation by end-users" above, as the two usually go hand-in-hand.

4. Privatization and/or commercialization of utilities

In many countries, utilities, historically government-owned and operated, are becoming private for-profit entities that must act like commercial corporations. Even if utilities remain state-owned, they are becoming "commercialized"—losing state subsidies and becoming subject to the same tax laws and accounting rules as private firms. In both cases, staffing may be reduced and management must make independent decisions on the basis of profitability. Interestingly, the existence of an IPP framework appears to precede privatization; more than half of countries with IPPs have passed privatization laws, but only one-third of countries without IPPs have done so (Weinberg 2000).

The effects of privatization and these trends on environment are difficult to judge: "the environmental effects of privatization can be positive or negative, depending on such factors as the strength of the regulatory body, and the political and environmental policy situation in a country" concludes USAID (1998a, p.7). Some potential effects on environment:

(a) *No demand-side management?* Privatization and deregulation of utilities has been eliminating incentives or regulatory mechanisms for utilities to do demand-side management (DSM). With privatization and deregulation, utilities may no longer be obligated to meet all future customer demand—an obligation which had DSM make sense. In the U.S., utility spending on energy efficiency programs dropped from $2.7 billion in 1994 to $1.6 billion in 1997 as companies anticipated increased deregulation (Hirsh and Serchuk 1999). After adopting a utility restructuring law, "Maryland will become the first state with a previous commitment to energy efficiency to abandon that commitment in a competitive market" say Hirsh and Serchuk (1999, p.32). In Norway, deregulated utilities slashed their energy-efficiency program staff after deregulation (Nadel 1996). In developing countries, established programs may be similarly jeopardized. For example, the GEF and Thai government have expended large resources to develop a highly capable DSM office in the Thai national electric utility over the past several years. Now that the utility is being privatized, no one is sure what to do with this office or how to fund it, and there are fears it could be disbanded.

On the other hand, if a privatized utility remains obligated to serve certain customers but doing so is a net cost (i.e., when the marginal costs of generation exceed revenue potential from certain customer classes), then profit-maximizing private utilities may find new incentives to invest in end-use energy efficiency to reduce their net financial losses from serving those customers (USAID 1998a).

(b) *More financing available for renewables?* According to Kozloff (1998), privatization might promote renewables by providing a new financing mechanism—raising capital on private debt and equity markets—that can be used to finance capital-intensive renewable energy projects. However, the transition from public to private may shorten time horizons, increase borrowing costs, and increase requirements for high rates of return. All of these factors would limit investments in more capital-intensive projects, in favor of lower-capital-cost, higher-operating-cost forms of energy (fossil fuels and natural gas in particular).

(c) *More or less R&D?* Deregulated utilities, faced with competition and short-term financial goals are spending less and less on long-term R&D. Declining expenditures on R&D translates into slower development and adoption of the next generation of cleaner technologies. Hirsch and Serchuk point to "the uncertain future facing public-interest R&D in a restructured electricity market" (p.34). On the other hand, private power developers, aggressively targeting new utility markets, may be expanding their investment in R&D as a way of enhancing future competitiveness.

(d) *More efficient production, transmission, distribution.* As with competitive wholesale power markets, managerial incentives to improve the technical performance of existing power plants may increase as competitive pressures occur.

5. Unbundling of generation, transmission and distribution

Whereas one monopoly utility traditionally performed generation, transmission and distribution functions in a vertically integrated manner, each of these functions is being parceled out to different commercial entities, some retaining a regulated monopoly status (particularly distribution utilities) and others starting to face competition (particularly generators). This trend has a number of potential effects on environment:

(a) *Greater consumer incentives to self-generate.* If retail tariffs accurately reflect generation, transmission and distribution costs, customers may face the full costs of centralized generation and delivery, and as such may have more incentive to self-generate.

(b) *Lower incentives to avoid transmission and distribution costs with distributed generation by utilities themselves.* If the utility that is in a position to invest in distribution-based generation (the distribution utility) cannot also benefit from the avoided costs of upstream infrastructure (generation and transmission), then mismatched institutional costs and benefits may hinder distributed generation (which is more likely to be renewable-energy-based than centralized generation).

(c) *New regulatory incentives for distribution companies to promote energy efficiency.* Experiences from several developed countries are emerging over regulatory mechanisms to get unbundled distribution companies to invest in or promote end-use energy efficiency. For example, in the UK, the Office of Electricity Regulation has established "Standards of Performance" requiring each distribution company to achieve certain energy savings levels among its customer base (King et al. 1996).

(d) *Transmission pricing penalties for intermittent renewable energy sources.* Unbundling requires new methods and structures for transmission pricing. If renewables have to pay transmission charges on a capacity basis—even when the capacity is not being used—then the result may be an abnormally high transmission cost per kWh that will make renewables uncompetitive (Harris and Navarro 2000).

(e) *Transmission incentives for demand reduction and ancillary services.* Unbundled transmission services may highlight the value of demand reductions during peak periods and distributed generation near constrained transmission lines. This in turn could create a new opportunity for renewable energy and energy efficiency.

6. Competitive retail power markets and "green power" sales

Competition at the retail level means that individual consumers are free to select whichever power generator they would like to buy their power from (intermediated through separate distribution and transmission entities). Competitive retail power markets are among the newest phenomena in developed country power sector restructuring.

One of the effects of competitive retail power markets so-called "green power" sales. In such markets, end-users can purchase power from a "green" supplier, usually at a premium. Proponents of green power markets point to the competitive marketing advantage of green power firms and surveys that show consumer willingness to pay a premium for green power. Recent developments show that green power wholesalers are beginning to make renewables investments specifically for new green power contracts (Edge 1998). However, Rader and Short (1998) believe a "green revolution" in the electric industry is unlikely. They argue that green power providers must conduct substantial marketing campaigns, not just to distinguish their product, but to explain to consumers that a choice in power supplier exists at all. They also note the problem of investor financing risk and time frame: customer demand for green power is expected primarily in the short-term-oriented residential sector, while the long-term power-sales contracts that reduce financing risk are available mostly from the industrial sector.

Nevertheless, green power markets have begun to flourish in recent years. The Netherlands is perhaps the best-known example, where as a result of restructuring at the start of 2001, an estimated 40% of residential consumers are now interested in green power. Green power demand is so high that utilities have to import green power from abroad, and by early 2002, an estimated 150,000 households (2.5% of Netherlands' 6 million households) were green power customers. That trend has been assisted greatly by the exemption of green power from an increasing tax on fossil-fuel generated electricity, which has made green power almost competitive with conventional power. In the U.S., green power markets are emerging in several states, also in response to state incentives and aggressive marketing campaigns by green power suppliers. In California by 2000, there were 170,000 residential customers and 50,000 nonresidential customers of green power, spurred by a 1 cent/kWh subsidy to green power providers, paid for by California's "system benefits charge" levied on all electricity sales (Bolinger et al 2001).

But the difficulty of establishing a green power market is underscored by more recent developments in California. "California's initial experience points to the difficulty of setting up an active power market….Enron Energy Services, which was expected to be one of the leading purveyors of green power, stopped taking on new residential customers, saying that the high cost of educating and signing up new customers far outweighed the potential profits" say Hirsh and Serchuk (1999, p.35). And during the power crisis in 2000-2001, with wildly increasing wholesale power rates, green power marketing essentially ceased and many customers went back to their old suppliers (Bolinger et al 2001).

D. Policies for Incorporating Clean Energy with Restructuring

There are a number of specific policies for incorporating clean energy within power sector restructuring that can be observed in practice or policy in many countries. Still, experience and lessons from such policies is just emerging, and many effects remain poorly documented.

Enact stable frameworks for independent power producers. Private-sector involvement and investment in the power sector are greatly facilitated by establishing a transparent and stable framework and rules governing competition (both on price and access to customers). Establishing these conditions can assist in promoting renewable energy market development and scale-up. For grid-connected renewables in many countries, utility regulatory frameworks that allow fair competition for electricity generation by independent power producers, including power purchase agreements and a transparent and stable tariff-setting regime, are an essential first step towards creating private markets for renewable energy. In addition, rules and institutions for bidding and transacting power purchases are also essential elements of a power market.

Eliminate subsidies. If conventional generation remains subsidized, these subsidies should be eliminated to create a "level playing field." Explicit or implicit subsidies for traditional forms of generation are prevalent in many countries. Implicit subsidies may exist, for example, if tariffs do not incorporate full capital replacement costs of aging fossil units or if environment standards are not being enforced. Though it is often difficult to eliminate existing subsidies, that is the preferred option.

Provide open access to transmission. An open-access transmission system must allow power wheeling between buyer and seller that provides open access to customers. Transmission services should not discriminate against or give unfair advantage to specific ownership or certain types of generation. For example, in India open wheeling policies have been credited with helping catalyze the wind industry there; industrial firms may even produce their wind power in regions with good wind resources and transfer the power over the transmission system for use in their own facilities—or for sales to a third party (Gupta, 2000). Similarly, in Brazil, reduction of transmission wheeling fees has been credited as a major influence promoting a booming small hydro industry there.

Enforce comparable environmental standards on all generators. Existing facilities, even if old, should face the same environmental standards as new plants, even if this means they must be retired because of prohibitive retrofit costs. Many coal plants in the U.S., for example, have been "grandfathered" in environmental laws and are not required to meet current regulations. These plants are often the low-cost producers and also the dirtiest. As mentioned above, in a competitive environment, such low-cost producers unfairly benefit from their exempt status.

Attend to environmental policy at the same time as restructuring. Emissions standards, monitoring requirements, and other aspects of environmental policy can be integrated to strengthen power sector changes. For example, enforced emissions monitoring and disclosure can be one element of promoting "green power" markets. The time of major power sector changes is often the time when there is maximum political leverage to incorporate related environmental policies. Advocates should anticipate this opportunity and be prepared with thoughtful, feasible policy recommendations.

Enact renewable energy portfolio standards (RPS). An RPS requires that a minimum percentage of power sold in a given region or service territory is met by renewable energy sources. Usually proposed along with RPS are power trading schemes whereby retail providers may trade their "renewable energy" generation obligations with one another as long as all meet their respective standards, using "green certificates." At least nine states in the U.S. have now enacted an RPS, including New Jersey, Maine, Nevada, Massachusetts, Connecticut, Arizona, New Mexico, Texas and Wisconsin (Wiser, Porter and Clemmer 2000, Bolinger et al. 2001). RPS-type programs have also been adopted in Denmark, Italy, and the Netherlands, and are being proposed in other countries such as Japan, India, and Portugal. In the Netherlands, utilities are adopting RPS voluntarily, without a government mandate, although the Netherlands does have a national target of 17% of all electricity produced from renewable energy by 2020 (Schaeffer 2001). As a whole, European policy calls for 12% of energy supply from renewables by 2010. China and India also have national goals: in China, renewables should account for 5% of annual new generation being added to the system by 2010, and in India this percentage is 10% by 2012.

Enact mandatory purchases of renewable-energy-based power at a fixed price. The early PURPA implementation in California in the 1980s set avoided-cost pricing for mandatory utility purchases of power from independent power producers (under "standard offer" rules). The electricity feed-in laws in Germany, and similar policies in other European countries in the 1990s, similarly required purchases of renewable energy power at a fixed price. For example, in Germany, producers could sell to the utility at 90% of the retail market price. Feed-in laws led to a rapid increase in installed capacity and development of commercial renewable energy markets in Germany and Spain in particular. Partly because retail prices have been falling with competition, making renewable-energy producers and financiers more wary, the new German Renewable Energy Law changes pricing to that based on production costs rather than retail prices. One of the criticisms of historical feed-in approaches is that they have not encouraged cost reductions or innovation; this new German law includes provisions for regular adjustments to prices in response to technological and market developments (Shepherd 1998; Wagner 2000; Sawin 2001).

Enact competitively-bid renewable-energy-resource obligations. The United Kingdom has had positive experiences with competitive bidding for renewable-energy-resource obligations under its NFFO policy, which has led to price reductions over time. For example, wind power contract prices declined from 10 p/kWh in 1990 under NFFO-1, to 4.5 p/kWh in 1997 under NFFO-4. One of the lessons some draw from the UK is that competitively determined subsidies could lead to rapidly declining prices for renewable energy. However, critics of the NFFO say that domestic manufacturers became more and more squeezed over time and eventually became unprofitable in order to remain in the market. In addition, awarded resource obligations have not always translated into projects on the ground. In any case, this arrangement is now over, as the government has recently rescinded binding targets (Shepherd 1998; Trends in Renewable Energies, April 2000).

Levy "system benefits charges" (per-kWh) to provide funds for public renewable energy and energy efficiency programs. In the United States, some funds for renewables and energy efficiency are coming from what is often referred to as a System Benefits Charge (SBC). "State clean energy funds supported by system benefits charges appear to be one of the more positive developments to emerge from electricity restructuring" wrote Bolinger et al. (2001). Fourteen states in the U.S. will collect $3.5 billion through 2011 in system benefits charges. In California, a three-percent fee added to consumers' electricity bills supported $540 million worth of renewable energy programs and $872 million worth of energy efficiency programs during the early years of restructuring (1998-2001). SBC support in the U.S. for renewables has gone largely to windpower so far, along with subsides for distributed solar PV. Similar "pollution taxes" exist in Europe for fossil-fuel-based generation. In general, the funds serve a variety of purposes, such as paying for the difference between the cost of renewables and traditional generating facilities, reducing the cost of loans for renewable facilities, providing energy efficiency services, funding public education on energy-related issues, and supporting research and development.

Enact policies to accelerate retirement of older, less efficient plants. Such policies are taking hold in China, for example, where national policies have banned further construction of smaller coal power plants (less than 50MW) and mandate the retirement of small power plants. But there are many difficulties in implementing such policies, particularly if utilities face severe demand pressure and can't retire units without decreasing reliability, or simply don't want to because of the favorable economics of the older plants.

Create independent energy efficiency centers. Public support, perhaps through system user fees or surcharges, can support energy efficiency centers jointly owned by utilities and third parties. (If distribution utilities operate such centers, they aren't seen as credible or independent.) These centers can offer independent advice to businesses and residential customers for energy efficiency improvements, business services such as audits, and even ESCO-like performance contracting. Norway and its Energy Act provide an example of a country that has taken this approach, although "concerns over anti-competitive behavior have been a stumbling block to fully implementing the energy efficiency programs envisioned under the Act" (King et al. 1996, p.19).

Encourage distributed energy. Kozloff concludes that: "renewables are likely to play a larger role in power systems dominated by the distributed model than by the central station paradigm. However, successful deployment of distributed renewable in an unbundled system requires that at least one player can capture system benefits" (1998, p. 2). Some of the ways that distributed energy can be supported are:

- new financing mechanisms
- common interconnection standards
- standard power purchase agreements and tariffs that reduce transaction costs
- "net metering" schemes for residential consumers
- reduced bureaucratic procedures for grid connections and/or metering
- incorporation of cost savings in distribution system upgrades into energy tariffs
- attention to local zoning and code requirements that may inhibit distributed generation (i.e., building code and aesthetic issues of rooftop solar panels).
- capacity credits in tariff structures

Distribution and transmission system avoided costs, if factored into power purchase tariffs, can substantially alter the economics of distributed renewable energy generation. Solar photovolatic power is perhaps the most significant. This principle was behind the development of the Philippines CEPALCO grid-connected PV plant supported by the GEF; conjunctive use with variable hydroelectricity on the distribution system can avoid costly transmission system upgrades or other investments to level out power curves. Although only about 20% of global PV production was used on-grid in 1998 (mostly for government-sponsored rooftop markets), utility policy and distribution planning frameworks for such conjunctive uses offer the promise of accelerating on-grid PV applications. Such policies are more often at local or regional levels, rather than national levels.

Regulate distribution utilities to encourage distributed generation. Regulation can encourage distribution utilities to consider the lowest system cost when making decisions about types of service. "Regulation of retail electricity suppliers should create economic incentives that promote full consideration of renewable energy technologies for bulk power, distributed generation and demand-side applications. Power sector reforms should ensure that distributed options can compete to provide electricity services" (Kozloff 1998, p.2).

Provide incentives to new distribution utilities to perform DSM services. If anti-competitive concerns can be overcome (these have been raised in Norway and the UK, for example), then distribution companies can be regulated to be obligated to provide energy efficiency services that are subsidized through a levy on electricity sales or consumers (King et al 1996). "Performance-based regulation can also create incentives for retail service providers to invest in demand-side management by decoupling profits from sales" echoes Kozloff (1998, p.19). However, as utilities move toward commercial interests and away from social interests, and as it becomes more difficult to protect against anti-competitive behavior in the retail market, the prospects for DSM programs by utilities in a deregulated environment appear mixed.

E. Experience and Lessons from GEF Support of Grid Renewable Energy

This section reviews the emerging experience and lessons from GEF-supported efforts to promote grid-connected renewable energy in developing countries.[4] From 1991-2000, the GEF approved 17 such projects implemented through the World Bank, UN Development Program, and Asian Development Bank. Nine of these projects promote wind power (in Cape Verde, China, Costa Rica, India, Kazakhstan and Sri Lanka), five promote small hydropower (in India and Sri Lanka), six promote biomass and bagasse power generation (in China, Cuba, Hungary, Mauritius, Slovenia and Thailand), one promotes power from biomethanation (in India), and one promotes geothermal power (in the Philippines). Total GEF contribution to these projects is $180 million, and total project costs exceed $1.2 billion as the GEF has facilitated substantial co-financing.

Most of these projects are just getting started or are in early stages of implementation (8 of the 17 projects were more recently approved by the GEF Council, during 1998-2000, and some of them were still awaiting formal approval by implementing agencies or governments). Thus, experience from the portfolio is still quite limited. This section focuses on the emerging experience and lessons from two projects which have been completed (in Mauritius and India) and a third with substantial implementation experience (in Sri Lanka). Emerging experience from China and Costa Rica is also covered.

In general, GEF projects take five main approaches to promoting grid-connected renewable energy: (a) demonstrate technologies and their commercial and economic potential; (b) build

[4] This section is taken from Martinot (2001).

capacities of project developers, plant operators, and regulatory agencies; (c) develop regulatory and legal frameworks that encourage independent power producers and establish transparent, non-negotiable tariff structures; (d) create financing mechanisms for project developers; and (e) develop national plans and programs informed by the institutional and business models piloted in projects.

Wind and Small Hydro Power in India

In India, GEF support for wind power occurred in parallel with the explosive market growth that emerged in the mid-1990s fueled by favorable investment tax policies and a supportive regulatory framework. Besides investment tax credits, transparent power purchase tariffs, transmission wheeling, third-party sales, guarantees for local utility power-purchase contracts and power "banking" all contributed to the development of the market. By 2000, almost 1200 MW of wind capacity had been installed in India, virtually all of that by the private sector. In addition, dozens of domestic wind turbine manufacturers had emerged, many of them joint ventures with foreign partners. Exports of turbines began and high-technology turbine designs with variable-speed operation were being produced. During the 1990s, the GEF and World Bank directly financed 41 MW of wind turbine installations and 45 MW of mini-hydro capacity in India through the Renewable Energy Development project.[5]

More importantly, the India project also strengthened the capabilities of the India Renewable Energy Development Agency (IREDA) to promote and finance private-sector investments. As a result, more than 360 MW of wind projects and 65 MW of mini-hydro projects have been financed through IREDA. Another 65 MW of mini-hydro capacity is scheduled for financing and completion through 2001. The project also helped to raise awareness among investors and banking institutions of the viability of wind power technology and helped to lobby for lower import tariffs for wind systems. During the 1990s, many financial institutions decided to offer financing for wind farms, which was a key project goal.[6]

One lesson from India is that more understanding is needed about the relative effectiveness of production-based incentives relative to capacity-based incentives. In the 1990s, one-year 100% investment tax depreciation provided large economic gains for installation of wind farm capacity, regardless of the electricity generation from that capacity. This incentive is shifting, as capacity-based tax incentives have decreased due to the reduction in marginal corporate tax rates from 55% in 1992/93 to 35% in 2000, at the same time that power tariffs, production-based incentives, have continued to rise. In addition, IREDA offers incentives for wind farms it has financed to achieve higher capacity factors—in the form of interest-rate reductions.[7]

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[5] Additional hydro capacity was under development in 1999 and 2000, and a second World Bank renewable energy project for India, which would finance additional mini-hydro, was approved in 2000.

[6] More information can be obtained from the document "Case Study: India Renewable Resources Development Project" by the GEF.

[7] Interest rate reductions are 0.5% for plants exceeding 18% capacity factor (1.6 GWh/MW/yr), 0.6% for exceeding 23% capacity factor (2.0 GWh/MW/yr), and 0.75% for exceeding 27% capacity factor (2.4 GWh/MW/yr).

Another possible lesson from India may parallel that gained in California in the 1980s: it takes a substantial amount of time and a large, growing wind industry to work out technical and operational difficulties and gain enough experience to enable superior wind farm performance. The recent decline in wind farm development in Tamil Nadu, for example, has been attributed to variety of factors. In addition to financial and policy factors, the decline has been attributed to inadequate capacity of substations, weak distribution connections, poor maintenance, inadequate facilities for repair, rotor blade failures due to manufacuring defects and lighting, control system failures due to disregard for grounding regulations and lightning protection, and inadequate wind speed data resulting in differences in actual and expected energy production (Berger 1997; Jagadeesh 2000b).

Bagasse Power in Mauritius

In Mauritius, a World Bank/GEF Sugar Bio-Energy project indirectly catalyzed dramatic changes in electricity generation in Mauritius. From 1994 to 1996, the project dispersed $6 million for efficiency investments in sugar mills to provide surplus bagasse for power generation. The project also provided technical assistance and technology demonstrations to promote private/public sector cooperation in power plant ventures and evaluate ways to decrease the transport costs for bagasse and to optimize the use of sugar cane for power generation. A planned demonstration bagasse plant under the project was never constructed. Electricity generation from bagasse increased from 70 GWh/yr in 1992 to 118 GWh/yr by 1996. Several sugar mills have completed or embarked upon bagasse power plant investments on their own, independent of the GEF project, including the original mill that had been targeted for the bagasse power plant under the project. The European Investment Bank has agreed to finance a bagasse/coal-fired power plant. A project completion report states that "extensive dialogue between the public and private sector on design work, the least-cost power development plan, and power purchasing agreements have directly or indirectly led to the development of other power plants."

One of the lessons from the Mauritius project is how creating an investment climate for renewable energy power projects, and creating public-private partnerships, can lead to supportive regulatory frameworks. In this case, the project led to the establishment of a framework for independent-power-producer (IPP) development and an administrative focal point for private/public sector partnership in IPP development. A project evaluation states that "the project's major accomplishment was progress in helping to establish an institutional and regulatory framework for private power generation in Mauritius and the provision of technical studies and trials to support technologies for improved bagasse production and improved environmental monitoring." Another lesson may be that technical demonstration (in this case the planned demonstration bagasse plant that was never constructed) has less of an influence on promoting markets for a technology than other types of project interventions.

Small Hydropower in Sri Lanka

In Sri Lanka, the World Bank/GEF Energy Services Delivery project begun in 1997 points to the difficult and time-consuming nature of evolving business and regulatory models suitable to a given country and the flexibility needed to support approaches that show promise. Prior to the project, all mini-hydro development was done by the national electric utility. The project has opened up the market to third-party mini-hydro developers. The project has financed more than 21 MW of small hydro by independent-power-producers (IPPs) and has been developing regulatory frameworks for IPPs, including standardized "non-negotiable" power-purchase tariffs and contracts (PPAs). This project provided enough incentive for the national utility to adopt IPP frameworks and agree to PPAs, which together with demonstration effects of prior mini-hydro installations and new incentives for developers (such as import duty waivers and income tax concessions) spurred the market.

However, one of the lessons from the Sri Lanka project is that variable power-purchase tariffs can hinder market development. In this case, tariffs were tied to *short-run* avoided utility costs based on the international price of oil. In 1997 and 1998 tariffs were set at the equivalent of 5 cents/kWh and mini-hydro development flourished. However, because of the downturn in oil prices in 1998-99, prices were only the equivalent of 3.5 cents/kWh in 1999. As a result, all development essentially stopped in 1999. And this fluctuation has seriously hurt the longer-term interest of private mini-hydro developers in Sri Lanka. "The low tariffs and unresolved dispute [on tariff calculation methods] have caused a deep slump in mini-hydro development" said a project status report in 2000.

Another lesson from Sri Lanka is that attention must be paid to proper structure of power-purchase tariffs so that renewable energy receives credit for the value it creates, in terms of both energy and capacity. The original power-purchase arrangements negotiated with the national utility (a "single buyer" market given the utility's monopoly status in transmission and distribution) called for only energy-based tariffs, with no credit given for capacity. Negotiations were on-going between a mini-hydro industry association and the national electric utility to incorporate capacity credits into what was an energy-only tariff; but for now the mini-hydro industry has to make do with energy-only tariffs. Finally, bureaucratic bottlenecks in getting PPAs approved and in getting physical connections to the grid have been cited as other factors hindering market development (Bandarenke 2000).

Wind Power in China

The emerging experience from the World Bank/GEF Renewable Energy Development project in China highlights the pressing need to address regulatory frameworks and find ways to reduce risks to project developers. The project was designed to finance four newly formed windfarm companies for construction of 190 MW of wind farms in Inner Mongolia, Hebei, Fujian, and Shanghai provinces. These companies were to be jointly owned by the State Power Corporation and subsidiary electric power utilities (at regional, provincial or municipal levels) and would sell power to utilities under power-purchase agreements developed through the project. The costs of wind-generated electricity from these wind companies would be higher than those of conventional electricity generation, but utilities in three provinces (Hebei, Fujian and Shanghai) were initially willing to purchase this wind power from the project developers (and in fact are required by government policy to do so, at production-cost-based tariffs). At least at small scales, the added costs of wind power were marginal relative to total utility revenue for these three large utilities.

However, a planned 100-MW wind farm in Inner Mongolia as part of that project was cancelled in 2000 because the smaller Inner Mongolia utility was unable to sign power purchase agreements with neighboring provinces for sales of the wind power, which could not be absorbed within the Inner Mongolia grid itself. Originally, the North China regional power company had said it would purchase wind power from Inner Mongolia. But when the North China power company was split into three provincial utilities and given an explicit mandate to operate on strictly commercial terms, Inner Mongolia has been unable to persuade any of these three provincial utilities to sign power purchase agreements with it for higher-cost wind power. And being unable to use this power itself—given the small size of the Inner Mongolia grid (but abundant wind resources)—it proved unable to undertake this investment.

The general lesson suggested by this experience is that some means must be found to supply the cost difference between wind power production costs and utility average system tariffs (or avoided cost) in the case of wind power—until such time that wind power becomes fully competitive with conventional forms of generation (i.e., as externalities as incorporated, fuel prices rise, and/or wind power technology costs decline—all expected within the medium term). This issue will be a recurring problem with wind power in developing countries in the short term. So far, wherever wind power investments have been made, in developed or developing countries, this cost difference has been covered through specialized policies—for example, through the Feed-in Law in Germany or Green Certificates in the Netherlands, or from higher payments by self-selected retail consumers who choose to purchase "green power" in the U.S. In India, investment tax credits for wind power meant that the cost difference was covered through general government revenues. Given this issue, one of the main challenges for the GEF will be four-fold: (1) to assist client governments to commit to creating a mechanism to cover the cost difference; (2) to identify an appropriate and effective policy mechanism; (3) to create the necessary regulatory conditions and institutions; and (4) to identify the conditions under which this mechanism should no longer be employed.

General Lessons from GEF Portfolio

Experience from the India, Mauritius and Sri Lanka projects suggests that two key forms of support go hand-in-hand in helping develop a market for grid-connected renewable energy: creating a favorable investment climate for private power projects, and establishing a regulatory framework for independent power production. Further, experience from these three projects suggests that that the GEF is quite capable of providing these two key forms of support. It should be recognized, nonetheless, that the Sri Lanka project points out that at least half of this formula—allowing IPPs and PPAs into a previously monopoly system—can face many challenges.

The experience from the China project, in which the 100 MW Inner Mongolia wind power component was canceled due to lack of a supportive regulatory and power-purchase structure, suggests that regulatory frameworks must address the question of how the additional cost of wind power (relative to conventional sources) can be covered—and especially the questions of who will pay this additional cost and what policy/institutional mechanisms allow the additional cost to be collected and channeled to wind power development. Variations of this issue can be seen in India, where the government adopted very favorable investment tax credits that were successful in promoting a large wind industry in a short time (although how it can be sustained remains to be seen), and in the Sri Lanka project, where definitions of “avoided cost” and levels of power purchase tariffs lie at the heart of market viability.

Project experience suggests that national-level policies for technology market development and industry incentives may partly depend first on technical demonstrations and greater policy-maker awareness. But project experience also suggests that market development takes a long time and that a large and growing domestic industry is required to work out regulatory, contractual, technical, and operational challenges of grid-connected renewable energy. This means that GEF projects must focus explicitly on the medium term as well as the short-term and ensure that sustainable regulatory mechanisms, policies, financing, and adequate skills and manpower are in place before project completion.

F. Recommendations from GEF STAP Workshop on Power Sector Reform

A June 2000 workshop on power sector reform and the environment sponsored by the GEF’s Scientific and Technical Advisory Panel (STAP) considered many options and opportunities for the GEF to assist governments in incorporating clean energy more strongly within the process of electric power sector reform. The STAP concluded that “there is a need for the GEF to be more present in the reform process” (GEF STAP 2000). More specifically, the workshop showed that key roles for the GEF are to:

- Assist with developing frameworks for independent power producers, formulation of standard (or model) power-purchase agreements (including transparent buy-back and transmission pricing), feed-in tariff schemes, and simplified procedures for access to the grid (i.e., legal and transactional support). Such frameworks should strive to incorporate proper pricing of diurnal and seasonal effects and capture the value of no-fuel-price risk renewables.

- Fund risk-mitigation instruments, like equity funds to cover pre-investment costs or counter-guarantee funds to cover specific risks (i.e., resource risks associated with early stages of geothermal or mini-hydro development). Appropriate risks must be identified; see Annex B.

- Support the emergence of third-party project developers and provide them with the tools and information they need, such as renewable energy resource assessments, evaluations of potential sites, contingent loans for feasibility studies (i.e., only repayable if the project is financed), and information on local financing and partners.

- Create a “track record” of experience on regulatory and policy approaches to supporting grid-connected renewable energy, and assist policy-makers in understanding and adapting potentially relevant and appropriate approaches.

- Provide capacity building for power-sector regulators. Such capacity building would help the regulators understand technologies and applications, build confidence in them, and show ways in which they can explicitly support these technologies with regulatory frameworks. Basic skills may need to be strengthened among regulators (and the utilities they regulate), like lifecycle costing concepts so that renewable energy technologies are not penalized in investment decisions due to their high initial capital costs. Or regulators may need to understand the renewable-specific features of capacity credits, fuel-price-risk reduction, transmission wheeling, and other aspects of a "level playing field."

- Build awareness, confidence, and familiarity with renewable energy and energy efficiency technologies among financial institutions and other investors. This is clearly demonstrated in the case of India, where support for wind power by the GEF included greatly raising the willingness of Indian financiers and investors to finance wind power.

- Help negotiate "harmonized" policy approaches and help promote "convergence" of donor programs to the goals of power sector reform supportive of cleaner energy technologies.

- Help countries develop the capabilities and understanding to regulate a more distributed power sector, where institutional and regulatory models for rural electricity supply may not necessary follow the experience in developed countries, and thus entirely new models or informed adaptations of existing models must be applied.

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