FINANCING RENEWABLE ENERGY AND ENERGY EFFICIENCY IN EMERGING MARKETS: A TARGETED FUND FOR PROJECT DEVELOPMENT

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SUMMARY

This Summary provides an overview of the current barriers to financing renewable energy (RE) and energy efficiency (EE) projects, and proposes creation of a targeted fund (the Fund), to support RE and EE project development in foreign markets. The report lays out the supporting arguments for the Fund and analyzes several options regarding funding instruments that address specific hurdles to RE and EE project development, as well as how the Fund itself could be structured.

Goals and Objectives of the Fund

The Fund is proposed as part of the U.S. Government's (USG) effort to implement flexible and cost-effective measures to reduce greenhouse gas (GHG) emissions on a global basis. The concept is to establish a relatively small capital fund of $100 million, designed to enable RE and EE projects to be financed on a commercial basis, with minimum distortion to the market forces that make them sustainable in the long term. *By leveraging private- and public-sector activities with a $100 million fund, the USG will be able to mobilize up to $1.6 billion (in capital-cost terms) in EE and RE project finance.*

USG spending on GHG mitigation through the Fund would address *project implementation*, rather than research and development, because projects need to be financed in order for actual emissions to be reduced. There is sufficient analysis to confirm that RE and EE projects have a positive effect on GHG emissions, and there are technically proven, commercially available technologies to implement projects, given the right financial instruments. A strong push towards a broad financing program will begin to establish enough comfort among financial institutions, large developers, and customers to make the market sustainable.

Under the current circumstances of the international debate on implementing the Framework Convention on Climate Change (FCCC), the Fund should be viewed positively by the developing countries (Annex II) and economies in transition (part of Annex I) that are signatories to the FCCC. These countries are characterized by low marginal costs of emission reductions and high projected rates of increase in future emissions. The Fund would therefore promote sustainable investment in RE and EE project development in countries where these types of projects represent a readily available and economically efficient course of action for GHG emission reduction activities.

Hurdles to Renewable Energy and Energy Efficiency Addressed by the Fund

Large and capable project developers and commercial financial institutions are under-represented in RE and EE project development. With a few notable exceptions, smaller niche firms and development banks make up the community of RE and EE project developers. There are several readily identifiable reasons for this situation, including the following:

1. *Lack of knowledge and exposure to RE and EE technologies and concepts.* Developers and financiers are often simply unaware of the technical and financial viability of RE and EE technologies.
2. *Relatively small size of RE and EE projects.* Technological constraints usually limit the project size for RE and EE projects. As a result, the projects often have low gross returns, even while the rate of return may be well within market standards of what is considered an attractive investment.
3. *Transaction costs of smaller projects are disproportionately high compared to conventional projects.* Any investment requires initial feasibility and due diligence work. But transaction costs are relatively inelastic with respect to project size. As a result, pre-investment costs – including financing, legal and engineering fees, consultants, and permitting costs – have a proportionately higher impact on the costs of RE and EE projects.
4. *Lack of market development and maturity.* Many of the markets where RE and EE technologies could have significant impact – such Central and Eastern Europe, the Newly Independent States (NIS), China, South and Southeast Asia, and Latin America – are still in the early stages of transition from largely state-run economies.
5. *Lack of commercial guarantees to enable project financing.* Even when project developers and developing country public agencies successfully negotiate long-term contracts (containing take-or-pay clauses and performance incentive structures), these public agencies are not considered investment-grade without commercial guarantees. In many instances, foreign government agencies are encouraged to privatize and adopt market-based pricing structures at the same time that they are required to provide sovereign guarantees to secure long-term debt from the private sector. As a result, the liability for the project does not shift from the government's balance sheet to private project sponsors. Given the limited amount of exposure any government can credibly assume, RE and EE projects are often unable to compete with other development priorities that receive sovereign guarantees.

Structure and Instruments of the Fund

The Fund would provide selected risk mitigation and cost buy-down instruments for private or joint public-private development of RE and EE projects internationally. A recommendable capitalization of the Fund is $100 million per year for a 10-year period – a sum large enough to have an impact on the level of project development without constituting a large USG budget outlay. Seventy-five million dollars of the Fund would be dedicated to financial instruments that leverage private and other international financial institution investments in RE and EE project development. An additional $15 million would be dedicated to direct cost buy-downs in the form of feasibility funding. Finally, $10 million would be dedicated to market development through technical assistance.

Financial Hurdles Addressed with $75 Million from the Fund

Seventy-five million dollars dedicated to financial instruments would target the hurdles identified above with innovative use of what could be considered traditional means of leveraging much larger sums of finance. The leveraging instruments include:

1. Partial risk and credit guarantee facilities; and
2. Reserve accounts for loans.

While these might be considered traditional financial instruments to reduce the costs and risks of project development, there has been little concerted, large-scale effort to focus and coordinate these instruments on RE and EE project development for the benefit of the global environment.

Partial Risk and Credit Guarantee Funds

Partial risk guarantee funds would guarantee debt servicing payments from RE and EE projects to selected lenders or other investors in the projects, such as commercial bank lenders. This could be done for specific time periods or exposure levels. For example, the Fund could guarantee part of a line of credit or direct loan such that a certain portion of the debt repayment is guaranteed to the lender, in the case of default by the borrower. The Fund would cover the risk associated with specified cash-flows from the project and/or the ability of local financial institutions to meet credit line requirements of international projects.

Partial credit guarantees would simply act to extend the loan repayment period (e.g., from 10 years to 12 years), thus improving the project's cash flows. Precedents exist for this targeted type of financial mechanism in the activities of the World Bank and the International Finance Corporation (IFC).

Guarantees would be directed toward three types of lending:

1. Direct lending to projects through wholesale and retail agents;
2. Lending through established and future lines of credit; and
3. Existing and to-be-established debt funds.

Direct lending would be done through a financial distribution network consisting of a few wholesale agents, such as the Overseas Private Investment Corporation (OPIC) and the U.S. Export-Import Bank (Exim Bank), and retail agents already established. The retail agents would be chosen based on regional presence and track record. These agents would provide direct loans to projects, which would be guaranteed by the USG through the wholesale agents.

Credit lines are readily available for large, conventional projects, but are often too costly (high interest rates) or simply not available for numerous, smaller RE and EE projects. The Fund could establish a line of credit that would pool the credit line requirements of numerous projects that

would be approved by the Fund. Additionally, there are precedents for private sector credit lines for EE, which have successful track records. To reduce costs, the Fund might choose to work with other financial institutions who would set up these lines and use the guarantee funds of the USG. Because the risks and assets of all the projects are pooled or bundled, the Fund would be able to offer the credit backing at lower cost (lower interest rates).

Numerous debt and/or equity funds exist as models for a RE and EE investment fund for projects that reduce GHG emissions. These are usually regional or sector-specific funds, such as the various funds developed by OPIC. In fact, a Renewable Energy/Energy Efficiency (RE/EE) fund is likely to be established by the IFC with an anticipated capitalization of $100 million, though it will not participate exclusively in projects that reduce GHG emissions. The Fund could be a co-participant – through provision of guarantees – in one of these existing funds for environment and RE and EE projects, making GHG emission reductions part of the prerequisite to receiving a specified tranche of capital. The Fund could also set up its own GHG-project debt facility through OPIC. This mechanism would again help to overcome the proportionately high transaction costs and other hurdles to smaller RE and EE project financing by spreading the risk associated with individual debt and/or equity investments across a portfolio of projects.

Line Item Appropriation for Reserve Margin

All banks are required by the Federal Reserve to maintain a certain amount of cash reserves in relation to deposits and loans. A bank can then lend at a multiple of the cash in reserve. Reserve requirements for OPIC are lower than for commercial banks, depending on the risk of the lending, and can be as low as 2.5 percent. By providing an institution such as OPIC with a cash infusion to be used as a reserve margin account dedicated to a particular portfolio of lending, the *lending capacity* increases dramatically. There is a precedent for this, with a program to provide debt financing to projects in Russia following the breakup of the Soviet Union. Such a line item dedicated to RE and EE exclusively would provide a large pool of debt capital at a relatively low cost to the USG.

Feasibility and Other Pre-Investment Support Addressed with $15 Million from the Fund

A portion of the Fund would be dedicated to covering the fees charged by commercial investors for financial due diligence on RE and EE projects. These transaction costs are prohibitively high in relation to the size of RE and EE projects, as noted above. Besides simply reducing the transaction costs associated with RE and EE projects, such targeted grants would enhance the knowledge base of traditional financial institutions regarding RE and EE project finance, building capacity that will remain after grant funding is eliminated. To limit the drain on funds resulting from these grants, they could be made with the condition that they be repaid within a certain period of time should the project go to financial closure.

Among numerous USG pre-investment support programs available for international projects, perhaps the U.S. Trade and Development Agency (USTDA) has a strong record of success. The

Fund should devote a significant amount of its total resources, in this case a suggested $15 million, to direct grant funding to support the costs of due diligence and feasibility assessments for RE and EE projects that reduce GHG emissions. The drain on Fund resources from this kind of grant activity can also be limited by requiring that they be repaid within a certain period of time should the projects go to financial closure.

Such a grant funding mechanism could be administered by the USTDA, although to some observers, sector requirements such as RE and EE investment are outside the objectives of the Agency, and would be met with resistance. Therefore, the USTDA could be used as a model for management of due diligence and feasibility grant funding, but the grant activities of the Fund itself could be managed independently through contractors.

Technical Assistance and Capacity Building Addressed with $10 Million from the Fund

Technical assistance and market development for RE and EE projects has been undertaken with some success by the U.S. Agency for International Development (USAID). In some cases, this assistance includes training and research involving host-country scientists, financial experts, and regulators. In other cases, USAID funding has been part of a larger effort to introduce private power development in a host country. This has spill-over benefits for RE and EE projects through capital market activity and simply a growing knowledge base of what is required for private-sector participation in the market more generally.

These successes should be continued with additional support from the Fund. Above all, it is important that this spending activity be regularly reviewed to ensure it is still needed in the identified countries and/or regions, and that spending is manifestly benefiting GHG emission reduction projects rather than conventional power project development that is already commercially viable and often highly profitable without the support of the USG.

GOALS AND OBJECTIVES OF THE FUND

This report proposes that the U.S. Government (USG) provide a significant source of capital to promote development of RE and EE projects in emerging market countries. The capital, called simply "the Fund" in this report, would be provided by the USG as a tool to enhance the viability of RE and EE projects, to increase market penetration in the short term, and to create the necessary momentum in the global marketplace and among developers and financiers of projects. This shift toward RE and EE projects would make a significant impact on GHG emissions, through the offset of fossil-fuel-based energy and through demand-side energy-use reduction.

The Fund would be created such that it engages private sector capital and development expertise, and leverages this capital to create $1.25 billion in new financing for RE and EE projects each year. Actual funding from the USG will be significantly less than this amount. *By leveraging private- and public-sector activities with a $100 million fund, the USG will be able to mobilize up to $1.6 billion (in capital-cost terms) in EE and RE project finance.* Financial mechanisms would be created to allow this capital to encourage the placement of additional capital from the private sector and, in some cases, multilateral development banks (MDBs).

Creation of such a Fund would contribute positively to demonstrating USG commitment toward climate change mitigation, at a critical point during the development of global consensus on the issue. The continuing debate among signatories to the Framework Convention on Climate Change (FCCC) is focused on the relative contributions of the developed versus the developing countries. This trend threatens to derail a major objective of the FCCC – to jointly implement projects and programs that will reduce global emissions *in the most cost-effective way*. Without support of the major developing and emerging economies, the entire framework for global emissions reductions is challenged. Furthermore, without international cooperation, it is unlikely that major developed nations – including the United States – will implement serious targets for emissions reductions.

Therefore, it is critical to provide not only intellectual and moral support to the original tenets of the FCCC, but hard policy and financial support as well. There is very little debate as to the enormous potential of RE and EE for reducing GHG emissions, and the technological barriers have largely been overcome in the past few decades. The remaining barriers are primarily related to the lack of financial mechanisms, and the continuing misperceptions of policymakers, potential consumers (mainly utilities), and large project developers. To overcome these misperceptions, projects and their proponents need access to finance, which will help break the logjam that currently exists. In the discussion below, many of the major barriers to implementing GHG emissions reduction projects will be outlined, and several mechanisms to overcome some of these hurdles will be proposed.

It is very important that the USG focus its efforts on project development and project finance. There is sufficient evidence that viable RE and EE technologies exist, and reliability has increased tremendously over the past decade. There is also a great deal of investment capital – both in developed and developing countries – searching for sound, profitable investments. To date, this capital fundamentally has not been convinced that these types of projects are sufficiently profitable, and when compared on a one-to-one basis with large-scale fossil projects, they are usually less profitable and therefore passed over. Of course, environmental costs are rarely factored into the economics of fossil projects, and therefore a simple comparison is not justified. However, unless and until some action is taken to address the issue of environmental costs, financiers, regulators, and customers will continue to choose the larger projects that appear less risky because they are familiar.

The Global Environment Facility (GEF) of the World Bank addresses this issue through the concept of incremental cost: it is willing to pay the costs necessary to make an environmentally benign yet unprofitable project feasible. That is, it will subsidize the project to help make it economically feasible. In essence, the USG needs to have the same objective, the difference being that many of these projects are already profitable. It is these projects that should be addressed: those that are profitable already, but which appear somewhat less attractive than large-scale fossil projects.

For example, the Fund could ensure that projects result in significant greenhouse gas emissions reductions through a criterion on tons of carbon savings per dollar of guarantee or financing. The criterion could serve as a threshold that all Fund projects must meet or exceed. It could also be used to lower financing costs for particularly cost-effective projects by providing lower interest rates or guarantee fees based on this carbon savings ratio.

Need for a Cohesive Strategy

In addition to the creation of funding that will foster development of RE and EE projects, the USG needs to have a cohesive strategy among its various agencies to demonstrate a strong commitment to the goals. The current activity in the USG consists mainly of several small programs designed to promote joint implementation. This is primarily coordinated through the U.S. Initiative on Joint Implementation (USIJI), a joint program of the Departments of Energy and State, and the Environmental Protection Agency. USIJI has been active in setting the protocols and procedures for registering JI projects in an initial pilot phase during which no credits will be granted. Unfortunately, the process is quite onerous and costly for project developers, and many decline to participate because of the demands of the program and the uncertainty of the benefits. Only recently has USIJI offered funding for the early-stage development of JI projects, but the amount ($250,000 for all projects) is too little make an impact. The intent of USIJI is certainly good, but its current structure and low budget compromise its effectiveness.

Contribution of Renewable Energy & Energy Efficiency Projects

Several assessments have been made regarding the potential contribution of RE to increased electric power generating capacity. One of the most detailed assessments, showing potential on a project-by-project basis, presents approximately 3 GW of wind, solar, biomass, small hydro and geothermal capacity.[1] These projects were identified by several potential developers, and do not represent the aggregate market potential. For instance, the Government of India has estimated that approximately 5 GW of excess capacity exists in the Indian sugar industry (using bagasse as the fuel). Estimates of the market potential for biomass in Brazil range from 3.2 GW to 8.8 GW. Market potential estimates for developing countries in the Americas and Asia/Pacific show about 26 GW of biomass, wind and geothermal. When hydroelectric power is included in these estimates, the figures become much larger.[2]

There are still strong interest groups who assert that RE and EE have major drawbacks: namely, that they are not cost effective, and that their relatively small scale will limit their impact on the problem of climate change. The former assertion is a major topic of discussion in this report, and the conclusion is that they are not cost effective when compared to conventional energy projects using current standards. When considering the cost of environmental externalities, including climate change, conventional technologies become less attractive. The goal of the Fund is not to make fossil energy less competitive through taxation, but to make RE and EE more competitive by leveling the playing field through use of innovative financial mechanisms. The creation and funding of the financial mechanisms is justified because of the positive environmental benefits. The second point is irrelevant if the projects are able to compete, because any reduction in GHG emissions is a positive development.

[1] Confidential document from the International Finance Corporation.

[2] Energy Information Administration, *Renewable Energy Annual 1996*, pp. 130-131.

BARRIERS TO FINANCING RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS

Currently, the playing field on which energy technologies compete is not level. Conventional supply technologies, such as fossil fuel-fired power generation, still have significant advantages over RE and EE technologies for several reasons:

- Environmental costs are not factored into the cost of energy;
- Strong industry lobbying groups continue to protect and obtain subsidies for conventional technologies and fuels;
- Market structures – such as subsidized pricing of conventional energy, and clear policies on energy contracts – favor conventional technologies; and
- There is a continued perception that significant technology risk exists for RE and EE projects.

Despite recent and continuing developments in technology reliability and cost – particularly in wind turbines – there are still significant barriers to financing RE and EE projects, especially in developing countries. Some of the barriers are due to prohibitively high transaction costs, others have more to do with the lack of adequate commercial contractual agreements from the buyers (i.e., bankable long-term contracts and payment guarantee mechanisms) and regulatory uncertainty (e.g., lack of transparent pricing formulas). Other barriers tend to address technical uncertainties, in as much as they may lack predictability of performance. All of these issues affect the project development cycle enormously and continue to make these projects difficult and costly to finance.

There are three broad areas that represent barriers to RE and EE project financing:

- Size of project, transaction and capital costs;
- Lack of market development and maturity; and
- Lack of commercial guarantees.

These are discussed in the following sections.

Transaction and Capital Costs

Many of the markets where RE and EE technologies could have significant impacts – namely, EE in Central and Eastern Europe, the NIS and China, and RE in Asia and Latin America – are still in transition from state-run economies. As a result, there is often confusion about who is the customer and who will pay the bills. Moreover, many of the customers either have bad credit or no credit at all, as a legacy of state-run economies with no market-based financial systems.

Because a large hurdle to any investment is the initial feasibility and due diligence work, attention must be paid to reducing these costs for developers of RE and EE projects. Pre-investment costs

– including financing, legal and engineering fees, consultants, and permitting costs – are a function of time and are relatively inelastic with regard to project size, and thus have a greater impact on small projects.

Physical constraints usually limit project size for RE and EE technologies and projects. Energy efficiency projects tend to be small because they do not involve creating new infrastructure, like building a new coal-fired power plant. Renewable energy projects tend to be small because the available resources, such as wind or biomass, are either limited in supply or difficult and costly to gather and transport. Thus, the fixed development costs are spread over fewer units of output, and therefore the profit margin is lowered. Banks, both commercial and multilateral, prefer large projects because they offer lower transactions costs.

The primary development costs for EE projects are marketing, structuring project finance, analysis (energy audits), and legal fees (contracts). Despite the relative technical simplicity of many of these projects, there is usually a fairly time-consuming marketing effort required to sell the concepts to end-users. This is still true in the United States, where factory managers are often reluctant to acknowledge the importance of energy savings, despite the readily apparent (and real) cost savings. Typically, factory managers are more concerned with *output*, and do not become very excited simply by prospects of reducing input. This has caused certain energy service companies (ESCOs) to change strategies when marketing to industrial customers: that is, to focus not only on reducing energy consumption, but to have a positive impact on output as well, thereby reducing energy consumption per unit output.[3] Convincing facility owners in developing countries can be even more difficult, except perhaps in cases where fuel and electricity costs are prohibitive. Energy audits are time-intensive efforts, especially when plants or buildings have poor metering and record-keeping, which is often the case in developing countries, especially when energy has been subsidized. The same is true for executing contracts in developing countries, where even the concepts of shared savings and other ESCO contractual vehicles are new and unexplored.

Transaction costs for RE projects are also quite high on a unit cost basis. They require as much up-front work as conventional projects to ensure that the project is structured in a sound fashion. In large projects, defined here as greater than 50 MW, equipment (hard) costs are usually the major share of the total capital costs (on the order of 70 percent), and the soft costs can be absorbed by the overall project's profitability, in terms of net present value (NPV). These soft costs represent a larger share of total capital costs for RE projects. Most commercial banks will not get involved with renewable projects for this reason alone.[4]

[3] From conversations with Proven Alternatives, Inc., San Francisco, California, January 1997.

[4] The U.S. Export-Import Bank assumes an approximate development cost of $1.2 million per project, regardless of size. This includes legal, engineering, and financial due diligence costs.

Typically, capital costs of renewable projects are in the range of $750 to $1500/kW (somewhat higher for small hydro and solar) and conventional fuel power projects are usually in the range of $500 to $1300/kW. These roughly translate into an average range of $0.05 to $0.06/kWh for renewables and $0.025 to $0.05/kWh for conventional fuel power projects. The additional infrastructure costs required for large conventional fuel power projects are usually not factored into the overall cost to the system – namely, transmission and distribution (T&D) lines for central power stations or, in the case of natural gas, pipeline infrastructure. Because of their smaller size and distributed nature, RE projects often do not require this T&D infrastructure, a fact that is often overlooked by policymakers when comparing the technologies.

Moreover, fossil-fired projects have negative environmental impacts that are yet to be factored into the actual cost structures of the projects. While much has been done to quantify the costs of these impacts, regulation has not – in most countries – allowed for including these costs in either capital or operating costs. Conversely, the positive environmental benefits of RE and EE projects do not yet benefit them financially in most cases. In the isolated cases where RE projects are being promoted in developing countries – for example, in India and the Philippines – the higher tariffs offered compared to conventional energy are not incorporating environmental costs. The higher tariff, which makes the projects viable, is to promote increased capacity from underutilized resources, such as bagasse. This policy is driven more by the gap between supply and demand, rather than environmental benefits.[5]

Despite these cost hurdles, generation costs for RE projects have dropped significantly in the past decade and the technology risk has been reduced. Current costs of both renewable and conventional technologies are described in Appendix C to provide a comparison of the stage of technology development. Many renewable technologies have gone through long periods of demonstration and commercialization, to the point where most of the technology risk has been reduced to a level competitive with conventional generation technologies. In some areas there are new, unproven approaches that have great potential but are not yet commercially viable. Specifically, biomass gasification holds great promise for efficiency improvements but is not yet established on a basis that provides comfort to developers and investors.[6]

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[5] Even in the Philippines, the government's policy has been ambiguous. While originally offering a reasonable tariff for RE in October 1996, the National Power Corporation subsequently put the tariff on hold because of concerns it would cost too much. It will soon be coming out with lower tariffs for RE.

[6] General Electric recently announced that its LM2500 turbine (25 MW) has successfully demonstrated combustion of low-Btu-content fuels produced from gasification of biomass. The Biomass Integrated Gasification-Gas Turbine project in Brazil is using the LM2500 and gasification technology from TPS Termiska Processor to produce 30 MW of combined-cycle output. No economic data have yet been published; however, the technical feasibility appears to be established. If successfully completed at economic prices, it should pave the way for many similar projects, especially given the popularity of the LM2500 to date. From *Independent Energy*, May 1997, p. 57.

Market Maturity

Legal and institutional frameworks for private sector energy project development, generally speaking, are currently undeveloped in many emerging market countries. This applies not only to RE and EE projects, but to conventional energy projects as well. Many of the driving forces for mobilizing private capital for energy projects still do not exist, because of continued control and domination of energy sectors by state companies or ministries. Beyond creating the necessary frameworks, policymakers can offer economic incentives to promote private sector participation. Such incentives can be fiscal (e.g., tax incentives), or direct price structuring incentives.

The lack of structure in markets and legal frameworks in developing countries and transition economies can also provide additional transaction costs for developers. For example, developers often have difficulty answering basic questions such as "Who is the customer?" and "Who will guarantee repayment?" This difficulty is easy to understand in, for example, a project to upgrade a grossly inefficient district heating system. The utility is often state-owned and controlled by the local government. The utility probably receives large subsidies for industrial and certainly residential customers who do not – usually cannot – pay the full cost of heat. So, who is the customer for alternative energy or energy savings? Is it the residents? Or is it the utility, the city or other government agency that actually pays the subsidies? And who can approve the investment? The utility, the city, the regional government, or the central government? Answering such questions can be very costly and time-consuming to a project developer.

Subsidized energy is a very important barrier to demand-side mitigation, because as long as energy prices are very cheap, people will continue to waste energy. Significant progress has been made in rationalizing energy prices in Poland, the Czech Republic, Hungary, and parts of the NIS, where prices have nearly reached replacement levels. The record elsewhere in the region is less impressive.

A major barrier for RE and EE debt financing is the lack of appropriate contractual instruments. The RE industry has made tremendous progress in being able to deliver a higher degree of predictable power, and hence should be treated in the same fashion as conventional power projects. Long-term contracts need to be at least 12-15 years so that the financing costs to the project can be reduced and the burden of debt service is spread over a longer time horizon. In the case of EE, the problem has more to do with a lack of information and familiarity with appropriate contracts, which takes time and education to overcome.

Another major barrier to financing RE and EE projects is the lack of local capital. The benefits of having some local financing in a project are straightforward. Foreign lenders are always more comfortable if there is a local bank involved in the financing. This local financing is key because it spreads the project's financial risk among several institutions. Another important reason to have local lenders involved is to finance the local costs of a project and thereby reduce any unnecessary foreign exchange exposure to the project. This issue can be partly addressed through technical assistance to build local financial expertise. In addition, creating a distribution network of funds,

using wholesale agents in the United States and retail agents in target countries, will help to establish the necessary local financial capacity.

To create necessary and effective legal frameworks and economic incentives, there are fairly steep and long learning curves for policymakers. It is in this area of technical assistance that most market development should be focused. There have been several successful USG programs, mainly conducted through USAID, which have focused on transferring to developing countries the knowledge and experience gained through the relatively recent and ongoing deregulation efforts in the United States, the United Kingdom, Argentina, and other countries. While such programs can be wasteful and inefficient if designed poorly, effective use of government officials and technical consultants can provide useful information to policymakers trying to design systems that will encourage private sector participation in the power sector in general, and RE and EE project development in particular.

Lack of Guarantees

Even when long-term contracts, containing take-or-pay clauses and incentive structures, are successfully negotiated with developing country public agencies, these agencies often are not considered investment-grade risk and financing is not feasible without commercial guarantees. The issue of commercial contractual guarantees poses an interesting economic development conundrum. While developing countries are encouraged to privatize and reform their economies towards market-based structures, guarantees from central governments are being required to secure long-term debt from the private sector, which does not fundamentally shift the liability off the government's balance sheet. Since the available exposure of any given government is limited, RE and EE projects requiring government guarantees have to compete with other priorities for that treatment, including conventional power projects. In general, it is becoming more politically difficult for developing country governments to provide sovereign guarantees for large infrastructure projects, and therefore unlikely that smaller, environmentally sound projects will obtain these guarantees. World Bank guarantees exist, but they also favor large projects.

While it may seem that the USG should be reluctant to accept this exposure if other countries will not, in this case the contrary is true: it must take a leadership position because of the nature of the problem and the political hurdles that must be overcome to create an effect climate change mitigation consensus. Therefore, a USG position on providing guarantees to environmentally sound projects could help to level the playing field.

FUND INSTRUMENTS AND STRUCTURE

There are three general areas addressed by the Fund:

1. Partial guarantees of debt;
2. Direct lending using a reserve account; and
3. Transaction cost assistance and technical assistance for market development.

The bulk of the funding – $75 million per year – would be used for guarantees and establishment of new reserve accounts to allow more direct lending, while the remainder – $25 million – would be used to help reduce transaction costs and develop markets.

The guarantees would be issued to private and quasi-private lending through three channels:

1. Guarantees to direct loans to projects, using a USG wholesale agent and various retail agents throughout the world;
2. Guarantees to lines of credit established by private financial institutions to provide credit to developers where pre-established terms are used for project preparation; and
3. Guarantees to debt funds, both existing and to be created, including public/private funds such as the Renewable Energy/Energy Efficiency Fund of the IFC.

The government and private financial institutions involved would be selected based on their ability to finance energy efficiency and renewable energy projects, their track record of financing such projects, their staff capabilities and their ability to leverage additional financing.

The guarantees would have a cost (guarantee fees) that would be borne by the project sponsor and not the host government. These fees should be able to cover the cost of administering the guarantee program. The leverage achieved would depend on the type of guarantee (partial risk or partial credit) and the riskiness of the project. Also, depending on the type of project and the requirements of the lenders, the guarantee might be applied to principal only, or both principal and interest.

Partial Guarantees for Direct Loans

Background

While the USG can lend directly to projects, it is more effective for it to provide capital in the form of a guarantee that will allow its capital to be leveraged. This role could be performed by a "Partial Guarantee Fund," which would guarantee principal payments to commercial lenders to projects for up to two years, thereby reducing the perceived risk of the projects and stimulating private investment. The risk to the guarantor (USG) is relatively low, particularly if the guarantees are spread across a portfolio of projects. The opportunity cost of the capital

committed to the fund is primarily the risk-related cost, followed by the probability of covering up to two years of debt service payments from the developer/owner.

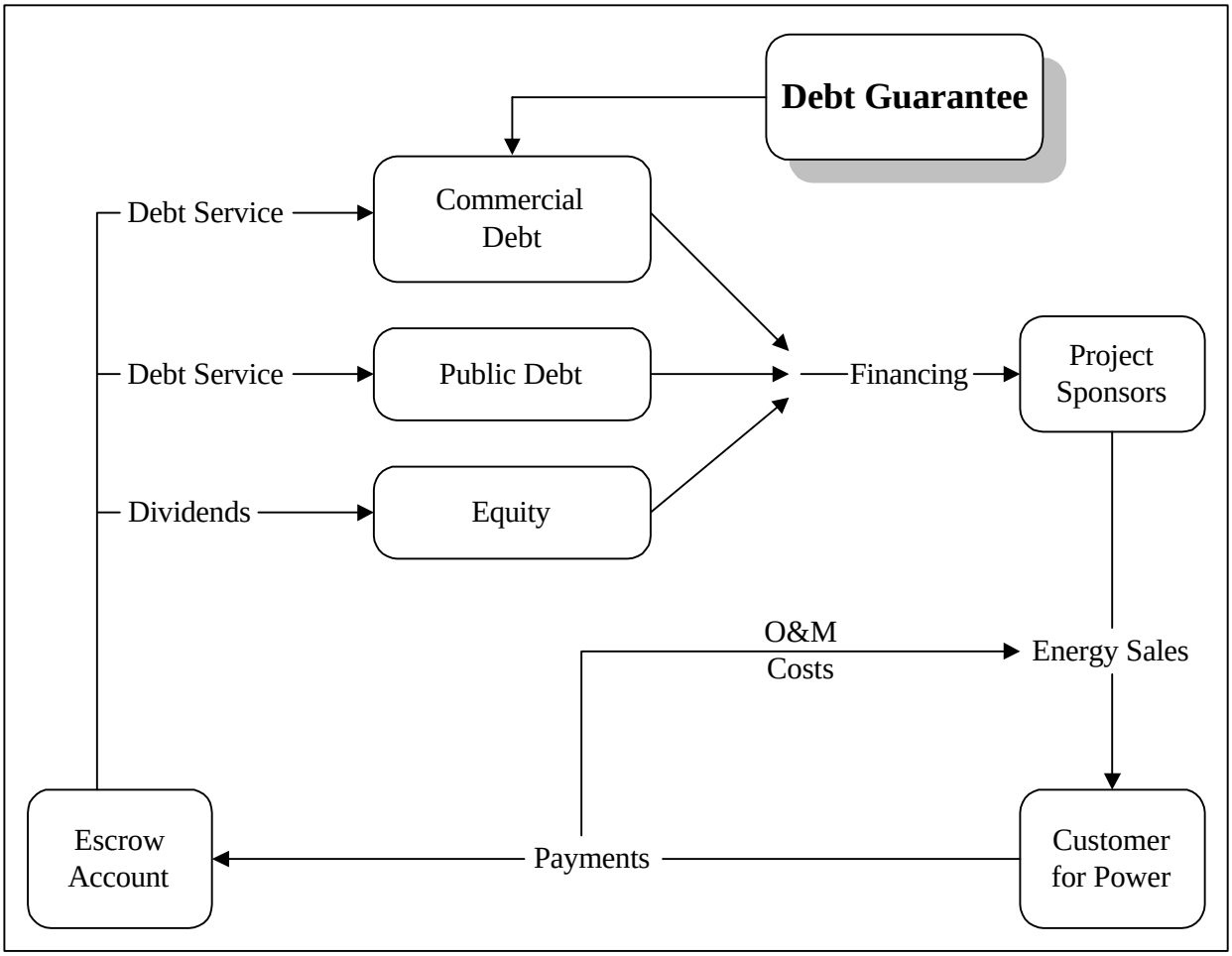
A relatively small guarantee fund can leverage a large amount of capital by freeing up lenders to provide more debt or more favorably structured debt to a project, thereby making the project financially viable. For example, guaranteeing the cash flows with a value equivalent to 10 to 20 percent of the total project cost may be enough risk reduction to make the entire project viable. A similar mechanism has been used by the World Bank, usually targeted toward large, privately financed infrastructure projects. The *partial risk* g*uarantee* targets approximately two years of debt service payments, usually toward the latter part of the maturity. This is equivalent to about 20 percent of the loan in cases where the term of the loan is 10 years. The partial risk guarantee could also be in the form of a *limited deficiency guarantee,* with a maximum limit of exposure to the guarantor, say 20 to 25 percent. The deficiency guarantee would cover the first loss of a lender, including interest, expenses, and the unpaid loan balance.

Alternatively, providing a *partial credit guarantee* against two years of debt service could extend the term of the loan to 12 years, reducing the annual cash flow burden to the borrower. In either case, the interest rate on the loan should improve over a non-guaranteed loan, thereby increasing the financial viability of the project. Another benefit of the guarantee could be to increase debt-to-equity ratios, further enhancing returns to developers.

To some degree, the fund would serve in the place of sovereign guarantees for project finance, which have always been difficult to secure for smaller projects and have become increasingly uncommon in general over the last two to three years. In this case, however, the risk is separated between private and public lenders to the project. Private lenders face market constraints that are manifest in the shortage of debt flows from safe havens in highly developed capital markets to riskier ventures in developing countries.

The figure below shows generally how the cash flows in an electric power generation project might be structured when a commercial loan guarantee is employed.

Figure 1. Debt Guarantee Structure



Structure, Organization and Management

It is important for the USG to maintain the role of a wholesale supplier of credit in the form of guarantees. Retail agents, such as banks or other financial institutions in developing countries, can provide on-site guarantee provision. These retail agents would not be the lenders, but the guarantors of loans provided by commercial banks worldwide, provided they meet acceptable criteria. In other words, the retail agents would provide guarantees that are a direct pass-through to OPIC or another wholesale agent, this passing in turn directly to the USG. By maintaining a position of guarantor, and not direct lender, the USG will play a crucial role in the development of capital markets for GHG mitigation projects. In addition, it will be able to achieve a large multiplier effect on its funding, thereby satisfying some of the needs for fiscal restraint.

As an example, consider a $10 million project with a 75:25 debt-to-equity ratio, a 10-year maturity and a 12 percent interest rate, with a level amortization of principal (principal equal to $7,500,000). The annual payment would be variable, as the interest payments decreased and the principal payments remained steady. (The required payments would be structured based on the projected cash flows of the project.) In this case, payment in the first year would be $1,560,000, and in the second year, $1,470,000 for a total of $3,030,000, or 40 percent of the total loan. This is a fairly high exposure, and therefore with this type of loan, the guarantor might choose to cover principal only, for a total of $1,500,000 in the first two years, or 20 percent of the loan. The Fund would need to set goals for leverage ratios, and remain flexible on the type of guarantee, and what it covered. A proposed guarantee exposure is 20 percent of the loan value, providing a leverage of 5:1. (The leverage on the entire project would be greater, depending on the debt-to-equity ratio.)

Partial Guarantees for Lines of Credit

Background

Many have discussed the concept of *bundling* as a way to reduce transaction costs for EE and RE projects. This concept, in theory, has merit, because it allows developers to define and identify multiple projects for funding, thereby increasing the total investment amount. This bundling, in turn, would theoretically reduce the unit cost of procuring finance, because the developer would incur a single fee for lenders, rather than multiple fees for multiple projects. This approach could presumably reduce legal and engineering fees as well.

The problem with this idea, unfortunately, is that projects can only rarely be treated as identical, either technically or financially, but the cookie cutter approach requires almost identical projects – same technology, size, customer, location – to be successful. In addition, there are some limitations to the economies of scale achievable in the development stage.

A slight variation on this theme, however, might work in certain cases. By guaranteeing lines of credit for both EE and RE projects, some of the economies of scale on the financing side might be achieved, while providing the necessary credit enhancement to provide commercial lenders with the necessary comfort level. A successful example of a line of credit is one created in the United States by Proven Alternatives Capital Corporation (PACC), a San Francisco-based company. PACC developed a $30 million line of credit with Banque Paribas to finance targeted investments in commercial, industrial and institutional EE programs and projects. The pool of capital is non-recourse, with the collateral for each project's financing limited to the physical assets, contracts and cash flow of the project. The fund pools many projects into one portfolio, thereby increasing the credit strength of the overall portfolio and reducing the interest rate. PACC's role includes fund administration, loan documentation, structuring customer contracts and negotiating non-standard approvals. The minimum project size is $1 million, and $5 million is the maximum size.

Specific credit and technical criteria were established by PACC to create a relatively automatic and smooth approval process. Programs that meet the pre-approved criteria are not required to go through a detailed approval process, which enables a rapid turnaround time and helps to maintain low transaction costs. PACC first reviews the structure for pending investment opportunities; this ensures that projects submitted for financing will be approved either through the automatic mechanism or with as little additional review as possible. PACC has developed a thorough underwriting and review process that identifies all key risks and eliminates or establishes prices for these risks. This has expanded the market for investment opportunities, thus allowing PACC to allocate fund expenses over a larger number of projects, lowering the fixed cost per dollar invested.[7]

Since the fund was organized in 1993-94, PACC has expended all the capital and is currently in the process of organizing a new fund with Banque Paribas. While this fund's success can partly be attributed to its domestic (U.S.) focus, there is potential for similar funds for GHG projects in emerging market countries. In the initial stages, because of the additional country and credit risk (both real and perceived), some USG assistance would be appropriate, similar to the partial guarantee reserve fund discussed above. In fact, the Fund could be used to extend guarantees to credit lines developed by private sector financial institutions. The USG would encourage and initiate the development of these lines. By then extending guarantees, the USG would still achieve the multiplier effect required for greater impact.

Structure, Organization and Management

From the example above, we can see that certain private sector organizations have already embarked on this course of providing credit lines for EE projects in the United States. To extend this mechanism to embrace EE and RE projects in emerging market countries, the USG needs to work directly with existing financial institutions who are prepared to go this route with some USG guarantee. The organization that acts as the wholesale guarantor, for example, OPIC, would also work with financial institutions such as PACC and Banque Paribas. OPIC's reach into the financial community is fairly deep and broad, and it could promote such activities with the right personnel in place. By working with existing credit lines and the entities that have created them, fewer start-up costs will be involved. In addition, it should be easy to encourage successful companies such as PACC to take their U.S. model overseas, provided some sort of guarantee mechanism is available.

[7] U.S. Agency for International Development, Office of Energy, Environment and Technology, "Strategies for Financing Energy Efficiency," July 1996, p. 4-9.

Partial Guarantees for Debt Funds

Background

The difficulty of effectively bundling projects has been described. Potential passive investors and lenders can achieve bundling much more readily by creating common investment pools and funds. In this area, the MDBs can play a critical role by seeding the capital for these funds and partially subsidizing the associated transaction costs associated with the pools or the funds.

The International Finance Corporation (IFC) has been carrying out a feasibility study on a potential Renewable Energy/Energy Efficiency (RE/EE) Fund, and preliminary findings suggest the fund could fill the perceived gap in RE and EE financing, as well as provide an attractive return to investors. The RE/EE Fund equity tranche is expected to be $100 million, with investment from several limited partners. The debt portion will also be $100 million, in the form of a debt club. There will also be $30 million from the Global Environment Facility to provide for very small projects, as well as feasibility study grants. The USG is not participating directly in this fund, but may want to work closely with it to ensure its success.

In this scenario, the existence of the RE/EE Fund would establish expertise within the multilaterals and drive down transaction costs by reviewing many projects at the same time. Private sector lenders and investors could then easily review pre-selected projects from the RE/EE Fund, with a minimal investment of time and resources. One of the primary objectives of these funds would be to extend the debt maturity structures available from the commercial bank market.

Insurance Industry as a Co-Investor

In several large private investment partnerships focused on energy projects, the insurance industry plays a significant equity role. This includes several funds managed by Energy Investors Funds, the investment company managing part of the RE/EE Fund. Insurance companies have tremendous pools of capital due to their structure, where there is a constant influx of money from premiums, with only intermittent (albeit often large) benefits paid out.

In addition, the insurance industry has a serious vested interest in the mitigation of climate change. Global warming effects could be disastrous for insurance companies, if weather changes and especially coastal damage claims increase significantly. Therefore, the insurance industry has to date been more pro-active on the issue of climate change than most other industries. The USG should consider an initiative to attract more active financial participation from the industry. The most logical mechanism would be for insurance companies to participate in debt/equity funds such as the RE/EE Fund, where they could earn a return on their investment and also actively promote climate change mitigation.

Structure, Organization and Management

An example of an organization within the USG with a track record of creating funds as described above is OPIC. OPIC has created and underwritten dozens of country and regional funds, as well as a few funds specifically designated for environmental projects (one, for example, is managed by the Global Environment Fund). However, none of these funds are focused specifically on climate change mitigation. A mandate from the Administration to structure additional funds to address the needs of RE and EE projects could mobilize OPIC to underwrite additional funds, perhaps with support from large institutional investors such as insurance companies.

The USG might also consider providing guarantees to funds already in existence, such as the RE/EF Fund, or new funds to be developed and managed by MDB affiliates such as the IFC or the Asian Finance and Investment Corporation (AFIC). AFIC, a quasi-public financial institution set up by the Asian Development Bank in Manila, Philippines, currently invests debt and equity in a wide variety of relatively small projects, not necessarily focused on the environment.

Currently, the USG has a mechanism for transferring funds to the MDBs for use in a variety of projects. This is called the "Evergreen Fund," and it is essentially USTDA funding that is used by institutions such as the IFC to provide feasibility study funding for projects. A similar structure could be devised to guarantee funds developed by the MDBs for RE and EE projects.

Loan Reserve Account

Background

Direct lending can greatly benefit some projects because it reduces the cost and time necessary to structure a more complicated deal involving multiple financial institutions. A loan reserve account can provide a mechanism for financing some small, cost-effective projects because it limits the transaction costs.

OPIC provides an example of how such a loan reserve account might work. OPIC support of U.S. investment in private sector projects in developing countries through its project finance and political risk insurance programs is accomplished with only a small budget appropriation and limited risk to the USG. OPIC leverages the "subsidy" appropriated to it each year at a rate of roughly 40:1. In other words, a $25 million appropriation for lending (excluding operational costs) will provide enough leverage for $1 billion dollars of project finance and political risk insurance. This is based on the concept of reserve requirements, where all banks are required by law to keep a minimum amount of capital as a percentage of outstanding loans. The reserve essentially provides coverage against bad loans.

The risk is acceptable because OPIC's portfolio management strategy limits its exposure in any given industry in each country. The cost of the financing is acceptable to the borrower because the loans are backed by the full faith and credit of the USG. In most cases, OPIC does not

actually provide the debt; rather, it provides a U.S. commercial bank with a loan guarantee, thereby removing the project risk from the bank.

Structure, Organization and Management

A similar mechanism could be employed to create a source of debt capital to projects that meet the criteria of GHG mitigation. The suggested funding for this component of the Fund is $25 million, which would provide a USG lending institution such as OPIC (with lower reserve requirements) a leverage ratio of 40:1, or $1 billion in lending capacity annually.

The additional burden on OPIC of determining which projects meet the GHG criteria is a factor that needs consideration. OPIC would either have to hire staff that could competently determine the GHG characteristics of each project and provide some sort of benchmarking or rating to determine its development benefits (much as they hired Russian experts previously), or out-source this function to private sector firms qualified to undertake this analysis. As will be discussed later, these outside firms could also screen projects and provide financial advisory services. The firms would then be given the responsibility and the mandate to develop the project's credit and financial due diligence, according to OPIC's standards, for presentation to its Investment Board.

Transaction Cost Support

Background

Funding for transaction costs would assist developers in the following categories:

- Pre-investment engineering support; and
- Financial fee buy-down.

While there are several programs within the USG to promote RE and EE projects through pre-investment support, they are for the most part small, scattered, and relatively difficult to access by those developers who could benefit from them. For example, USAID provides several different sources of funds, all relatively similar in purpose, but managed through different contracts and different contractors, all of whom operate differently and have varying requirements. These include the Biomass Energy Systems Technology project (managed by Winrock International); funds managed by the International Fund for Renewable Energy and Energy Efficiency (recently merged with E&Co.); and project support funds from the U.S. Export Council for Renewable Energy (a USAID contractor). There are several other programs within USAID, as well as other agencies (OPIC, for example, sponsored a program several years ago through the U.S.-Asia Environmental Partnership).

The structure of the funds is the basic problem. Many of the funds are spread among different agencies, or even divisions of a single agency. While they do not compete with one another, they also do not complement one another, and it is up to the project developer to track down and

assess each different program and funding source to determine which one(s) are best suited for the project in question.

Most of the current funding emanates from the USTDA and USAID. While USTDA acts as both a wholesale and retail agent, funds from USAID are typically managed by contractors. Often these are non-governmental agencies (NGOs) that do not fully understand the project development process and the costs of doing business. As a result, many of the application, approval and reporting processes are simply too onerous, and developers forego applying. In order to make such funding more attractive and useful, the USG needs to coordinate its many existing programs, centralize information on available programs, and streamline the application and review process. This does not imply that unworthy applicants or projects should receive money; however, the approval process in some cases has five or six steps with dozens of reviewers, enough to discourage most private sector project developers.

In addition, pre-investment support for EE and RE projects should not continue indefinitely. Several hurdles need to be cleared to advance the long-term viability of such projects in developing countries: technologies need to be accepted, larger developers need to become more involved, and financial markets and mechanisms need to be developed further. However, it will take several years to overcome these barriers. In the interim, early-stage support for projects that reduce GHG emissions will be required. The USG should plan on a horizon of approximately 10 years of sustained support and effort in this area, with reassessments along the way.

Bank Fee Buy-Down

One strategy involves creating a fund that can compensate the financial institutions undertaking the financial due diligence by covering some portion of the processing fees associated with each loan. In the case of project financing, these fees range from 0.5 to 1.5 percent of the expected loan. Because the amount of effort required is somewhat inelastic with respect to the size of the project, these figures could increase to more than 5 percent for smaller projects, thereby overburdening the project development cost structure. Thus, it may be possible to create a fund that could be accessible to either the bank or the project sponsor to offset these fees.

The mechanics of the process would need to be worked out, but in all likelihood the extra funding should be triggered only when the bank has determined that the project meets most of its criteria for financing. This is done usually at an early credit and project review stage, and is not costly for the bank to undertake.

Another mechanism that could possibly achieve the same result would be to reward banks with a bonus for projects that meet strict GHG mitigation standards. The amount of the bonus could be attached to the amount of GHG emissions that are offset or sequestered. The incentive may induce banks that are interested in these projects to become more proactive and supportive of the project development and financing process.

Structure, Organization and Management

The USTDA has the best track record in moving funds for feasibility study analysis for projects of all types. It is very focused on projects, their economics and technical merits, and the potential exports that can be developed from their implementation. Its goal is to get U.S. companies involved in the early stages of projects, so USTDA is relatively fast in its bid and approval process, and more importantly, it is not risk averse. While it reviews projects and developers on their merits, it is willing to take some risks, which speeds the process enormously. Bureaucratic inertia and fear of failure are the biggest obstacles to creating a successful pre-investment fund.

The challenge for the Administration will be to structure a fund that has the complete buy-in of the U.S. agent, in this case USTDA. In the past, there has been resistance to setting aside designated funds for environmental projects. Currently, USTDA funds many projects in the power sector, but its bias is toward large projects, to achieve the export multiplier. This is the ratio of potential exports to feasibility study funding, and USTDA typically looks for a multiple of 100. Funding smaller projects would require lowering the multiple or, alternatively, lowering the funding, and a combination of these two actions might be required. However, funds for feasibility studies should not be lowered to less than $100,000, because there is simply little that can be accomplished for this amount. On the other hand, the typical USTDA grant amounts – $500,000 – may not be required. In addition, exports from RE and EE projects will likely not be above $20 million. Therefore, it seems that the agency would have to be more flexible in its export multiple requirements. At the same time, the funding for GHG projects should come from a separate fund and be managed by a dedicated staff, so as not to compete with the traditional projects.

Funding for pre-investment support is suggested to be $15 million per year, *on a conditional grant basis, repayable if the project is successfully closed.*

Market and Policy Development

Background

The path toward less reliance on fossil fuels and large power plants, and increased demand-side efficiency often goes on a parallel path with a reduction in energy subsidies (especially for EE), allowance of private power, and easing of controls in general in the energy sector. Many such reforms take years, even decades to take shape, especially when government control is very strong and entrenched.

In restructuring their energy sectors, many developing countries look to countries such as the United States for guidance, based on their experience in dealing with these changes previously. While MDBs have made such technical assistance a part of their energy sector loan programs (particularly over the past 10 years), it would be useful for the United States to continue such efforts, not only because it can bring across the U.S. perspective and assist U.S. business, but also

because it could focus much of the assistance on reducing GHG emissions by helping to develop policies and market reforms beneficial to RE and EE.

Structure, Organization and Management

To date, USAID, mainly through its Office of Energy, Environment and Technology and some of its Missions, has provided technical assistance and market development support to developing countries in the areas of EE, RE, and more generally, private power development. It has had some successes in this area, primarily in providing training through contractors on such issues as performance contracting for EE projects, structuring power purchase agreements, and other legal and regulatory issues that need to be addressed by countries as they prepare for a lessening of government control and deregulated markets.

USAID has provided most of the funding and technical assistance in this area during the past decade, because of the importance of energy to the economies of USAID-assisted countries. USAID has made some inroads and established programs that have helped develop the necessary markets for these types of projects. It makes sense, therefore, to continue funding such programs through USAID, to the extent that market conditions in certain countries do not exist.

The suggested funding for this component of the Fund is $10 million annually for the first few years, to be reviewed after three years of operation and revised appropriately.

TARGETS AND GOALS OF THE FUND

Emissions Reductions Goals

Background

New research findings at PNNL suggest that even with relatively low rates of market penetration, new energy supply technologies and EE could result in a dramatic reduction in mitigation costs. For example, when advanced biomass technologies are made available to even 25 percent of the global energy supply market, total discounted mitigation costs over the next century to hold CO_2 concentrations to 550 ppm fall from $2.2 trillion to $790 billion. If these technologies are deployed in conjunction with an emissions stabilization path that allows for a later onset in reductions, the costs fall to $207 billion. Holding the line at 450 ppm is possible without increasing costs exorbitantly, but implementation must start immediately – at least by 2005.

These results have important implications for both the models and the policies that they inform. First, the findings suggest that technology can generate cost savings in both the United States and formerly planned economies in Eastern Europe and the NIS. These cost savings increase with the effectiveness and level of penetration of advanced energy technologies, a relationship that holds across emissions paths and levels of stabilization. Second, the findings suggest that previous macroeconomic modeling efforts have overestimated the costs generated by the inefficient formerly planned economies.

The Fund as proposed here could have a potentially significant impact on GHG emissions. Using a rough example based on an actual project, one can estimate emissions reductions as a result of the increased capital available. A combined EE and RE project costing $40 million has the potential to reduce CO_2 emissions by 162,000 mt/yr. Assuming $1.66 billion in finance annually made possible through the Fund, about 42 such projects could be financed, for a total of 6,750,000 mt/yr of CO_2 emissions reductions. On an annual basis, this is roughly equivalent to offsetting the emissions from an 800-MW coal-fired power plant. If each of these projects has a life span of 20 years, the CO_2 emissions reductions resulting from the financing would be approximately 135 million mt.

Examples of Mitigation

While the problems associated with climate change mitigation may be daunting, there are many examples of successful EE projects in Central and Eastern Europe. No single project will solve the problem of global warming, but they are all steps in the right direction.

One example is the Russian Enterprise Housing Divestiture Project, one of the first large World Bank projects focusing on EE. The goal of this project is to increase residential efficiency to help enterprises divest themselves of worker housing. When enterprises are privatized, they want to

get rid of worker housing to consolidate their holdings and avoid the high costs of residential utility bills. However, because this housing is expensive to maintain, the municipalities do not want it, and the residents are wary that if they privatize their apartments, their energy bills and taxes will go up. As a result, the enterprises cannot even give this housing away. To make housing divestiture more feasible by reducing the burden of high energy bills, the World Bank would loan municipalities $300 million to pay for EE measures, such as insulation and weather stripping. The World Bank is currently appraising this loan and is expecting to begin implementing it in 1997 or early 1998.

Another potential project targets industrial enterprises in Ukraine for EE upgrades. The total cost would be about $100 million, and the European Bank for Reconstruction and Development has expressed an interest in financing it. This would pay for controls, steam traps, steam pipe insulation, efficient motors, and some modernization costs. This project began as an effort to find alternatives to the power generated at Chernobyl, which would allow the Ukrainians to close the power station. The Ukrainian Government argues that it cannot shut down Chernobyl until alternative sources of power are established. Industry in the Ukraine is the major energy consumer, so this project would tackle both the problem of industrial inefficiency, and that of excess electrical demand in Ukraine.

An example of a private project is the work of some ESCOs in the Czech Republic. One U.S. ESCO signed $30 million worth of contracts with Czech hospitals and industrial enterprises during the first meetings with these organizations. The Czech enterprises saw the need for energy efficiency, and decided to invest their own money in it. This indicates that there are cost-effective mitigation options in the Czech Republic despite the barriers.

Return on Investment Targets

The USG should set a target for return on its investment, or in many cases, a return on funds provided for guarantees and reserve accounts. The USTDA, for example, currently has targets set in terms of the dollar value of potential exports; however, this is often difficult to measure.

A more easily measured target would be one that provides for additional funds – generated through fees – allowing the guarantee funds to be rolled over year after year, thus providing a sustained pool of reserve capital over the long term. The fee structure would need to be relatively nominal to make the burden light on the projects, yet taking into account expenses and losses that will accrue from bad debt. World Bank guarantee fees range from 25 basis points to one percentage point of the amount guaranteed. More detailed analysis would be required to determine exact fee structures, operating expenses, and expected losses on loans and guarantees.

Loan and guarantee fees should not be at a level that create added burdens on projects, and should be relative to the amount of financing – not a fixed fee per transaction. An estimation of losses, expenses, and fees would also provide the USG with a replenishment target – the amount required each year to keep the lending at the desired level, and to continue funding transaction

costs and market development activities for several years into the Fund. It is expected that actual direct appropriations would decrease over time.

The Fund would achieve some degree of leverage in terms of amounts spent by the USG and project finance resulting from these expenditures. The table below shows a rough calculation of overall leverage resulting from the various components of the Fund. Most of the assumptions have been explained above, especially regarding leverage ratios on guarantees and reserve account lending. It is assumed that the funding for transaction costs and market development are necessary costs of the Fund, which will be phased out over time. The table shows how the leverage achieved through guarantees and reserve accounts provides a total leverage of 12.5:1, for a total of $1.25 billion in project loans. Assuming a debt-to-equity ratio of 3:1, the leverage on total project costs increases to 16.6:1.

Table 1. Appropriations and Expected Leverage

	Guarantees	Reserve Lending	Transaction Costs	Market Development	Total
Appropriation	$50,000,000	$25,000,000	$15,000,000	$10,000,000	$100,000,000
Lending Leverage	5	40	-	-	12.5
Lending Amount	$250,000,000	$1,000,000,000	-	-	$1,250,000,000
Total Project Costs	$333,333,333	$1,333,333,333	-	-	$1,666,666,666
Total Leverage					16.6

Geographic Priorities

Economies in transition (Eastern Europe and the NIS) should be a major focus of any funding activities by the USG. Some might argue that these countries, having already agreed to the basic provisions of the FCCC and offsets trading, do not need assistance. On the contrary, there are still large market barriers in many of the countries, yet tremendous opportunities for GHG mitigation exist. The opportunities are mainly in the EE arena, as load growth is not increasing rapidly, and there is a large installed base of power generation already in place. However, efficiency in all sectors of these economies is extremely low, and therefore paybacks in both financial and environmental terms can be very attractive.

The developing countries obviously need to be a focus of the Fund as well. Because growth rates are so much higher in parts of Asia and Latin America, as well as Africa, we can expect a great deal of new capacity power generation to be added in the next few decades. While EE should not be neglected in these countries, a focus on RE for new generation capacity would be appropriate. In the near term, more focus should perhaps be placed on those countries with significant GHG

emissions potential that are also still ambivalent about issues such as emissions targets and tradable offsets.

PUBLIC- AND PRIVATE-SECTOR PARTNERS

Potential partners, contractors and other participants in the USG's effort to promote EE and RE projects include private sector developers, public and private financial institutions, and government agencies. Each group has different roles to play. Some of the potential individual participants are listed in the matrix below, which shows some of the basic characteristics of each. (The list is indicative only, and each participant would need to be approached.)

Table 2. Potential Partners and their Roles

	Public	Private	NGO	Whole-sale	Retail	Debt	Equity	Grants
OPIC	x			x		x	x	
U.S. Exim Bank	x			x		x		
USAID	x			x				x
USTDA	x			x				x
USIJI	x			x				x
Asian Finance and Investment Corporation	x				x	x	x	
Copernicus Fund		x			x			
Empresas Ambientales Centroamerica SA			x		x	x	x	
Industrial Credit and Investment Corp. of India	x				x	x		
International Finance Corporation	x			x		x	x	x
Asian Development Bank	x			x		x		x
Inter-American Development Bank	x			x		x		x
European Bank for Reconstruction and Development	x			x		x	x	x
African Development Bank	x			x		x		x
Global Environment Facility	x			x				x
Environmental Enterprises Assistance Fund			x		x	x	x	x
E&Co.			x		x		x	x
Banque Paribas		x			x	x		
Insurance Companies		x					x	

Wholesale and Retail Agents

The USG and its agencies, such as OPIC, USTDA, and Exim Bank, could act as wholesale agents for any or all of the funding instruments discussed above. These agencies have been proposed initially due to their track records in administering their traditional programs: lending (and provision of guarantees) by OPIC and Exim Bank, and feasibility study funding by USTDA. All have successful records in their respective areas, each with its own particular strengths and weaknesses. OPIC has a fairly long history of providing guarantees to commercial banks lending to all types of projects in developing countries, and it has financed many power projects. Exim Bank has less familiarity with power projects, though in 1994 it initiated a project finance group devoted almost exclusively to power projects, a deviation from its traditional practice of providing export finance only. Exim has also established U.S. Export Assistance Centers in several regions around the world, along with the Department of Commerce and the Small Business Administration. These centers might prove useful, especially in helping to set up a viable distribution network of retail agents.

Both OPIC and Exim Bank have tried to administer financing programs targeted at environmental projects, with limited success. For several years, OPIC administered a fund provided by the U.S.-Asia Environmental Partnership, intended to provide pre-investment support to environmental projects. The fund apparently had little internal support, however, and no projects were financed as a result. OPIC, in general, does not pursue small projects. Another potential drawback is OPIC's inability to operate in certain countries, particularly China. This gap could potentially be filled by Exim Bank, which does not face the same restrictions.

USTDA was established primarily to provide assistance to projects that have the potential to provide U.S. exports and jobs. It has a very singular focus – to provide feasibility study funding to projects in developing countries and economies in transition. USTDA's ability to quickly execute projects has so far been impressive. It has resisted the idea of having a sector focus, and therefore it is possible that some internal opposition would be encountered in trying to set up a dedicated fund for pre-investment support targeted at GHG mitigation projects.

Retail agents for the various Fund elements would likely be fairly numerous, given the broad geographic scope envisioned. Existing banks or financial institutions would be likely candidates, in order to reduce setup costs. Moreover, any institutions that have existing relationships with OPIC, Exim Bank or USTDA would be favored, especially if programs are targeted toward small enterprises or environmental projects. Some suggestions include:

- The Asian Finance and Investment Corporation, which is partly owned by the Asian Development Bank and commercial banks, provides debt and equity financing to small projects, ranging in size from $2 million to $10 million. Its main objective is to assist in the promotion and development of private enterprises in the developing countries of Asia and the Pacific. It has experience in project finance as well as trade finance and financial services, and is regionally headquartered in Manila and could serve the Southeast Asia market. Similarly,

U.S.-based institutions, such as the Environmental Enterprises Assistance Fund, may be qualified to act as retail agents, given their existing portfolios of projects and global activities.

- The Industrial Credit and Investment Corporation of India, Ltd., which is government owned, yet is operated like a private bank. It has extensive experience in lending to private enterprises, and has participated in several on-lending programs, including a program funded by USAID to provide credit to environmental entrepreneurs.
- Empresas Ambientales de Centroamerica S.A. (EAC), which is a subsidiary of the Environmental Enterprises Assistance Fund, is based in San Jose, Costa Rica. EAC has invested small amounts ($100,000 to $1,000,000) in various environmental projects throughout Latin America. It has also put together a fund for investments in similar projects.

CONCLUSIONS AND NEXT STEPS

The Fund, as proposed in this report, would provide a source of finance, through guarantees and loans, as well as pre-investment assistance, to leverage more than $1 billion in lending to RE and EE projects worldwide. Because most of the projects will have equity components as well, actual project funding will be even more. This project funding level is estimated on an annual basis, and the Fund should be continued for at least 10 years in order to firmly establish the presence of a financing establishment for RE and EE projects globally.

In order to realize the goals of the Fund, a strong, cohesive strategy and business plan needs to be developed. The business plan should be developed as it would be for a private company, including targets, obstacles, marketing plans, and so on. Specifically, the business plan for the Fund needs to address the following issues:

- Strategic Objectives (i.e., the primary objectives to be accomplished by the Fund);
- Detailed Outline of the Fund Components, including guarantee and lending facilities, as well as technical assistance and pre-investment support;
- Investment Targets, including total capitalization of projects, as well as specified lending/guarantee targets;
- Distribution Plan, including proposed wholesale and retail agents and plans for their recruitment, and identification and analysis of funds and credit lines that may be agents of the Fund;
- Marketing Plan, including a strategy for advertising the Fund to developers and financial institutions, and an analysis of potential projects, including a representative pipeline;
- Pro forma Cash Flow Analysis of the Fund, including startup and operating expenses, income from interest and guarantee fees, drawdown of funds for pre-investment support and technical assistance, and replenishment requirements.

The business plan should be approached and completed as if the Fund were a business seeking capital from the market; the difference being, of course, that the objectives of the Fund have overarching international political ramifications.

APPENDIX A

TARGET MARKETS

Annex I economies in transition, and developing countries worldwide, should be targets for a USG program to reduce GHG emissions. However, we focus below on two major markets for EE – Annex I countries and China – as examples of potential business and emissions reductions.

Annex I Countries: Transition Economies

The FCCC calls on developed economies to take first action to reduce GHG emissions, and excludes developing countries from this initial effort. Transition economies, including the Former Soviet Union and Eastern Europe, belong to the Annex I, or developed, countries. A vast literature has indicated that a large amount of GHG emissions reductions could be achieved through the cooperation of richer and transitioning Annex I countries.

It is generally accepted that geographic flexibility in emissions mitigation can cut costs, and that improving technology dramatically reduces costs. An economic windfall of emissions mitigation potential exists in the transition economies: the economic irrationality of central planning has left emissions mitigation options that, compared to cutting the same emissions in the West, would save up to $1.5 billion per year between 2005 and 2020. Stated differently, delaying policy action to 2020 would squander up to $37 billion worth of low-cost mitigation options in the transition economies.[8]

Countries with energy-intensive economies, such as the Eastern Europe/NIS nations, are already interested in using efficiency measures to cut costs and restructure industry. Opportunities for savings can be substantial. For example, one study in Poland identified 400 petajoules of energy savings that could be captured with investments providing an internal rate of return of 18 percent or more. Russia is already spending $450 million on equipment and services to use energy efficiently in all sectors of the economy. Energy efficiency programs and financing could expand this market, providing new customers for U.S. manufacturers.

Some researchers have argued that money can be saved by delaying the onset of emissions reductions. However, they base their arguments on models that have underestimated the current potential for energy savings in certain regions. Facilitating the transfer of existing energy-efficient technologies could reduce emissions even in countries that are not willing to ratify the FCCC. In addition, technology transfer programs would serve as an important precedent in addressing

[8] C. N. MacCracken, S. L. Legro, J. A. Edmonds, and W. U. Chandler, "Climate Change Mitigation Costs: The Roles of Research and Economic Reform." Battelle, Pacific Northwest National Laboratory, 1997: DRAFT.

existing non-tariff barriers. Even if technologies are available for sale, lack of financing or information could prevent them from entering regions where they could have the greatest impact.

China

Background

China's rapid economic growth, outdated industrial system, and elevated concern for environmental protection have created the largest single export market for U.S. energy-efficient technology. While achieving remarkable success over the past two decades in reducing energy intensity, China still has one of the most wasteful energy sectors in the world. During this time, average real economic growth averaged 9 percent, while energy growth averaged only about half as much. A number of studies have indicated that China has the potential to cost-effectively achieve a further 30 to 50 percent reduction in energy consumption by raising its industrial EE to international levels.

Three drivers have pushed energy conservation and efficiency since China initiated economic reforms in 1978: (1) energy shortages, particularly in electric power, resulting in billions of yuan in lost industrial output; (2) environmental pollution that claims a larger and larger share of lost GDP; and (3) competition with other nations for limited export markets, resulting in the need for greater overall economic efficiency. One might also note that the economic prudence inherent in the Chinese psyche, resulting from a history of resource scarcity and overpopulation, adds further to the ability of newly-created market forces to promote EE better than centralized command-and-control policies.

While China's achievements in lowering energy intensity are commendable, it would have been even more remarkable had intensity not declined. Between the late 1940s and early 1960s, China adapted many of the Soviet Union's practices and structures. The government promoted energy-intensive heavy industries, and tried to achieve local self-sufficiency by constructing small, albeit inefficient, factories across the countryside. Combined with little foreign trade to introduce new energy-efficient technologies and scant domestic R&D, China could do nothing but improve the economic use of energy resources.

In parallel with the evolution of decentralized decision-making in China, EE and conservation are now also relying less on central government command-and-control, and more on market forces. Initial efforts to get serious about EE and conservation began in the Sixth Five-Year Plan (1981-86), when the Chinese government allocated approximately 10 percent of energy supply investments into energy conservation. Energy quotas, minimum efficiency standards, subsidized loans and tax breaks, public outreach programs, and a growing network of provincial and municipal energy conservation organizations combined to significantly lower China's energy intensity over the next decade. China's Ninth Five-Year Plan continues to put high priority on EE. The Plan intends to promote the application of new technologies to increase efficiency and strengthen energy conservation legislation and enforcement. Although the 5.5 billion yuan

allocated to energy efficiency and conservation under the Plan is overshadowed by new supply investments, the government acknowledges that it will play an equally important role in the development of the nation's economy and environmental quality.

The market potential for EE in China is demonstrated by four facts:

1. No other developing country has cut energy demand growth to half the rate of economic growth, as has China since market reforms were initiated. That is, the income elasticity of demand for energy averaged just over 0.5 since 1979, as a result of price and market reforms, government financing for technological upgrades, and structural change.
2. No country places greater emphasis on EE. China's Ninth Five-Year Plan, which took effect in January 1996, ranks efficiency equal to supply as a priority.
3. No other country, with the possible exceptions of Russia and Ukraine, uses energy more wastefully in either an economic or technical sense.
4. No other U.S. energy industry in China is doing better than the energy efficiency industry. One U.S. energy-efficiency firm alone sold more equipment in 1995 than did all U.S. vendors of power equipment combined.

The Chinese market for energy-efficient products and services over the next decade totals an estimated $300 billion. This market has already been penetrated by U.S. technology, including industrial controls, motors and motor speed controls, insulation, lighting products, energy services delivery, steam systems and cogeneration equipment. Honeywell, Inc., for example, had revenues of $250 million in China in 1995, and projects revenues of $750 million by 2002. Note that this sum includes process refinement, an important means of improving energy productivity. Johnson Controls is estimated to have sales of a similar magnitude in commercial building equipment.

Focus on Industry

Industry currently consumes almost 70 percent of China's total commercial energy. In 1990, this amounted to 26.6 quadrillion Btu (28 EJ). Coal accounts for 75 percent of China's commercial energy consumption. China's industrial boilers consumed 8.6 quadrillion Btu (9.1 EJ) of coal, about one third of total coal use. Raising boiler efficiency from the current 60-65 percent average to the 80 percent average offered by U.S. equipment vendors could save over 120 million tons of raw coal (2.6 EJ) per year by 2010. Annual carbon dioxide emissions would drop by 230 million tons.

Industrial furnaces and kilns consume about 25 percent of China's end-use coal. China can reduce energy consumption in furnaces by 40 percent as it replaces old furnaces and adds new ones over the next decade.[9] Savings should total over 2.5 quadrillion Btu (2.9 EJ) per year, worth $5 to $10 billion annually in coal savings. These investments would reduce another 250 million tons of carbon dioxide emissions annually.

[9] "Energy Efficient Opportunities in China," BECon, February 1995.

Reducing the cost of high-efficiency electric motors is a particularly promising area for foreign investment. The Chinese government offered a recent delegation the startling example of industrial electric motor imports into China, especially variable-speed systems. According to the State Economic and Trade Commission (SETC), in 1985 China imported $200 million worth of efficient motors, 90 percent of which came from Japan. The SETC estimates the size of the efficient motor market to be $25 billion over the next 10 years. "Where are the Americans?" one official asked. He noted that the Japanese had taken the trouble to establish special leasing arrangements to facilitate the financing of efficient motor purchases. The U.S. Department of Energy has provided funding to the American Council for an Energy Efficient Economy over the past year to address this issue.

Another indication of the potential for EE improvements in Chinese industry is shown in Table 4. In order for China to compete effectively with the other dynamic Asian economies like Korea, Taiwan and Japan, China must bring down unit energy consumption levels for steel, cement, chemicals, and electricity.

Table 3. Comparison of Unit Energy Consumption Levels: China

Units	China [a]	International Level [b]	Ratio
Steel (kgce/tn)	989	613	1.6:1
Cement (kgce/tn)	208	135	1.5:1
Ammonia (kgce/tn)	2,066	1,000	2.1:1
Ethylene (kgce/tn)	1,580	872	1.8:1
Motors (%)	87	92	1.1:1
Thermal Power (>6 MW only) (kgce/kWh)	0.39	0.33	1.2:1

a 1990 Levels
b Primarily 1980 Japanese Levels
Source: World Bank, “China Energy Conservation Study,” 1993; and “Energy Efficient Opportunities in China: Industrial Equipment and Small Cogeneration,” 1995.

One way of assessing the reality of China’s energy efficiency market is to consider the internal rates of return being earned on current energy efficiency investments. Unlike investments in electricity generation, which have struggled to get approval for returns over 15 percent, energy efficiency investments commonly fall in the 20 to 40 percent range.[10]

[10] World Bank, 1993.

APPENDIX B

FINANCING RENEWABLE ENERGY AND ENERGY EFFICIENCY PROJECTS: A PRIMER

Renewable Energy Project Finance

Background

Project finance, defined as debt based on the project's – rather than the company's – assets, has proven to be a valuable mechanism for financing power projects in the past 15 years. Thus far, project finance has mainly been utilized in traditional power project development for the independent power industry. With some exceptions, project finance has not penetrated the RE industry, primarily due to the reluctance of the banking community to consider smaller, less traditional projects and technologies. Mobilization of the capital pools available through project finance sources is critical to growing the RE industry, and should be a major objective in attempts to mitigate GHG emissions.

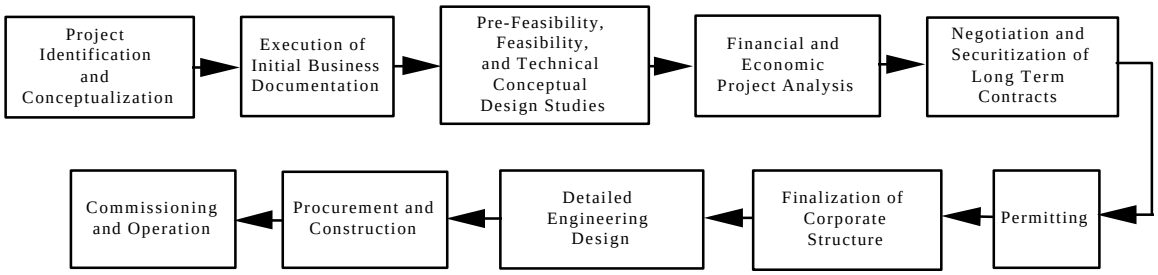
The underlying soundness of the structured project finance model is that it allows the project to prosper on its own merits, without having to be supported externally (i.e., through subsidies or other schemes). Thus, the project is by definition viable and sustainable in the long run. Private-sector RE and EE projects worldwide must seek this goal, or the financial markets will not allow these projects, with substantial environmental benefits, to prosper.

In fact, structured project finance rewards the party that is exposed to the most risk: the private sponsors or developers. This is the party that has the most project experience, and therefore is best suited to bear this risk, through their experience in developing, building and operating projects. Developers will not only contribute time and in-kind resources to the project development effort, but also in most cases they will provide a portion of the total financing requirements via equity contributions. (Typical infrastructure project debt-to-equity ratios are 4:1 in OECD markets, with lower debt leverages in economies in transition and developing countries.) Formal long-term contracts establish a legal framework for more passive investors and lenders to get involved with the financing of the project. A fixed revenue stream for a long period (10 to 30 years) becomes the basis for long-term financing, and allows the lenders to provide credit with a reasonable assurance of repayment. The debt financing usually covers the fixed revenue stream, whereas the equity financing covers the variable revenue stream based on performance of the project, which will either punish the equity investors for non-performance or reward them for exceptional performance.

Development Cycle

The project development cycle for RE projects can be a fairly long process, involving many steps, many actors/participants, and consequently large costs. With a few variations, the cycle includes the steps shown in Figure 2, some of which often occur concurrently. The whole project cycle requires much time to ensure that the project design is sound, and that all risks have been contemplated and accounted for. The development cycle could therefore take up to several years.

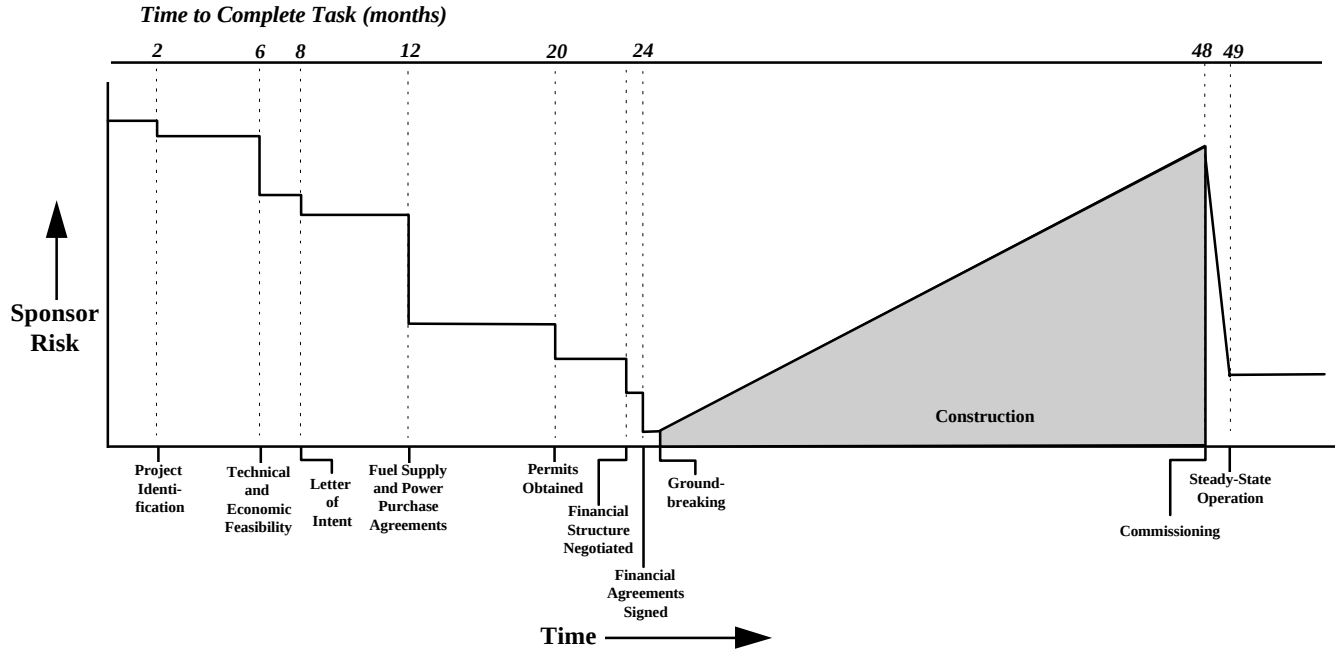
Figure 2. Typical Project Development Cycle for a Cogeneration Project



Source: Econergy International Corporation.

It is useful to compare Figure 2 against the sponsor risk profile in Figure 3 for the purposes of analyzing opportunities for USG interventions in the market to assist private developers of RE and EE projects to reduce project risks, to secure financing.

Figure 3. Project Sponsor Risk Profile



Source: Econergy International Corporation

Energy Efficiency Project Finance

Background

Financing EE projects is fundamentally different from financing RE projects in that the cash used to pay lenders and equity investors is not generated from the sale of output, but rather from savings in costs to the end-user. The savings result from increased efficiency in operations, and have a positive impact on net income and cash flow for the end-user based on lower fuel or electricity costs.

Efficiency projects are implemented through direct contracting, equipment purchases, new standards, technological progress, and behavioral response to price increases. Energy efficiency projects in the United States and Europe have typically been designed and implemented by various entities, including utilities, facilities owners, and ESCOs. ESCOs generally have played a minor role in EE in the United States, although their role is growing. Projects are implemented primarily by end-users, with vendors and banks playing the roles of equipment suppliers and financiers.

ESCOs perform a role similar to project developers, in that they typically market the customer, provide the pre-investment funding, design and implement the project, and arrange financing. Yet ESCOs typically have had different risk profiles than developers of energy generation projects (including RE projects), and tend to take less equity in projects.

In fact, most EE projects are financed mostly with commercial debt in the form of working capital to the ESCO or credit to the end-user, backed by the reputation of the ESCO and, more importantly, a strong contract with the end-user. Other typical forms of finance are lease programs and vendor finance.

The end-user's creditworthiness is the key to financing most EE projects; however, there is often little or no collateral provided. Therefore, banks, leasing firms, and vendors must rely on the ability of the ESCO, their belief that the savings will be realized, the strength of the contract with the end-user, and the willingness of the end-user to pay the ESCO. Sometimes financial institutions will receive guarantees of repayment from the ESCO or the ESCO's owners, but many ESCOs are too small to provide adequate balance sheet support to a loan.

Many EE projects are fairly small and are financed using a corporate finance structure (on-balance sheet, with recourse to the sponsor). However, many projects are quite large: for example, Honeywell recently signed a deal in China to provide energy savings controls worth $100 million. Sometimes developers will employ a project finance structure, providing limited recourse to the project sponsors, where the financial institutions have recourse mostly to the project's assets. This typically allows the sponsors to pursue larger projects (because the companies' net worth is not the basis for the finance). This type of finance for EE projects is more complex than traditional performance contract-based corporate finance, and therefore takes more time and has higher transaction costs resulting from more in-depth analysis, including more detailed risk analysis. Part of the complexity also stems from the fact that EE projects often consist of the aggregation of many small equipment installations and retrofits that, individually, do not have much value other than their original cost less depreciation. This contrasts with an RE project, which has a stand-alone value often greater than the simple book value of its equipment, based on its ability to operate independently of other facilities and to generate revenue.

Development Cycle

The development cycle for EE projects is usually considerably shorter and less complex than that for RE projects. This is because EE projects are necessarily integrated into existing or new facilities, as opposed to being stand-alone facilities that require additional land, siting permits, environmental permits, new corporate entities, and often multiple owners. While the contracting in EE projects is critical and often complex, there are usually only two parties involved – the ESCO and the end-user. In RE projects, the structure is often fairly complex, with multiple owners, customers and suppliers.

Despite the simpler structure of EE projects, development can nevertheless be fairly time-consuming. This is due mainly to the process of performing energy audits, which can involve simple but tedious engineering reviews of facilities.

Performance Contract (Third Party) Financing

Third-party financing for EE projects is completely reliant upon the development of sound contracts between the end-user and the ESCO. The principal contract driving the finance is the performance contract. In performance contracting, some part of the contract is based upon the ESCO's performance in delivering verifiable energy savings. The performance guarantee is similar to a product guarantee provided by a vendor or manufacturer, except that performance is based on a number of factors, including the performance of individual pieces of equipment and the operation of the equipment.

The performance guarantee shifts some risk away from the end-user, and provides an incentive to proceed with the project. In addition, the performance contract usually minimizes or eliminates the up-front cash outlay by the end-user. The end-user will have reduced costs through higher efficiency operations, and will pay the energy manager from these savings, retaining some portion for itself until the equipment costs are paid back (shared savings). After the project has been paid for and the contract has expired, the owner retains all of the savings. The energy manager is guaranteeing the performance of the project, and in some cases puts his profit at risk during the life of the contract. The ESCO benefits from the project by receiving fees from the project, and by its return on investment. The revenue from the project will be in the form of savings through reduced fuel bills or reduced electricity consumption.

APPENDIX C

RENEWABLE AND CONVENTIONAL ENERGY TECHNOLOGY COMPARISONS

Wind

The most dramatic example of cost reductions and reliability improvements in RE technology has been in wind energy, where estimated costs of generation have decreased from $0.52/kWh in 1981, to $0.06/kWh in 1990. During the 10-year period, the estimated capital cost, including balance of plant, dropped from $2,200/kW to $900/kW. O&M costs decreased from $0.03/kWh to $0.009/kWh during the same period. The total cost of energy includes both of these inputs, and is expressed in 1990 dollars.[11]

Of course, when discussing the cost of energy, the plant's capacity factor has a major impact, because the fixed costs are spread over the amount of actual energy generated. In the case of wind turbine technology, *capital and O&M costs decreased while capacity factors increased.* This resulted from a dramatic increase in the quality of technology produced during a relatively short period of time which, in turn, was the result of a program of tax incentives provided by the state of California. The incentives attracted many developers and vendors who installed equipment mainly to take advantage of them, while having poorly developed technology and little understanding of the technology. The many technological failures, and continuation of the incentive program through the 1980s, resulted in a rapid technology evolution with increased reliability and lower costs.

Biomass

Several factors make biomass energy fairly competitive and reliable, with manageable risks. First, there is a fairly well-established equipment supply industry for biomass combustion worldwide, often with reliable manufacturers in the larger developing countries such as Brazil, China and India. This is due to the fact that many process industries, including sugar and pulp & paper mills, have long used the residues from feedstocks as fuels for generating process steam, with some attendant electricity production (i.e., cogeneration). While most of the combustion systems have utilized relatively low-pressure (and therefore less efficient) equipment, many manufacturers of industrial boilers have begun adapting high-pressure utility boiler principles and materials to industrial-size boilers to increase efficiency.

[11] Spera, David A., Editor, *Wind Turbine Technology, Fundamental Concepts of Wind Turbine Engineering*, pp. 593-594 (New York: The American Society of Mechanical Engineers, 1994). These data were calculated by the Electric Power Research Institute, based on a case study of wind turbine technology in the Altamont Pass area of Pacific Gas & Electric.

Second, the fuels (bagasse, rice husk, wood waste) may often be considered waste products and have little or no cost associated with them.[12] This gives biomass projects an advantage over conventional thermal projects, where fuel costs are a large component of variable costs.

Third, in certain cases, projects may be large enough to spread development costs thinly. Many biomass projects, especially cogeneration projects at industrial facilities, can reach sizes of 10 MW to 70 MW. Many developers consider 10 MW to be the threshold for small projects, below which the development costs are not economically justified.

All of these advantages, however, point to potential drawbacks. For example, despite the relatively wide availability of reliable and cost-effective combustion equipment, there is still a gap in supply of associated power equipment in certain size ranges. Namely, there are few suppliers of reliable and cost-effective steam turbines in the range of 10 MW to 30 MW. This is a result of the size of industrial plants and power market regulation. Most developing (and developed) countries have only begun in the past decade to allow private producers of electricity to sell excess power to utility grids.

In these same markets, with a few exceptions, industrial companies have often been allowed to produce power for their own requirements (self-generation). Because most industrial companies do not have demands exceeding 10 MW, historically there has been a fairly large and active market for back-pressure turbines from 2 MW to 10 MW in size. The other market segment has been the utility market, where large steam power plants may often be designed by combining several identical units. Typically these units have been 30 MW or greater, with few exceptions. As a result, for decades there has been little demand for steam turbines in the 10-MW to 30-MW range. In the case of cogeneration from sugar cane bagasse, this is the range that would be most prevalent based on the size of most sugar mills, but many larger turbine manufacturers simply decline to quote turbines in this size range.[13] Industrial turbine manufacturers, on the other hand, often do not have the engineering and manufacturing capacity to accommodate this niche market.[14]

The bottom line is that pricing has been high and reliability low for steam turbines in this size range. The market is slowly changing, but demand has not become strong enough yet to increase

[12] We can expect this to change as biomass generation becomes more prevalent and markets for agricultural wastes and other biomass begin to develop. Sugar mills, for instance, often encounter cane suppliers who demand payment for bagasse, once news of cogeneration project development activities at the mill begins to circulate.

[13] The smaller cane sugar mills process about 2,500 tons cane per day (tcd), and increase in increments of 1,250 tcd, with larger mills processing 10,000 tcd (except in Brazil and Thailand). In India, for instance, the majority of mills fall in this range. A modest estimate of cogeneration potential from a 2,500 tcd mill is 10 MW of which the mill itself may consume 3 to 4 MW; the electrical output from larger mills should increase proportionately.

[14] Based on conversations with General Electric, GEC-Alsthom, Ansaldo, and Elliott Turbines, 1994-96.

output from qualified turbine manufacturers, although some, such as GEC-Alsthom, have targeted this niche market and have begun developing turbines specifically designed for bagasse cogeneration.[15]

In addition, because biomass fuels are traditionally bartered or sold in relatively undeveloped markets, there is a certain amount of risk associated with the fuel supply. This is compounded by the fact that most biomass fuels are agricultural wastes, and are therefore subject to the vagaries of weather and other factors that affect crop production. The nature of the fuels – typically low in density and heating value – has meant that tremendous quantities (in terms of volume) are required for large-scale plants (greater than 30 MW). Therefore, fuel supply and fuel transportation become critical in ascertaining the feasibility of projects.

Small-scale Hydropower

Small-scale hydropower is generally considered to comprise those projects under 20 MW, and typically are run-of-the-river, as opposed to reservoir projects. As with biomass, there is a fairly well-developed equipment supply industry, and the technology has had many years of operating experience to satisfy developers of its reliability. There are two primary advantages that hydropower has over other technologies, both renewable and conventional: (1) fuel costs are zero; and (2) the project life is usually 50 to 100 years, and equipment can often be rehabilitated to last longer. With proper site evaluation, providing accurate resource data and reasonable civil works costs, small-scale hydropower can be extremely competitive.

There have been many problematic hydropower projects, especially among the MDB- and government-funded projects, but these have primarily been large reservoir projects. The risks of poor operation are based mainly on variations in rainfall, which of course cannot be controlled.

Natural Gas

Similar to the evolutionary pace of wind energy technology has been that of gas turbine technology over the past 10 to 15 years. The development has been primarily driven by advances in aeroderivative turbine technology produced by the aerospace industry. Most of the advances have been in new materials for turbine blades (allowing higher temperatures), combustion systems, and pollution control (low-NO_x burners). Combined-cycle plant efficiencies have increased tremendously as a result.[16] A natural by-product of this technology development has been smaller aeroderivative turbines designed by General Electric, as well as the larger frame versions that are now being used in large-scale power plants.

[15] GEC-Alsthom, a large French manufacturer of steam turbines, has recently established a joint-venture manufacturing facility in India to supply the medium-sized cogeneration market.

[16] Gas Turbine World, 1996 Handbook, pp. 1-08 through 1-16. Net plant efficiencies for combined-cycle plants range from about 40% to almost 60%, achieving heat rates of about 5,800 Btu/kWh. Efficiencies for turbogenerators alone reach as high as 44%, in the case of large gas turbines.

Independent of these technological advances has been the rapid and widespread expansion of the natural gas industry, following its deregulation in the late 1970s. Increased pipeline capacity and development of new, low-cost fields has brought on a period of low prices and wide availability since the mid-1980s. As a result, what used to be considered a high-cost, peaking-power technology, has become a baseload technology. Installed costs of large combined-cycle gas turbine (CCGT) power plants have decreased from about $900/kW in the late 1980s to as low as $400/kW in 1997.[17] The cost of energy for large-scale plants often reaches as low as $0.025/kWh.

Because of the tremendous strides made by CCGT plants in the past decade, utilities and independent power producers (IPPs) have made natural gas a fuel of choice. This is true in the United States, Europe, and increasingly in developing countries. The primary constraint is availability of gas; however, because of the tremendous competitiveness of the technology, many countries that have little or no gas are nevertheless making great efforts to develop natural gas infrastructures. This is either done through importation of liquefied natural gas (LNG), or construction of long pipelines to bring in gas from neighboring countries or from remote parts of the country. Several countries with large indigenous resources of RE, especially biomass, are nevertheless compelled to seek sources of natural gas because of high growth in demand for power and the low cost of the technology.[18]

[17] *Ibid.*, p. 1-16

[18] In the past several years, India has debated the efficacy of building LNG terminals to supplement its small natural gas reserves with imported gas. The largest project was to be the Dabhol project sponsored by Enron Power, to supply 2,700 MW of power using natural gas fuel imported from the Middle East. However, the high cost of the LNG component caused the Government of Maharashtra to force Enron to change the design to fire naptha fuel instead. Brazil is currently building a large pipeline to import natural gas from Bolivia. In the Philippines, a gas pipeline approximately 300 miles long is being designed to transport gas from Palawan, a relatively remote and undeveloped island, to Luzon, the main population center. Current estimates of the generating potential from the Palawan fields are 3,000 MW over 10 years (National Power Corporation, Manila, Philippines).

Table 4. Technology Capital and Operating Costs

Technology	Capital Cost ($/kW)	Variable Costs ($/kWh)	Levelized Cost of Energy ($/kWh)
Wind	900	0.009	0.06
Bagasse[19]	900 - 1,500	0.005 - 0.01	0.05 - 0.08
Hydro	1,000 - 4,600	0.01	0.037 - 0.136
Geothermal	1,000 - 4,000	N/A	0.03 - 0.075
Solar PV	2,000 - 7,650	0.005-0.07	0.25 - 3.00
Coal	1,300	0.025	0.051
Natural Gas CC	450	0.02	0.03

Sources:
Wind: Spera, David A., Editor, *Wind Turbine Technology, Fundamental Concepts of Wind Turbine Engineering*, pp. 593-594.
Bagasse: Econergy International Corporation.
Hydro & Geothermal: Econergy International Corporation and International Finance Corporation, unpublished document.
Solar PV: Ahmed, Kulsum, *Renewable Energy Technologies*, World Bank Technical Paper Number 240, 1994.
Coal: Linden, Henry R., "Operational, Technological and Economic Drivers for Convergence of the Electric Power and Gas Industries," *The Electricity Journal*, May 1997. Costs are for pulverized coal with flue gas desulfurization.
Natural Gas CC: Linden, Henry R., "Operational, Technological and Economic Drivers for Convergence of the Electric Power and Gas Industries," *The Electricity Journal*, May 1997.

[19] Bagasse is used in this paper as a proxy for all biomass, although many other sources of biomass exist and have well-developed technologies for conversion. Other fuels that are particularly important in developing country context include rice husks, palm oil and palm waste, and wood waste.

Econergy International Corporation (EIC) is a firm that combines the talents of engineers, financial analysts, international economists and policy experts, and experienced project managers to develop its own portfolio of energy projects. EIC also provides consulting services to support its clients in developing projects in the energy, industrial process, infrastructure, and environmental sectors of the emerging markets in Latin America, Asia, and Europe, created by the ongoing deregulation and liberalization of energy and infrastructure sectors, and by the need for industrial modernization and pollution control. EIC supports its clients entering these new markets, from the initial phase of project identification through project feasibility assessments, project finance, and project implementation.

The Advanced International Studies Unit (AISU) is an international problem-solving unit that promotes energy efficiency as a means of achieving the twin goals of economic development and environmental protection. AISU staff conduct research on financial mechanisms to stimulate investment in energy-efficient, climate-friendly technologies, and they have also conducted workshops and training programs related to climate change mitigation. AISU is part of the Strategic Planning Division of the Pacific Northwest National Laboratory, operated by Battelle for the U.S. Department of Energy. Battelle was created in 1925 as a not-for-profit organization to conduct scientific research for the advancement of humankind.