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THE CONTRIBUTION OF LEGISLATIVE INITIATIVES SUCH AS PURPA TOWARDS INVOLVING THE PRIVATE SECTOR IN THE DEVELOPMENT OF SMALL HYDROELECTRIC POWER PLANTS IN DEVELOPING COUNTRIES

FINAL REPORT

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1.0 INTRODUCTION

The involvement of the private sector in managing small hydroelectric power projects in developing countries brings with it the possibility of a quick and efficacious development of a nation's hydroelectric resources. By their nature, small hydro projects are attractive propositions for the entrepreneur:

- Geographical dispersion of sites minimizes the stress on a nation's infrastructure.
- Project scale permits its development by a small group of professionals in a relatively short space of time.

The development of small hydropower power plants (SHPP) by the private sector is helped when a market is guaranteed for the plant generated energy at an attractive price. The developer can then negotiate a capital loan from a bank to finance the SHPP construction and operation. In this context, the promulgation by the U.S. Congress in 1978 of the Public Utilities Regulatory Policies Act (PURPA) is a very promising development. Of particlar relevance are Sections 201 and 210 of the act. These sections mandate electricity utilities to purchase electricity from any small producer (of capacity of up to 80 MW and which uses renewable resources as its primary energy source) at the price that reflects the incremental cost to the electric utility of alternative electrical energy. On the other hand, PURPA mandates that sales of supplementary and backup power by the utility to the small producer shall not be discriminatory and that they reflect the utility's average cost of electricity generation.

This paper then considers the contribution of legislative initiatives such as PURPA towards fomenting the involvement of the private sector in the development of small hydro electric power plants in developing countries. Elements of the U.S. approach that are appropriate for developing country application are emphasized. Other in-country factors that would be indispensable for transferring the PURPA model are explored. The paper is divided in the following sections:

- A major U.S. Initiative: The Promulgation of PURPA
- Applicability of PURPA to Developing Countries.
- Draft Policy.
- Example of a PURPA Situation.

2.0 A MAJOR U.S. INITIATIVE: THE PROMULGATION OF THE PUBLIC UTILITIES REGULATORY POLICIES ACT (PURPA)

The promulgation in 1978 of the Public Utilities Regulatory Policies Act (PURPA) has played a major role in renewing interest in the development of Small Hydroelectric Power Plants (SHPP) in the U.S. Extracts from Section 2 of the Conference Report point to the interest of the U.S. Congress in this issue:

"The Congress finds that the protection of the public health, safety and welfare, (and) the preservation of national security ... require

(1) A program providing for increased efficiency in the use of facilities and resources by electrical facilities (and)

(2) A program to provide the expeditious development of hydroelectric potential at existing small scale dams to provide electric power.

Title II of PURPA contains provisions that are without precedent world-wide (Taubman and Weingart, 1981), namely the use of legislative fiat to govern the purchase of power from two types of electric power generators-small power producers (including SHPPs) and cogenerators. Specifically, Section 210 of PURPA was designed to circumvent three obstacles faced by small power producers that desired to interconnect with an electric utility (Silverstone, November 1980):

- First, heretofore, electricity utilities were not required to purchase electricity generated either on an "as available" or firm contract basis even if the electricity were offered at a favorable rate.

- Second, backup power sales to small power producers, who usually met all or most of their own needs was often priced at a discriminatory high rate.

- Third, even if a small power producer were permitted to supply energy to a utility, it ran the risk of being deemed a utility and thereby being subject to a plethora of federal and state regulations. Compliance with such regulations could often be much more costly than any economic benefits that could accrue from the sale of electricity.

Section 201 in conjunction with Section 210, addresses each one of these impediments and to varying degrees eliminates or substantially reduces them.

2.1 Discussion of Relevant Parts of Sections of 201 and 210 of PURPA

Important provisions of Title II of the Public Utilities Regulatory Policies Act (PURPA) are listed in Appendix I. In essence, they provide the framework that determines the purchase of electricity by electric utilities from qualifying small power production facilities (QF) at a rate consonant with the incremental cost to the utility of alternative electrical energy. A QF is defined to include facilities of capacity no greater than 80 megawatts that produce electric energy primarily by the use of a renewable resource (including hydroelectric) and of which no more than fifty percent of the equity interests is owned by an electric utility.

PURPA also requires that the rates for the sale of electricity by an utility to a QF shall not be discriminatory and that QFs be exempted from federal and state laws and regulations that pertain to electrical utilities. A further mandate of PURPA calls for "rulemaking provisions respecting (a) minimum reliability of qualifying ... facilities (including reliability of such facilities during emergencies)" and (b) "reliability of electric service to be available to such facilities from electric utiities during emergencies."

Additionally, Congress had directed the Federal Energy Regulatory Commission to promulgate rules to guide the implementation of Sections 201 and 210 of PURPA after "appropriate consultation with representatives of Federal and State regulatory authorities having ratemaking authority for electric utilities" and the general public. Finally, Section 210(f) defines the role which states are required to perform in the PURPA regulatory structure by requiring that each state regulatory authority shall after appropriate consultation with the general public," implement such [FERC] rule (or revised rule) for each electric utility for which it has ratemaking authority".

4

2.2 Federal and State Implementation of Selected Provisions of TIRE II of PURPA

2.2.1 FERC Promulgation of Rules

On February 25, 1980, FERC issued its final set of rules under Section 201 and 210 of PURPA (to be codified as 18 CFR §292). Broadly, the regulations cover the following issues: (1) electric utility reporting requirements; (2) purchase rates; (3) sales rates; (4) interconnection costs; (5) required characteristics of qualifying facilities such as a) ownership; b) operating and efficiency standards; and c) certification and d) exemptions from federal and state law. In general, the rules are designed to make it exceedingly worthwhile for QF's to sell electricity to any (inter)connected utility at an agreed purchase rate.

The purchase rate of electricity from a new QF (i.e., built after 11/9/78) by an electric utility will depend upon the avoided costs (which are the FERC defined proxies for incremental costs as mentioned in PURPA) plus the characteristics of the QF system itself. Avoided costs are "... the incremental costs to an electric utility of electric energy or capacity or both which, but for the purchase, from the qualifying facility or qualifying facilities, such utility would generate itself or purchase from another source" (Section 292.101 (b)(6))[45 FR 12214 (2/25/80)]. The data reporting requirements of the utilities have been designed to assist the competent state regulatory agencies in determining the avoided costs. These include: 1) the estimated avoided energy costs (¢/kWh) for various levels of purchases from QFs. Data must include costs of daily and seasonal peak and off-peak periods for the current year and each of the next five years; (2) the utility's plan for additions to or retirements from capacity (by type and amount) and any purchases of firm energy and capacity for the next ten years; and (3) estimated capacity costs in dollars per kilowatt and associated energy costs per kilowatt for each planned capacity addition or planned firm purchases [Section 45 FR 12214 (2/25/80)].

Data provided by the QFs which may also be considered in calculating the avoided costs include (1) availability of capacity or energy during

6

daily and seasonal peak periods (including dispatchability, expected or demonstrated reliability); (2) contract terms with the utility (including duration of purchase obligations; termination notice requirements and sanctions for non compliance); (3) coordination of scheduled outages; (4) usefulness of QF capacity and energy during emergencies, including ability to separate its load from its generation; (5) the individual and aggregate value of energy and capacity to the electric system. Also, the relationship of the availability of energy or capacity and the ability of the utility to avoid costs (including the deferral of capacity additions and the reduction of fossil fuel use plus the costs or savings resulting from line losses) may be taken into account (Section §292.304(E)]

Each state regulatory authority has the option of weighing the above mentioned factors as it sees fit, of utilizing and promulgating standard purchase rates throughout its service area for each type of QF (such as wind energy conversion systems (WECS) or SHPPs) or of examining the factors on a case by case basis (for facilities of capacity greater than 100 KW only).

FERC rules for sales rates by utilities to QFs are couched in terms of average costs of electric energy generation and provisions of generating capacity. Rates shall not discriminate against any QF in comparison to other customers of the same class who do not generate electricity for supplementary, backup, maintenance, and interruptible power. Also rates for backup and maintenance power must reflect the extent of coordination between scheduled outages of the QFs and the utility's facilities.

The above discussion has touched lightly on the rules that have been issued by the FERC to facilitate implementation of Section 201 and 210 of PURPA. More detailed analyses of the rules have been made by Silverstone (1980, 1981), Golden (1981), and the Energy Law Institute (1980). The work of Fox (1981) is particularly useful in developing a methodology for calculating avoided cost. Finally, it bears noting that small projects, such as SHPPs will only gain substantial allowances for avoided capacity costs if considered in the aggregate for both size and reliability criteria.

2.2.2 Implementation of FERC Rules by State Regulatory Authorities

PURPA and the FERC regulations promulgated thereto do not specify a specific implementation plan for the states. Each state is given broad

procedural and substantive latitude in formulating its response to federal directives which thereby permits it to implement PURPA with greater sensitivity to local conditions and with innovative methodologies. A well conceived state implementation plan will reflect state policy objectives and regulatory principles and have a rulemaking procedure that minimizes demands on state fiscal and administrative resources and that addresses directly the issues and concepts relating to rate structure and design on a technology option basis. Then, regulations would be established that would be applicable statewide to all utilities and QFs.

The state utility commissions were required to promulgate implementation plans for carrying out the mandate of Sections 201 and 210 of PURPA by March 20, 1981. As of early June 1981, only 15 states had implemented FERC rules regarding PURPA small producer rules (Hydrowire, July 1981). As expected, the standard purchase rates are heavily influenced by the fuel (such as nuclear, coal, or fuel oil) that the purchased power would replace. Sample purchase rates are shown below (Pope, 1981).

State	Intermittent Power (¢/kWh)	Constant Power (¢/kWh)	Displaced Fuel
New Hampshire	7.7	8.2	Fuel oil
North Carolina	3.0	5.0	Nuclear
Vermont	6.6	9.0	Fuel oil

2.3 Impact of Private Sector Involvement on Small Hydro Development

In April, 1980, the Federal Energy Regulatory Commission (FERC) in an Environmental Impact Assessment estimated that PURPA would stimulate the building by non-utility controlled entities of 12,000 MW of capacity by 1995 (for all renewable resource technologies plus cogeneration).

However, already it seems that the FERC's estimate is unduly conservative. In 1981, the FERC expects to receive 1,800 applications to study hydro- generation at existing dams and in developement sites - a hundred fold increase from just 18 in 1977 (Norman 1981). Most of the applications deal with sites that meet PURPA requirements, albeit approximately half of them compete for the chance to develop existing dams. As of April 1, 1981, private entreprenueurs had filed applications representing 5,674 MW with the FERC (Gallant, 1981).

The proposed projects are scattered throughout the country and involve installing SHPPs in places such as impoundments of abandoned textile mills (in New England and the Southeast), irrigation dams (in the Northwest) and at locks in major rivers such as the Mississippi, the Missouri, the Arkansas, and the Alabama.

A noticeable feature of private sector involvement in small hydro development is that a new kind of company is entering the field. Typically, this kind of company aims to develop small hydro on a large scale and specializes in putting together "package deals" that include (1) the management of a project through all its regulatory, technical, and financial aspects, (2) developing a contract to sell the SHPP output, and (3) formulating a scheme to attract investors.

A typical contract between a QF and a facility would require that:

- The QF be responsible for constructing, owning and maintaining the hydroelectric plant;
- The utility would be responsible for constructing, owning, operating and maintaining all the distribution and substation connection facilities required to connect the QF and the utility,
- The QF would reimburse the utility for all the initial distribution and substation facility connection costs and pay an annual fee to the utility for O&M of the facilities (Barkovich, 1981).

2.4 Technical Issues

The incorporation of qualified facilities in the generator/load mix of a given utility will occasion a review of the utility planning and operating practices. As a minimum the following technical concerns will need to be addressed:

- safety to personnel and equipment
- quality of service
- operational accommodations
- metering
- sizing procedures and interconnection limits
- installation data needs.

None of these concerns are insurmountable. Prichett (1981) has delineated possible procedures for dealing with them. However, clear guidelines need to be established on who is going to pay for any special equipment and/or labor consuming procedures that will be involved.

3.0 APPLICABILITY OF PURPA TO DEVELOPING COUNTRIES

The circumstances that induced the U.S. Congress to promulgate the Public Utilities Regulatory Policies Act (PURPA) in 1978 apply even more in developing countries whose economics have been devastated by the oil price increase since 1973. The massive payments for oil imports have soaked up a growing share of the export earnings of these countries, strained their ability to pay for essential imports and slowed down their economic development. Thus the development of all viable renewable sources of energy (including small hydro) is imperative (from both national security and economic well being viewpoints) for developing countries.

For many countries, the optimal development of its indigenous hydroelectric resources will need a partnership arrangement between the public and private sectors. The existence of legislation, such as PURPA, that guarantees an attractive market price for electricity generated by qualified facilities is a necessary but not sufficient step for involving the private sector in the development of Small Hydroelectric Power Plants (SHPP's) in developing countries. This section first delineates other factors that influence SHPP development by the private sector and then reviews those elements of the U.S. PURPA that may be applied in developing countries.

3.1 Factors that Influence SHPP Development in Developing Countries

Some factors that need to be considered in judging whether SHPP development by the private sector is viable are:

- *A national awareness of the importance of fomenting small-scale energy projects* by the public and private economic sectors and the general public is vitally necessary to get rapid action. This is especially important in countries where the production potential of small energy resources is so large that it may make a significant contribution to the energy supplies country-wide.

  In practise, this awareness translates into a positive attitude on the part of all public and private entities that may influence the success of small hydroelectric projects.

- *Sensitivity to overcoming institutional problems.* For example legally in India, SHPP projects cannot be developed by the private sector (Barnea 1981). In most countries in Latin America, water use for food production has the first priority such that hydroelectric projects are always subordinated to the use of water for irrigation. Thus it is important that clear rules define the involvement of the different entities interested in water resources development (Indacochea 1980).

- *Eenergy organizations charged with planning the development of the nations energy resources* can highlight the importance of developing hydroelectric and other renewable resources. Such organizations can also influence electric utilties in developing tariff structures that reflect the true cost of fossil fuels and encourage the incorporation of hydroelectric and other renewables into their energy supply mix.

  Since many SHPP service areas will be in rural areas, such an energy planning organization could also be used in catalyzing the coordination of the activities of energy development entities with those of agriculture and rural development agencies.

- *Existence of a public utility commission*, with the responsibility to regulate the orderly development of the electricity sector and especially to regulate electricity tariffs.

- *Availability of capital for construction* is a major concern to private developers. Clasgens and Rothchild (1981) have listed many mechanisms for financing SHPP projects including tax-exempt bonds and debt-services guarantees. The State of California for example has created the California Alternative Energy Source Financing authority to issue tax-exempt bonds to make low-cost funds available for solar, wind, biomass, geothermal and SHPP projects.

- *Government debt service guarantees* reduce project risk and thereby stimulate private sector interest in SHPP development, at little or no cost in tax revenues. If rigorous screening of projects takes place to minimize the possibilities of default, the program can operate at virtually no cost. A standardized technical and financial project appraisal procedure is also necessary in minimizing program costs (Marsden, 1981).

- *The availability of drought insurance* especially for the early SHPP operating years is also important.

- *Flexibility in the possible contracting arrangements between* the utility and the SHPP developer is another important issue. The possibility of the utility giving a contract that would allow the SHPP to pay back all loans in the first 5 years after the plant is operating would make many projects very attractive. (Merrill 1981).

- *Availability of programs for training possible project managers technologists and technicians* for planning, design, construction and operation of the SHPP's is vitally important. Wherever the prospects for obtaining trained personnel are poor, investments become risky, and credit will not be available.

- *A high level of local community interest and participation in small energy projects and similar (water sanitation projects)* is an important factor. The involvement of the local community helps SHPP projects in lowering project costs (especially civil engineering costs) and improving reliability of operation through maintenance of the watershed upstream from the headrace entry point and concern for proper plant operation.

3.2 Elements of the U.S. PURPA That May be Applied to Developing Countries

In the context of this paper, the most important objective of PURPA is to incentivate the rapid development of a nation's renewable (including hydroelectric) resources through a partnership of the public and private sectors. A measure of the efficacy of PURPA will be the rate that new renewable systems (including SHPP's) are integrated into the national grid and the subsequent reliability of the new systems.

For developing countries, any PURPA style initiative will have to be promoted within the context of each nations legal/socio-economic milieu. What is important is to bear in mind the five principal assumptions of sections 201 and 210 of PURPA:

- Only qualifying facilities can sell electricity to the utility. The QF will be defined in terms of its ownership structure, its size and the resources it uses for generating electricity.
- The utility will purchase electricity at a rate consonant with the incremental cost to the utility of generating electricity.
- The utility will not discrimate in its sale tariffs against QF's.
- The QF's will be exempt from the legal and regulatory requirements governing the organization and financial reporting of electrical utilities.
- The QF's and the utilities will be expected to meet minimum specified reliability requirements in furtherance of the objective of PURPA.

The actions taken by the Federal Energy Regulatory Commission (FERC) and the Public Utility Commission (PUC's) shoudl be judged strictly on their applicability to the reality that exist in each country. The concept of "avoided cost"that takes into account both the capacity and the amount of electricity provided by the QF to the electric utility seems a useful one. Likewise the criteria that may be used in determining the reliability of service provided by the QF to the utility are helpful.

As time progresses, a rich lode of experience is being generated on the efficacy of PURPA in the U.S. It may be interesting monitor the situation in a state such as California, where already a number of utility-private sector SHPP contracts have been signed (Barkovich 1981) with the objective to finding out what kinds of arrangements are proving to be the most satisfactory.

There is one element that must be accounted for in many developing countries in a PURPA type initiative that is not contemplated in the U.S. law. This is the active participation of the local community in the construction and operation of the SHPP to help ensure its reliability of peformance. Experience in many countries has shown that SHPP's are often out of service because of poor maintenance of the watershed upstream of the diversion dam. This adverse situation can be avoided when the local community knows that the continuation of their electricity service depends uniquely on how well they conserve "their" watershed.

4.0 DRAFT POLICY

For many countries, the optimal development of its indigenous resources will need a partnership arrangement between the public and private sectors. Clearly, a PURPA type initiative is a necessary step for stimulating the involvement of the private section in mid or higher level developing countries. In such cases, the vitality of the private sector's contribution to small hydro development would be enhanced if public policy followed the lines mentioned below.

- The national legal infrastructure (including the pertinent electricity sector and water resources law) would permit participation of the private sector in the development of small hydro sites and guarantee the subsequenct sale of electricity to the electrical utilities (using a wide range of possible contract mechanisms).

- An energy planning organization be put in place with the mandate to plan for the rational development of the nation's energy resources and to coordinate all energy development activities.

- Availability of capital for SHPP construction (using mechanisms such as tax-exempt bonds and debt service guarantees) would be assured.

- Clear rules delineating the role and responsibilities of foreign resources (capital, technical) would be promulgated including guidelines for the establishment of joint ventures with host country firms.

- Drought insurance would be made available where appropriate.

- Training programs for SHPP project managers, technologists and technicians would be put in place.

- The role of local communities in the development and operation of SHPP's would be highlighted through the provision of educational outreach programs in rural communities on the benefits of electricity and on the important role these same communities will play in guaranteeing reliability of its supply. The local communities will benefit from their involvements in the development of small hdyro systems through electrification on favorable terms.

Figure 1 shows the interrelationship of the public and private sectors in the development of SHPP's when a PURPA style initiative is used.

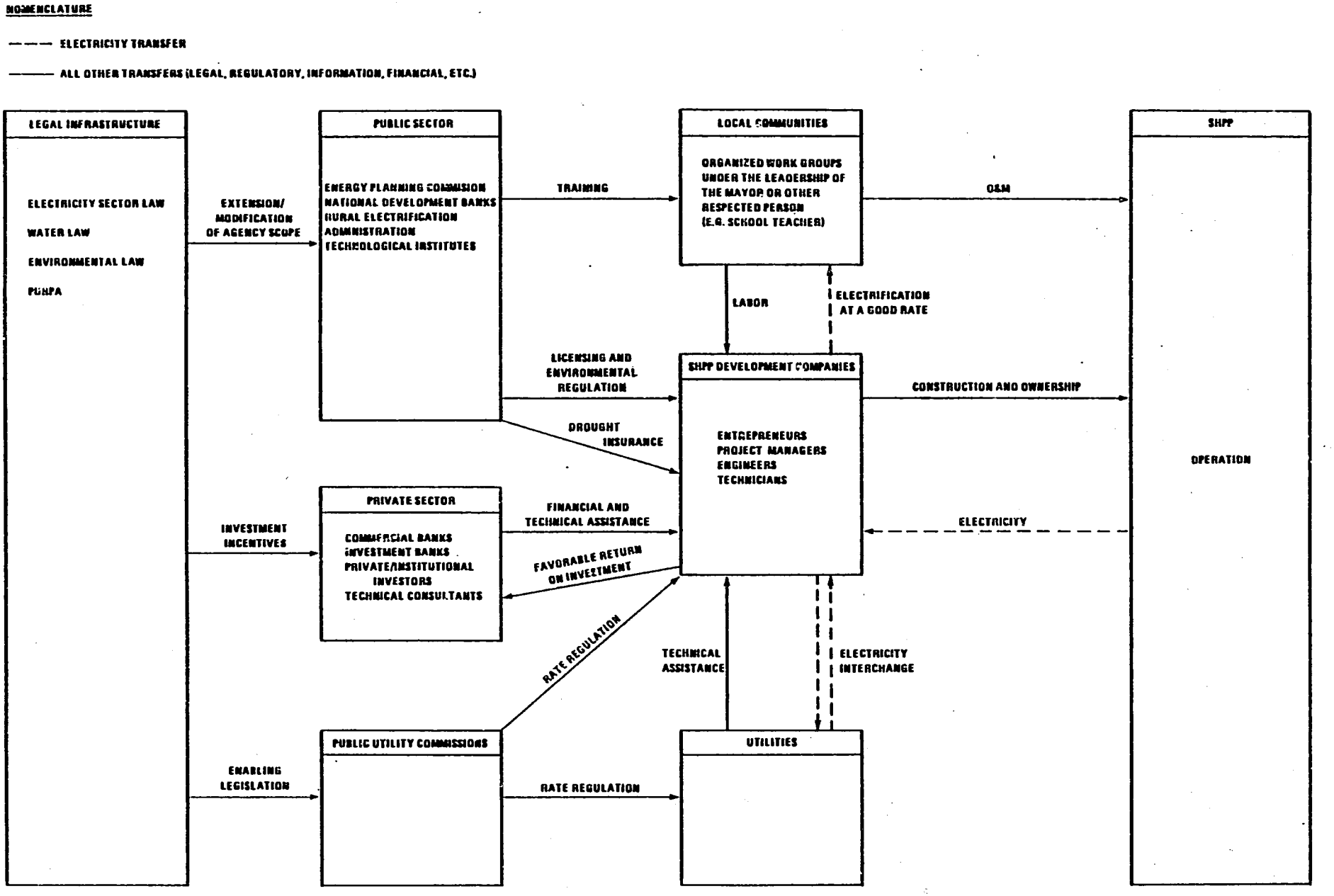

FIGURE 1 INTERRELATIONSHIP OF THE PUBLIC AND PRIVATE SECTORS IN THE DEVELOPMENT OF SHPPs

15

5.0 EXAMPLE OF A PURPA SITUATION

In this section, a real example from the Dominican Republic has been chosen to demonstrate how the application of a key provision of Section 210 of PURPA (i.e., the purchase price of electricity by a utility from a small producer should reflect the utility's avoided cost) could make the development of a SHPP very attractive for the private sector. The situation as described below is a summary of a detailed study (NRECA, July 1981) that was conducted using a customized site selection methodology (NRECA, June 1981). This methodology reflected current standard engineering practice in the United States and the Dominican Republic. The discussion is divided into 2 parts: (1) engineering review of the project; and (2) financial review of the project.

5.1 Engineering Project Review

The engineering review of the project begins by looking at the site characteristics in terms of location, hydrology, and topography and then develops a design that optimizes the site electricity generation capabilities.

Site Characteristics: The site is located in Azua Province with the proposed location of the powerhouse about 1 km distance from a 12.5 KW distribution line. The drainage area of the watershed associated with the intake to the power canal was 200 km^2 in surface area. Five years of pertinent stream flow data were available.

Design Considerations: Using information provided by a flow duration curve and following the procedures laid down in the site selection methodology, a design flow (Q_d) of 1.5 m^3/sec was determined. A number of project configurations were considered that depended upon project layout and single vs. multiple turbine arrangements. The optimal configuration chosen was a cross-flow turbine of 726 kW capacity based on a design head of 61.75 meters and potential annual generation of 2.41 GWh. Further engineering details of the project are shown in Table 3.

The project also included the following features:

- A diversion rock and concrete dam 36 meters long and 3 meters high;
- A 2.3 KM trapezontal rock and mortar tailrace with a gradient of 0.01 and a flow capacity of 1.7 m^3/sec;
- A 36" diameter steel penstock of 8mm thickness, 100 meters length and 1.5 m^3/sec capacity;
- A synchronous 726 KW generator with a voltage rating of 4160 volts at 60 Hz and a speed of 1200 rpm (through a stepped speed increaser);
- 7 km of 12.5 kV transmission line.

5.2 Financial Project Review

The financial review of the project first estimates the project costs, then estimates the project benefits and finally evaluates the project in terms of internal rate of return, benefit-cost ratio, and net benefits.

Project Costs

The following assumptions prevailed in determining the costs:

1. The equipment and material costs reflect the price as delivered to the site.
2. All costs are expressed in terms of 1981 RD$. All equipment that would be procured abroad was costed at the official exchange rate of 1 RD$ = 1 U.S. $.
3. The cost of labor in construction and installation is assigned a value that is a weighted average of local labor costs and semi-skilled labor cost.

Table 1 presents a summary of the project costs as prepared by a team of professionals from the Dominican Republic while following the above-mentioned site selection methodology.

Project Benefits

The project's benefits are calculated as the revenues from the sale of the annual report of electricity generated at the assumed grid purchase rate of 11¢/kWh. This is the average cost of generation of electricity

TABLE 1
ESTIMATED PROJECT COSTS

		RD$
1.	New Dam and Spillway	105,000
2.	Power Canal	198,700
3.	Power Intake	24,000
4.	Penstock	56,000
5.	Power Plant and Electrical Equipment	405,800
6.	Transmission Line, Transformer and Protection Equipment	102,000
7.	Land Clearing and Access	14,000
		950,000
Admin. and General Expenses (10%)		95,100
Contingencies (15%)		142,600
		1,188,200

17

for the National Electrical Utility (CDE, 1980). It is calculated as follows:

	Cost per kWh
Operation	9.15
Maintenance	0.42
	9.67

At an annual inflation rate of 15% for 1981, this comes to 11.12 ¢/kWh. The following additional assumptions are made:

1. All capital costs will be incurred prior to the first year of operation (C_o).

2. Recurring costs for year i (R_i) include 1.28% for operation and maintenance (O&M) and 0.01% for administration and general expenses (A&G), as percentages of capital cost.

3. The discount factor represents the opportunity cost of capital, officially set at 12%.

The procedure for calculating the present value of the project benefits, costs and net benefits is shown in Table 2 plus the pertinent calculations for this example. The results may be summarized as follows (1981 dollars):

The total present value of the project benefits (PVB_{30}) = RD \$3,415,720
The total present value of the project costs (PVC_{30}) = RD \$1,311,665
The total present value of the net project benefits ($NPVB_{30}$)= \$2,104,055

The benefit cost ratio = 2.60

The project internal rate of return is 34%.

5.3 Institutional Considerations

The previous two subsections have shown the feasibility (both financially and technically) of developing a real site in the Dominican Republic. Financially the project is very attractive. In fact the project benefits have been underestimated because the analysis assumed:

18

Table 2

CALCULATION OF THE PRESENT VALUE OF THE PROJECT BENEFITS AND COSTS

For a planning horizon of 30 years the total present value of the benefits (PVB_{30}) is:

$$PVB_{30} = \sum_{i=1}^{30} B_i \frac{1}{(1+r)^i} \quad ....(1)$$

In this case B_i is constant (B) for each year of the planning horizon and

$$B = 0.11 \text{ \$/kWh} \times 3.855\times10^6 \text{ kWh} = \text{RD \$424,050}$$

and remembering that the present value factor PVF_T is defined as

$$PVF_T = \sum_{i=1}^{T} \frac{1}{(1+r)^i} = \frac{1-(1+r)^{-T}}{r}$$ where,

T is t. length of the planning horizon (Maass, 1962).

In this case,

$$PVF_{30} = 8.055.$$

Thus equation (1) may be re-written

$$PVB_{30} = PVF_T . B$$

$$= 8.055 \times \text{RD \$424,050} = \text{RD \$3,415,720.}$$

The total present value of the project costs (PVC_{30}) is:

$$PVC_{30} = C_o + \sum_{i=1}^{30} C_i \frac{1}{(1+r)} = \quad ..... (3)$$

In this case,

$$C_i = (0.0129)C_o, \; i = 1, 2... 30$$

Thus equation 3 may be re-formulated as:

$$PVC_{30} = C_o + 0.0129 \; PVF_{30} \; C_o$$

$$= C_o \; (1 + 0.0129 \times 8.055) = \text{RD\$ } (1,188,200 \times 1.104)$$

$$= \text{RD\$ } 1,311,665$$

The net project benefits ($NPVB_{30}$) are calculated as follows:

$$NPVB_{30} = PVB_{30} - PVC_{30} = \text{RD\$2,104,055}$$

1. The utility's average rather than marginal cost of electricity generation;

2. No real increases in imported petroleum costs over the planning horizon;

The prima facie evidence shows that this project is extremely attractive for the private sector. An analysis was made of the factors listed in Section 3.1 that could affect the feasibility of this project being brought to fruition by the private sector. The results of the analysis are shown in Table 3. Essentially, the prognosis for private sector development of SHPP sites in the Dominican Republic is good, but not at this time.

The current impediments to SHPP development in the Dominican Republic by the private sector are primarily institutional. What is needed are the following:

1. The promulgation of a rational Electrical Sector Law (ESL) that clearly defines institutional responsibilities for the generation, transmission, distribution and sale of electricity. The law will carefully delineate institutional responsibilities for hydroelectric resources development;

2. The ESL will also mandate the establishment of a public utility commission (PUC) that will oversee the rational development of the electricity sector;

3. The promulgation of a PURPA style law to optimize the contribution of both the public and private sectors in SHPP (and other renewables) development. The general characteristics of the law are outlined in Section 3.2.

TABLE 3 ANALYSIS OF THE EXISTING SITUATION IN THE DOMINICAN REPUBLIC CONCERNING SHPP DEVEOPMENT BY THE PRIVATE SECTOR

FACTOR	SITUATION
A National Awareness of the Importance of Fomenting SHPP	Feasibility SHPP studies have been conducted under the aegis of many foreign governments and agencies (including USAID, KfW, Canada, France, Norway and Spain) in conjunction with Dominican Republic Government agencies. [illegible] are in operation, [illegible] is under construction. Construction will begin on 3 more in the near future. USAID is contemplating financing at least 3 more SHPP projects.
Existence of an Energy Organization Charged with Planning the Development of National Resources.	A permanent National Energy Policy Commission (CNPE) was established in 1979 to help coordinate the energy-related activities of different agencies, analyze the national energy situation and identify and promote appropriate energy policies and programs. CNPE has established a hydroelectric unit that has the responsibility for the preparation of short, medium and long-term plans and policies for hydroelectric generation. The National Electrical Utility (CDE) tariff structure is designed to put the utility on a solid financial basis.
Sensitivity to Overcoming Institutional Problems	Currently, only CDE can sell electricity. CDE has a barter arrangement with some large autogenerators of electricity to transfer energy back and forth at appropriate times. Legal situation on the development of hydroelectric resources is very unclear and has lead to turf battles between CDE and INDRHI (National Hydraulics Development Institute). A comprehensive study of the legal structure of the electricity sector is planned to get under way shortly that will eventually lead to the drafting and promulgation of a modern and efficient electricity sector law. The law may mandate the operation of an electrical utility regulatory commission.
Availability of Capital for Construction by the Private Sector	At present this is a moot point, since only CDE may sell electricity. The country has an active commercial banking system and more than 15 development lending institutions with ties to the central bank. One development institution (FIDE) has a policy, of nearly two years standing, of special treatment of loans designed for energy conservation in industry or agriculture or production of alternative energy devices.
Availability of Drought Insurance	No
Flexibility in Contracting Arrangements Between the Utility and the SHPP Developer	N/A
Availability of Programs for Training Possible Project Managers, Technologists and Technicians	The Dominican Republic has a cadre of well-trained professionals who are familiar with all aspects of SHPP development. CDE has in place a training program in O&M for SHPP operators.
Community Interest and Participation in Small Energy and Similar (Water Supply) Projects	Field trips by NRECA personnel and discussions at all levels of society attest to a widespread community interest in small energy projects and an active record of participation in previous water supply projects.

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