Nicaragua: Policy Strategy for the Promotion of Renewable Energy: Situation and Perspective of Hydroelectric Generation

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(ESMAP)

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Acronyms and Abbreviations

AdAguas	Administración Nacional de Aguas
BCIE	Banco Centroamericano de Integración Economica
BOO	build-own-operate
CABEI	The Central American Bank for Economic Integration
CAC	Comisión Administradora de Cuenca
CDM	Clean Development Mechanism
CEB	Ceylon Electricity Board
CERUPT	Certified Emission Reduction Unit Procurement Tender
CIDA	Canadian International Development Agency
CNDC	Centro Nacional de Despacho de Carga
CNE	Comisión Nacional de Energía
COSUDE	La Agencia Suiza para el Desarrollo y la Cooperación
CRE	Comisión Federal de Electricidad
DAI	Derechos Arancelarios de Importación
DGA	Dirección General de Aguas
DGCA	Dirección General de Calidad Ambiental
DGRN	Dirección General de Riquezas Naturales
DIA	Declaración de Impacto Ambiental
DPR	Detailed project report
EDC	Energy Development Centre
EEGSA	Empresa Eléctrica de Guatemala Sociedad Anónima
EGEHID	Empresa de Generación Hidroeléctrica Dominicana
EIA	Environmental Impact Evaluation
ENEE	Empresa Nacional de Energía Eleléctrica
ENEL	Empresa Nicaragüense de Electricidad
ENEL	Empresa Nicaragüense de Electricidad
ENTRESA	Empresa Nacional de Transmisión Eléctrica S.A.
EPC	Engineering, Procurement, Construction
ESD	Energy Services Development Project
ESMAP	Energy Sector Managemnet Assistance Programme
FNDR	Fondo Nacional de Desarrollo Regional
FONDIEN	Fund for the Development of the National Electrical Industry
GEF	Global Environment Facility
GGG	Guatemala Generating Group
GON	Government of Nicaragua
H.P	Himachal Pradesh (India)
HIDROGESA	Generadora Hidroeléctrica, SA
IEE	Initial Environmental Examination
IFC	International Finance Corporation

ILD	El Instituto Libertad y Desarrollo
INDE	Instituto Nacional de Electricidad
INDRHI	Instituto Nacional de Recursos Hidráulicos
INE	Instituto Nicaragüense de Energía
INETER	Instituto Nicaragüense de Estudios Territoriales
IPP	Independent Power Producer
IR	Impuestos sobre la renta
IREDA	Indian Renewable Energy Development Agency
ITF	Impuestos de Timbres Fiscales
IVA	Impuestos al Valor Agregado
LIE	Ley de la Industria Eléctrica
MAGFOR	Ministerio Agropecuario y Forestal
MARENA	Ministerio del Ambiente y los Recursos Naturales
MEM	Ministry of Energy and Mines
MHP	Micro Hydropower Plant, Mini Hydropower Plant
MIFIC	Ministerio de Fomento, Industria y Comercio
NAPOCOR	National Power Corporation
NEA	Nepal Electricity Authority
NGO	Nongovernmental organization
NWRB	National Water Resources Board
O&M	Operating and Maintenance
PCA	Planta Hidroeléctrica Centro América’
PCF	Prototype Carbon Fund
PCH	Pequeñas Centrales Hidroeléctricas
PDF	Power Development Fund
PERZA	Proyecto de Eléctrificación Rural en Zonas Aísladas
PLANER	Plan Nacional de Eléctrificación
PLN	Perusahaan Listrik Negara
PPA	Power Purchase Agreement
PREEICA	Proyecto Regional de Energía Eléctrica Istmo Centroamericano
PSB	Plant Santa Bárbara’
PSKSK	Small private power producers
RAAN	Región Autonóma Atlántico Norte
RAAS	Región Autonóma Atlántico Sur
RL	Régimen Legal
SHP	Small Hydropower
SIEPAC	Sistema de Interconexión de los Países de América Central
SIN	Sistema Interconectado Nacional
SPPA	Small Power Purchase Agreement
TA	Technical Assistance
UNCDF	United Nations Capital Development Fund
UNDP	United Nations Development Programme
WBG	The World Bank Group

Units of Measure

(according to the International System of Units)

GW	gigawatt
GWh	gigawatt-hour
km	kilometer
kV	kilovolt
kW	kilowatt
kWh	kilowatt-hour
l	liter
m	meter
m^3	cubic meter
mt	metric ton
MW	megawatt
MWh	megawatt-hour
s	second
TWh	terawatt-hours

Preface

This report presents the results of the study "Situation and perspective of hydroelectric generation (100 kW–25 MW) in Nicaragua."

The overall scope of this hydropower study is to identify the legal, regulatory, economic, financial and political barriers hampering private investment in hydropower development, to identify government incentive mechanisms, to attract private investment, and to propose an appropriate strategy to trigger the development of the hydropower sector in the range of 100 kW to 25 MW by involving the private sector.

This hydropower study is the third of a series of Renewable Energy Technologies Reviews (covering wind, geothermal, and hydroelectric power) providing the basics for a policy study on private sector involvement in renewable energy projects in Nicaragua supported by the World Bank under the Energy Sector Management Assistance Program (ESMAP). The ESMAP study will assist the Comisión Nacional de Energía (CNE) in fulfilling its political mandate of promoting the utilization of national renewable energy resources and their incorporation in the energy sector of Nicaragua. This case study is one of three (geothermal, hydropower, wind) that assessed prospects and barriers for the most important renewable resources in Nicaragua, and served as the basis for the formulation of the overarching strategies delineated in the main ESMAP report.

The hydropower study was divided into 4 tasks.

Task 1—International Experiences in Hydropower Development. The scope of Task 1 is to present a summary of essential international experiences of energy policies and strategies that have allowed or hampered private sector involvement in hydropower development.

Task 2—Classification of Hydropower Projects. The scope of Task 2 is to classify the identified hydropower projects according to their generation capacity utilizing the existing CNE classification of hydroelectric projects and to propose a prioritisation of the range of projects for further development.

Task 3—Competitiveness and Viability of Development of Hydroelectric Projects with Private Participation. The scope of Task 3 is to "identify all the legal and regulatory aspects of the market that can affect the development of hydroelectric projects with private capital. Within the analysis one should identify the factors that can affect the competitiveness of a project, from the perspective of a private investor, be they cost structure, types of hydroelectric projects (dam, storage, run of river, average or low head, etc.), and determining those variables which can be affected with the purpose of reducing costs and of making these projects competitive within the market without distorting it."

Task 4—Policy and Strategies for the Promotion of Hydroelectric Projects of the Hydropower Study. The scope of Task 4 is to "recommend over the medium and long term the mechanisms that the Nicaraguan Government must undertake in order to

guarantee the execution of hydroelectric projects, at the level of power policy specifying the lines of strategic action."

The information utilized in this report was gathered during the first mission of the consultant to Nicaragua on July 31—August 8, 2003, and updated during his second mission on October 1—8, 2003. At the end of the second mission, the consultant presented to the CNE his suggestion for the market segmentation for the hydropower sector and identified possible focal areas of hydropower development (see Chapter 4 (Task 2) of this report). During his third stay in Nicaragua on December 9—13, 2003, the consultant presented the results and preliminary recommendations of this study at a Renewable Energy Policy Seminar organized by CNE.

The consultant would like to thank in first place the staff members of CNE for their assistance, namely Mr. Raúl Solórzano, Ms. Gioconda Guevarra, Mr. Victor Valencia, and Mr. Ricardo Mendoza. He would also like to express his gratitude for the warm welcome and the enormous amount of information he received during his visits from the Ministerio de Fomento, Industria y Comercio (MIFIC), the Ministerio del Ambiente y los Recursos Naturales (MARENA), the Instituto Nicaragüense de Energía (INE), from the Centro Nacional de Despacho de Carga, the National Dispatch Center (CNDC), and from other institutions and individuals.

Thanks also goes to the World Bank Team, namely Ms. Clemencia Torres, Mr. Charles Feinstein, and Mr. Kilian Reiche, all of whom supported the work of the consultant through intensive discussions and provision of valuable background information. Special thanks to Nidhi Sachdeva for formatting the report and to Marjorie K.Araya for supervising the publications process, both for ESMAP.

Executive Summary

Background of the Study

1. The scope of this hydropower study is to identify the legal, regulatory, economic, financial, and political barriers hampering private investment in hydropower development, to identify government incentive mechanisms to attract private investment, and to propose an appropriate strategy to foster the development of the hydropower sector in the range of 100 kW to 25 MW by involving the private sector.

2. This hydropower study is the third of a series of Renewable Energy Technologies Reviews (wind, geothermal, and hydroelectric power), which are the basis for a policy study on private sector involvement in renewable energy projects in Nicaragua supported by the World Bank under the ESMAP facility. The ESMAP study will assist CNE in fulfilling its political mandate of promoting the utilization of national renewable energy resources and their incorporation in the energy sector of Nicaragua.

Summary of International Experience (Task 1)

3. The international experience with deregulated power markets shows that hydropower projects are finding it difficult to compete with thermal power generation alternatives. If developed along the lines of an independent power producer (IPP) model as has been successfully used for thermal power, the hydro option is not attractive for the private sector (with the exception of captive or off-grid plants). A more responsive approach is needed if hydropower is to thrive, particularly private, small hydropower (SHP) development.

4. Chapter 3 summarizes the experience of other countries in supporting the development of small hydropower projects through the involvement of the private sector. While any private infrastructure development is a challenge for all stakeholders, SHP projects have additional issues for which different countries have found a variety of solutions. These issues are:

- Regulatory and promotional issues
- Project identification and definition
- Project risks
- Power purchase agreements
- Financing constraints and project set-up
- Project implementation schemes.

5. From the review of the experience in private SHP development in eleven countries in Latin American, the Caribbean, and Asia, the following lessons can be learned:

a). The regulatory framework, comprising six aspects that include water use rights, grid connection policy, and environmental clearances, must be specifically defined for small hydro so that no legal uncertainties exist for developers and sponsors of SHP.

b). A selection of attractive small hydro sites should be made available to the developers, preferably in the form of water resources master plan that distinguishes SHP sites from other water development plans so that the uncertainty about potential water use conflicts is reduced. However, self-identified sites must remain open to private developers.

c). A large amount of hydrologic and geologic data as well as hydropower-related experience resides with the (national) utilities and international hydro consultants. Tapping into this wealth of knowledge and experience is not possible by private developers alone. The learning curve of local SHP developers can be shortened with the assistance by government agencies and international technical assistance (TA).

d). International experiences show that the availability of standard power purchase agreements (PPAs) and tariffs is crucial for attracting private developers. The full exposure of small hydro (especially the smaller range below 10 MW) to a spot market without long-term supply contracts is detrimental to private SHP development, and guaranteed tariffs for at least the first five years of SHP operation should be made available.

e). The power purchase tariffs offered to SHP projects by the utilities need to be around US$0.05 per kWh so that private developers can be attracted. Strong international support (from donors with TA, or development finance institutions) is often needed to make utilities agree to such cost-covering tariffs.

f). The vehicle of a special-purpose company for private SHP development is adequate; however, banks often require substantial collateral to support SHP on a project Finance/ non-recourse financing basis. Information campaigns for bank managers and solid SHP project documentation can help reduce exaggerated caution from the banking sector.

g). Quality assurance in design and implementation should be made available either locally or through TA so that local banks are prepared to provide long-term financing with lending terms in excess of five to six years.

h). Engineering, procurement, construction (EPC) contracts for SHP development have not provided the expected measure of risk avoidance and cost reduction. The alternative approach of using a multitude of single-discipline contracts is recommended.

Existing Hydropower Potential and Classification of Projects (Task 2)

Hydropower potential

6. Hydropower resource assessments in 1980 and later updates identified a potential in the range of 3.760 MW, ranging from micro, mini, and small hydropower up to larger resources of 150 MW and above. This estimated potential corresponds to gross energy of 32.938 GWh per year, based on a (theoretical) plant availability of 100 percent. However, only 9.541 GWh per year (equivalent to 1.094 MW at 100 percent availability) are regarded as technically feasible and only 6.552 GWh per year (equivalent to 751 MW at 100 percent availability) are regarded as economically feasible.

7. For some of the identified projects, positive feasibility studies made them the subjects of renewed national interest in developing Nicaragua's existing hydropower resources. Among these projects, which were the subject of different update studies during the past decade, are the hydropower projects Mojolka (originally 78 MW, now 138 MW), Copalar (originally 181 MW, now 150 MW), Larreynaga (originally 40 MW, now 17 MW), Pantasma (originally 15 MW, now 24 MW), projects in the Upper and Lower Rio Viejo region (extension of the existing hydropower facilities Planta Hidroeléctrica Centro América and Planta Santa Bárbara), and projects at the Y-Y river (estimated at some 27 MW).

Classification of projects

8. There is no internationally recognized standard classification of hydropower schemes. While modular equipment and standard designs can usually be applied to the design of wind parks, geothermal plants, biomass plants, and solar energy schemes, a hydropower plant—particularly its civil engineering structure—requires a site-specific design irrespective of its generating capacity.

9. Hydropower plants can generally be classified in the following ways:

a). By generating capacity (rated power output in MW)

5 kW–100 kW	Micro hydropower
100 kW–1 MW	Mini hydropower
1 MW–10 MW (- 30 MW)	Small hydropower
> 10 MW (> 30 MW)	Medium and large hydropower

b). By available head (low-, medium-, and high-head schemes)

10. The power output of a hydropower scheme is proportional to the water flow and to the available head, the latter being the only site-specific parameter, that does not vary over the lifetime of the scheme.

Low-head scheme	2–10 m
Medium-head schemes	10–100 m
High-head schemes	> 100 m

c). By type of plant

11. Hydropower power plants can also be classified in five categories depending on the different ways of using the water flow. This has a profound effect on their technical and environmental characteristics. As in the case of classification by power output, no binding international definition exists. Typical classifications are as follows:

- Run-of-river schemes
- Pondage schemes (day storage)
- Reservoir schemes
- Schemes integrated with an irrigation canal
- Schemes integrated in a drinking water system.

d. By mode of operation (off-grid or on-grid).

12. The classification of hydropower schemes by the mode of operation is a common approach when it comes to defining the objectives and design of hydropower programs.

13. There are two main ways to make use of the existing hydropower potential: off-grid and on-grid.

Isolated operation (off-grid)

14. Stand-alone systems are mainly pico (< 5 kW) or micro hydropower schemes (usually below 100 kW) supplying electricity to individual rural households or to a single consumer. Although having the potential to contribute to decentralized rural electrification in Nicaragua, these small systems are not considered in this study.

15. Micro and mini hydropower schemes with capacities of approximately 50 kW to 500 kW are usually operated as *off-grid schemes* providing electricity to single villages or a set of villages isolated from the national grid. A grid (mini grid) to households (usually numbering 100 to 1,000 families) locally distributes electricity to small commercial and industrial consumers and powers public lighting.

16. This is often the least-cost option for decentralized rural electrification. It provides reliable 24-hour electricity supply at low operational costs compared to a diesel generator set or other renewable energy sources.

Grid connected (on-grid systems)

17. Grid-connected hydropower plants feed the generated electricity into the national distribution grid, be it for national consumption or export. Theoretically, all sizes of hydropower plants can be operated in grid-connected mode, whether they are classified as mini, small, or large hydropower. However, the criteria for grid connection of mini or small hydropower plants are quite different from those for larger plants.

18. Current practice is that mini hydropower plants with generating capacities of approximately 500 kW to 1 MW are usually grid connected, supplying electricity to a local grid and feeding excess electricity into the national grid. The decision as to whether a mini hydropower scheme should be grid connected or not depends mainly on two key considerations:

- What is the initial electricity demand in the local grid and the demand growth forecast?
- What amount of excess electricity can be sold to the national grid at an economic tariff?

19. These questions help ascertain if the amount of excess electricity and the obtainable tariff in the grid justify the investment in transmission lines, which in turn depends on the distance from the power house to the nearest grid connection point.

Market segments for hydropower in Nicaragua

20. Follows the classification according to generating capacity, the hydropower market can be divided in the three main categories

- 100 kW–1 MW (mini hydro for off-grid or on-grid electrification)
- 1–25 MW (small hydro to feed into the national grid)
- 25–150+ MW (large hydro for on-grid and regional export market like Sistema de Interconexión de los Países de América Central, SIEPAC).

21. For the purpose of this study, the small hydropower segment (1–25 MW) as the main focus area is divided in subsegments. This subdivision accounts for the preexisting legal framework for small hydropower projects of up to 5 MW and the need for policy and regulatory interventions for the remaining range of 5 to 25 MW.

Conclusions and recommendations

22. Based on the analysis of Nicaragua's supply and demand for hydropower in plants larger than 100 kW, the following conclusions can be made:

a). Hydropower schemes ranging from 100 kW to 1 MW address mainly rural electrification and can be off-grid or on-grid. This segment is covered by internationally supported programs and does not need additional support.

b). The low-end subsegment of small hydropower power ranging from 1–5 MW may quickly become the most interesting market segment for national private investors, once the remaining confusion in the interpretation of Presidential Decree No. 279-2002 on dispatch of intermittent renewable sources and its regulations can be clarified.

The recommendation for CNE is that the hydropower potential and possible project sites of this subsegment should be assessed carefully and pre-feasibility studies prepared to attract private developers.

To promote the 1–5 MW subsegment it is essential that the government create a portfolio of potential projects that can be offered to the private sector. Other possible incentives could be that the government would provide concessionary loans for the required transmission lines, access roads, or other infrastructure. The CNE should take the lead in these activities, which should be initiated as soon as possible.

c). The range of 5–15 MW hydropower plants may also present an attractive market for private sector entrepreneurs, though at higher economic risks. However, as long as new water legislation is not in place, no private developer will invest in such a project. Therefore, pending the removal of political and legal barriers, the assessment of hydropower potential in this range as well as the identification of concrete projects should be initiated by CNE on a medium-term planning horizon.

d). For projects in the 15–25 MW range, the same legal barriers apply as for the lower capacity ranges. However, the associated risks for developers as well as for the financing banks are higher and therefore, the realization of projects of that nature requires a medium- to long-term planning horizon. As in the case of the lower capacity ranges, CNE should be prepared to do initial planning at pre-feasibility level for such projects, to attract developers.

e). The medium and large hydropower development is a long-term program and requires an overall improvement of the rating of Nicaragua in the financial markets. However, if the SIEPAC is implemented, it may create an attractive new market.

Competitiveness and Viability of Development of Hydroelectric Projects with Private Participation (Task 3)

Analysis of hydropower sector development

The energy sector and renewable energy policy

23. The Nicaraguan energy sector was restructured in the late 1990s. The new Electricity Law from April 1998 (LIE—Ley de Industria Eléctrica, No. 272) separated the generation, transmission, and distribution divisions of the state-owned Empresa Nicaragüense de Electricidad (ENEL). That sector reform initiated privatization of the generation and distribution activities. The LIE created four generation companies (GEMOSA, GEOSA, HIDROGESA, and GECSA), the transmission company (Empresa Nacional de Transmisión Eléctrica S.A., ENTRESA) and two distribution companies (DISNORTE and DISSUR).

24. The Government of Nicaragua, through the CNE, has decided to encourage the development of the abundant renewable energy resources in the country as an essential element in the growth of the national energy system.

CNE's renewable energy and hydropower policy mandate

25. The CNE was created by the new Electricity Law (LIE, 1998) and is in charge of formulating, coordinating, and setting overall objectives, policies, strategies, and general directives for the entire energy sector (as transferred from INE). It is also in charge of undertaking strategic indicative planning for the energy sector aimed at achieving development goals and optimizing the use of national energy resources.

26. The mandate of CNE includes also the development of rural electrification initiatives in coordination with multilateral and bilateral agencies and the promotion of national and foreign investment. In fulfillment of its mandate, CNE is implementing a Plan Nacional de Eléctrificación Rural (National Rural Electrification Program, PLANER), aiming to achieve a national electrification rate of 70 percent by 2014.

Installed electricity generation capacity and demand growth

27. The total installed generating capacity in the national grid (Sistema Interconectado Nacional, SIN) was 658.5 MW in December 2002 with a peak demand of 422 MW. This results in a reserve capacity of 36 percent. Hydropower capacity is 104 MW, representing 16 percent of the national energy mix with the remainder made up of 72 percent (477 MW) thermal and 12 percent (77 MW) geothermal generation capacity.

28. The annual average increase of electricity generation between 1997 and 2002 was 7.1 percent while the annual demand growth was only 3.6 percent. The load factor of the installed generation capacity is 65.5 percent which is similar to the load factors of neighboring countries. With 33 percent losses (21.1 percent nontechnical and 11.9 percent technical, total of 797 GWh), the losses in 2002 were the highest in Central America.

29. The 47 percent overall electrification rate in 2002 is the lowest of the neighboring countries (Honduras 63 percent, Guatemala 84 percent, Costa Rica 97 percent). About 89 percent of the rural population still lacks access to electricity.

Recent experience with hydropower development in Nicaragua

30. The current situation of the energy sector and of hydropower development in Nicaragua has been the subject of numerous studies and reports during recent years. The Nicaraguan experiences are presented in chapter 2 and 3.

31. The experience with the exploitation of Nicaraguan hydropower potential falls into three main areas:

a). Assessment of the existing medium to large hydropower potential

b). Implementation and operation of micro, mini and small hydropower plants

c). Experience with large hydropower plants.

32. Summarizing these activities and comparing them to other countries like Costa Rica, it can be concluded that there is little local experience in the planning and implementation of mini and small hydropower plants in Nicaragua.

Market for hydroelectricity and outlook for future development

33. INE expects a power demand growth of about 6 percent annually over the next 20 years, requiring US$1.8 billion in new investments to increase generation capacity by 1,179 MW. It is a declared objective of the Government to increase the electrification rate from 47 percent at present to 70 percent in 2014.

34. Based on the facts listed below, it can be concluded that hydropower should definitely play a decisive role in the future electricity market of Nicaragua:

- Hydropower offers the largest known renewable energy resource in Nicaragua.
- Hydropower covers a wide range of electricity demand, from micro hydropower for rural electrification, to small plants feeding into the national grid, to large hydropower plants generating electricity for the export at Centro American (SIEPAC) level.
- Hydropower development has the potential to trigger socioeconomic development, such as jobs in local production of components, energy service companies , and in maintenance and operation of SHPs.
- The medium to large hydropower potential was studied in detail over the last decades.
- Hydroelectricity is competitive with thermal generation in the long term considering its expected long life span and its low operating and maintenance (O&M) cost.

Current hydropower programs in Nicaragua

35. As a result of the Nicaraguan government's efforts to promote the exploitation of existing hydropower potential, there are several ongoing activities in the hydropower sector covering the range from mini hydropower plants below 1 MW up to medium and large projects.

36. CNE implements the Proyecto de Eléctrificación Rural en Zonas Aísladas (PERZA) with cofinancing from the World Bank. PERZA aims at improving the living conditions of at least some 16,000 inhabitants of isolated rural communities, mainly in the Region Autonoma Atlantico Sur (RAAS) and Region Autonoma Atlantico Norte (RAAN), by providing a sustainable energy supply based on hydropower and village photovoltaic systems.

37. The program Usos Productivos de la Hidroelectricidad a Pequeña Escala (PCH) is cofinanced by the Global Environment Facility (GEF) under Operational Program No. 6 and is implemented by the United Nations Development Programme (UNDP). It aims at improving living conditions in rural areas through improved income generation based on hydroelectricity.

38. Like PERZA, CNE is the project-executing counterpart organization.

CNE's portfolio of hydropower projects

39. The CNE's project portfolio presented in their Investment Guide contains presently a total of 54 hydropower projects of which 26 are mini hydropower projects totaling 9.25 MW, 15 are small hydropower projects in the range of 1–15 MW totaling 125 MW and 13 projects are medium to large projects (15–281 MW) as suggested by the 1980 Master Plan. These projects give an estimated capacity of 1,776 MW. However, since the majority of these projects are only at the level of pre-feasibility studies or of technical profiling, the generation capacities are estimates only.

40. A pipeline of medium to large hydropower projects was proposed in the 2001 IFC study "Assessment of Hydroelectric Generation Alternatives." In this study, medium and large projects from the project list of the 1980 Master Plan were screened and put forward for implementation in the medium- to long-term planning horizon. In this list, there are only two projects below 25 MW and therefore of concern for this study, Larreynaga (17 MW) and Pantasma (24 MW).

41. The current portfolio can summarized as follows:

- There exists a portfolio of about 45 projects ranging from 100 kW to 25 MW and about 15 large projects ranging from 40 to 425 MW that CNE wishes to promote mainly by mobilizing private capital investment.
- The overwhelming majority of projects are limited to technical profiles or pre-feasibility studies. Very few projects have been studied at feasibility level.
- The basic data (mainly generating capacity in MW and electricity generation in GWh per year) of these hydropower projects vary significantly in the different project lists published by CNE.
- The discrepancies in basic data create confusion among potential investors and raise questions about the reliability of the released data, which may undermine the credibility of CNE.
- It is therefore recommended to undertake a detailed review and update of the published project lists and released project data.

Analysis of the legal and regulatory framework

Regulatory requirements for successful small hydropower development

42. The international experience from successful hydropower development shows that six essential statutory regulations need to be enacted by governments in order that small hydro development by the private sector can take place.

Water rights and water usage fees:

43. Granting of water use rights is a difficult issue for government agencies. If unrestricted water use rights are granted to small hydro developers without careful evaluation of future water requirements, then the state may not make optimum use of its water resources. On the other hand, too restrictive an approach can completely block

small-scale hydro development. Agencies can effectively handle water use rights if they can rely on

- a solid water resources master plan
- agency personnel with an intimate knowledge of the water resources available in the country so that they can predict possible future water use conflicts.

Land acquisition and resettlement policy:

44. Even without the existence of a reservoir or pond, small hydro facilities often require the acquisition of considerable plots of land and a displacement of families. If not already constructed, access roads constitute another land acquisition issue.

45. Without assistance by the government in negotiations with stakeholders, land acquisition may be a very costly affair for the developer. If the developer can count on the application of standard government land prices (or long-term lease fees) and compensation fees for crops, then a considerable stumbling block to small hydro development is removed. Land acquisition by the government or assistance in this issue is one of the support mechanisms a government can provide to stimulate private sector involvement.

46. In the case of access roads, government intervention is highly desirable since it provides a multiple purpose benefit for the local population, including easier access to regional markets.

Environmental clearances:

47. For economic reasons the study of environmental impacts in detail is not desirable for small hydro even though an ill-conceived project can have very adverse impacts. It is therefore necessary to define an intermediate level of regulation which both avoids a very costly, full-scale environmental impact assessment (EIA) and identifies the crucial environmental aspects of the project. Simplified environmental examinations have been defined by a number of countries for small hydro plants 3 to 6 MW range. Above this range, full-scale environmental impact studies are generally required.

Grid connection policy:

48. Small run-of-river hydro plants are only attractive for the private sector if they can make use of the available water flow at all times irrespective of the power demand in the grid.

49. If a small hydro plant has to offer its output on a daily basis in a fully deregulated power market, it will not be able to sell its full potential. Without a strong policy that obliges grid operators always to accept the generated power from small private hydro producers, many SHP projects may not be feasible.

Import policy for electromechanical equipment:

50. Customs regulations seldom specifically address the issue of import duties on hydropower equipment. In the absence of specific rules, duties on electromechanical equipment often amount to between 10 and 30 percent. This puts a further disincentive in

the way of small hydro development. Duty-free import of electromechanical equipment and components has to be granted to SHP developers for successful and sustainable hydropower development.

Company registration and foreign investment policy:

51. Regulators want to make sure that a private developer has the resources to complete a project successfully and does not leave the site with a half-finished plant. Full documentation giving the company background and information on funding sources, along with the signing of an implementation agreement (with security fees or bonds), are required by most host governments.

52. Implementation agreements for small hydro projects are different from contracts for infrastructure projects with private sponsors such as toll roads, wharves, or large-scale hydro where projects are usually solicited by public authorities. Successful, small, private hydro programs are mostly based on a build-own-operate (BOO) concept, in which there is no transfer of the asset to the state at the end of a specified contract period or water use concession.

Existing legal and regulatory framework

General legal framework of the energy sector

53. The existing legal framework for the development of the country's hydropower resources is defined by the following Laws and Decrees, which also comprise the general legal framework for the energy sector.

- **Political constitution (Art. 102)**
- **General Law of the Exploitation of the Natural Resources**
- **General Law of the Protection of Environment and the Natural Resources** (Ley General del Medio Ambiente y los Recursos Naturales, Ley No. 217, 1996)
- **The Civil Code** (on water resources)
- **Law of Organization, Competencies and Procedures of the Executive and its Regulation** (Ley No. 290, June 1998—Ley de Organización, Competencias y Procedimientos del Poder Ejecutivo y su Reglamento)
- **Water Law (First Draft, July 2003)** (Ley de Aguas, Anteproyecto Julio 2003)

Laws and regulations of the electrical sector and the hydropower sector

- **Statutory law and its reforms of the Nicaraguan Institute of Energy (INE)** (Ley Orgánica y sus reformas del Instituto Nicaragüense de Energía (INE), Decree No. 16, 1985 y su reforma Ley No. 271, 1998)
- **Law of the Electrical Industry** (Ley de la Industria Eléctrica (LIE), Ley No. 272, 1998)

- **Law of Promotion of the Hydroelectric Sub-sector** (Ley de Promoción al Sub-Sector Hidroeléctrico, Ley 467, 29.8.2003)
- **Presidential Decree 279-2002 and the Resolution of INE No. 07-2003** (Acuerdo Presidencial No.279-2002 (09.07.2002) y la Resolución No.07-2003 del INE)
- **Law of Organization, Competencies and Procedures of the Executive and its Regulation** (Ley No. 290, June 1998)

Analysis, comments, and recommendations

General evaluation of the existing legal framework

54. While legal, regulatory and other barriers still exist for medium and large hydropower projects, a favorable legal framework and an attractive incentive structure is in place for mini and small hydropower plants below 5 MW. The existing legal framework for these small projects enables a developer to obtain the necessary environmental permits from MARENA, generation licenses from INE, and water concessions from MIFIC.

55. Although the framework for mini and small hydropower projects has been improved, particularly for hydropower schemes below 5 MW, the recently approved fiscal incentives for hydroelectric projects do not yet create a level playing field for hydropower development in general compared to thermal projects, since the latter continue to be highly subsidized.

56. The analysis of the existing legal and regulatory framework suggests that the following issues should be addressed through correction or amendment of the existing laws and their rules and regulations:

a). The legal and regulatory responsibilities with respect to hydroelectric generation are dispersed between different ministries and government authorities. Therefore, they are not transparent and in some cases are not coherent.

b). It appears that the interinstitutional information flow, consultation, and coordination between ministries and government authorities like MIFIC, MARENA, CNE, INE, CNDC, INETER, and others is not as efficient as it should be.

c). The approval of hydropower projects is subject to authorization and opinions of several authorities. Apart from the complicated process of approval, the respective authorities often do not have sufficient technical criteria to justify their decisions and make the reasons for them clear to a developer. This may create a situation where project proposals or applications are rejected that possibly would have been approved if clear definitions and transparent decision-making criteria had been available, such as clear definition of run-of-river schemes.

d). The existing legal framework appears to be directed at protection of important areas of national interest like the environment, natural resources, and consumers (via the tariff structure), rather than the initiation and promotion of hydropower development. Therefore, any hydroelectric project will face a conflict with these areas of national interest that might discourage developers wanting to invest in this sector.

e). The legal basis for water concessions was suspended in 2002 and the draft Water Law that is presently in the making needs quick approval. The main challenge in water management is the equal and fair distribution of water resources in a given watershed area for which the natural decrease of water flow due to climate change is the main risk. The draft Water Law addresses that issue by allowing the authorities to suspend, revoke, or modify a valid concession in case of natural reduction of flow. Clearly, this may affect the economic performance of a hydropower project and constitutes a potential threat for an investor, particularly as the use of water for human consumption has been declared a national priority. It may also affect a bank's willingness to finance hydropower projects.

Specific analysis, comments, and recommended adjustments

57. The laws and their regulations relevant for the hydropower sector have been analysed and recommendations have been made in chapter 3.

58. The respective recommendations are as follows:

Box 1: Law of Promotion of the Hydroelectric Sub-sector

Law No. 467, 29.8.2003: Law of Promotion of the Hydroelectric Sub-sector

The law exempts new hydropower projects (storage or run-of-river hydropower) for a period of 15 years (period started in August 2003) from the following duties:

- Import duties and taxes
- VAT on equipment, materials, and other accessories for generation/transmission and G/T/distribution for isolated systems
- Income taxes for seven years from the beginning of commercial operation
- Municipal taxes during the construction period and for 10 years from the beginning of commercial operation
- Stamp duties (Impuestos de Timbres Fiscales, ITF) for 10 years
- All taxes which may exist in relation to the exploitation of natural resources
- Water concessions or permits for hydropower plants below 1 MW.

Recommendations

1. Consider extending the validity of the law beyond 15 years for small hydropower plants.
2. Remove the 1 percent tax on the capital of hydropower projects.
3. Adjust the draft Water Law to accord with the provision of the Hydroelectric Law by deleting the need for water authorization for plants below 1 MW in Arts. 81 to 83.

Box 2: Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

This Decree specifically aims at promoting wind power and run-of-river hydropower projects by providing special privileges for such schemes. These privileges refer to following issues:

First, INE defines in the Regulation of the Decree (Resolution 07-2003) the term "run-of-river" as electricity generation from the hydraulic energy of a river *without a dam* that can store hydraulic energy.

Second, the Decree limits the incorporation of wind power generation plants into the SIN to a maximum of 5 percent of the national maximum demand.

Third, the Decree establishes a monetary incentive per kWh for wind and hydropower electricity fed into the SIN grid. This incentive is defined as a premium of 70 percent of the difference between the hourly wholesale price of the electricity (including auxiliary contracts and services) and the hourly price of the spot market. This preferential price will be paid as long as it does not create a surcharge on the consumer tariffs.

Comments

(a) General comment

The experience from hydropower development in other countries reveals that run-of-river schemes selling electricity on the spot market is very problematic. Without a PPA with fixed tariffs for at least five years or guaranteed preferential dispatch of electricity on the spot market at preferential fixed prices, there will not be investment by the private sector.

However, decentralised mini hydropower plants below 1 MW may have advantages since these plants usually feed directly into a low-voltage grid and thus save wheeling charges.

(b) Definition of "run-of-river"

The definition of run-of-river as defined by INE in Resolution 07-2003 is obviously *contrary* to the common practice in Nicaragua. For example, the hydropower plant Santa Bárbara is recognized as a run-of-river scheme although its storage capacity is 40 days of generating capacity.

(c) Five percent ceiling for wind power

Although the Decree limits the incorporation of wind power generation capacity to 5 percent, in its Regulation INE applies this 5 percent ceiling to wind power *and* run-of-river hydro schemes. While a ceiling may be justified for wind power generation, the resolution unnecessarily limits hydroelectric generation.

(d) Preferential feed-in price

Resolution 07-2003 does not specify how the wholesale price will be calculated at an hourly level, because the calculation of many of its components (like payments by capacity andreserve) is based on daily or long-term levels. Also, neither the Resolution nor its Regulation clarifies what is meant by "the incentive will be paid as long as it does not cause a surcharge to the final tariffs" or who is going to pay for this incentive if it cannot be charged to the tariffs. However, according to CNE, this decree has not been put into practice because there are different interpretations of all these items (1), (2) and (3) on the part of the government entities like CNE and CNDC as well as among the investors themselves.

In an attempt to solve these problems, and at the same time to improve the attractiveness of the incentives given for wind and run-of-river hydropower, in November 2003 CNE recommended a modification of the existing Presidential Decree 279-2002 that would attempt to correct its imperfections.

The modification proposes a competitive bidding process in order to grant generating licenses to the investor who offers the lowest price for electricity fed into the SIN. The modified Decree also proposes to switch from the 70 percent premium in Decree 279-2002 to maximum prices for wind power and run-of-river hydropower fed into the SIN, which are US$0.0575 per kWh for wind power and at US$0.0590 per kWh for hydropower.

The modified Decree also proposes to exempt wind power and run-of-river hydropower generators from providing or paying the additional cost for capacity backup ("spinning reserve").

Recommendations

1. If the existing Decree 279-2002 remains in its present form, clarification will be required as to how the preferential prices for wind and hydropower will be calculated and who is going to pay for the margin of preference. Further, a precise definition will be needed of the circumstances under which the premium on the spot market price will be paid.

2. For run-of-river hydro, the 5 percent ceiling should be skipped and the text in Resolution 07-2003 changed accordingly.

3. Redefine in Resolution 07-2003 the term run-of-river scheme using the Relative Criteria B1 (volume of storage relative to design flow of hydropower scheme), which seem already to be common in Nicaragua (they are used at Santa Bárbara). In this case, a run-of-river hydro plant could make optimal use of its hydro resources generating electricity when it sells at maximum prices maximizing the return of investment for the investor.

4. Review the option to establish the legal basis for PPAs for small hydropower plants with fixed feed-in tariffs.

5. Additionally, negotiate with INE (and Union Fenosa) for elimination of wheeling charges for capacity, which are presently contained in the selling price on the spot market.

6. If the Decree is amended to maximum feed-in prices, it would be necessary to introduce an indexation of these maximum prices. For example, prices could be indexed to the adjustments of consumer tariffs, since this would already include compensation for inflation or exchange rate changes.

Box 3: Draft Water Law (2003)

(First Draft, July 2003) (Ley de Aguas, Anteproyecto Julio 2003) Draft Water Law (2003)

The CNE study 2003"Propuesta Política Energética Indicativa—Subsector Hidroenergía" states: "The multiple functions delegated to different entities of the State for the sustainable use of the water resource cause difficulties in the resolution of conflicts in most of the cases, since the existing legal framework does not manage to balance the interests of all the potential water users and in particular those who would use water resources for electricity generation".

Comments

Along with government institutions, territorial organizations, including regional municipalities and local governments, also participate in and comment on the granting of authorizations and concessions (see draft Water Law, Arts. 22, 79). Although comprehensive stakeholder participation is desirable and necessary for the sustainable use of water resources, the consultation process can delay and complicate the granting of a water concession. However, there is no way to circumvent this process and a water authorization or concession is a prerequisite for a generation license from INE. Therefore the process of obtaining a water concession should begin at the earliest possible stage in the implementation process of a project.

Streamlining this process should be one of the tasks of CNE under its proposed "one-stop clearinghouse" function. Before the water concession can be applied for officially at MIFIC, a consultative mechanism facilitated by CNE may reassure an investor that outstanding issues will be addressed and a water concession will be issued.

Contradiction regarding granting water concessions and authorisations

According to the Law of Promotion of the Hydroelectric Sub-sector, hydropower projects with less than 1 MW capacity are exempted from any water concessions or permits (Art. 6) and according to the LIE, such hydropower plants also do not need a generation license.

However, there is a contradiction between Art. 6 of the existing "Law of Promotion of the Hydroelectric Sub-sector" and the draft Water Law, Arts. 81 to 83;these articles state that hydropower plants up to 1 MW need an authorization to access water resources.

Recommendations

1. Declare explicitly in the draft Law or in its Regulation that hydropower development is an objective of national importance and is a "Mayor beneficio económico y social para el pais," which is suggested as one of the priority criteria in the new Law. (Tit. VI, Cap. I, Art. 72).

2. Add the following text to the draft Water Law under Tit. VI, Cap. I, Art. 68: "El MIFIC, ...debera tener en cuenta,.....y el Plan Indicativo de la Generación Sector Eléctrico de Nicaragua."

3. Adjust the draft Water Law Arts. 81 to 83 by deleting the provision requiring a water authorization for hydro plants below 1 MW, in accord with the provision of the existing Law of the Promotion of the Hydroelectric Sub-sector, Art. 6.

4. CNE should not only actively participate in the mediation process between hydropower developers and the other stakeholders in a multipurpose project but also should take the lead in defending the position of interested hydropower developers. This dialogue should be guided by the principles stated in the draft Water Law (Tit. III. Cap. I).

5. The CNE should raise public awareness that sustainable use of water flow for electricity generation will ultimately benefit consumers by stabilizing energy tariffs, protecting the environment by reducing greenhouse gas (GHG) emissions, and reducing dependence on imported fossil fuels.

Box 4: Law of the Electrical Industry (LIE, Ley de la Industria Eléctrica, No. 272)

Law No. 272: Law of the Electrical Industry (LIE, Ley de la Industria Eléctrica, No. 272)

The LIE provides a considerable number of obligations and rights relevant to hydropower development as analysed and commented on in chapter 3

(a) Functions of CNE (Art. 12)

Among other tasks, the LIE mandates the CNE to do the following:

- Prepare, review, and evaluate periodically the strategic plan of the energy sector
- Develop the profiles and if necessary pre-feasibility and feasibility studies for the formulation of strategy and energy planning
- Issue criteria and publish investment opportunities in energy projects
- Develop and submit the draft laws of the sector to the executive
- Promote and stimulate the participation of private capital investors
- Promote relationships between the financial organizations and the private sector
- Administer and regulate the Fund for the Development of the National Electrical Industry (FONDIEN)
- Promote policies and strategies that allow the use of renewable energy sources for electricity generation.

Comments

The LIE mandates CNE to assume the role of a protagonist and promoter of renewable energies in Nicaragua, including hydroelectric development at national and international levels.

While the unit of CNE for rural electrification (Dirección de Electrificación Rural) is fully operational, its capacity seems to be entirely committed to the implementation of the PERZA and the UNDP/GEF-supported PCH projects.

Hence, there is lacking not only a suitable strategy on how to develop projects in the range of 1 to 25 MW, but also capacity to fulfill the tasks related to promotion of 1–25 MW projects.

However, it should *not be the function* of CNE to *elaborate* technical project profiles, pre-feasibility studies, and feasibility studies as outlined in the LIE Art.12, but rather to outsource and supervise their execution.

Recommendations

1. To cope with the mandate given under Art.12, particularly regarding small hydro development, the CNE has two options:

- To increase its own capacities in terms of personnel and qualifications in order to cope with the given tasks. This would require a considerable increase in the budget, and it would be difficult to recruit sufficiently qualified and experienced personnel in a timely manner.
- To outsource the tasks to national/international consultants. This option would also require considerable funds and would lead to a situation wherein CNE does not generate in-house expertise to provide the required supporting and controlling functions.

The following solution lies between the two extremes: Increase or reassign personnel specifically to cope with the development of a portfolio of small hydro projects which can be offered to the private sector, but minimize the involvement of CNE in the execution of studies, which will make available staff required to control and guide externally contracted expertise.

2. Implementing projects from the project portfolio presented in CNE's investment guide requires systematic, immediate development of a hydropower program for small-scale projects of up to 5 MW, and development of projects of larger capacities once the draft Water Law goes into force.

3. Elaborate and publish an investment guide for small hydropower that nominates CNE as *the* "one-stop clearinghouse" for hydropower development in Nicaragua.

(b) Sustainable financing of CNE's operation

According to Art. 13., funds will be assigned for the operation of the CNE from the national budget of the republic. Are these funds sufficient and permanently available to fulfill the assigned tasks?

According to Law No. 272 (Ley Organica No. 272), Art. 13, INE resources seem to be more secure than CNE's. INE enjoys administrative and financial autonomy from government agencies, and is under the direct oversight of the Nicaraguan president.INE receives funding through a service charge of up to 1.5 percent on the invoiced activities of the concessionaires and holders of distribution licenses. CNE is mandated to manage the National Electricity Fund (FONDIEN), which, however, is earmarked for rural electrification. This consultant found that promotional activities for small hydropower projects with private investment capital cannot be financed by FONDIEN and would have to come out of the core financing budget of CNE.

Recommendation

Consider a type of financing model similar to one used for INE to enable CNE to carry out its functions in a sustainable way.

(c) Tariffs

The tariff structure for the final consumers has to be approved by INE, and is based on the principles of economic efficiency as well as of financial feasibility. The structure will also take into account the price policies for electrical energy given out by the CNE (Art. 112). The INE has all the tools needed for preferential tariff treatment of renewable energies, including the Norm of Tariffs (Norma de Tarifas), which regulates transfer of the cost of electricity purchase and generation to the tariffs (for example, by setting maximum prices—see Norm 3.4.2).

The rate of discount used is the prevailing opportunity cost of capital in the capital market. If this is not considered suitable, a different rate will have to be fixed by the INE on the basis of yields from activities in Nicaragua with similar risks (Art. 117). This criterion for fixation of tariffs can create certain long-term risks for investment projects.

At the moment, INE does not give much help in setting tariffs for isolated areas. While INE has been given the task of reviewing and approving proposed tariff schemes in these areas, no guidelines yet exist to serve as a basis for this task. There are also no guidelines either on service quality for off-grid connections or on managing the transition to grid service of existing isolated systems.

(d) Temporary Licenses

The realization of studies for power stations using renewable energies and studies for transmission facilities require a Temporary License issued by the INE for a maximum term of two years. Art. 68 of the present Law establishes the procedure for granting this license. A fee is paid to INE of 0.1 percent of the total investment.

River flow data can be regarded as reliable if measured over a period of about 20 years. Therefore, if flow data have to be gathered, the period of 2 years is too short for hydroelectric projects. The present Law does not provide for an extension of the Temporary License and it is understood that that a new Temporary License would have to be applied for and the license fees paid again.

Recommendation

The term for a Temporary License for hydropower should be granted for up to five years, if an investor applies for it. Alternatively, the option should be introduced to extend the license at the investor's request at no additional cost.

(e) Generation forecast and contracts

Art. 87 of the LIE obliges each distributor to have PPAs with generators located nationally, or in another country through import or export contracts that cover a percentage of the predicted demand. On December 1 of every year, a distributor must have firm contracts that cover 80 percent of the anticipated demand for the following year and 60 percent of the anticipated demand for the subsequent year (Regulation, Art. 172).

This requirement clearly favors thermal electricity production, unless LIE provisions to maintain contracts based on a 24-month forecast are skipped or modified in favor of longer planning horizons, at least for hydropower projects. Otherwise, distributors would not consider the hydropower option due to the long planning periods of 2–4 years for a small hydropower plant.

(f) Options for hydropower generation

(i) Options for the private investor or developer

(a) Generation and commercialization in off-grid systems

Create an integrated utility and commercialize hydroelectricity (including generation, transmission, distribution, and sale). Such a utility must connect its isolated system to the SIN if INE orders it to do so (LIE, Art. 31).

(b) Generation and connection to the SIN (or SIEPAC)

Generate run-of-river hydroelectricity, own the secondary transmission line to connect the hydropower plant to the SIN (LIE, Art. 26), and sell electricity according to Presidential Decree 279-2002 on the spot market.

Create a utility to generate, transmit (wheeling charges may apply), distribute, and sell run-of-river hydroelectricity in a local grid outside the concession area of the distribution concessionaire (in the "open area"), provided that generation capacity does not exceed 10 MW (LIE, Art. 34). Sell surplus electricity to the SIN through utility's own secondary transmission line under the provision of Decree 279-2002.

Generate hydroelectricity and sell it based on direct contract to a large consumer if capacity is greater than 2 MW (as of January 2005, greater than 1 MW) and less than 10 MW (LIE, Art. 31, 49).

Generate medium and large plant hydroelectricity and sell it to the distribution concessionaire based on contract (PPA); or export electricity based on international contracts.

(ii) Options for the distribution concessionaire

Invest in a hydropower plant with capacity below 10 MW and transmit (wheeling charges may apply), distribute, and commercialize hydroelectricity in its own concession area (LIE, Art. 34).

Recommendations

1. Adjustment of the definition of a Large Consumer (Gran Consumidor) from a present minimum demand of 2 MW to 1 MW as of January 2005 will increase the opportunities for development of small hydropower plants with capacities larger than 1 MW.

However, further lowering the minimum demand of a Large Consumer to 500 kW (as in Guatemala) would open up additional market opportunities and increase the attractiveness of mini hydro plants below 1 MW.

2. A Large Consumer can connect directly to the transmission system (Regulation of LIE, Art. 50). In that case there is no obligatory contractual relationship with the distribution concessionaire and the Large Consumer gets instructions directly from NCDC, the Cento Nacional de despacho de Carga (CNDC) which also controls these direct contracts. It may worth analyzing the consequences of reducing the lower limit of 69 kV for transmission lines in order to reduce the wheeling costs which would have to be charged on the tariffs.

3. Consider increasing the generation limit from 10 MW (LIE, Art. 31) to 20 MW, but only for electricity generation based on run-of-river hydro plants or wind power plants. This will increase the attractiveness of investments in hydropower (and wind power as well) for private investors as well as for the distribution concessionaire Union Fenosa (UF).

Summary of licenses, concessions, and permissions for small-scale hydropower plants

59. Table 1 summarizes the present situation with regard to the granting of licenses, concessions, and permits for hydropower plants.

Table 1: Current Licenses, Concessions, and Permits for Hydropower Plants

Generating capacity of hydropower project [MW]	Generation license (from INE)	Water concession (from MIFIC)	Environmental permission (from MARENA)	Direct contracts with Large Consumers possible (limits determined by INE, contracts administered by CNDC)
0,1–1	✓	✓	✓ *	No
1–5	✓	✓	✓ *	With consumers > 2 MW **
5–15	✓	Pending	EIA	✓
15–25	✓	Pending	EIA	✓
> 25	✓	Pending	EIA	✓

Notes:

✓ Can be obtained under the existing legal and regulatory framework

EIA Environmental Impact Assessment Study required

* Only permission without EIA

** Only with consumers with demand above 2 MW and voltage of at least 13.8 kV (above 1 MW as of January 2005)

60. Table 2 compares key areas for hydro development in Nicaragua and other countries.

Table 2: Key Areas for Hydropower Development in Nicaragua and Other Countries

Success factors for hydropower development	Legal framework and practice and experiences in other countries	Existing legal framework and practice in Nicaragua
(1) Water rights and water usage fees	No water concession is required for plants < 1MW. If water or head is needed by other project of national interest, water right is revoked and hydro project is duly compensated. Such risk can be reduced by a water resources masterplan and capacity building in water resources planning.	Law 476 (Promotion of Hydroelectric Subsector) stipulates the following: • Hydropower schemes below 1 MW do not need a water concession, but will get a permit for 15 years (according to new draft Water Law). • From 1 to 5 MW a simplified procedure applies to obtain a water concession from MIFIC. • Water concessions can be granted for up to 30 years and are extendable and transferable. • Existing water concessions were suspended in 2002 until the draft Water Law has been approved.
(2) Land acquisition and resettlement policy	Governments assist in negotiation with stakeholders. Developers can rely on the application of standard government land prices (or long-term lease fees) and compensation fees for crops.	Land issue is not regulated in the existing legal and regulatory framework.
(3) Environmental clearances	Simplified environmental examinations have been defined by a number of countries for small hydro plants between 3 and 6 MW.	Law 217 (General Law of the Protection of Environment and the Natural Resources) stipulates the following: • The law requires the issue of an Environmental Permission from MARENA. • Power projects < 5 MW do not need an EIA. • Power generation plants > 5 MW, irrespective of its energy source, require an EIA.
(4) Grid connection policy	Grid operators are always obligated to accept the generated power from small private hydro producers.	Decree 279-2002 and Resolution 07-2003 stipulates the following: • There is preferential dispatch of wind and hydropower, limited to 5 percent of the maximum national demand. • Incentives payment are made for nondispatchable energy of 70 percent of the difference between the hourly wholesale price of the electricity (including auxiliary contracts, services, and the the spot market) and the hourly price of the spot market.

(5) Import policy for electromechanical equipment	Duty-free import of electromechanical equipment and components must be granted to SHP developers for a successful and sustainable hydropower development.	Law 476 (Promotion of Hydroelectric Sub-sector) stipulates the following: • For new hydropower projects the law exonerates equipment, materials, and other accessories for generation, transmission, and distribution for isolated systems from various taxes and duties for up to 15 years.
(6) Company registration and foreign investment policy	Full documentation of the company background, information on the sources of funding and signing of an implementation agreement (with security fees or bonds) are required by most host governments. In some countries, restrictions for foreigners have been specified in order that the exploitation of small hydro resources can be taken up by local investors and sponsors. Successful small private hydro programs are mostly based on a build-own-operate (BOO) concept.	CNE has developed a prequalification procedure for project tenders in order to screen suitable developers. There are no restrictions for foreign investment in the energy sector.

Policy and Strategies for the Promotion of Hydroelectric Projects

Policy and strategy considerations

61. Hydropower development has a large potential to meet a considerable share of future electricity demand in Nicaragua. The increased exploration of hydropower potential will help shift the present thermal-energy-dominated electricity generation toward a more sustainable, environmentally friendly, and macroeconomically beneficial electricity generation mix.

62. The strategy to develop the hydropower sector can be formulated as follows:

63. **The main objective of hydropower development is to establish an environment that is conducive to making maximum use of the hydropower potential.**

64. The achievement of that objective requires these conditions:

- An integrated sector approach
- A sufficient time horizon (minimum 10 years)
- Specific strategies for the different market segments.

65. The Nicaraguan government has declared that hydropower development is an important part of its energy policy. However, legal, financial, and technological barriers still exist and reduce the attractiveness for of hydropower to private developers. To

implement the envisaged energy policy, these barriers have to be removed. The government, through CNE, is required to implement or delegate specific activities in the short-, medium-, and long-term outlook as outlined in Chapter 4 of this report.

66. Hydropower plants can serve all segments of the Nicaraguan electricity market, be they rural isolated grids, the national grid (SIN), or the upcoming Central American system SIEPAC. To develop these market segments the following sector strategy is recommended:

Rural decentralized electrification (< 1 MW)

67. Rural decentralized electrification is mainly the domain of nongovernmental organizations (NGOs), self-help organizations, and communities. It is not attractive for private sector involvement due to the low electricity consumption, low purchasing power of the target groups, and low load factors of the hydropower plants. Required activities are as follows:

- Promote the work of NGOs, cooperatives, and communities in the field of mini hydropower development for rural electrification.
- Build up local expertise for planning, construction, operation, and maintenance of complete mini hydro plants (up to 1 MW).
- Initiate technology transfer of micro- and mini-hydro-turbine technology (mainly for Pelton and crossflow turbines), using proven mature designs.
- Support local manufacturing (for example, in workshops and craft centers) of pico and micro hydro turbines (up to 100 kW).
- Promote local manufacturing of hydromechanical structures like sluices, valves, gates, and penstocks.
- Promote local fabrication of posts and electric accessories for the local low-voltage distribution grid.
- Import the more sophisticated components, like electronic load controllers, from experienced producers.
- Promote informal capacity building in operation and maintenance of small hydropower plants up to 25 MW.

Grid-connected small hydropower (1–25 MW)

68. Grid-connected small hydropower is interesting for national private investors. To develop this sector, the following additional activities are necessary:

- Prepare or update the pipeline of projects and present it to interested investors (by way of a hydropower investment guide), with particular focus on the ready-to-implement subsector below 5 MW.
- Update or prepare feasibility studies for the projects in the updated pipeline.

- Assist private investors in obtaining licenses and concessions.
- Provide tailor-made information and training to the staff of financing institutions to educate them in technology and risk assessment.

69. The consultant believes that there is presently no need to elaborate a new hydropower master plan. Instead, the government should update the project pipeline, improve its reliability by correcting project data, and increase the level of project planning by upgrading projects from pre-feasibility level to feasibility level.

Grid-connected large hydropower (> 25 MW)

70. Grid-connected large hydropower is the potential market for larger hydropower development targeting international investors.

71. In addition to the implementation of the strategy discussed above, which would considerably improve the investment climate in Nicaragua, CNE is required to assist developers with any legal and environmental aspects but particularly those dealing with any problems arising from the draft Water Law.

Conclusions

72. Based on this review and analysis of the hydropower sector in Nicaragua the following main conclusions can be drawn:

a). There is a large untapped hydropower resource that is worth developing, particularity considering the country's dependence on imported oil products for electricity generation.

b). Experience with hydropower plants is limited to micro and mini hydropower projects during the recent past, and the two large hydropower plants of Hidrogesa.

c). There are a large number of identified hydropower projects, but only a few of them have been studied with satisfactory results. Most of these studies were either done as desk studies or at the pre-feasibility level only.

d). The hydrologic data base for many of the identified projects is weak, and data from the hydropower sites are either missing or incomplete. Basic data of published project lists are often contradictory.

e). Existing legislation only allows development of hydropower plants up to 5 MW. Before projects with larger capacities can be developed, the draft Water Law must be passed.

f). The Nicaraguan government has made significant efforts to create an enabling environment for hydropower development. However, there are still barriers and obstacles discouraging private developers from engagement in this sector.

g). The clean development mechanism (CDM) can improve the economics of hydropower investment and should therefore be utilized whenever possible.

h). The hydropower potential is adequate to serve all segments of the electricity market: rural decentralized small grids, grid-connected hydropower to feed into the national grid SIN, and large hydropower with the potential for export once SIEPAC commences operation.

i). Based on the market segmentation just described, the consultant proposes concentrating further study on the small hydropower market of 1 to 25 MW with emphasis on the two subsegments 1 to 5 MW and 5 to 15 MW. These segments seem to be more attractive for private investors in the short and medium term than the larger projects from 15 to 25 MW that require a longer-term planning horizon.

73. Nevertheless, the proposed hydropower development strategy includes also looking at 15 to 25 MW plants, as well as promoting large projects in view of the future market opportunities that SIEPAC will offer to market participants.

Recommendations regarding the strategy to promote hydropower development

a). As outlined in the Executive Summary (Task 2), it is recommended to concentrate short-term hydropower development on the promotion of projects with a chance to attract the interest of the private investment sector. However, the government should first solve existing difficulties with the interpretation of Decree 279-2002 and the Law of Promotion of the Hydroelectric Sub-sector. This is the SHP market segment of 1 to 5 MW.

b). The segment of 5 to 15 MW will also attract private national investors However, the draft Water Law will have to be approved before any development will happen. This sector is attractive for consortia of national investors.

c). In the 15 to 25 MW segment, two projects, Larreynaga (17 MW) and Pantasma (24 MW), have already attracted the interest of investors and need to be proactively pursued by CNE.

d). Projects greater than 25 MW comprise the 13 projects suggested by IFC, of which the projects Valentin (28 MW), El Carmen (100 MW), Piedra Fina (42 MW), and Corriente Lira (40 MW) are planned for implementation according to the Indicative Program of the Electricity Sector in 2003–2014. CNE consequently should further the development of these projects by supporting potential investors in all stages of project development.

74. Recommendations for improving the legal and regulatory framework were summarized earlier in this report. The following additional recommendations discuss how to remove existing economic and technical barriers and complete the hydropower development strategy proposed for Nicaragua.

Recommendations for economic and technical barriers

a). The government should enable CNE to fulfill the “one-stop clearinghouse” function by providing an adequate financial budget to sustain the operation of CNE.

b). CNE should help developers secure access to financing by expediting licenses and concessions, land acquisition, and access to foreign technical assistance.

c). CNE should consider providing subsidies through financing of transmission lines and access roads.

d). CNE should prepare hydropower projects through collection of reliable flow data and elaboration of feasibility studies (with its own personnel or hired consultants).

e). In close coordination with the Instituto Nicaragüense de Estudios Territoriales (INETER) CNE should take first steps to secure and improve river flow measurements for high-priority sites on their project list in the investment guide.

f). This activity may require that CNE acquire suitable software for evaluation of flow measuring data as well as training in applying the respective methods.

g). Capacity building should be incorporated as an essential component in the proposed development program for hydropower projects in the ranges of 1 to 5 MW and, in the medium term, 15 and 25 MW.

1

International Experiences in Hydropower Development (Task 1)

Overview

1.1 In deregulated power markets, hydropower projects are finding it difficult to compete with thermal power generation alternatives. If developed along the lines of an independent power producer (IPP) model as has been successfully used for thermal power, the hydro option is not attractive for the private sector (with the exception of captive and off-grid plants). A more responsive approach is needed for hydro, and particularly for private small hydro development, to thrive.

1.2 This section summarises the experience of other countries in supporting the development of small hydropower projects by the private sector. While any private infrastructure development is a challenge for all stakeholders, the case of small hydropower features additional issues for which different countries have found a variety of solutions. These issues are:

- Regulatory and promotional issues
- Project identification and definition
- Project risks
- Power purchase agreements
- Financing constraints and project set-up
- Project implementation schemes.

1.3 These issues and challenges are further specified in the following sections, followed by relevant experience from developing countries and countries in transition.

Regulatory and Promotional Issues

1.4 Hydro resources are generally regarded as state properties and exploitation by the private sector must be regulated in order not to impede wider development objectives. Most countries are struggling in defining a regulatory framework that is conducive to small hydro development but does not distort market conditions of the power sector. Clear rules of the game and a variety of incentives are required for the private sector to take up the opportunities of the small hydro sector.[1]

1.5 Generally, there are six different areas of statutory regulation to be defined by governments in order that small hydropower development by the private sector can take place:

- Water use rights and water use fee
- Land acquisition and resettlement policy
- Grid connection policy
- Environmental clearances
- Company registration
- Import policy for electromechanical equipment.

1.6 Promotion of small hydro development by the private sector starts with the definition of clear regulations as outlined above. As international experience shows, without complete certainty as far as policies and regulations are concerned, developers and sponsors do not pick up projects. Further incentives (for example, in the form of cash support for feasibility studies) cannot make up for an incomplete regulatory framework. A detailed discussion of these issues and their respective conclusions follows in Chapter3.

1.7 The host utilities often cut down or even boycott incentive schemes if there is concern that private sector projects will undermine the financial viability of existing utility assets and operational structures.

Project Identification and Definition

1.8 Project identification under the traditional public sector utilities did not focus on small hydro in the range below 10 MW, because such projects—individually—rarely contribute to the needs of the national grid. Usually only projects above 10 MW are studied up to feasibility stage by the grid operator or national utility, followed by soliciting bids from the private sector for implementation.

[1] Between 1991 and 1996, hydropower generation projects accounted world-wide for only about 2.5 percent of new private power projects, including small hydro.

1.9 For a private investor, the identification of small hydro project sites is a lengthy process with high front-end costs associated with the risk that a feasible and attractive project will not be found. Small hydro development with private sector participation *has been successful* in countries where a master plan with pre-identified sites has been published and promoted among private developers and investors.

1.10 The master plan serves two purposes: (1) it specifies sites that are not earmarked for other water development projects (large hydro, irrigation, water supply), and (2) it gives a first possible layout of an SHP project including head, flow, power output, distance to roads, and interconnection points or load centers. State authorities have to adopt a flexible approach with the potential developers. Private developers tend to optimise medium-term financial benefits which often lead to smaller, compact schemes that do not make full use of the total hydro potential. The state authorities' layout on the other hand often aims to maximize the annual energy produced. If authorities rigidly stick to their layout, no private SHP development will take place. But leaving the site selection completely to the private sector is not possible either. International experience shows that inviting the private sector to small hydro development at a very early stage, where no concrete projects are available, *does not work*.

Project risks

Hydrologic risk

1.11 Hydrologic records for extended periods (greater than 10 years) are seldom available at small hydro sites. In addition, even with good records, the occurrence of very dry years resulting in production deficits or exceptional flooding and subsequent plant damage cannot be predicted. In most cases, the hydrologic risk is solely carried by the developer, which is a heavy deterrent for investors.

1.12 Governments can ease such risks by maintaining a dense network of gauging stations and by assisting the private developer in obtaining all available records for to assist in hydrologic analysis.[2]

Construction risk

1.13 Cost and time overruns are common features in hydropower development. Geologic uncertainties and the exposure of the construction sites (including access roads) to flooding and landslides are inherently linked with small hydro development. Such risks have to be borne by the developer. Coverage by contractual penalties and insurance is common in industrialised countries but can unduly increase project costs in developing countries as their small hydro industries are still in an early stage of

[2] Utilities are not always cooperative in distributing stream flow data gathered by them in the past. For them, the opening of the electricity generation business to the private sector is sometimes considered a criticism of utilities' past performance; assisting these newcomers of the private sector would make them look even worse.

development. Hence, contractors and insurers (if available at all) tend to put too high a price on the risks passed on to them by the developer. It is often less costly for the developer to personally assume some site risks (such as geology and flooding) rather than passing responsibility to contractors in special contract clauses.

Design flaws

1.14 One reason for the slow start of private small hydro development in developing countries is lack of local engineering expertise. As hydropower is very site specific with no two projects being the same, standard engineering solutions are not possible and private developers are hesitant to invest in locally engineered schemes without quality control by experienced (overseas) companies.

1.15 For the lower range of mini or small hydro projects (less than 3 MW), an engagement of overseas experts is often too expensive and in many cases not advisable; such experts, when flown in for short periods from different areas of the world, may lack the local knowledge required to design a flawless scheme. This crucial issue has been solved by international development agencies providing technical assistance (TA) and quality control for all private developers virtually free of charge. Once this TA has been proven effective, it can reduce the perceived risks of private developers and effectively trigger investment decisions. This has been the experience in in Nepal, where German and Norwegian TA programs have been operational for many years. Experience also shows that international TA and quality control of plant design can help mitigate risk mitigation for banks involved in financing of hydro projects and increase their willingness to finance such projects.

Environmental risk

1.16 Compliance with national environmental rules and regulations is a basic requirement for small hydro development. Environmental issues can be complex and state agencies tend to emphasize a thorough study of project impacts and environmental mitigation. Due to the limited experience with small hydro, applicable norms are taken from full-scale hydro development and therefore the costs for such studies and mitigation measures can be excessive. Few countries have established precise instructions and expertise on environmental issues such as minimum residual flow requirements in the bypassed river section between intake and powerhouse.
1.16 Environmental agencies often resolve issues on a case-by-case basis, which creates additional uncertainties for project developers.

Power Purchase Agreements

1.17 The predictability of the tariff regime and sales conditions is critical for the private sector. In none of the countries with a small hydro promotion scheme is the private developer exposed to a fully liberalized power market. Preferential tariff schemes and associated model power purchase agreements (PPA) are published for grid-connected schemes. The starting point of such tariffs is generally avoided costs or long-run marginal costs as specified by the grid operator or national utility.[3] Where developers have to negotiate PPAs individually with the off-taking utility, private sector interest in small hydro is limited. Table 1.1 provides an overview of published tariffs for small hydro in selected countries.

Table 1.1: Published Power Purchase Tariffs for Small Hydro Development by the Private Sector

Country	Capacity limit	Tariff	
		Local currency	**US$ equivalent**
Nepal	100 kW to 10 MW	Wet season: Nr 4.25/kWh Dry season:[a] Nr 3.00/kWh	US$0.059/kWh US$0.042/kWh
Himachal Pradesh, India	< 3 MW (5 MW)	Rs 2.50 / kWh	US$0.055/kWh
Indonesia	< 1 MW	LV (Java-Bali):[b] Rp 345/kWh MV (Java-Bali): Rp 443/kWh	US$0.041/kWh US$0.052/kWh
Philippines	100 kW to 10 MW	Rates to be agreed upon by both parties, typically around ₱ 1.90/kWh	US$0.03.4/kWh
Sri Lanka[c]	5 MW increased to 10 MW after 2003	Wet season: SL Rs 4.91/kWh Dry season:[d] SL Rs 5.13/kWh	US$0.052/kWh US$0.054/kWh

LV = low voltage
MV = medium voltage
a. Dry season in Nepal is defined as between mid-November and mid-May.
b. The tariffs are higher for the outer islands of Indonesia.
c. Announced tariffs for the year 2002.
d. Dry season in Sri Lanka is February, March, and April according to the Ceylon Electricity Board (CEB), the largest national utility.

1.18 The purchase tariffs are not the only crucial issue of a PPA. The following points are equally important for private developers:

1.19 **Long-term PPA and price adjustment:** The term of standard PPAs is limited in most countries (Himachal Pradesh, India, 40 years; Nepal, 25 years) except in Indonesia (unlimited) where projects are very small and intended for village and community developers (less than 1 MW). Tariff escalation (dollar or oil price linked) is usually specified for the first 5 years from contract signing to allow the developer to meet his debt payments in situations with high inflation. A different approach is being used in Sri Lanka, where a non-negotiable small power purchase tariff computed by the national utility (based on avoided costs) governs the PPA. The tariff is estimated at the end of each year for the year ahead; the announced tariff is then given by the average of this estimate and that of the past two years. The disadvantage of this approach is that tariff and the methodology of calculation may be controversial because of disagreements about both the methodology and derived tariff level.

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3 Participating developers in some countries find that the purchase tariffs are biased in favor of the utility, which is suspected to state lower marginal costs than they actually have.

1.20 **Capacity payments:** In countries with successful small hydro programs that are reviewed in this report, there are no firm-capacity PPAs. Generally, the payment is based on bulk energy supply without consideration of capacity; that is, the utility has to keep capacity reserves in order to maintain adequate supply security. At many dispatch centers it is considered uneconomic to include small hydro plants below approximately 10 MW capacity in the dispatch regime of the grid operator. For small isolated (diesel) grids, this capacity limit may be much lower and the small hydro plant may have to assume grid stability and deliver firm capacity against proper reimbursement.[4]

1.21 **Obligation to purchase power—take-or-pay contract:** If the buyer or off-taker frustrates delivery due to instructions from the dispatch center or due to grid failure, the small hydro developer is at a loss. In Himachal Pradesh, India, and to some extent in Nepal, provision for so-called "deemed generation" is made. If the grid operator cannot take power from the small hydro generator for more than 20 days per year, he pays for an estimated amount of energy not taken off. Estimates are based on actual generation in previous years.

1.22 **Credibility of the buyer of power:** The financial standing of utilities and grid operators in a number of developing countries is relatively poor and small hydro developers fear they may never be paid for energy supplied. Himachal Pradesh, India provides government guarantees in the event of a default by the public grid operator.

1.23 **Change of law:** Private small hydro development is still in a state of evolution and adjustment of legislation is to be expected in most countries. This risk is charged almost exclusively to the private developer except in the standard PPA of Nepal where, in case of change of law, provisions for reimbursing losses to either party have been made.

1.24 Off-grid hydro plants (less than 1 MW) have been developed by NGOs and village communities under donor-assisted programs in many countries. The financial viability of such mini hydro plants is only possible if end-user tariffs are not fixed by the government to match those of the national grid. These grid tariffs often contain cross-subsidized tariffs for the small household categories (lifeline rates) which are, however, the main customer categories of village hydro. Since plant load factors[5] in isolated village hydro schemes are usually below 40 percent, the tariffs charged to consumers must be (at least) about 2.5 times higher than the typical purchase tariffs presented in table 1.1 if a small hydro business is to be viable. As rural customers are

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4 The first small private power program (1997) in Indonesia included provisions for firm-capacity payments, but developers voiced concern about the complicated definitions. The question for small isolated diesel grids was who would be allowed to provide the base load, the small hydro or the grid operator.

5 The plant load factor is defined as the ratio between the energy actually sold to consumers and the energy that the plant could generate gi ven its capacity and available stream flow; the reference period is usually one year. The plant capacity factor is the ratio between the annual mean load and the installed capacity of the plant.

typically unable or unwilling to pay more than US$0.12/kWh for electricity, the private sector does not take up small hydro development for off-grid rural electrification without substantial subsidies by donors or the government. In off-grid situations, economies of scale do not work since larger plants (over 1 MW) need to add extensive transmission lines (medium- to high-voltage) in order to reach distant load centers for their larger output. For this reason, micro hydro plants (less than 100 kW)—which are not covered in this study—perform best in off-grid situations, as shown by successful programs in Asia (especially Nepal and Indonesia) and Latin America (for example, Bolivia and Peru).

Financing Constraints and Project Set-up

1.25 Small hydro is highly capital intensive and the private sector is faced with the task of raising large capital sums to meet these up-front costs. Typical costs of grid-connected small hydro schemes in the range below 10 MW, where some experience from implemented projects is publicly available, are summarized in Table 1.2.

Table 1.2: Investment Costs for Grid-Connected Small Hydro Plants with Figures from Sri Lanka, India, Indonesia, and Nepal

Investments	Cost
Civil works	US$500 to US$1,000/kW
Electromechanical equipment	US$400 to US$1,000/kW
Transmission lines, transformation, grid connection	US$20 to US$100/kW
Project planning and design, site supervision, project management	US$100 to US$200/kW
Total costs	US$1,020 to US$2,300/kW

Note: High-head plants have lower costs; Low-head plants or remote sites have higher costs.

1.26 Annual operation and maintenance (O&M) costs vary between US$50 to US$80 per kW of installed capacity for schemes below 1 MW; for larger schemes in the 10 to 20 MW range, O&M costs of around US$25 per kW have been reported.

1.27 In order to attract the private sector to small hydro development, the availability of long-term financing is crucial.

1.28 For pure grid-connected projects without captive use in a factory or plantation, most small hydro developers establish locally incorporated special-purpose companies. The project must then be financed purely on the strength of its cash flow. There is thus little to no recourse to the developers' assets or parent company balance sheets. Such conditions make it difficult for commercial banks to provide loans.[6]

[6] The Central American Bank for Economic Integration (CABEI) already finances hydro projects in neighboring countries and seems willing to finance hydro projects in Nicaragua as well (such as El Bote). However, CABEI requires from the borrower 150 percent collateral of the loan amount, which presents a major hurdle for potential private developers.

1.29 Special-purpose small hydro companies have been developing and operating SHP plants for many years. Successful examples are known from Europe but also from the Philippines Hydro Electric Development Corporation, HEDCOR). They operate in much the same manner as commercial industries. Each project or product moves through a distinct cycle from a high-cost development stage, to full production with loan payback, to a "cash-cow" stage where expenditure is down to pure O&M costs and surplus revenue can be used to finance new projects. The risk profile of such special-purpose companies owning and operating several SHP plants in parallel is also very favorable: If one plant experiences long downtimes due to flooding or equipment failure, the company as a whole is not at risk as would be a company with only one project. It has been shown that only companies with a multitude of SHP projects at different stages of maturity can thrive in a competitive market with other power generation technologies or large scale hydro. It must be the objective of any SHP development program to attract private developers with a long-term commitment to the sector and not those with a one-off project in mind.

1.30 This conclusion supports the proposal to promote the market segment of plants up to 5 MW in the short run, because the development of several smaller projects rather than one single large project distributes and minimises the risks for a private company.

Project Implementation Schemes: EPC Contract versus Single Contracts

1.31 In Nepal and elsewhere there has been a strong move towards EPC (engineering, procurement, construction) contracts, where a single contractor assumes overall responsibility from detailed design to implementation and commissioning. The risk of a mismatch between design, equipment supply, and construction is thus taken away from the developer. This aspect is not always beneficial: In the tendering stage, each participating contractor joins up with engineering companies and equipment suppliers known to him or her and together they produce a joint offer. Though it may be clear that the winning contractor has a suitable overall concept and lowest price, individual items (such as intake design or turbine selection) may not be the most suitable ones for the particular project. There is no competitive evaluation for each individual item.

1.32 In addition, the EPC contract by definition leaves most design aspects to the contractor. If an EPC contractor runs into difficulties such as geologic matters, land issues, or a flooded construction site, the contractor tries to get compensated for such "unexpected" events. Settling these disputes can drag on for years since the developer is bound to the EPC contractor and cannot buy from another source as is always possible with single-discipline contracts.

1.33 Another difficulty of the EPC approach may be to find suitable contractors that are willing to enter such contracts. In particular, the smaller hydropower plants (less than 1 MW) are often not attractive for international contractors as their operational costs are too high compared to the sum of the contract. Furthermore, in some developing countries there are few if any local contractors that have the capacity and capability to implement such contracts successfully. As a result there may be a lack of real competition which tends to increase cost and compromise quality of work.

1.34 The experience with EPC contracts in the small hydro sector is therefore mixed. The expected risk avoidance and cost reduction for the developer has either not been achieved or the lower cost came at the expense of reduced quality of the work.

1.35 The conventional arrangements with a series of single-discipline contracts has proven to be advantageous, especially in those cases where the developers and their engineering consultants have ample experience in the hydro field, or where technical assistance programs are available to properly judge risks and guide the developers through the project implementation and decision-making process.

Country Experiences

Brazil

1.36 In Brazil hydroelectric plants between 1 and 30 MW are classified as small hydropower plants.Provided the associated reservoir is not larger than 3 square kilometers, small hydropower plants require only a simple licence, which is granted to the first suitable applicant. In exceptional cases, however, public auctions may also be held. Licences are granted for a length of time that allows reasonable refinancing of the investment, but for no more than 35 years.

1.37 The PCH program (small hydropower plants between 1 and 30 MW) as part of the Structural Programme to Expand the Supply of Electricity 2001-2003 (Programa Estruturado de Aumento da Oferta) includes a provision for the construction of 847 MW of generating capacity.

1.38 The following incentives for small hydropower were put in place:

- Only 50 percent of the normal tariffs are to be paid for electricity transmission and distribution.
- A 100 percent allowance is granted for small hydropower plants that enter operation by 2003.
- Samll hydro plants are exempt from compensation payments for submerged land.

1.39 Consumers with demand of 500 kW or more can negotiate free contracts. The program for the development and commercialisation of electricity from small hydroelectric plants (PCH-COM) was launched in July 2000, with the intention of building new plants of this type with a connection to the grid or reviving existing plants. Eletrobrás, the government-controlled holding company responsible for implementing Brazil's electric power policy, guarantees that the electricity will be purchased, while the state development bank BNDES (O Banco Nacional de Desenvolvimento Econômico Social) finances up to 80 percent of the investment costs through loans.

Chile

1.40 In Chile, the use of hydropower has a long tradition, mainly in the micro and mini hydro sector in the southern regions. The use of hydropower was heavily influenced by Europeans who settled in Chile and transferred the technology. These plants were usually privately owned and operated either as stand-alone systems or in local mini grids. Recently, with support of the CNE and in conjunction with regional authorities, some micro hydropower demonstration projects have been implemented in indigenous communities on the Bio-Bio river (Region VIII).

1.41 Larger hydropower plants have been installed during the last decades mainly in the Bio-Bio region.

1.42 At the end of 2000 there was a total of 10,079 MW of generating capacity installed in the public supply sector, of which 6,038 MW comprised thermal power stations and 4,041 MW hydroelectric plants. IPPs provide approximately another 340 MW.

1.43 Gross electricity generation in 2000 in the public supply sector amounted to 39,290 TWh; with a very high generation capacity growth rate at some 8.5 percent per year.

1.44 Despite this rapid expansion in capacity, between the end of 1997 and May 1999 a period of extreme drought resulted in a far-reaching supply crisis and rationing of electricity distribution. This led to a new Electricity Industry Act, adopted in November 2001, which provides the legal basis for governing the connections between the various distribution systems and defines responsibilities in the event of a failure of supply.

1.45 As a result of the lack of precipitation and the growing significance of fossil energy sources, electricity generation from thermal power stations exceeded that from hydroelectric plants for the first time in 1998. In the following year, too, the importance of electricity from hydropower was considerably below the average for the previous years.

1.46 Micro, mini, and small hydropower important again for rural electrification. Of Chile's population of about 15 million, some 15 percent (2.2 million) live in rural areas. At the end of 1994 the CNE launched the Programa de Electrificación Rural (PER), under which rural electricity coveragereached about 78 percent in 2000.

1.47 The PER program is heavily decentralised and lets regions devise, evaluate, and finance suitable projects. Each project is subjected to a rigorous assessment in order to determine the level of private investment and the corresponding assistance funds, both of which are linked to the achievement of positive social impacts.

1.48 When the new government came to power the program was extended to the end of 2005, and a coverage rate of 90 percent was set as a new target. Between 1995 and 1999, around 90,000 households were either connected to the public supply or equipped with individual solutions (usually diesel generators). Altogether US$115 million of government funds were expended on this expansion of coverage.

1.49 At the end of 2000 the coverage rate was up 78 percent, but there were still about 123,000 households without access to electricity. While 88,500 of them probably could be connected to the conventional grid, the remaining 48,500 households could be supplied either individually or through small isolated networks from renewable energy sources, partly from hydropower.

1.50 Local distribution companies play a major role in rural electrification. Licensing agreements are concluded for rural electrification, which commit the electricity supply companies to set up the supply scheme on behalf of the local authorities and operate it over a certain period (at least 30 years in the case of distribution networks and at least 20 years in the case of supplies from renewable energy sources).

1.51 The investment costs for generating plants and distribution lines under the PER are borne by the local governments (60 to 70 percent), the distribution companies (20 to 30 percent), and the users (10 percent). The electricity customers pay for the meter, the wiring in the houses, and for the electricity connection, and these payments can be made in installments along with normal tariffs.

1.52 The public funds come from a national fund for regional development (Fondo Nacional de Desarrollo Regional—FNDR), which was set up to develop the regions through various social sector projects. In 1995 a portion of the fund was reserved for financing rural electrification (FNDR-ER).

1.53 There are no incentive systems for renewable energy sources beyond the promotion of rural electrification. No specific legislation is in place either. Almost all activities in the electricity sector are subject to free competition and have to establish themselves on the market through economic efficiency.

1.54 For electrical systems with a power requirement of 1.5 MW or less, the law prescribes the agreement of maximum tariffs between the local administration and the distribution company.

1.55 Hydro projects with a capacity of less than 3 MW require an Environmental Impact Assessment (EIA) or only an Environment Impact Declaration (Declaración de Impacto Ambiental—DIA) depending of the magnitude of the impact which is specified in the respective environmental legislation.

1.56 The legal base for hydropower development is the 1981 Código de Aguas (Water Law), which has a strong market orientation. The Law privatized the water rights and, for the first time in Chile, it separated water rights from land rights. This law defines water as a national good of public use whose rights of use are granted by the Dirección General de Aguas (DGA), a unit of the Ministry of Public Works. After granting these water rights, the state does not intervene anymore. The redistribution of rights takes place through transactions between individuals and thus creates the "the market of the water."

Dominican Republic

1.57 To promote the use of renewable energy including small hydropower, at the end of 2000 the Dominican government passed a law on the taxation of consumption of fossil energy sources and petroleum products. From the tax proceeds, a special fund for the regulation of renewable energies and energy-saving programs was created, starting with 2 percent of the revenue in 2002 (approximately US$8 million). The proportion of tax proceeds given to the fund will increase by one percentage point every year until it reaches 5 percent.

1.58 Additionally, a draft of an incentive law for the development of renewable energy sources was submitted to the National Congress for debate in October 2001. Along with other renewable energy sources, the draft law relates , to small hydro plants up to 10 MW. Among other measures, this new incentive law proposes tax exemption for imports of plants and systems for exploiting renewable energy for a period of 5 years, a 5 year exemption from taxes on earnings from electricity generation on the basis of renewable energy, and accelerated depreciation of corresponding generating plant equipment for a limited period.

1.59 Preferential arrangements are also envisaged for feeding into the national grid. In the event of falling oil prices, tradable compensation payments (bonds) are to be introduced in order to maintain the competitiveness of renewable energy sources.

1.60 In the Dominican Republic, the Instituto Nacional de Recursos Hidráulicos (INDRHI), which is also the licensing authority for use of water resources, has identified and developed a comprehensive portfolio of possible small hydro projects in the range of 100 kW to 2 MW. These projects are ready for implementation and and can be offered to the private sector for investment. However, only small hydropower potentials below 1 MW can be developed and exploited by private developers; hydropower resources above 1 MW may only be developed and operated by the state-owned company EGEHID (Empresa de Generación Hidroeléctrica Dominicana).

Guatemala [7]

1.61 Beginning in the 1970s, Guatemala became heavily reliant on hydropower with the construction of large hydroelectric dams (especially Chixoy, which provides a large percentage of the country's power). By 1990, hydropower accounted for 92 percent of Guatemala's total electricity generation, with oil and diesel-fired plants accounting for the rest.

1.62 By the end of 1998, the total installed capacity in Guatemala was 1,358 MW and electricity generation was 4,563 GWh. Demand grew at an average 9.3 percent per year in the period 1991-1997, but growth is expected to slow a little during the next decade. The electrification level of the country as a whole is only 66.7 percent, and 52.3 percent in the rural areas. The system behaves as a sole market and will be part of the Central American Interconnected Market (SIEPAC) as of 2006. As a result of the General Electricity Law (Decree No. 93) ratified by Congress October 1996, the government moved out of most of the commercial activities. The Instituto Nacional de Electricidad (INDE) and Empresa Eléctrica de Guatemala Sociedad Anónima (EEGSA) have unbundled generation, transmission, and distribution activities. EEGSA privatized its generation and distribution companies in mid 1998; eighty percent of the government's shares in EEGSA's distribution assets were privatized. INDE privatized its distribution companies at the end of 1998 by selling them to Spain's Unión Fenosa Group; however, INDE retained ownership of the hydro generation assets and the transmission network.

1.63 The regulatory commission (CNEE) created in 1996 as an independent agency under the Ministry of Energy and Mines (MEM) sets the rules and procedures for the market; and oversees the behavior of the different market agents. CNEE is in charge of regulating the electricity law, overseeing the market, and defining the transmission and distribution tariffs.

1.64 The MEM is in charge of setting sector policies. The administration of the wholesale market is currently under the transmission company, but will be transferred to a new privately owned independent company.

1.65 Municipal utilities that are not of private or mixed ownership and enterprises possessing less than 5 MW of generating capacity are excluded from the unbundling rule. Large consumers with more than 100 kW are allowed to buy from any supplier.[8]

1.66 Competition is based at the wholesale level, at which companies compete in two markets: the deregulated contracts market and the spot market. More than half the installed capacity (700 MW) belongs to IPPs with long-term PPAs. Until 1997, most PPAs were unsolicited, and therefore were awarded without competitive bidding. Due to the fact that most of the energy has already been contracted via PPAs with

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7 Sources of Information: (1) IADB – The Power Sector in Guatemala and (2) Ministerio de Energía y Minas de Guatemala

8 This figure was recently reduced from 500 kW to 100 kW.

independent producers, competition in the wholesale market is restricted. Most of the private generation companies hold PPAs with either INDE or EEGSA.

1.67 Analysing the Guatemala case, it appears that the existence of PPAs between independent power producers and INDE or EEGSA was a factor for private sector involvement in the today's hydropower sector in Guatemala. In 1993 INDE signed its first PPA with a private 12 MW hydropower plant developer. The Guatemala Generating Group (GGG) has secured an 18-year PPA that allows the consortium to construct up to 150 MW of new capacity, with free choice of site, fuel, and technology. During the first phase of the PPA (3 years), GGG will sell EEGSA 80 MW of output from the existing units they recently acquired, thereby raising part of the cash needed to build the new plant, which will sell power on a dispatchable basis over the next 15 years.

1.68 Currently, INDE and EEGSA have around 1,000 MW (from hydro, thermal, and other sources) of capacity under 15-year PPAs with IPPs, co-generators, and self-generators. About 560 MW of that capacity is in operation. INDE resells this power to distribution entities.

1.69 The new wholesale market in Guatemala that started its operation in July 1998 was supposed to bring competition, as the market is open to new investors, and companies are free to sign contracts at agreed prices with their customers. The spot market is administered by an independent entity, which guarantees competition. Marketers, distribution companies, and large consumers are obliged to hold contracts that cover their capacity and energy requirements for both the current and subsequent year.

1.70 This restriction puts most of the generation under the contracts market. However, the number of long-term contracts already signed by INDE and EEGSA does not allow for the healthy operation of the market, and there is not enough new and noncontracted demand to promote the entrance of new investors.

1.71 Under the new General Electricity Law, no authorization is needed for generation units up to 5 MW of capacity. Larger units and plants that use public goods and resources require an authorization from MEM (for a maximum of 50 years). Temporarily licences for one year may be issued for studies, exploration, and measurements on a nonexclusive basis for projects related to potential generation units like hydro site studies.

1.72 In October 2003, the Guatemalan parliament approved a Renewable Energy Law (Decreto 52-2003) which creates incentives for power generation from renewable energies. The law was prepared by the Ministry of Energy and Mines of Guatemala and provides economic and fiscal incentives such as exemption of duty taxes on imports of relevant equipment and various degrees of tax exemptions for companies and individuals implementing such projects. For details see: www.mem.gob.gt/energia/index.htm

Honduras

1.73 In Honduras, the upper limit for small hydropower plants is 20 MW. The total installed generation capacity is 1,016 MW of which 43 percent is hydropower based. There 5 state-owned and 3 private small hydropower plants in operation. Presently, there are 15 new SHP under development or construction by private developers totalling 105 MW of capacity.

1.74 The Honduran government shows a strong interest in changing the existing legal framework. However, a new law proposing an open market for generation is not approved yet. The government also intends to privatize the distribution system, which is presently state owned by the (vertically integrated) public company ENEE (Empresa Nacional de Energía Eleléctrica).

1.75 The promotion of the hydropower sector began in 1998. The Ley Marco del Subsector Eléctrico from 1994 established a selling price for electricity under a PPA as being equivalent to the short-term marginal cost. The government established an incentive mechanism for renewables which offered payment of an additional 10 percent to the already established short-term marginal cost for all renewable-based generating plants below 50 MW and for all hydropower plants that contribute to flood control and thus to the watershed management of the country. Additionally, investors were exempted from paying sales taxes on equipment, materials, and accessories during construction time and from paying import taxes and duties on equipment and accessories during the study and construction period. Investors are also exempted from net income tax for a period of five years after commercial operation started.

1.76 Since 2001 there has existed a dispatch guarantee for electricity generated in hydropower plants below 50 MW. ENEE is obliged to buy from these private producers. However, this arrangement will change once the new electricity law comes into force and ENEE is sold to a private owner.

1.77 In October 2003, the Banco Centroamericano de Integración Economica (BCIE) announced a cofinancing arrangement with the government of Honduras worth US$8.3 million (48 percent of total investment) for a new 12.2 MW hydropower plant. The plant is intended to save Honduras US$1.2 million per year, money which otherwise would be spent on the import of fossil fuel. The electricity will be sold to ENEE over a period of 15 years. Other benefits of the plant will be the creation of about 200 jobs for two years, and the mitigation of 26,000 tons of CO2 per year. Additionally, the project will manage the 115 square kilometer watershed area of Rio Cuyamapa.

1.78 One main factor in the success of private engagement in hydropower development was the elaboration of the Power System Master Plan, which was done in the early 1990s with the support of the Canadian International Development Agency (CIDA). Before the Master Plan existed, the energy sector was fragmented by studies and site inventories. All present private hydropower developers select their sites in accordance with the Master Plan.

India

1.79 Small hydropower in India includes plant capacities between 100 kW and 25 MW. As of March 2003, small hydropower plants ("small hydel," up to 25 MW) with a total output of 1,509 MW out of an estimated capacity of 15,000 MW were installed and operational. The hydel sector in India has shown steady annual growth in recent years of some 6 percent.

1.80 In the mid-1990s, the Indian government opened up private sector investment in small hydropower development, an area hitherto reserved for government operations. Himachal Pradesh (H.P.) is among the few Indian states that has streamlined procedures for private sector participation in small hydro development of 100 kW to 5 MW. In three consecutive tenders between 1996 and 2000 covering over 250 sites, the H.P. government allotted 69 projects (at reconnaissance level) to private companies for detailed investigation and implementation. Under the H.P. regulation, there are a number of cash incentives (reduced royalty for water use, reduced wheeling charges for captive power, land compensation according to Government rules and income tax exemptions) as well as non-cash incentives (facilitation for expediting permits and clearances). Up to now, only two private sector projects under this incentive scheme have entered the construction stage in H.P.

1.81 In H.P. the private sector was invited to select small hydro projects from a list of government-identified sites for development. Developers signed an MOU with the Himachal government and are given two years to establish a detailed project report (DPR), which forms the basis for all government clearances, certificates, and the PPA with the utility.

1.82 To promote, support, and accelerate the development of small hydro in India by tapping the potential available in the hilly terrain, rivers and streams, irrigation dams, and canal falls, the Indian Renewable Energy Development Agency (IREDA) provides concessional loans (up to 70 percent of projects cost). For hydro projects below 25 MW the loan interest rates are currently between 13.75 percent and 14.25 percent, and loan duration is 10 years with a grace period of 3 years.

1.83 IREDA also provides assistance for project preparation. Incentives are paid for a DPR, including detailed surveys and investigations showing the technical soundness of the project, its least-cost design, and a financial rate of return not less than 12 percent. Currently, these incentives amount to Rs 200,000 (around US$4,500) for projects between 1 and 5 MW in hilly areas. Small hydro developers have made heavy use of these incentives but few have reached the implementation stage in hilly areas. Apparently, project risks are considered too high for the developers despite the attractive loan conditions.

1.84 An interesting approach taken by H.P. is the banking of energy. When a private small hydro developer uses the generated power in his own factory in H.P. (captive use), a balance between the hydro output and the factory consumption is only computed for the whole year and not on an hourly or daily basis. Hence, if the hydro supplies very little power during an exceptionally dry season, it can make up for the deficit during the wet season and reduce the loss to some extent.

1.85 Mini and small hydro plants (less than 25 MW) based on irrigation canals implemented by the private sector in the central and southern states of India are more advanced, despite the lack of state incentive schemes. This relative success can be explained to some extent by the fact that the hydrologic risk is smaller in irrigation canals where the flow regime is usually known, based on irrigation rules and existing flow data. In the Himalayan states where specific incentive schemes have been set up, notably in Himachal Pradesh, the difficulty in defining attractive projects can be attributed to (1) the difficult site access, especially in winter; (2) the absence of long-term flow data for the rivers where small hydro sites are located; and (3) the challenging site conditions with alpine characteristics where most smaller Indian hydro consultants and contractors have limited experience to date.

Indonesia

1.86 In Indonesia, small-scale hydropower includes micro hydropower (plants with capacities of up to 100 kW, not part of this study), mini hydropower (100 kW to 1 MW), and small hydropower (1 MW to 10 MW).

1.87 In August 1996, the Indonesian government announced regulations governing small private power producers (PSKSK) selling to the national grid operator Perusahaan Listrik Negara (PLN). Tariffs were based on PLN's long-run marginal cost for the different regions and islands of Indonesia. The tariffs also differentiated between peak and off-peak as well as medium- and high-voltage supplies. The legislation was valid for plants up to 30 MW; priority was given to renewable energy resources including small hydro.

1.88 Due to the financial crisis of 1997 and subsequent economic downturn, political changes, and litigation between PLN and a number of large thermal IPPs, this excellent model for small private power producers was abandoned.[9] A new version, the so-called regulation on small distributed power (PSK), was issued in June 2002. Under this new regulation, the national utility PLN is obliged to purchase energy from renewable energy generators with a capacity not larger than 1 MW.

1.89 Presently, only two village cooperatives have signed contracts for mini hydro schemes (less than 100 kW) for interconnection under the present PSK legislation.The first of these projects was successfully commissioned in October 2003.

1.90 Generally, small-scale hydropower development in Indonesia is far below its potential. One reason may be the bad experience of the large thermal IPPs during the crisis in 1997 and the following years when PLN was unable to pay the tariffs previously agreed on in the PPAs. Moreover PLN today still is financially weak and

9 The PSK was based on a draft regulation established with World Bank support

thus often not regarded as trustworthy by both private investors and financing institutions.

1.91 A promising development in the micro and mini hydropower range has resulted from long-term technical assistance in this sector (mainly through GTZ). Under the various TA programs local capacity to implement small-scale hydropower plants was built. A recent result was an off-grid mini hydropower plant (250 kW) with local content of around 90 percent that was implemented in 2002 by a private investor to supply an isolated tea estate with electricity.

Mexico

1.92 Unexploited hydropower resources in Mexico are quantified at 11,500 MW, including an estimated 3,250 MW from plants with less than 10 MW capacity. These small hydropower plants used to be widespread, but were gradually closed due to permit-specific or other reasons. At the end of 2000 only seven small hydropower plants with 84 MW total capacity were in operation.

1.93 The fact that non-conventional renewable energy sources are not prioritized and the lack of a separate set of rules and regulations currently render large-scale exploitation difficult. The monopoly enjoyed by the state utilities, and the political constraint that electricity must be purchased or generated at the lowest possible costs and ideally only from "safe" production sources, represent an almost insurmountable obstacle. Moreover, unclear or lacking provisions in construction and planning law, as well as a lack of experience among public authorities and developers, doom both large- and small-scale hydro projects to failure at the outset.

1.94 The tariffs offered generally do not allow commercially viable operation, especially since deductions have to be accepted for nonfirm capacity. However, projects for autonomous supply could be of economic interest, provided that electricity purchase prices are sufficiently high, and generation at the point of consumption holds out the prospect of lower electricity costs.

1.95 Foreign companies can own up to 100 percent of projects in sectors of the energy industry that do not belong directly to the public power supply. However, the consent of the Comisión Nacional de Inversiones Extranjeras (national commission for foreign investments) is necessary for shares above 49 percent.

1.96 The Comisión Federal de Electricidad (CRE) recently adopted rules concerning the setting of transmission tariffs and other specific issues connected with supply and carriage of intermittent electricity from renewable energy supplies (hydropower, solar, and wind energy). According to these rules, operators of installations with more than 0.5 MW only have to pay 30 to 50 percent of the costs normally incurred for connections and electricity transmission. It remains to be seen whether this arrangement will advance further projects, particularly in the field of hydropower.

Nepal

1.97 In Nepal small-scale hydropower includes plants up to 10 MW. The water use rights for hydroelectric power generation are controlled by the Electricity Act rather than the Water Resources Act. Thus for hydropower uses, the Energy Development Centre (EDC) has the authority to issue water use rights. To improve the contribution of small hydropower to the electricity supply in Nepal, the Nepali government passed in 1992 a number of policies and legislation that allow private entities to build, own, and operate power generation, transmission, and distribution facilities, including connection to the national grid or operation of independent mini grids.

1.98 The regulations have the following features:

- The policy of preferential treatment of small hydropower is valid for projects up to 10 MW capacity; for plants below 1 MW, the Nepal Electricity Authority (NEA) is obliged at all times to buy the mini hydro output at pre-announced tariffs. For larger schemes, NEA regularly announces the capacity that it is prepared to buy at these tariffs from new projects in accordance with the load growth in the system.
- For hydropower generation and distribution facilities with a capacity of less than 1 MW there is no license required; the facilities are exempted from income tax as well as royalty payments to the government.
- No transfer of ownership is required from the foreign investor to the government or the joint venture partners before the end of the license term (a maximum of 50 years).
- 100 percent foreign investment is allowed.
- Repatriation of profits in hard currency is possible.

1.99 Environmental Impact Assessment studies are required for hydropower projects. For projects below 5 MW of capacity, only an Initial Environmental Examination (IEE) is required, which reduces the scope of the assessment, the costs, and the time required to assess environmental concerns.

1.100 There is no distinction between capacity and energy charge. Tariffs are not part of the legislation but are stipulated in the standard PPA to be signed between the developer and the national utility NEA.

1.101 So far, four projects under this legislation with capacities ranging from 180 kW to 7.5 MW have been commissioned and three are under construction.

1.102 In Nepal, a small hydro master plan containing 70 sites (of less than 10 MW) was established in the early 1990s with German technical assistance. Most of the projects were studied up to pre-feasibility level with government and donor funding. All the developers who recently implemented small hydro projects under the current legislation identified their projects from that master plan. In Nepal, an exclusive survey licence valid for one year is issued to a prospective developer for a specific site so that no two developers compete for the same site.

1.103 In Nepal, PPAs with small hydro developers now often include a requirement for isolated operation so that the immediate vicinity of the small hydro plant can still be supplied with electricity even if the national grid is down or under a load-shedding regime, which is not uncommon in Nepal.

1.104 Once this TA has been proven effective, it can reduce the perceived risks of private developers and effectively trigger investment decisions as has been shown in Nepal where German and Norwegian TA programs have been operational for many years.

1.105 The World Bank supported Power Development Fund (PDF) of Nepal is not yet operational. Despite this absence of concessional loans from overseas development finance institutions, small hydro developers and local banks have pushed through with their projects. This remarkable achievement in this poor country with political unrest must be attributed to (1) the current absence of attractive investment alternatives (tourism, trade, and domestic consumption are down due to the Maoist movement); (2) long experience with small-scale hydro since the 1980s; and (3) the availability of technical assistance for quality assurance (particularly, the German GTZ program). The loan conditions agreed on by the private Nepalese banks for mini and small hydro projects typically have a seven-year term, 13 percent interest rate, and cover up to 70 percent of project costs. There is usually a lead bank carrying out due diligence and one or two additional banks forming a consortium with the lead bank (Table 1.3).

Table 1.3: Commercial Loan Financing for Small Hydro in Nepal

Project	Capacity in kW	Bank loan in US$ thousands	Banks (lead bank in bold)	Status
Chaku	1,600	1,780	LB, SBI, PF	Under construction
Chilime	20,000	22,000	PF,NB	Commissioned
Indrawati	7,500	21,800	NB, NBB, PF	Commissioned
Piluwa	3,000	2,550	BK, PF, NMB	Commissioned
Sunkoshi	2,600	2,700	NIB, KB, LB	Under construction
Syange	183	180	MB	Generating electricity

Note: MB (Machhapuchhre Bank), LB (Lumbini Bank), SBI (State Bank of India, Nepal), PF (Provident Fund), BK (Bank of Kathmandu), NB (Nepal Bank), NMB (Nepal Merchant Bank), NBB (Nepal Bangladesh Bank), NIB (Nepal Investment Bank).

Philippines

1.106 In the Philippines small hydropower includes plants with capacities of 100 kW to 10 MW. Nonexclusive permits for project studies for three months (extendable) are issued on a first-come, first-served basis.

1.107 A Mini Hydropower Incentives Act (Republic Act 7156) and associated rules and regulations were passed by the Philippine parliament in 1992 to encourage private participation in mini and small hydro development (100 kW–10 MW).

Incentives mainly cover tax holidays, special tax rates, and exemptions on VAT and import duty. These incentives are granted to local companies with a minimum of 60 percent Filipino ownership. The Department of Energy was mandated to provide assistance and guidance to mini hydro developers especially in the field of site data and government clearances.

1.108 The Act requires the developer to have additional working capital available of at least 60 percent of the project cost estimate to cover cost overruns and to bridge a delayed start of plant operation and revenue generation. Without proof of such reserve funding, the operating contract or licence is not granted.

1.109 Small hydro projects with capacities of less than 6 MW require only an Initial Environmental Examination, which is less demanding than the Environmental Impact Statement (EIS) mandatory for larger schemes.

1.110 The National Power Corporation (NAPOCOR), the national utility, is obliged to purchase the energy from mini hydro plants at the avoided cost of supply, which is based on large thermal or full-scale hydro alternatives. So far, few developers have taken up mini hydro development in the Philippines mainly due to the somewhat underestimated figures of avoided costs by NAPOCOR and, subsequently, the limited returns on investment available in this business.[10]

Sri Lanka

1.111 A small private power industry was virtually nonexistent in Sri Lanka in 1997 and only about 1 MW of privately owned mini-hydro capacity was available. With the World Bank supported Energy Services Delivery Project (ESD, 1997 to 2002), a market for grid-connected mini and small hydro (less than 5 MW) was created. While power sector reform with complete deregulation aiming at third-party access is not yet in place, the ESD managed to implement 15 private sector projects of mini and small hydro size with a total capacity of 31 MW in five years. Awaiting complete sector reform, the ESD project supported the preparation of a Small Power Purchase Agreement (SPPA), a standardized, formula-based way of determining the least-cost tariff (small purchase power tariff) and interconnection specifications. The SPPA is a legally binding arrangement between the small power project developer and the national utility Ceylon Electricity Board (CEB). The SPPA replaces the cumbersome process of negotiating every small power project on an individual basis. In many cases the negotiation process required substantial input from specialists and lawyers, often increasing the bureaucracy and overhead to a level at which the project became unviable.

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10 One successful mini hydro developer, HEDCOR of the Avoitiz Group, has moved to larger-scale hydro development (more than 20 MW), as such plants seem to benefit from economies of scale and reap better returns on investment than the smaller hydro projects (less than 10 MW).

1.112 The small purchase power tariff is estimated at the end of each year for the year ahead; the announced tariff is then given by the average of this estimate and the tariff of the past two years. The tariff and the methodology of calculation have been controversial, with several committees and an independent consultant coming to varying conclusions. Two mini hydro developers were in an arbitration proceeding against CEB contesting CEB's tariff determinations for the year 2001.

1.113 The ESD credit program provided medium- to long-term financing to private developers of small hydro projects. The ESD featured direct on-lending of World Bank funds to participating credit institutions through an Administrative Unit. The Administrative Unit was assumed by a private entity, the Development Finance Corporation of Ceylon Bank, on contract by the government. The on-lending terms for participating credit institutions and eventual borrowers reflect market conditions (five year term, 24 percent interest rate). Typical financing plans of the Sri Lankan small hydro projects consist of 40 percent equity and 60 percent debt. With these financing conditions and the above tariffs and costs, the financial internal rate of return on equity becomes 23 percent,[11] which is attractive for Sri Lankan small hydro developers (currently 11 companies operating 15 plants).

Conclusions

1.114 From this brief summary of international experience in private small hydro development the following lessons can be drawn:

1. The regulatory framework, including six aspects from water use rights to grid connection policy and environmental clearances, must be specifically defined for small hydro so that no legal uncertainties exist for developers and sponsors of SHP.

2. A selection of attractive small hydro sites should be made available to the developers, preferably in the form of a water resources master plan that distinguishes SHP sites from other water development plans so that the uncertainty about potential water use conflicts is reduced. However, self-identified sites must remain open to private developers.

3. A large amount of hydrologic and geologic data and hydropower-related experience rests with the (national) utilities and international hydro consultants. Tapping into this wealth of knowledge and experience is not possible by private developers alone. The learning curve of local SHP developers can be shortened with assistance by government agencies and international TA.

4. The availability of standard PPAs and tariffs is crucial for attracting private developers. The full exposure of small hydro (especially the smaller range

[11] This is an industry average provided by the Sri Lankan Grid Connected Small Power Developers Association. Actual project figures are not available due to confidentiality

below 10 MW) to a spot market without long-term supply contracts is detrimental to private SHP development. Guaranteed tariffs for at least the first 5 years of SHP operation should be made available.

5. The power purchase tariffs offered to SHP projects by the utilities need to be around $US0.05 per kWh so that private developers can be attracted. Strong international support (such as donor with TA and development finance institutions) is often needed to make utilities agree to such cost-covering tariffs.

1.115 The vehicle of a special-purpose company for private SHP development is adequate but banks often require substantial collateral to support such project or non-recourse financing of SHP projects. Information campaigns for bank managers and solid SHP project documentation can help reduce exaggerated caution from the banking sector.

1.116 Quality assurance in design and implementation should be made available either locally or through TA so that local banks are prepared to provide long-term financing with lending terms in excess of five to six years.

1.117 EPC contracts for SHP development have not provided the expected risk avoidance and cost reduction measures and the alternative approach of using a multitude of single-discipline contracts is recommended.

2

Classification of Hydropower Projects (Task 2)

Identified Hydropower Potential in Nicaragua

Interpretation of past estimates of total hydropower potential

2.1 Nicaragua occupies a total area of some 130,000 square kilometers (including the large lakes) and is geographically divided into the Atlantic Region, the Central Region, and the Pacific Region. Hydrologically, Nicaragua is divided into two main watershed areas, the Atlantic and the Pacific. Due to its location, geomorphology, and climate, Nicaragua is blessed with abundant hydropower resources.

2.2 Most of this potential (94 percent) is located on the Atlantic side of the country in the basins of the rivers Grande de Matagalpa, Coco, Escondido, and San Juan. The remaining 6 percent of the potential is located on the Pacific side.

2.3 The hydropower potential identified so far is said to be in the range of 3,760 MW per year,[12] not including many micro and mini hydropower sites. Possible hydropower sites include some of very small potential (just a few kilowatts—so-called “pico” and “nano” hydros), as well as micro, mini, and small hydropower potentials going up to large hydropower resources of 150 MW and above. The estimated potential of 3.760 MW corresponds to a gross energy of 32.938 GWh per year, if based on a (theoretical) plant availability of 100 percent. However, only 9.541 GWh per year (equivalent to 1.094 MW at 100 percent availability) is regarded as technically feasible and only 6.552 GWh per year (equivalent to 751 MW at 100 percent availability) is regarded as economically feasible.[13]

2.4 As shown in Table 2.1, the identified hydropower potential based on CNE’s hydropower inventory as well as other sources (including UNDP and PERZA) comes up to a gross potential of 3.282 MW.

[12] Inter-American Development Bank/CNE, Políticas Energéticas Indicativas, Borrador, Managua, Nicaragua, August 2001. The figure of 3,760 MW is obviously based on an estimate from 1980 within the framework of the Master Plan 1977–2000.

[13] *The International Journal on Hydropower and Dams: World Atlas and Industry Guide* 1998.

2.5 As the different numbers and interpretations show, these estimates of potential hydropower projects should be used with some caution: These figures ranging from 3.282 to 3.760 MW show the existing *theoretical* hydropower potential. The *technically and economically feasible potential* will definitely be less and depends mainly on factors which have to be determined in site-specific case-by-case studies. Some factors influencing whether a hydropower project is economically or technically feasible are site-specific and do not depend solely on the available head and hydrologic conditions. Other factors, however, may well change over time. What is shown to be infeasible today may well become feasible in the medium or long term. Roads built for other reasons may provide easier site access, and innovative hydropower technologies may decrease investment costs. Furthermore, new policies and strategies can help to create attractive incentive structures; incremental funds may become available (such as Certified Emissions Reduction, CER trading opportunities or a Prototype Carbon Fund, PCF); tariffs can be adjusted; fossil fuel prices might rise dramatically at the international level; or a new electricity market like SIEPAC may create attractive business opportunities. All these factors and others unforeseen may turn an infeasible hydropower site into an attractive investment (and vice versa). And finally, as several studies reviewing the potential hydropower sites in the upper and lower Rio Viejo Valley reveal (Master Plan Rio Viejo, IFC study), hydropower sites can be developed in alternative ways resulting in different cost structures and technical designs.

Past experience with hydropower in Nicaragua

2.6 The Nicaraguan experience with hydropower-based electricity generation goes back into the first half of the twentieth century, when small sites below 250 kW were exploited.[14] These mini hydropower plants, however, were abandoned either as the result of technical difficulties or after the national grid was extended to these sites.

2.7 Despite the huge hydropower resource and its potential for contribution to the economic development of the country at large—be it for rural electrification or urban or industrial electricity supply—only two larger hydropower projects have been realized during the past four decades. These are the Planta Hidroeléctrica Centro América (, built in 1965 at the Río Tuma and the Planta Santa Bárbara, built in 1972 at the Rio Viejo, each with a nominal generating capacity of 50 MW.

2.8 In the early 1970's a UNDP-assisted hydropower program was initiated but suspended due to the social and political unrest of the following years. This program was re-initiated in the 1980s and commenced evaluating micro and mini hydropower potentials, mainly in the departments of Matagalpa, Jinotega, and Boaco. In 1985, the hydropower plant at La Chata with a capacity of 100 kW was constructed to supply the population of El Cuá with electricity. The two hydropower plants of Wabule (Wabule River) and Las Canoas (Malacatoya River) were installed in 1989, each with a capacity

[14] Asociación de Trabajadores de Desarrollo Rural – Benjamín Linder (ATDER-BL). Study of Small Scale Hydroelectricity Generation Potential and Technical-Economic Pre-Feasibility of 30 sites with Hydroelectric Potential.

of 1.5 MW, both feeding into the SIN. In 1991, the hydropower plant San José de Bocay with a generating capacity of 230 kW was built.

Identification and update of hydropower potential

2.9 The larger hydropower potential in Nicaragua has been the subject of desk studies and field surveys since the early 1980s, including the elaboration of master plans at the regional and national level.

2.10 In 1980, a comprehensive assessment of the hydropower potential at national level was carried out by a consortium led by the German consulting company Lahmeyer under contract to INE.[15] This assessment identified 58 hydropower sites ranging from 4 MW to 281 MW with a total hydropower potential of 3.122 MW, as well as an additional 110 hydropower sites that were not further specified. However, this additional inventory was based on very general information (such as maps to a scale of 1:50,000) without any supporting studies and is therefore of an indicative nature only (see list of sites in the Annex). The higher figure of 3.760 MW as repeated in various studies may be realistic if the additional 110 hydropower sites in CNE's inventory are added.[16]

2.11 For some of the identified projects, positive feasibility studies made them the subjects of renewed national interest in developing Nicaragua's existing hydropower resources. Among these projects, which were the subject of different update studies during the past decade are the hydropower projects Mojolka (originally 78 MW, now 138 MW), Copalar (originally 181 MW, now 150 MW), Larreynaga (originally 40 MW, now 17 MW), Pantasma (originally 15 MW, now 24 MW), projects in the Upper and Lower Rio Viejo region (extension of the existing hydropower plants Planta Hidroeléctrica Centro América and Planta Santa Bárbara) and projects at the Y-Y river (estimated at some 27 MW).[17]

2.12 More detailed information on the available potential was provided by the feasibility studies of selected hydropower projects like Larreynaga, Copalar, Tumarín, and Mojolka, as well as the Master Plan for the Rio Viejo Valley[18] and the Assessment of Hydroelectric Generation Alternatives.[19] Based on the review of these studies and an update of CNE's inventory of hydropower resources,[20] the theoretical hydropower potential in Nicaragua at sites greater than 0.1 MW (including the projects identified by the UNDP and the PERZA program) is estimated at 3.282 MW.

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15 Instituto Nicaragüense de Energía (INE), 1980, Plan Maestro de Desarrollo Eléctrico 1977–2000, Consorcio Ieco–Laymeyer, Managua, Nicaragua.

16 A desk study by the Lahmeyer- Study/ Master Plan identified 110 additional sites in 1980 but they were not quantified in details.

17 See list of projects in the Annex proposed by the IFC study (2001).

18 INE, 1996, Proyecto Rio Viejo—Master Plan, Swedpower/ Norconsult International, Managua, Nicaragua.

19 IFC, 2001, Nicaragua—Assessment of Hydroelectric Generation Alternatives, Final Report by SWECO International, April.

20 CNE, 2000, "Inventario recursos actualizados," October 10.

2.13 From the review of the numerous studies as well as from consultations with stakeholders, the consultant understood that there is a lack of systematic assessment of the hydropower potential particularly in the range of 2 MW to approxiamtely 10 MW. This finding is supported by the fact there are only seven sites in this range listed in CNE's inventory (and seven sites added by the consultant from a different source) with a total capacity of just 56 MW, although it is said the hydropower potential below 10 MW is estimated to be some 165 MW.

2.14 The reason for the lack of information may be twofold. First, master plans, hydropower assessments, and pre-feasibility and feasibility studies have concentrated in the past only on the larger and obviously more attractive and feasible sites in the range 20 MW and above. Second, potential hydropower sites below 2 MW seem to be better evaluated and documented as a consequence of the ongoing UNDP/GEF-supported PCH program as well as the PERZA program supported by the World Bank and GEF . A systematic assessment of 30 mini hydropower sites was carried out under the PCH program by the Nicaraguan NGO Asociación de Trabajadores de Desarrollo Rural – Benjamín Linder (ATDER-BL) Study of Small Scale Hydroelectricity Generation Potential and Technical-Economic Pre-Feasibility of 30 sites with Hydroelectric Potential.

2.15 The theoretical estimated hydropower potential in Nicaragua is summarized in Table 2.1. The estimate is based on a review of the documents cited above. This list, however, is certainly not complete since there are more potential sites identified but not listed in CNE's inventory.

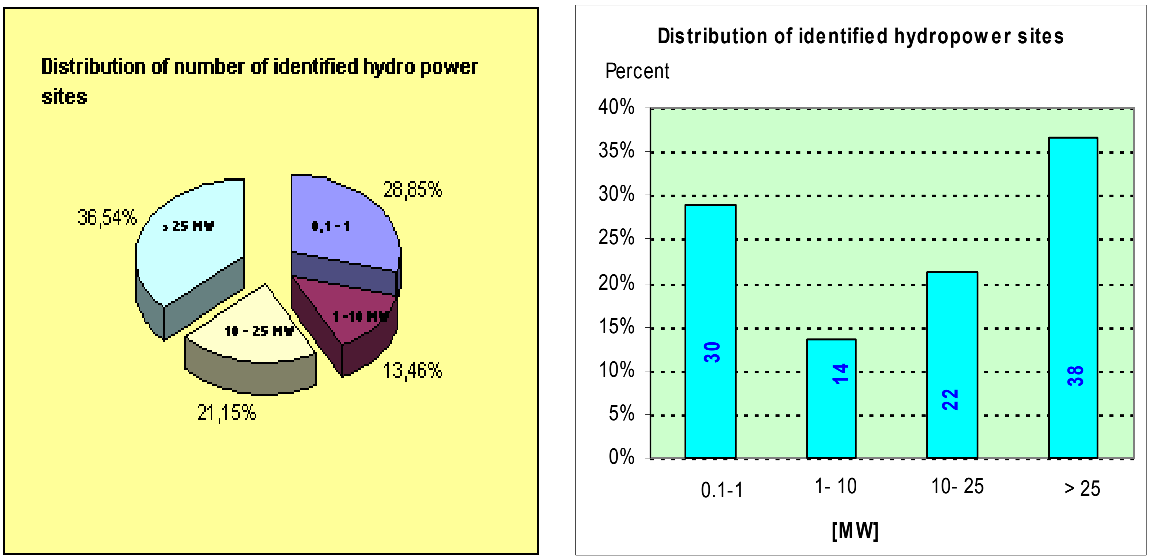
Table 2.1: Summary of Identified Hydropower Site and Estimated Hydropower Potential

Capacity range (MW)	No. of identified hydropower sites	Distribution of identified hydropower sites (%)	Total Capacity (estimate in MW)	Distribution of size of identified hydropower sites (%)	Notes
0.1–1	30	28.85	10	0.30	30 MHPs in the UNDP project, including the PERZA - projects El Bote y El Ayote.
1–10	14	13.46	60	1.83	Figures from CNE inventory and other hydropower studies (incl. the small hydropower projects Wilwili, Salto Grande, Siempre Viva)
10–25	22	21.15	416	12.68	
25–(272)	38	36.54	2.796	85.19	
Total	104	100.00	3.282	100.00	

Source: Own compilation of data, based on CNE's hydropower inventory, IFC study, and other documents.

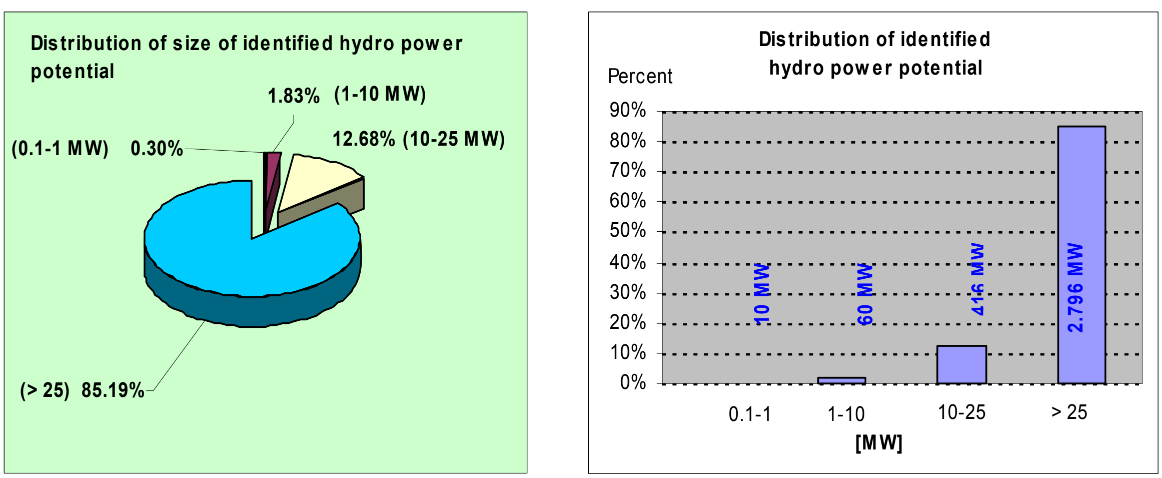
2.16 This analysis of 104 hydropower projects from the inventory of the CNE and other assessments and studies like those from IFC, the World Bank (PERZA), and UNDP, show that there are 30 potential projects in the range of 100 kW to 1 MW, 36 projects ranging from 1 to 25 MW. The remaining 38 projects (approximately 37 percent) are larger than 25 MW and go up to approximately 150 MW or more. Figure 2.1 shows the detailed distribution of these 104 potential sites.

Figure 2.1: Distribution of Identified Hydropower Projects (Sites)



2.17 The total hydropower potential of these 104 projects is estimated to be 3.282 MW. However, analysis shows that only some 0.3 percent (approximately 10 MW) of that figure is sites with a potential less than 1 MW while approximately 15 percent (476 MW) are potential sites in the range of 1 to 25 MW. The details of that analysis are shown inFigure 2.2.

Figure 2.2: Distribution of Hydropower Potential



2.18 This figure of 3.282 MW identified hydropower potential contrasts with the figure of 1.500 MW mentioned in the Terms of Reference of this study. However, the latter figure may refer to the economically feasible hydropower potential.

2.19 Nevertheless, it can be taken for granted that the realistically exploitable hydropower potential in Nicaragua is large and at least three times higher than the presently installed nominal thermal and hydropower capacity of 639 MW. The nominal installed hydropower capacity connected to the SIN is presently 104 MW and represents only about 17 percent of the generation capacity presently installed in Nicaragua.

Classification of Hydropower Plants

The need for classification

2.20 While modular equipment and standard designs can usually be applied to the design of wind parks, geothermal plants, biomass plants, and solar energy schemes, a hydropower plant—particularly its civil engineering structure—requires a site-specific design irrespective of its generating capacity.

2.21 However, beside its site-specific design a mini hydropower plant of some 100 kW is different in many ways from a 25 MW hydropower plant. Due to their differences in generating capacities, technology characteristics, investment cost, operational cost, environmental and social aspects, and development impact at national level, mini and small- to medium-size hydropower plants require different development and promotion strategies. These must address the specific characteristics of either electrification schemes based on small rural decentralized hydropower, or of small- to medium-size hydropower schemes feeding into the national grid.

2.22 To promote the exploitation of the existing hydropower potential in Nicaragua, it is necessary to classify that potential in order to be able to formulate sector-specific strategies and policies aiming at private sector involvement in hydroelectric projects.

2.23 Hydropower plants can generally be classified in the following ways:

- By generating capacity (rated power output in MW)
- By available head (low-, medium-, and high-head schemes)
- By type of plant (run-of-river, storage schemes, irrigation, and drinking water schemes)
- By mode of operation (off-grid or on-grid).

2.24 Due to the fact that the available head and the water flow determine the power output of a hydropower scheme, the investment costs are highly sensitive to these two parameters. In general terms, a large hydropower scheme with a low or medium head and a storage facility (dam or reservoir) requires higher investment cost than a medium- or high-head run-of-river scheme.

Classification according to generation capacity

2.25 There is no internationally recognized standard classification of hydropower schemes. A widely used practice, however, is to classify hydropower plants according to their generating capacity (rated power output) with the main categories being micro, mini, small, and large hydropower plants. This classification of hydropower schemes is given in Table 2.2.

Table 2.2: Classification of Hydropower Plant by Size and Generation Capacity

Generation capacity	Classification	Mode of operation		
		Stand-alone	Off-grid	On-grid
5 kW–100 kW	Micro hydropower	x	x	
100 kW–1 MW	Mini hydropower		x	(x)
1 MW–10 MW (- 30 MW)	Small hydropower		(x)	x
> 10 MW (> 30 MW)	Medium and large hydropower			x

Note: Hydropower schemes below 5 kW are so-called nano hydro and pico hydro schemes and are mainly used in individual stand-alone applications or for battery charging stations.

2.26 While there is a common international understanding of the classification of micro and mini hydropower, there are different definitions of what is the limit for small hydropower varying between 10 MW and 30 MW as the Table 2.3 shows.

Table 2.3: Upper Limits for Small Hydropower Schemes

Country / Organization	Upper limit for small hydropower
Bolivia	10 MW
Brazil	30 MW
Canada	25 MW
China	30 MW
Costa Rica	20 MW
Dominican Republic	10 MW
El Salvador	10 MW
ESHA (European Small Hydropower Association)	10 MW
European Commission (and five European countries)	10 MW
Honduras	20 MW
India (before 1998: up to 15 MW)	25 MW
Indonesia	30 MW
Jamaica	10 MW
Mexico	10 MW
Philippines	10 MW
UNIPEDE (International Union of Producers and Distributors of Electricity)	10 MW
United States	30 MW

2.27 This listing shows that countries define the limits for small hydropower differently. There seems to be an increasing international tendency to define the upper limit for small hydropower at 10 MW; however many countries define small hydropower as up to 30 MW. This limit may be acceptable from a technical standpoint. However, from economic and environmental points of view, hydropower schemes of up to 30 MW could create serious problems, especially if the classification "small hydropower" is used to justify a hydropower scheme as simple, cheap, environmentally friendly, and socially acceptable. This is especially true of low-head schemes, which require large dams or basins that may create a significant negative environmental and social impact. These considerations make it difficult to accept a definition of small hydropower based on installed power only. The other main characteristics, which are the available head and the water flow, should in particular be considered before a decision can be made to exploit an existing hydropower potential at a specific site.

2.28 Therefore, it seems acceptable for the purposes of this study to apply the term small hydropower to schemes up to 25 MW.

Site specific classification

Classification according to available head

2.29 The power output of a hydropower scheme is proportional to the water flow and to the available head, the latter being the only site-specific parameter that does not vary over the lifetime of the scheme. While the water flow can vary according to rainfall patterns and global climate changes, the head is constant and should therefore always be exploited to its maximum. Hydropower schemes are usually classified in three categories according to head, as shown in Table 2.4.

Table 2.4: Classification of hydropower sites by head

Typology	Limits
Low-head scheme	2–10 m
Medium-head schemes	10–100 m
High-head schemes	> 100 m

2.30 High-head schemes result in smaller turbines and longer penstocks, usually without large reservoirs, while low-head schemes generally require large turbines and costly dam structures. Due to the constant head, high-head schemes are less vulnerable to dry spells and climate change patterns. The different requirements of the civil design are some of the reasons why high-head schemes tend to be more economical than low-head schemes.

2.31 However, the limits in Table 2.3 should not be thought of as rigorous standards. A micro-hydropower plant with a design flow of only 0.1 cubic meters per second with a head of 50 meters can be regarded as high scheme, while a plant with a 10 cubic meters per second flow and 150 meters head can still be regarded as a medium-head scheme.

Classification according to use of water flow

2.32 Hydropower power plants can also be classified in five categories depending on the different ways of using the water flow, which has a profound effect on the plants' technical and environmental characteristics. As in the case of classification by power output, no binding international definition exists. A typical classification is as follows:

- Run-of-river schemes
- Pondage schemes (day storage)
- Reservoir schemes
- Schemes integrated with an irrigation canal
- Schemes integrated in a drinking water system.

Run-of-river schemes

2.33 A run-of-river hydropower plant uses the instantaneous river flow, and the filling period of its reservoir by the river flow is negligible. When the river dries up and the flow falls below the minimum technical flow of the turbine, generation ceases.

2.34 Medium- and high-head schemes use weirs to divert water to the intake, from which it is conveyed to the turbines via a pressure pipe or penstock. Since penstocks are costly, an alternative is to convey the water by a low-slope open canal to the pressure intake (forebay), and then in a short penstock to the powerhouse. If the topography and morphology of the terrain does not permit the easy layout of a canal, a low-pressure pipe, which offers more latitude in slope, may be an economical option.

2.35 Low-head schemes are typically built in river valleys. Two design options can be selected. Either the water is diverted to a power intake with a short penstock as in the medium- or high-head schemes, or a small dam provided with sector gates and an integrated intake, powerhouse, and fish ladder creates the required head.

2.36 Most mini and small hydropower plants are run-of-river plants because of the high cost of constructing a reservoir.

Pondage schemes

2.37 Occasionally a small reservoir, storing enough water to operate only during peak hours, (when electricity "buy-back" rates are higher) can be created by a weir, or a similarly sized pond can be built into the forebay. A pondage hydropower plant is a plant in which the filling period of the reservoir based on the stream flow permits the storage of water over a period of a few hours to a few weeks at the most. In particular, a pondage hydropower plant permits the water flow to be stored during periods of low load to enable the turbine to operate during high-load periods on the same or following days (known in the industry as "day- or week-storage").

2.38 Some small hydropower plants fall in this category, especially high-head ones with high installed capacities (over 1,000 kW).

Reservoir schemes

2.39 A reservoir hydropower plant is a plant in which the filling period of the reservoir based on the water flow is longer than several weeks. It generally permits the water flow to be stored during the high-flow periods to enable the turbine to operate during later low-flow periods. As the operation of these plants often requires the construction of large basins with significant associated economic, environmental, and social issues, in practice no small hydropower plant falls in this category.

2.40 Only in the those cases when the reservoir has already been built as a multipurpose scheme—such as for flood control, irrigation, water abstraction for drinking water supply, or as a recreation area—may it be possible to generate electricity using a discharge which conforms to the natural flow of the reservoir.

Schemes integrated with an irrigation canal

2.41 Two types of schemes can be designed to exploit planned or existing irrigation canals. In the first case the canal is enlarged to the extent required to accommodate the intake, the power station, the tailrace, and a lateral bypass. The lateral bypass is needed to ensure the water supply for irrigation in case of shutdown of the turbine. This kind of scheme should be designed at the same time as the canal, because the widening of the canal during full operation is an expensive proposition.

2.42 If the canal already exists it should be slightly enlarged to include the intake and the spillway. To reduce the width of the intake to a minimum, an elongated spillway should be installed. From the intake, a penstock running along the canal brings the water under pressure to the turbines in the powerhouse. From the powerhouse water is returned to the river via a short tailrace. Usually, fish are not present in a canal; therefore, fish ladders are not necessary.

Schemes integrated in a drinking water system

2.43 Drinking water schemes often supply water to a city or area by conveying the water from an elevated reservoir via a pressure pipe. Usually, in this type of installation, the dissipation of energy at the lower end of the pipe where it enters the water treatment plant is achieved through the use of special valves.

2.44 The fitting of a turbine at the end of the pipe to convert this otherwise wasted energy to electricity is an attractive option, provided that waterhammer, which could endanger the pipe, is avoided. To ensure the water supply at all times, a system of bypass valves should be installed. In some water supply systems the turbine discharges to an open-air pond. The control system maintains the level of the pond automatically. In case mechanical shutdown or load rejection causes the turbine to close, the main bypass valve can open automatically and maintain the level of the pond.

The Nicaragua context

2.45 For the development of the hydropower sector in Nicaragua, the run-of-river schemes are specifically relevant since energy generated by these schemes has been defined by Presidential Decree 279-2002 as nondispatchable energy that enjoys the incentives specified under that decree.[22]

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[22] The consequences of this presidential decree and its rules and regulations for the hydropower sector are analysed in Task 3 of this study.

Classification according to mode of operation

2.46 The classification of hydropower schemes by the mode of operation is a common approach when it comes to defining the objectives and design of hydropower programs. Considering the ongoing international discussion about "distributed generation," it is helpful to look at different ways of providing hydroelectricity to potential consumers.

2.47 As shown in Table 2.1, beside some special applications, there are two main ways to make use of the existing hydropower potential: supplying electricity in an isolated rural mini grid (off-grid) or feeding it into the national grid (on-grid); each method has a different implication for the development strategy of a country.

Individual stand-alone systems

2.48 Stand-alone systems are mainly pico (less than 5 kW) or micro hydropower schemes (usually below 100 kW) supplying electricity to individual rural households or to a single consumer. Although thye have the potential to contribute to decentralised rural electrification in Nicaragua, these small systems are not considered in this study.

Isolated operation (off-grid)

2.49 Micro and mini hydropower schemes with capacities from some 50 kW to approximately 500 kW are usually operated as *off-grid schemes* that provide electricity to single villages or a set of villages isolated from the national grid. The hydropower plant is usually located near to the load center in order to avoid the expense of long transmission lines. A grid (mini grid) to households (usually comprising 100 to 1,000 families) locally distributes electricity to small commercial and industrial consumers and for public lighting.

2.50 Off-grid generation is often the least-cost option for decentralised rural electrification. It provides reliable 24-hour electricity supply at low operational costs when compared to a diesel generator set or other renewable energy sources. From that viewpoint, it serves the national goal of extending the electricity coverage in rural areas utilising indigenous energy resources.

2.51 Due to the characteristics of decentralised rural electrification, such as low purchasing power of consumers, low energy demand, low population density, and low degree of productive electricity use, this kind of rural electrification usually requires subsidies (as do in many cases the diesel option or any other technology). Subsidy levels for off-grid mini-hydropower plants often reach 70–80 percent.

2.52 Beside site-specific conditions, the subsidies required in off-grid schemes usually depend on factors like tariffs, plant load factor, plant capacity factor, type of electricity consumption (consumptive or productive), and growth in demand.

2.53 The plant load factors and the plant capacity factors[23] of these plants are usually very low at the beginning of operation, often lower than 30 percent. The generating capacity of such a hydropower scheme is usually designed to meet the predicted electricity demand for over 20 years. The optimal plant design of an off-grid hydropower scheme has a high initial plant-load factor and a flat demand growth curve. On the other hand, a low plant-load factor and lower than predicted demand growth may turn the operation of a hydropower scheme into an uneconomic adventure requiring continuing high subsidies.

2.54 The design of an off-grid system based on hydropower often has to consider two extreme cases: too much or too little genrating capacity.

2.55 The first case is when the existing hydropower potential is larger than required by peak demand. The planning engineer has to decide on the right sizing of the plant taking into account the initial demand and the growth forecast for the next 20 years. The latter is sometimes difficult to predict.

2.56 As an alternative to maximum exploitation of an existing hydropower resource from the beginning, gradual development according to the growing electricity consumption may be more viable financially.

2.57 The second case is when the available hydropower potential does not fully meet the demand, and the designer has to consider technological alternatives like a hybrid system with a diesel backup.

2.58 In many cases the operational and institutional set-up is in the hands of a rural electrical cooperative which becomes the owner or plant operator. Such a cooperative has the legal status of a small electricity utility and provides the consumers with electricity services based on an agreed tariff structure. This cooperative is also responsible for maintenance and repairs of the plant, extension of the service to new customers, and for revenue collection and debt service.

2.59 If an off-grid rural electrification system based on a micro or mini hydropower plant (MHP) runs into economic difficulties or collapses, it is often the result of low tariffs which do not cover the operational costs and an overoptimistic growth forecast. This can result in a low plant load factor and high debt service relative to revenue. Another frequent reason for difficulties is a high “non-technical loss,” which is the usual term for unpaid consumption, be it theft of electricity or unpaid bills.

Grid-connected (on-grid systems)

2.60 Grid-connected hydropower plants feed the generated electricity into the national distribution grid, be it for national consumption or export. Theoretically, all sizes of hydropower plants can be operated in grid-connected mode, whether they are classified

[23] The plant load factor is defined as the ratio between the energy per year [MWh per year] actually sold to consumers and the energy that the plant could generate given its capacity and design flow. The plant capacity factor is the ratio between the annual mean load and the installed capacity of the plant.

as mini, small, or large hydropower. However, the criteria for grid connection of mini or small hydropower plants are quite different from those for the larger plants.

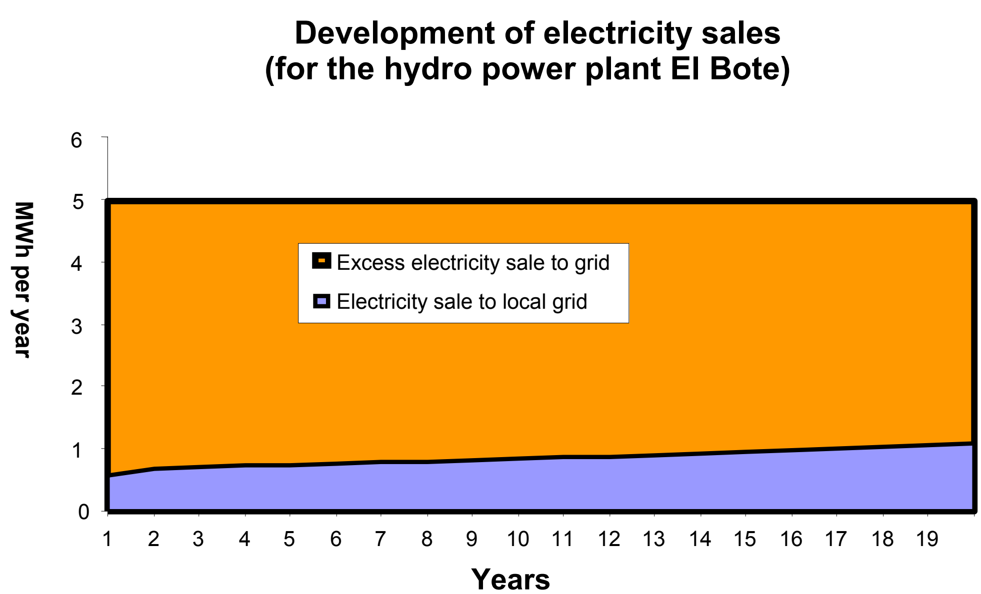
2.61 Current practice is that mini hydropower plants with generating capacities of approximately 500 kW to 1 MW are usually grid connected, supplying electricity to a local grid and feeding excess electricity into the national grid. The decision as to whether a mini hydropower scheme should be grid connected or not depends mainly on two key considerations:

- What is the initial electricity demand in the local grid and the demand growth forecast?
- What amount of excess electricity can be sold to the national grid at an economic tariff?

2.62 Based on these questions one must ask if the amount of excess electricity and the obtainable tariff in the grid justify the investment in transmission lines, which in turn depends on the distance from the power house to the nearest grid connection point.

2.63 Figure 2.3 shows the distribution of electricity sales in a local grid and to the SIN over 20 years, based on the example of the El Bote plant.

Figure 2.3: Distribution of Electricity Sales in an On-Grid System



Note: The part of electricity sale to the local grid includes the own consumption of the power plant as well as technical and nontechnical losses in the local grid. The part to be sold to the SIN includes also technical losses (transmission losses).

2.64 The figures for El Bote (generating capacity 900 kW) indicate that there is a total electricity production of 4.957 MWh per year, of which initially about 15 percent will be consumed locally and 85 percent will be sold to the grid. With the increasing local demand, within 20 years this portion sold to the grid will decrease from 85 percent to approximately 74 percent. If this scheme was developed to its maximum generating capacity of 900 kW but was not connected to the grid, the initial plant load factor would be as low as 14.6 percent.

2.65 In other words, initial plant load factor, local and national tariffs, and the length of transmission lines are key criteria for the decision as to whether a mini hydropower plant should be an on-grid or off-grid scheme. Mainly for economic reasons, small hydropower plants with capacities of 1 to 25 MW are usually connected to the national grid. The electricity demand in isolated grids is too low to absorb the generated electricity, even at the 20-year projection.

2.66 It is especially the case that at the upper limit of small hydropower station development (in this case up to 25 MW), the investment in such a plant can be only justified if a long-term contract at a fixed tariff (PPA) can be obtained from purchasers.

Market Segments for Hydropower in Nicaragua

2.67 The market in Nicaragua for hydropower encompasses the whole range of hydropower projects, from the micro range for stand-alone and off-grid rural electrification to large hydropower schemes of several 100 MW. In the following section, this hydropower potential is analyzed and divided it into segments, each of them addressing different markets.

2.68 This division follows the classification according to generating capacity as presented in middle of Chapter 2. The small hydropower segment (1–25 MW) is divided in subsegments that take into account the preexisting legal framework for small hydropower projects of up to 5 MW and the need for policy and regulatory interventions for the range of 5 to 25 MW.

2.69 The suggested breakdown into the different market segments and subsegments is given below.

First segment: less than 100 kW (micro hydropower)

2.70 This is the market for micro applications, stand-alone systems, or small village grid systems. So far, there is no specific program (at least, not covered by the PCH or PERZA programs) to systematically promote this segment. Development in this segment is sporadic and no systematic inventory of micro hydropower sites exists as yet. The key actors in this segment are NGOs and Rural Electricity Committees or cooperatives. The promotion of this segment does not need any policy or regulatory intervention, and will probably remain a political and social task of the CNE, possibly with the help of international donors.

2.71 This market segment is not attractive for private sector investment and is not a subject of the ESMAP study.

Second segment: 100 kW to 1 MW (mini hydropower)

2.72 Mini-hydropower plants in the range of up to 1 MW (partly overlapping with small hydropower of up to 2 MW) mainly serve the need for decentralised rural electrification. For the most part, they provide electricity to isolated mini grids covering the local demand for consumptive and productive use of electricity. However, hydropower plants with capacities toward the upper limit of that segment (approx. 1 MW) can also be grid-connected to the SIN. Examples of this kind are the projects 'El Bote' (900 kW), 'El Ayote' (>700 kW) and, 'Wilwili' (1.3 MW).

2.73 In this capacity range, the WB/GEF-supported PERZA program (as of 2003) and the UNDP/GEF-supported PCH program (2003–2007) will become active. La Agencia Suiza para el Desarrollo y la Cooperación (COSUDE) (Swiss Development Corporation, Switzerland) is considering the cofinancing of these programs.

2.74 Based on preparatory studies for these hydropower programs, the existing mini hydropower potential (supply side) as well as the potential market (demand side) was investigated by different Nicaraguan consulting companies. Although there is no complete inventory of mini hydropower sites in Nicaragua, there is a list of 30 mini hydropower plants located in the project area of the PCH program, which is the Central Region. This covers 67 Municipalities of the 8 departments Madriz, Nueva Segovia, Estelí, Matagalpa, Boaco, Chontales, Jinotega, and Río San Juan with some 90,000 rural families.

2.75 The World Bank will cofinance through a CNE loan up to three hydropower projects as part of the PERZA program as well as up to three hydropower plants of the PCH program.

2.76 The promotion and dissemination strategy for this segment is formulated in the respective program documents. These two programs cover most of the needs of this segment, which does not need further support at the moment.

Third segment: 1 MW to 25 MW

Subsegment 1–5 MW

2.77 This is the market segment addressing the lower range of small hydropower projects for which a favorable regulatory framework exists already. Hydropower plants of 1–5 MW are usually grid-connected; supplying electricity to rural grids in the neighborhood of the hydropower site is more of a side business than the main reason to invest in such a project.

2.78 There are three main legal reasons for the specific promotion of the development of small hydropower projects below 5 MW.

2.79 First, the water rights for run-of-river projects are regulated by the Ley de Promoción al Sub-sector Hidroeléctrico[24] for plants up to 5 MW, while the legal

[24] In force as of July 9, 2003.

framework for water rights for projects with capacities above 5 MW is subject to the draft Water Law which is still in the making.

2.80 Second, electricity generated by run-of-river schemes is declared by Presidential Decree 279-2002 as nondispatchable energy, which enjoys several incentives like preferential tariffs in the spot market as defined by that decree and its regulations. However, there are still parts of the decree that need clarification before its benefits can become effective.

2.81 Third, the minimum capacity for direct contract negotiation between generator and buyer will be lowered from 2 MW to 1 MW as of 2005, so that only wheeling charges will be due to the transmission company ENEL and the distributor Unión Fenosa.

2.82 This market segment may be attractive mainly for national investors, who want to invest in Nicaragua, take a medium risk, and do not want to enter transnational consortia for an investment project. The required investment in such a project is in the range of US$2–10 million.

2.83 Investment typically comes from private persons or small companies and groups of investors that are willing to invest in their country but have limited resources. Such investors would be interested in a hydropower project in the range of some US$2–3 million. Therefore a project like El Ayote with a potential of some 700 kW would probably not be attractive, but projects of 2-3 MW would.

2.84 This group would probably not invest in other countries but would take advantage of investment opportunities in their home country, since they know the risks and how to negotiate with the banks. They will also have sufficient economic and financial standing and be known to local banks, which might make it easier to secure the necessary loans.

2.85 Projects in this category could probably be developed relatively quickly. Several discussions between the consultant and potential investors revealed that there seems to be significant interest of private developers for projects in this range. However, there are only seven projects identified in that segment (see list in the annex) and it is recommended that they be systematically assessed.

2.86 Based on the attractiveness to the private sector and the promotional legal framework in place, the limit of 5 MW in this subsegment seems to be justified. As soon as the remaining uncertainties in the existing legislation are clarified investment can proceed right now.

Subsegment: 5 MW to 15 MW

2.87 The development of projects in this range requires significant investment. Associated technical and economic risks are higher than in the first sub-sector, and banks are more reluctant to finance such projects.

2.88 This subsegment encompasses projects which may attract joint ventures of national investors together with foreign business partners who are willing to invest in Nicaragua and are willing to share the associated risks with national developers.

2.89 For this subsegment, a lack of sufficiently prepared projects is as evident as for the foregoing subsegment of 1 – 5 MW projects. There are 9 projects listed in the updated CNE inventory of projects. Projects of this nature require a medium-term planning horizon of some 2 to 4 years.

Subsegment: 15 MW to 25 MW

2.90 This segment comprises large projects located in Nicaragua. Recently potential developers have showed some interest and acquired temporary licenses to develop projects like Larreynaga y Pantasma. However, the unfavorable legal framework, including the suspension of the existing water law and the legal preference given to thermal power generation, has prevented potential private investors from achieving any progress in developing these projects, including the privatization of the Hidrogesa plants.

2.91 The development of such projects requires a planning horizon of at least three to five years. There are 17 projects listed in the updated CNE inventory. Possible developers are consortiums of national companies or banks and foreign companies that would be willing to invest US$30–50M in the power sector. An example is the consortium of Banco Uno together with Coastal Power; they participated successfully in the Hidrogesa tender, though the deal was not completed due to political problems.

2.92 These consortiums look around internationally for attractive investment opportunities, but prefer to invest in the home country of one of the members of the consortium, in this case Nicaragua. The reasons again are that these investors have excellent relationships with the banking sector and possibly also to the political decision makers. They are usually aware of the risks and know how to mitigate or minimise them, and may also have easier access to credits from national and regional development banks. All of these reasons for home country investment are probably less applicable to developers of smaller projects.

2.93 This group of potential investors would be looking for opportunities in the hydropower sector (or any other opportunities in the energy sector) in the range 15–50 MW.

Fourth segment: 25 to 150+ MW

2.94 This segment comprises mega projects, not only in the Nicaragua context but also internally, especially if it comes to projects of high generating capacities. This is the segment for large international consortia that are looking around for large investment opportunities and long-term engagement in countries like Nicaragua.

2.95 In this segment, international investors or mixed consortia of Nicaraguan and international investors would be necessary to tap the hydropower market. This group would be looking for large long-term investments; and they will probably put together a financing package involving international banks and financial institutions.

Regional market for large hydropower

2.96 At the level of large hydropower mainly for export, Nicaragua will probably face strong competition from neighboring countries like Costa Rica, Honduras, and Guatemala.

2.97 Even if the legislation and regulatory framework were favorable for investment in this large hydropower segment, there would remain the present problem with the low rating of Nicaragua in the international banking sector. The logical consequence for these potential investors is to look out for easier-to-realize investments, for example in neighbor countries in Central America with a transparent and attractive legal framework in place.

2.98 Another option for larger investment in hydropower is to look at South American countries like Brazil where the present energy crisis and the expressed political will to strengthen the Brazilian hydropower sector seem to provide an attractive and responsive environment for investment in the sector. And considering the potential effects of the SIEPAC, investors would need strong reasons to invest in Nicaragua. Such reasons might be low specific costs for developing hydropower schemes or an attractive set of incentives offered by the Nicaraguan government.

2.99 Nevertheless, in the long term, there is no real alternative for the Nicaraguan government than to prepare a favorable legal and regulatory environment for the development of the existing large hydropower potential. As can be seen in Table 2.5, Nicaragua has an installed hydropower capacity that is only about 25 percent or less of the comparable capacities in the neighboring countries, which indicates good potential for further development.

Table 2.5: Installed Power Generation Capacities in Central America

Installed Capacity in MW by Type of Plant							
Type	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama	Isthmus
Hydro	525	407	435	103	1,226	614	3,311
Thermal	1,114	623	486	460	286	648	3,617
Geothermal	33	161	0	70	145	0	409
Wind	0	0	0	0	62	0	62
Total	1,672	1,192	922	633	1,719	1,262	7,399
Capacity Installed by Type							
Type	Guatemala	El Salvador	Honduras	Nicaragua	Costa Rica	Panama	Isthmus
Hydro	31.4	34.2	47.2	16.3	71.3	48.7	44.7
Thermal	66.6	52.3	52.8	72.6	16.6	51.3	48.9
Geothermal	2.0	13.5	0.0	11.1	8.4	0.0	5.5
Wind	0.0	0.0	0.0	0.0	3.6	0.0	0.8
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Source: Informe Final PREEICA.

Conclusions and Recommendations

2.100 Based on the analysis of Nicaragua's supply and demand for hydropower in plants larger than 100 kW, the following conclusions can be made:

1. Hydropower schemes ranging from 100 kW to 1 MW mainly address rural electrification and can be off-grid or on-grid. This segment is covered by internationally supported programs and does not need additional support.

2. The low-end subsegment of small hydropower power ranging from 1–5 MW may quickly become the most interesting market segment for national private investors, once the remaining confusion in the interpretation of the Presidential Decree 279-2002 and its regulations can be clarified.

   An alternative incentive for this market segment would be the definition of an absolute, fixed, spot-market tariff to be paid to any hydropower generator. This would help to create a transparent and output-based subsidy system for small hydropower plants. Hydropower power plants of 1–2 MW may also become more attractive due to the fact that the present minimum generating capacity of 2 MW for direct contract negotiation between a generator and a single buyer will be lowered to 1 MW as of 2005. An initial promotional framework is in place for this market segment and the Nicaraguan government should make strong efforts to remove the remaining uncertainties in the existing regulatory framework.

   The recommendation for CNE is that the hydropower potential and possible project sites of this subsector should be assessed carefully and pre-feasibility studies be prepared to attract private developers. To promote the 1–2 MW segment it is essential that the government prepare a portfolio of potential projects that can be offered to the private sector. Other incentives also could be offered by the government; for example, consessionary loans coul be given for the required transmission lines or access roads.

   The CNE should take the lead in these activities, which should be initiated as soon as possible.

3. The range of 5–15 MW hydropower plants may also present an attractive market for private sector entrepreneurs, though at higher economic risks. However, as long as the draft Water Law is not in place, no private developer will invest in such a project. Nevertheless, in anticipation of the removal of political and legal barriers, the assessment of hydropower potential in this range as well as the identification of concrete projects should also be initiated by CNE, but on a medium-term planning horizon.

4. For projects in the range of 15–25 MW the same legal barriers apply as for the lower capacity ranges. However, the associated risks for developers as well as for the financing banks are higher, and therefore the realization of projects of that nature requires a medium- to long-term planning horizon.

As in the case of the lower capacity ranges, CNE should be prepared to do initial planning at pre-feasibility level for such projects, to attract developers.

5. Medium and large hydropower development is a long-term program and requires an overall improvement of the rating of Nicaragua in the financial markets. However, the implementation of the SIEPAC may create an attractive new market.

3

Competitiveness and Viability of Development of Hydroelectric Projects with Private Participation (Task 3)

Analysis of the Hydropower Sector Development

The energy sector and RE policy

3.1 The Nicaraguan energy sector was restructured in the late 1990s. The new Electricity Law from April 1998 (Ley de Industria Eléctrica, No. 272) separated the generation, transmission, and distribution divisions of the state-owned Empresa Nicaragüense de Electricidad (ENEL). That sector reform initiated the privatization of the generation and distribution activities. The law created four generation companies (GEMOSA, GEOSA, HIDROGESA, and GECSA), the transmission company (ENTRESA) and two distribution companies (DISNORTE and DISSUR).

3.2 While the transmission company ENTRESA remains a government-owned company, the two distribution companies covering the Western, Central, and Northern zones of the country were sold to the Spanish company Unión Fenosa in September, 2000. The privatized concession area for electricity distribution covers the western part of the country along the Pacific Coast and divides Nicaragua in two equally sized parts along a North-South line. The privatized grid area has been divided into two concessions, both controlled by Union Fenosa: DISNORTE and DISSUR. DISNORTE covers the administrative Departments of: León, Chinandega, Matagalpa, Estelí, Nueva Segovia, and the western part of Managua. DISSUR covers the Departments of Carazo, Granada, Masaya, Boaco, Chotales, Rivas, Rio San Juan, and the eastern part of Managua.

3.3 More than half of the country on the Caribbean and Atlantic coasts remains out of the concession area, including half of the Rio San Juan Region, the Region Autonoma Atlantico Sur (RAAS), the Region Autonoma Atlantico Norte (RAAN) and two thirds of the Jinotega region, Matagalpa, Boaco, Chotales and Rio San Juan. The area not covered by the SIN is called the "Open Area." This area remains open to be divided into smaller concession areas on a case-by-case basis. The Open Area is characterized by very low population density—only 6 inhabitants per square kilometer. There are 15,584 households in an area of 124, 433 square kilometers, while density in the two concession areas reaches approximately 80 inhabitants per suare kilometer.. Population is highly dispersed and access is often difficult (for example, there is only river access for most of the Atlantic Region). These two characteristics prevent provision of electric services by the conventional grid, and call for site-specific off-grid solutions like the diesel plants, or if hydro resources allow, a micro, mini or small hydropower plant.

3.4 The Government of Nicaragua, through the CNE, has decided to encourage the development of the abundant renewable energy resources in the country as an essential element in the growth of the national energy system.

CNE's renewable energy and hydropower policy mandate

3.5 The Comisión Nacional De Energía (CNE), or National Energy Commission, was created by the new Electricity Law (LIE, 1998) and is in charge of formulating, coordinating, and setting overall objectives, policies, strategies, and general directives for the entire energy sector (as transferred from INE). It is also in charge of undertaking strategic indicative planning for the energy sector aimed at achieving development goals and optimizing the use of national energy resources. CNE reviews energy demand and supply balances, pricing policies, energy conservation programs, service coverage, and investment and financing strategies. It undertakes studies, issues criteria for investment projects, promotes private sector participation, and proposes concessions for use of natural resources by the private sector to the National Assembly.

3.6 The mandate of CNE includes also the development of rural electrification initiatives in coordination with multilateral and bilateral agencies and the promotion of national and foreign investment. In fulfillment of its mandate, CNE is implementing a National Rural Electrification Program (PLANER) aimed at achieving a national electrification rate of 70 percent by 2014.

3.7 CNE is also the structure in charge of administrating the National Electricity Development Fund (Fondo para el Desarollo de la Industria Eléctrica; FONDIEN). FONDIEN is a public fund that was created in October 2000 to finance the development of rural electrification in Nicaragua. FONDIEN can finance feasibility and pre-feasibility studies, project design, execution of projects, and education and communication campaigns in the field of rural electrification. FONDIEN resources can come from multilateral agencies, bilateral donors, and from the states via the general budget of the republic. The funds collected by the government through the award of concessions will be used as a resource by FONDIEN. FONDIEN can finance projects through grants, soft loans, loans without interest, and commercial loans.

Installed electricity generation capacity and demand growth

3.8 The total installed generating capacity in the SIN was 658.5 MW in December 2002 with a peak demand of 422 MW. This results in a reserve capacity of 36 percent.

3.9 Hydropower capacity is 104 MW, representing 16 percent of the national energy mix with the remainder made up of 72 percent (477 MW) thermal and 12 percent (77 MW) geothermal generation capacity. This installed hydropower capacity is about 7 percent of the technically and economically feasible hydropower potential and about 2.7 percent of the gross hydropower potential. The 16-percent share of hydropower capacity in the total generation mix is rather low compared to the average of the Central American countries, which is 45 percent.[25] In 2002, the hydropower-based electricity generation of 299 GWh was 12.5 percent compared to 8.2 percent in 2001 and 21.2 percent in 1997. Not included in this balance are some 40 micro and mini hydropower plants supplying electricity in isolated mini grids or in stand-alone applications which may add up to 1 to 2 MW.[26] Apart from these micro and mini hydropower plants, ENEL operates 26 small, isolated power plants.

3.10 The annual average increase in electricity generation between 1997 and 2002 was 7.1 percent while the annual demand growth was only 3.6 percent. The load factor of the installed generation capacity is 65.5 percent, which is similar to the load factors of neighboring countries. With 33 percent losses (21.1 percent nontechnical and 11.9 percent technical, for total of 797 GWh), the losses in 2002 were the highest in Central America.

3.11 The 47-percent overall electrification rate in 2002 is the lowest of the neighboring countries (Honduras 63 percent, Guatemala 84 percent, Costa Rica 97 percent). About 89 percent of the rural population still lacks access to electricity.

3.12 Meeting the officially declared goal of achieving 70 percent electrification coverage by 2014[27] requires huge reductions in the T&D losses on one hand and additional generating capacities on the other. Extending the SIN is another requirement. Without mobilizing the private sector and attracting sufficient investment capital this goal will be hard to achieve.

Recent experience with hydropower development in Nicaragua

3.13 The current situation of the energy sector and of hydropower development in Nicaragua has been the subject of numerous studies and reports in recent years.[28] Some of the Nicaraguan experiences are presented already in Executive Summary (Task 2) of this report.

3.14 The experience with the exploitation of the Nicaraguan hydropower potential can be differentiated into three main areas:

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25 Guatemala 33 percent, Honduras 43 percent, El Salvador 37 percent, Costa Rica 71 percent, and Panama 46 percent.

26 According to CNE, however, it is not known how many of these MHP are operational.

27 Originally, the 70 percent electricity coverage objective was to be achieved in 2005 but was corrected to 2014.

28 Studies, for example, by PREIICA, NRECA, UNDP, PERZA, COSUDE, as well as the ESMAP studies dealing with wind and geothermal energy.

Assessment of the existing medium to large hydropower potential

3.15 In the late 1970s, a series of assessments of existing hydropower potential began and culminated in the most comprehensive assessment so far, the 1980 master plan study Plan Maestro de Desarrollo Eléctrico 1977–2000, carried out by the German-American consortium Lahmeyer/IECO. Other important assessments of the hydropower sector are the Rio Viejo Master Plan, concluded in 1996 by Swedpower/Norconsult, and the Assessment of Hydroelectric Generation Alternatives carried out by Sweco International and financed by the IFC.

3.16 Many individual pre-feasibility and feasibility studies were carried out mainly by international consultants, concentrating in the Rio Viejo, Rio Grande de Matagalpa, Rio San Juan, and Rio Y-Y. A list of relevant hydropower studies available at CNE is presented in annex 6.2. However, it should be noted that most these studies concentrate on medium to large hydropower projects with little or no attention being paid to plant sizes below 15 MW.

Implementation and operation of micro, mini, and small hydropower plants

3.17 The experience with micro and mini hydropower plants (MHPs) started in the first half of the twentieth century and was limited at that time to capacities of some 250 kW. According to CNE, some 40 micro and mini hydropower plants are presently installed, feeding electricity into small isolated grids or supplying stand-alone consumers.

3.18 NGOs and private consultant companies have gained some experience in the planning of the civil and electromechanical engineering of MHPs as well as in the construction and operation of hydro schemes. There is also some experience in local manufacturing of small turbines, mainly Pelton and Mitchell-Banki (cross-flow) turbines. There is no evidence as to what extent the proposal of Swedco to initiate local production of small cross-flow turbines was implemented. In 1985, Swedco provided workshop drawings for cross-flow turbines that were suitable for local production. As far as is known, drawings for small Pelton turbines were provided as well.

3.19 As far as is known to the consultant, only recently was an effort undertaken to systematically assess the mini hydropower potential in Nicaragua.

3.20 In 2002, the NGO ATDER-BL identified a pipeline of 30 mini hydropower projects and carried out pre-feasibility studies for each project. This portfolio of projects was developed within the framework of the CNE/UNDP/GEF project Proyecto Usos Productivos de la Hidroelectricidad a Pequeña Escala en Nicaragua (Productive uses of Small-scale Hydropower Project). Out of this portfolio seven MHPs will be selected for implementation within the first phase of the project, with co-financing from GEF, WBG, COSUDE, and possibly additional donors.

3.21 The experience with the lower-capacity segment of small hydropower plants is limited to the planning, construction, and operation of two grid-connected SHPs: Wabule (1.6 MW, Wabule River), close to Managua (30 km), and Los Canoas on the Rio Malacatoya (1.5 MW), 60 km from Managua.

3.22 Another small project, the hydropower plant Wiwili (1.3 MW, 5.2 GWh per year, estimated investment US$2.5 million) with co-financing from UNCDF is presently being implemented but is experiencing difficulties due to cost overruns. At present, CNE is in the process of implementing the mini hydropower project El Bote (900 kW) and the small hydropower project El Ayote (700 kW to 5 MW).

Experience with large hydropower plants

3.23 Nicaragua has only two larger hydropower plants connected to the SIN, listed below:

a). The Planta Hidroeléctrica Centro América' (PCA) was built in 1965 as a diversion scheme from the upper Río Tuma to the Rio Viejo with an installed capacity of 48 MW, a design flow of 22 cubic meters per second, and a maximum head of 267 meters.

b). The Plant Santa Bárbara (PSB) was built in 1972 at the middle Rio Viejo with an installed capacity of 46 MW, a design flow of 16 cubic meters per second and a maximum head of 187 meters. Upstream of PSB there is a small reservoir (La Virgen) which can store about a month's supply of water. In 1998 hurricane Mitch destroyed the dam at La Virgen, thereby rendering Planta Santa Bárbara inoperational. The dam was rebuilt, thereby providing the opportunity for the Planta Santa Bárbara to undergo an extensive overhaul of its two turbines and generators. Despite the fact that the plant has a storage pond with a water capacity of 40 days, it is classified as a run-of-river scheme.[29]

3.24 Both plants are the main assets of a company called Generadora Hidroeléctrica, SA (HIDROGESA) which is still owned by ENEL after a failed attempt to privatize the company through the international tender process several years ago. The tender resulted in the award of new ownership to the international consortium El Paso Energy/Coastal Power Company and the Banco Uno of Nicaragua. However, before the award of the final acquisition contracts, political and legal challenges ensued that dealt mainly with the status of water rights and competitive usage of water resources, and presently the legality and status of the privatization are being argued in the Nicaraguan Supreme Court. The issue was originally raised in July 2002 by opponents to the privatization of Hidrogesa in the Congress.

[29] In Nicaragua, hydropower schemes with a storage capacity of up to one month generation at design flow are usually recognized as run-of-river schemes. This is in contradiction to the definition given in Resolution No. 70-2003. With the new legislation in place to promote run-of-river schemes as a nondispatchable energy source, the need arises to include a clear definition for run-of-river schemes in that legislation.

3.25 The case of (HIDROGESA) ultimately caused the legal suspension of all awarded water rights for hydropower generation in Nicaragua, as laid down in Law No. 440 requiring that existing water rights be renewed within one year (see Box 3.1 below).

3.26 A draft Water Law is presently in the making which will regulate the use of water and the issue of water concessions for hydropower plants irrespective of capacity and plant type. For new hydropower plants below 5 MW, Law 467 (Ley de Promoción al Sub-sector Hidroeléctrico) now provides that water concessions can be issued by MIFIC through a simplified procedure. For hydropower plants with capacities larger than 5 MW, no water concessions can be issued before the draft Water Law is approved.

3.27 Regarding the privatization of (HIDROGESA), it is, on one hand, unclear whether its assets will ultimately be awarded to the El Paso/Coastal consortium or another international tender will be required, while on the other hand, it remains open whether or not the consortium El Paso/Coastal is still interested in purchasing (HIDROGESA) once these legal problems are solved. Whatever the outcome of that case, it will have a strong influence on the private sector's willingness to invest in larger hydropower projects in Nicaragua.

3.28 With regard to the large hydropower projects identified in the Master Plan from 1980, the Copalar project (total capacity of 150 MW), which was updated by an INE study in 1994 and screened by the IFC-financed Assessment in 2001, has attracted the attention of a group of investors.

3.29 Summarizing these activities and comparing them to other countries like Costa Rica, it can be concluded that there is little local experience in the planning and implementation of mini and small hydropower plants in Nicaragua.

Market for hydroelectricity and outlook for future development

3.30 INE expects a power demand growth of about 6 percent annually over the next 20 years, requiring US$1.8 billion in new investments to increase generation capacity by 1,179 MW. It is a declared objective of the government to increase the electrification rate from 47 percent at present to 70 percent in 2014.

3.31 Hydropower should definitely play a decisive role in the future electricity market of Nicaragua, based on the following facts:

- Hydropower offers the largest known renewable energy resource in Nicaragua.
- Hydropower covers a wide range of electricity demand, from micro hydropower for rural electrification, to small plants feeding into the SIN, and up to large hydropower plants generating electricity for the export at Centro American (SIEPAC) level.

- Hydropower development has the potential to trigger socioeconomic development, such as creating jobs in local production of components, energy service companies, and in maintenance and operation of SHPs.
- The medium to large hydropower potential has been studied in detail during the last decades.
- Hydroelectricity is competitive with thermal generation in the long term given its expected long life span and its low O&M cost.[31]

3.32 The expressed interest of the government in promoting the exploitation of indigenous energy resources and CNE's parallel effort to create a supportive legal framework for private sector involvement are the corner stones for accelerating hydropower development in Nicaragua. If these efforts to promote the use of renewable energies continue and the remaining barriers can be removed, hydropower could significantly contribute to meeting the growing electricity demand in all three main sectors of consumption: The benefits of such a policy would be electrification of isolated rural areas, increased proportion of renewable energies in the national electricity grid SIN, and export of electricity to neighboring countries once the new Central American electricity market SIEPAC is operational.

3.33 From that perspective, it is worth creating in Nicaragua not only an enabling legal and regulatory framework to attract private investment, but also a comprehensive "hydropower culture." This in turn requires the creation of responsive structures for engineering, manufacturing, and operating capacities in the hydropower sector, including technology transfer and capacity-building of national professionals.

Current hydropower programs in Nicaragua

3.34 As a result of the Nicaraguan government's efforts to promote the exploitation of existing hydropower potential, there are several ongoing activities in the hydropower sector ranging from mini hydropower plants below 1 MW up to medium and large projects.

PERZA (Programa de Electrificación Rural de Zonas Aisladas)

3.35 CNE implements the program PERZA with cofinancing from the World Bank. PERZA aims to improve the living conditions of at least 16,000 inhabitants of rural isolated communities, mainly in the RAAS and RAAN regions, by providing sustainable energy supply based on hydropower and village photovoltaic systems.

3.36 PERZA will contribute to the increase of the national electricity coverage from its present 49 percent to 55 percent. The access of the rural population to the grid will be increased by 20 percent with the help of PERZA. The CNE will develop and implement the respective strategy for rural electrification in isolated areas including schools,

[31] Life expectancy may be as high as 100 years. In European countries, where plants are also the oldest, almost 45 percent are over 60 years old and 68 percent over 40.

hospitals, community centers, and public buildings. The program has a total value of US$23 million of which 52.2 percent or US$12 million is financed by a loan from the World Bank, US$4 million by GEF, US$2.2 million by the Nicaraguan government, and US$4.7 million by private investors.

3.37 PERZA will be implemented in two phases. In the first phase, two hydropower plants, El Bote (0.9 MW, Jinotega) and El Ayote (0.7 to 5 MW, RAAS) will be implemented. Both projects will be connected to the SIN to cover demand on the local grid and to sell the surplus electricity on the spot market in order to enhance the projects' economic feasibility. Nevertheless, both projects will require subsidies provided by CNE through the World Bank loan.

3.38 In the second phase, PERZA will assist and cofinance the UNDP/GEF program (see below) in the implementation of three SHPs in the Triangulo Minero: El Hormiguero (200 kW), Salto el Humo (150 kW) and Naranjo Alto (200 kW). Additionally, under PERZA there will be another hydroelectric project, La Unión (188 kW) in the southern part of RAAS.

Small hydropower program (PCH) <H4>

3.39 The program Usos Productivos de la Hidroelectricidad a Pequeña Escala (PCH) is cofinanced by GEF under Operational Program No. 6 and is implemented by UNDP. It aims at improving living conditions in rural areas through improved income generation based on hydroelectricity. As in the case of PERZA, CNE is the project-executing counterpart organization. As part of the GEF Project Development Fund Block B grant, several preparatory studies have been carried out by NGOs and consultancy companies. Among them is a reconnaissance study which identified 30 potential hydropower projects ranging from 150 kW to 1.5 MW and totaling some 11 MW.

3.40 The financing required to implement the entire program is about US$30 million. For the first project phase (2003 to 2007), a total budget of about US$14 million is earmarked including an incremental cost component of US$3.5 million provided by GEF. During the first phase, seven mini hydropower plants will be implemented, three of which will be financed by PERZA.

CNE's portfolio of hydropower projects

3.41 CNE is taking a proactive approach in promoting the use of renewable energies in Nicaragua. It has published an Investment Guide, the "Guia para el Inversionista Sector Eléctrico de Nicaragua." Besides general information for potential investors, the guide provides information on the hydropower projects CNE is offering to interested investors. This guide, as well as CNE's webpage www.cne.gob.ni, provides lists with basic data about mini, small, and large hydropower projects.

3.42 The CNE's project portfolio presented in the Investment Guide contains at present 54 hydropower projects of which 26 are mini hydropower projects totaling 9.25 MW, 15 are small hydropower projects in the range of 1–15 MW totaling 125 MW, and 13 projects are medium to large projects (15–281 MW) as suggested by the 1980 Master

Plan. These total 1,776 MW.[32] However, since the majority of these projects are only at the level of pre-feasibility studies or of technical profiling, the generation capacities are estimates only.

3.43 The mini hydropower projects were identified by a Nicaraguan NGO[33] within the framework of the PDF Block B preparatory study of the UNDP/GEF Project. A total of 30 mini hydropower projects were identified and studied at the pre-feasibility level. These are mainly off-grid with capacities between 140 kW and 950 kW, with a total capacity of approximately 12 MW. The majority of the mini hydro projects are located in the Department of Matagalpa. From that list, 7 projects will be implemented, partly financed by GEF/UNDP and the World Bank within the PERZA Program. This portfolio provides a valuable basis for further hydropower development in this segment.

3.44 The present portfolio of small hydropower projects comprises 15 projects ranging from 1 to 15 MW. Of these only 3 have completed feasibility studies; the other projects are at the level of technical profiles and pre-feasibility studies only. A detailed comparison of the content of technical profiles, pre-feasibility, and feasibility studies is attached for reference in annex 6.3.

3.45 The same restrictions apply for the medium to large hydropower schemes. The list of the 13 medium to large projects reveals that the majority of these projects are on a premature profile or pre-feasibility level only. Only for the projects Copalar and Larreynaga do feasibility studies exist.[34]

IFC Project Pipeline

3.46 A pipeline of medium to large hydropower projects has been proposed by the 2001 IFC study "Assessment of Hydroelectric Generation Alternatives." In this study, medium and large projects from the project list of the 1980 Master Plan were screened and put forward for implementation in the medium- to long-term planning horizon.

3.47 In this list, that there are only two projects below 25 MW and therefore of concern for this study, Larreynaga (17 MW) and Pantasma (24 MW).

3.48 The Larreynaga project at the Rio Viejo, downstream of the Planta Centro America, was the subject of several feasibility studies, the latest of which was carried out by INE. Originally planned with a dam, a capacity of 40 MW, and an annual production of 85.4 GWh, the project was downgraded to a project with a 17 MW in order to secure the status of a run-of-river scheme. For the 40 MW project, the project was expected to be able to obtain benefits from carbon certificates of approximately €3.4 million (US$2.8

32 There are some discrepancies between the capacity of individual projects listed in the Investment Guide and the updated list of projects presented by the IFC-supported 2001 study "Assessment of Hydroelectric Generation Alternatives."

33 ATDER-BL (Asociación de Trabajadores de Desarrollo Rural – Benjamín Linder) headquartered in Matagalpa.

34 Studies are stored at the INE office.

million). The temporary license issued by INE expired in 2003 and has not been renewed so far.

3.49 The second project, Pantasma, was the subject of several studies. The project is situated in the Department of Jinoteca at the Rio Pantasma. In 1995, INE granted a temporary license for one year to the Corporation Meco y Santa Fe S.A. to explore the Pantasma project and to carry out a feasibility study for a project of up to 10 MW utilizing a head of 400 meters. The result of the study was obviously not satisfactory to the interested developer.

3.50 In 2000, INE granted another temporary license to a developer from Costa Rica (Saret Costa Rica, Alajuela). This license expired recently; and no application for a renewal was requested.[35] According to local people at the project site, the last activities of the potential developers were registered in April, 2003. In the IFC Project List the generating capacity of Phantasmal is given as 24 MW.

3.51 In another data sheet, the basic data of Pantasma are given as capacity 23 MW, generation 92 GWh per year, estimated investment €35 million, and the expected benefit from clean development mechanism (CDM) is estimated as €2.9 million.

Summary of the current hydropower portfolio

3.52 Having reviewed the different sources of information on hydropower projects from CNE, Master Plans, project studies, and data sheets, the current portfolio can summarized as follows:

- There exists a portfolio of about 45 projects ranging from 100 kW to 25 MW and about 15 large projects ranging from 40 to 425 MW that CNE wishes to promote, mainly by mobilizing private capital investment.
- The overwhelming majority of projects are limited to technical profiles or pre-feasibility studies. Very few projects have been studied at feasibility level.
- The basic data (mainly generating capacity in MW and electricity generation in GWh per year) of these hydropower projects vary significantly in the different project lists published by CNE.
- The discrepancies in basic data create confusion among potential investors and raise questions about the reliability of the released data, which may undermine the credibility of CNE.
- It is therefore recommended to undertake a detailed review and update of the published project lists and released project data.

[35] The present legislation grants a license for two years and does not provide for the extension of a temporary license. See also chapter 3, “Analysis of the legal and regulatory framework.”

Analysis of the Legal and Regulatory Framework

Regulatory requirements for successful small hydropower development

3.53 The experience from successful hydropower development by the private sector in other countries shows that six essential statutory regulations need to be enacted by governments in order that small hydro development by the private sector can take place. This list is not complete, and there are additional factors that determine the sustainable development of hydropower plants in a country, such as country- specific incentives and targeted subsidies.

(1) Water rights and water usage fees

3.54 Granting of water use rights is a difficult issue for government agencies. If unrestricted water use rights are granted to small hydro developers without careful evaluation of future water requirements, then the state may not make optimum use of its water resources. On the other hand, too restrictive an approach can completely block small-scale hydro development.

3.55 A successful approach practiced in other countries is to grant water use rights freely to small hydro developers of up to about 1 MW capacity. If a larger project of national interest—whether hydropower or some other water-related project—requires the water or the head used by the small hydro plant, then the water use right is revoked and the mini hydro project is duly compensated for the loss of the remaining years of power generation up to the expiry date of the water use certificate. For larger schemes above 1 MW, compensation to the SHP owner may become prohibitively large and state agencies will need to grant water use rights in a more restrictive manner.

3.56 State agencies can effectively handle water use rights if they can rely on the following:

- A solid water resources master plan
- Agency personnel with an intimate knowledge of the water resources available in the country so that they can predict possible future water use conflicts.

3.57 Both these requirements do not always obtain in developing countries and small hydro development between 1 and 25 MW is often inhibited by long and troublesome procedures required to obtain water use rights. For these reasons, technical assistance has preferentially been directed to master planning and capacity building in the water resources sector.

(2) Land acquisition and resettlement policy

3.58 Even without the existence of a reservoir or pond, small hydro facilities often require the acquisition of considerable plots of land and a displacement of families. If not already constructed, access roads constitute another land acquisition issue.

3.59 Without assistance by the government in negotiations with stakeholders, land acquisition may be a very costly affair for the developer. If the developer can count on the application of standard government land prices (or long-term lease fees) and compensation fees for crops, then a considerable stumbling block to small hydro development is removed. Land acquisition by the government or assistance in this issue is one of the support mechanisms a government can provide to stimulate private sector involvement.

3.60 In the case of access roads, government intervention is highly desirable since it provides a multiple purpose benefit for the local population, such as easier access to regional markets.

(3) Environmental clearances

3.61 Hydropower projects can have considerable impacts on the environment. For economic reasons the study of these impacts in detail is not desirable for small hydro even though an ill-conceived project can have very adverse impacts. It is therefore necessary to define an intermediate level of regulation that avoids a costly, full-scale Environmental Impact Assessment, but –which also identifies the crucial environmental aspects of the project. Simplified environmental examinations have been defined by a number of countries for small hydro plants in the range between 3 and 6 MW. Above this range, full-scale environmental impact studies are generally required.

(4) Grid connection policy

3.62 Small run-of-river hydro plants are only attractive for the private sector if they can make use of the available water flow at all times irrespective of the power demand in the grid.

3.63 If a small hydro has to offer its output on a daily basis in a fully deregulated power market, it will not be able to sell its full potential. In other words, small hydro can normally not compete with large-scale power generation facilities as the latter can benefit from economies of scale and are not restricted by short-term hydrologic variations. Without a strong policy that obliges grid operators always to accept the generated power from small private hydro producers, many SHP projects may not be feasible. Such policy regulations are accepted by grid operators if the number of small-scale producers in a particular subsector of the grid is small and the market is not unduly distorted. These special regulations favoring SHP projects may only become obsolete once the environmental benefits of the renewables are taken into account, for example, by trading the Carbon Credits from SHP or taxing the CO_2 emissions of the fossil-fuel powered plants.

(5) Import policy for electromechanical equipment

3.64 Customs regulations seldom specifically address the issue of import duties on hydropower equipment as such imports are not seen every day. In the absence of specific rules, the duty on electromechanical equipment often amounts to between 10 and 30 percent. This puts a further disincentive in the way of small hydro development. Duty-free import of electromechanical equipment and components has to be granted to SHP developers for successful and sustainable hydropower development.

(6) Company registration and foreign investment policy

3.65 Regulators want to make sure that a private developer has the resources to complete a project successfully and does not leave the site with a half-finished plant which may become a threat to other water users and the environment. Full documentation giving the company background, information on the sources of funds, and the signing of an implementation agreement (with security fees or bonds) are required by most host governments. In some countries, restrictions for foreigners have been specified in order that the exploitation of small hydro resources can be taken up by local investors and sponsors.

3.66 Implementation agreements for small hydro projects are different from contracts for infrastructure projects with private sponsors; such as toll roads, wharves, or large-scale hydro where projects are usually solicited by public authorities. Successful small private hydro programs are mostly based on a build-own-operate (BOO) concept; that is, there is no transfer of the asset to the state at the end of a specified contract period or water use concession.

Existing legal and regulatory framework

Objective of the analysis

3.67 The legal framework, which determines directly or indirectly the chances of attracting private investment in the hydropower sector, must focus on the following questions:

- Does the legal framework support the general interest of investors and project developers to investment in Nicaragua and particularly in the energy sector?
- Does the legal framework facilitate or hinder the implementation of hydroelectric projects and if so, in what form?
- Does the legal framework facilitate or hinder the competitiveness of hydropower projects compared to other options?
- Does the legal framework cater adequately for the long-term of hydropower investment projects?

General legal framework of the energy sector

3.68 The existing legal framework for the development of the country's hydropower resources is defined by the following Laws and Decrees that are briefly described below in order of importance:

- **Political constitution (Art. 102)**

  It establishes the general principle that the natural resources of Nicaragua are part of the national patrimony and their exploitation shall be controlled by the state, which will grant contracts for exploitation of these resources whenever required by the national interest.

- **General Law of the Exploitation of the Natural Resources**

This Law deals with the issues of concessions, licenses, and permits for the exploration and exploitation of the natural resources and defines the obligations and rights of those who wish to explore and exploit them. This Law creates the Directorate General of Natural Resources (DGRN—Dirección General de Riquezas Naturales) within the Ministry of Promotion, Industry, and Commerce (Ministerio de Fomento, Industria y Comercio—MIFIC), which is responsible for enforcement of this Law and for the administration of the natural resources in the country.

- **General Law of the Protection of the Environment and Natural Resources** (Ley General del Medio Ambiente y los Recursos Naturales, Ley No.217, 1996)

This law establishes the norms for the conservation, protection, improvement, and restoration of the environment and natural resources, assuring their rational and sustainable use. It also establishes the right of free use of water by any person in order to satisfy his or her basic needs, as long as such use does not cause disadvantage to others. In addition, the law establishes the prioritized use of natural resources to satisfy human consumption needs and determines the regime of concessions, permissions, licenses, and quotas, according to this law or any other special laws.

- **The Civil Code** (on water resources)

The Civil Code establishes the general principle of private ownership of the water resources by the legitimate owner of the premises in which the source is located. Nevertheless, the owner cannot prevent the use of this water resource for domestic supply.

- **Law of Organization, Competencies, and Procedures of the Executive and its Regulation** (Ley No. 290, June 1998—Ley de Organización, Competencias y Procedimientos del Poder Ejecutivo y su Reglamento)

This Law is a significant effort aimed at streamlining the institutional management of the water resources. It creates the Directorate General of Natural Resources (Dirección General de Riquezas Naturales—DGRN) within MIFIC. DGRN will coordinate policies for the rational and sustainable use of natural resources and the water resources of the country.

- **Water Law (First Draft, July 2003)** (Ley de Aguas, Anteproyecto Julio 2003)

This law establishes the legal and institutional framework for the administration and protection of hydrologic resources. It regulates the planning, management, concessions, and protection of hydrologic resources for different types of utilization, including hydroelectric generation. It creates the Nicaraguan Council of Hydrologic Resources (Consejo Nicaraguense de Recursos Hídricos—CNRH) as the entity for the planning of the hydrologic resources. A dependency of the DGRN within MIFIC, called the National Water Administration (AdAguas), will act as the entity for the administration of hydrologic resources in coordination with MARENA and the Nicaraguan Institute of Territorial Studies (Instituto Nicaraguense de Estudios Territoriales—INETER) and the Ministry of Agroforestry (Ministerio Agropecuario y Forestal—MAGFOR).

AdAguas coordinates the programs of protection of the ecological system with MARENA and regional organizations like municipalities and regional governments. The emphasis is on the conservation of soil and water.

Laws and regulations of the electrical and the hydropower sector

- **Statutory Law and its Reforms of the Nicaraguan Institute of Energy (INE)**
  (Ley Orgánica y sus reformas del Instituto Nicaragüense de Energía (INE), Decree No. 16, 1985 y su reforma Ley No. 271, 1998)

This Law establishes the functions of the INE as the regulatory entity of the energy sector. The INE is in charge of regulation, overseeing, and standard-setting activities for the electricity and hydrocarbon sector. INE is also responsible for the issuance of licenses in the sector (including permits for exploration of energy resources and other activities). It is in charge of the formulation of the new market structure by developing the bidding criteria, defining the methodology for setting regulated tariffs and tolls, and the formulating of technical, operating, and safety criteria. It will also define indicators for performance and quality of service. Furthermore, INE will assist the National Energy Commission (CNE) in policy-making and concession activities, and is in charge of implementing further policies and directives issued by CNE. It will also oversee energy development activities undertaken by other agents of the state. Other assigned duties include safeguarding energy consumers' rights; ensuring compliance with sector norms and standards; performing inspections; approving regulated transmission, distribution, and retail tariffs; defining customer categories; resolving disputes among sector participants; and acting to prevent anti-competitive practices. It is also in charge of overseeing licensees and concessionaires (including those undertaking energy resource development or exploration and exploitation projects) and advising CNE on the extension or revocation of licenses and concessions for generators using natural resources.

- **Law of the Electrical Industry** (Ley de la Industria Eléctrica – LIE, Ley No. 272, 1998)

The Law of the Electrical Industry, promulgated on April 23, 1998, together with its regulation (Decree no. 42-98 Regulation of the Law of the Electrical Industry, June 23, 1998) regulates the activities of the electrical industry.

The present law and its regulation establish the mechanisms, procedures, and requirements for the granting of concessions, permits, and licenses for generation, transmission, and distribution, as well as the justification for any abrogation or cancellation of the rights and obligations contracted by economic agents in the electricity market. The LIE also creates the National Energy Commission (Comisión Nacional de Energía—CNE), charged with the formulation of the objectives, policies, strategies, and general guidelines of the power sector. It also provides for indicative planning aimed at the development and optimal utilization of the energy resources of the country.

- **Law of Promotion of the Hydroelectric Sub-sector** (Ley de Promoción al Sub-Sector Hidroeléctrico, Ley 467, 29.8.2003)

This Law, in force since its promulgation in August 2003, aims at the promotion of electricity generation utilizing the existing hydropower resources in a sustainable and environmentally compatible way. The publication of its regulation was expected by the end of November 2003.[37]

- **Presidential Decree 279-2002 and the Resolution of INE No. 07-2003** (Acuerdo Presidencial No.279-2002 (09.07.2002) y la Resolución No.07-2003 del INE)

This Decree aims specifically at promoting wind power and run-of-river hydropower projects. The Decree and its Regulation incorporate nondispatchable energy into the electricity market and recognize wind power plants and run-of-river hydropower plants as nondispatchable energy generators. Several incentives for wind power and run-of-river schemes are granted to promote the use of these technologies.

Box 3.1: Dispatchability of Run-Of-River Hydropower Schemes

When renewable energy-based electricity is fed into an existing grid, the electricity does not get respect from utility engineers and regulators because it is not available on demand (also referred to as not being "reliable" or "dispatchable"). Solar, wind, and micro hydropower, the ”zero emission renewables,” are only available when there is sun, wind, or water However, electricity demand continues 24 hours per day 7 days per week, and peak demand often does not coincide with solar, wind, or hydro-based electricity production. However, there are differences between the availability of the different renewable energy technologies. While solar energy is predictable in many countries and for many days or weeks in advance, wind power is difficult to predict on a daily or weekly basis.

In comparison, the predictability of run-of-river hydro schemes is quite good and relative reliable. This is particularly true for larger streams with higher storage capacities and inertia or for schemes with storage capacity provided by small reservoirs (daily or weekly storage). If reliable flow duration curves are available for a specific site, the firm capacity can be determined and controlled and can certainly be regarded as dispatchable energy.

[37] The respective document was not available before this study was finished in December 2003.

- **Law of Organization, Competencies, and Procedures of the Executive and its Regulation** (Ley No. 290, June 1998)

In order to obtain a concession or license for exploration and exploitation of a natural resource that can cause deterioration to the environment, the law requires the issue of an Environmental Permission which is granted by the Ministry of Environment and Natural Resources (Ministerio del Ambiente y los Recursos Naturales—MARENA). Executive Decree No. 45-94 (Regulation of Permission and Environmental Impact Evaluation) defines the projects for which an Environmental Impact Evaluation (EIA) is mandatory. It specifies that power generation plants with a capacity above 5 MW, irrespective of the energy source, require the presentation of an EIA before an Environmental Permit can be issued in accordance to the Electricity Law (Ley de la Industria Eléctrica No. 272—LIE).

For plants with less than 5 MW, the Environmental Permit has to be submitted to MARENA on an application form (Formulario de Solicitud de Permiso Ambiental). The responsible unit within MARENA (Dirección General de Calidad Ambiental—DGCA) will respond within 20 days to the application and communicate to the applicant whether an EIA has to be carried out (for hydropower plants larger than 5 MW) or an Environmental Permit can be granted without an EIA. In any case, an Environmental Permit has to be granted to an investor before the investor can proceed further with the application for a generation license from INE.

Analysis, comments, and recommendations

General appreciation of the existing legal framework

3.69 The legal framework for hydropower development has changed significantly during recent years and provides an improved basis for hydropower development involving the private sector. This development is a result of the strong commitment of the government and CNE to promote the use of indigenous renewable energy sources.

3.70 While legal, regulatory and other barriers still exist for medium and large hydropower projects, a favorable legal framework and an attractive incentive structure is in place for mini and small hydropower plants below 5 MW. The existing legal framework for these small projects enables a developer to obtain the necessary environmental permits from MARENA, generation licenses from INE, and water concessions from MIFIC. Under the given framework, a developer of small hydropower projects (especially if grid connected) should be able to obtain project financing from national or regional commercial and development banks, provided that the remaining uncertainties and contradictions regarding the interpretation of Decree 279-2002 can be resolved. It should, therefore, be possible in the short run to attract private investment from national developers for small projects.

3.71 Although the framework for mini and small hydropower projects has been improved in general, the recently approved fiscal incentives for hydroelectric projects do not yet create a level playing field for hydropower development compared to thermal projects, since the latter continue to be highly subsidized. These subsidies consist of indefinite tax exemptions on fuel and other tax incentives which normally hold for three years on the investments, but which are extendable. The further improvement of the competitiveness of hydropower-based electricity generation requires either the removal or reduction of incentives for fossil fuels or the provision of adequate incentives for the renewables. Since the first option is legally difficult to implement, the creation of adequate incentives for renewable energy is a more realistic option. Another option to increase the renewables' competitiveness is to make full use of the instruments and mechanisms provided under the Kyoto Protocol.

3.72 Analysis of the existing legal and regulatory framework suggests that there are three areas of particular concern regarding hydropower development:

- How can water rights be granted to electricity generators without creating a conflict with the other users?
- How can any negative environmental and social impacts of medium and large hydropower projects be reduced in order to be acceptable to society?
- How can the private sector be encouraged to get involved in the necessary investment in new generation capacity using the existing large hydropower potential?

3.73 More specifically, the following issues should be addressed through correction or amendment of the existing laws and their rules and regulations:

1. The legal and regulatory responsibilities with respect to hydroelectric generation are dispersed between different ministries and government authorities. They are therefore not readily understood and are in some cases not coherent.

2. It appears that the interinstitutional information flow, consultation, and coordination between Ministries and Government Authorities like MIFIC, MARENA, CNE, INE, CNDC, INETER, and others is not as efficient as it should be. Although the regulatory framework establishes mechanisms like committees, councils, working groups, ands so forth, there is much room for improvement in the interaction among these entities.

3. The approval of hydropower projects is subject to authorization and opinions of several authorities. Apart from the complicated process of approval, the respective authorities often do not have sufficient technical criteria to justify their decisions and make the reasons for them clear to a developer. This may create a situation where project proposals or applications are rejected that possibly would have been approved if clear definitions and transparent decision-making criteria had been available, such as clear definition of run-of-river schemes.

4. The existing legal framework appears to be directed at protection of important national areas of interest like the environment, natural resources, and consumers (via the tariff structure) rather than to the initiation and promotion of hydropower development. Therefore, any hydroelectric project will face a conflict with these

areas of national interest that might discourage the interest of developers wanting to invest in this sector.

5. The legal basis for water concessions was suspended in 2002 and the draft Water Law that is presently in the making needs quick approval. The main challenge in water management is the equal and fair distribution of water resources in a given watershed area for which the natural decrease of water flow due to climate change is the main risk. The draft Water Law addresses that issue by allowing the authorities to suspend, revoke, or modify a valid concession in case of natural reduction of flow (Tit. VI, Cap. I, Art. 69). Clearly, this may affect the economic performance of a hydropower project and constitutes a potential threat for an investor. It may also affect a bank's willingness to finance such a project.

3.74 The use of water for human consumption has been declared a national priority (Tit. VI, Cap. I, Art. 71). Water concessions for other purposes will be granted based on three priority criteria established in Art. 72: (1) collective over individual interests, (2) multiple uses of water, and (3) economic and social benefit for the country. It can be assumed that in case of suspending, revoking, or modifying a water concession due to the natural reduction of water flow, the same criteria will apply as for the granting of the concession. Since hydropower development is to be promoted for private investors, the Nicaraguan government should emphasize the exploitation of renewable energies, especially water concessions, as a national priority like general environment protection and other national objectives.

Specific analysis, comments and recommended adjustments

Box 3.2: Law of Promotion of the Hydroelectric Sub-sector

Law No. 467, 29.8.2003: Law of Promotion of the Hydroelectric Sub-sector

The law exempts new hydropower projects (storage or run-of-river hydropower) for a period of 15 years (period started in August 2003) from the following duties:

- Import duties and taxes (Derechos Anrancelarios de Importacón—DAI) on equipment, materials and other accessories for generation/transmission and G/T/distribution for isolated systems
- VAT (Impuestos al Valor Agregado—IVA) on) on equipment, materials, and other accessories for generation/transmission and G/T/distribution for isolated systems
- Income taxes for 7 years (Impuesto sobre la Renta—IR) from the beginning of commercial operation
- Municipal taxes during the construction period and for 10 years from the beginning of commercial operation, with a gradual reduction of exemption during that period
- Stamp duties (Impuestos de Timbres Fiscales—ITF) for 10 years
- All taxes which may exist in relation to the exploitation of natural resources.

Comments

Considering the long times of maturation of hydroelectric projects, especially for medium and large projects, the attractiveness of these incentives are reduced considerably by restricting the life of the law to only 15 years.

The law apparently does not exempt hydroelectric projects from the 1-percent tax on capital, which has a negative effect on the yield of a project, particularly on medium and large projects with a long planning and construction phase in which they do not generate any revenue. This is clearly discrimination against renewable energies in favor of fossil fuel.

The law authorizes MIFIC to grant *water concessions* ("permisos de aprovechamiento de agua") for projects with capacities of 1 MW to 5 MW in a defined watershed area and for a period of 30 years. However, this time period can be extended. MIFIC also defines the obligations of the holder of the concession regarding maintenance of the forest resources, multiple uses of water resources, and protection of the environment. The water concession also establishes the priority of the use of water for human consumption.

Hydropower projects with less than 1 MW capacity are exempted from any water concessions or permits (Art. 6). According to the LIE, such hydropower plants do not also need a generation license. However, there is a *contradiction* between Art. 6 of this Law and the draft Water Law. In Arts. 81 to 83, the draft Water Law requires that hydropower plants up to 1 MW need an authorization to access water resources. This authorization will be granted for 15 years and can be extended if required at the end of the period.

Recommendations

1. Consider extending the validity of the law beyond 15 years for small hydropower plants.
2. Remove the tax on the capital of 1 percent for hydropower projects.
3. Adjust the draft Water Law to accord with the provision of the Hydroelectric Law by deleting the need for water authorization for plants below 1 MW in Arts. 81 to 83.

Box 3.3: Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

This Decree specifically aims at promoting wind power and run-of-river hydropower projects by providing special privileges for such schemes. These privileges refer to following issues:

- INE defines in the Regulation of the Decree (Resolution 07-2003) the term "run-of-river" as electricity generation from the hydraulic energy of a river *without a dam* that can store hydraulic energy.
- The Decree limits the incorporation of wind-power generation plants into the SIN to a maximum of 5 percent of the total national demand.
- The Decree establishes a monetary incentive per kWh for wind and hydropower electricity fed into the SIN. This incentive is defined as a premium of 70 percent of the difference between the hourly wholesale price of the electricity (including auxiliary contracts, services, and the spot market) and the hourly price of the spot market. This preferential price will be paid as long as it does not create a surcharge on the consumer tariffs.

Comments

(a) General comment

The experience from hydropower development in other countries reveals that run-of-river schemes selling electricity on the spot market is very problematic. Without a PPA with fixed tariffs for at least five years or guaranteed preferential dispatch of electricity on the spot market at preferential fixed prices, there will not be investment by the private sector.[38]

However, decentralised mini hydropower plants below 1 MW may have advantages since these plants usually feed directly into a low-voltage grid and thus save wheeling charges.

[38] In Jamaica, renewable energy schemes feeding into the grid are allowed a 15- percent price advantage over generators using fossil fuel.

(b) Definition of "run-of-river"

The definition of run-of-river as defined by INE in Resolution 07-2003) is obviously *contrary* to the common practice in Nicaragua.For example, the hydropower plant Santa Bárbara is recognized as a run-of-river scheme although its storage capacity is 40 days of generating capacity. It is important to clarify this issue since it influences the investment costs of a hydropower scheme and the feed-in prices offered to INE. A run-of-river scheme as it is presently defined by INE will lead to lower investment costs in the civil structures and thus to lower feed-in prices.Alternatively, a run-of-river scheme with day or week storage could take advantage of a summer/winter tariff or a peak/valley tariff scheme that follows the national electricity consumption pattern, and would serve as a control mechanism to influence consumption patterns of local consumers.

A description of run-of-river schemes and options for common definitions are given in annex 6.7.

(c) Five percent ceiling for wind power

Although the Decree limits the incorporation of wind power generation capacity to 5 percent, in its Regulation INE applies this 5 percent ceiling to wind power *and* run-of-river hydro schemes. While a ceiling may be justified for wind power generation, the resolution unnecessarily limits hydroelectric generation.

(d) Preferential feed-in price

Resolution 07-2003 does not specify how the wholesale price will be calculated at an hourly level, because the calculation of many of its components (like payments by capacity and reserve) is based on daily or long-term levels. Also, neither the Law nor its Regulation clarifies what is meant by "the incentive will be paid as long as it does not cause a surcharge to the final tariffs" or who is going to pay for this incentive if it cannot be charged to the tariffs. However, according to CNE, this decree has not been put into practice because there are different interpretations of all three items on the part of the government entities like CNE and CNDC as well as among the investors themselves.

In an attempt to solve these problems, and at the same time to improve the attractiveness of the incentives given for wind and run-of-river hydropower, in November 2003 CNE recommended a modification of the existing Presidential Decree 279-2002 that would attempt to correct its imperfections The modification proposes a competitive bidding process in order to grant generating licenses to the investor who offers the lowest price for electricity fed into the SIN. The modified Decree also proposes to switch from the 70 percent premium in Decree 279-2002 to maximum prices for wind power and run-of-river hydropower fed into the SIN, which are US$0.0575 per kWh for wind power and at US$0.0590 per kWh for hydropower. The proposed prices are to be valid for six years from the approval of the Decree and are to be fixed for 12 years after the beginning of commercial operation. The agreed electricity selling price per kWh and the period after which it will be paid will be fixed in the generation license.

The modified Decree also proposes to exempt wind power and run-of-river hydropower generators from providing or paying the additional cost for capacity backup ("spinning reserve").

At the time this study ended it was not certain if or when this modified Decree would enter into force since INE did not accept this amended Decree. The reasons for INE's intervention are not known to the consultant.

Irrespective of INE's reservations, the consultant believes that introducing competitive bidding for generation licenses will lead to lower tariffs and is therefore generally a preferred approach as long as preferential dispatch of wind and run-of-river hydro on the spot market is guaranteed. Fixing a maximum feed-in tariff is also advisable since this helps to maintain the tariffs for the consumer on a certain level. This maximum feed-in price however, should not be indexed according to tariff adjustments or inflation.

Recommendations

1. If the existing Decree remains in its present form, clarification wil be required as to how the preferential prices for wind and hydropower will be calculated and who is going to pay for the margin of preference. Further, a precise definition will be needed of the circumstances under which the premium on the spot market price will be paid.

2. For run-of-river hydro, the 5 percent ceiling should be skipped and the text in Resolution 07-2003 changed accordingly.

3. Redefine in Resolution 07-2003 the term run-of-river scheme using the Relative Criteria B1 (volume of storage relative to design flow of hydropower scheme) which seem already to be common in Nicaragua (used at Santa Bárbara). In this case, a run-of-river hydro plant could make use of its hydro resources in an optimal way generating electricity when it sells at maximum prices, thus maximizing the return of investment for the investor.

4. Review the option to establish the legal basis for PPAs for small hydropower plants with fixed feed-in tariffs.

5. Additionally, negotiate with INE (and Union Fenosa) for elimination of wheeling charges for capacity, which are presently contained in the selling price on the spot market.

6. If the Decree is amended to maximum feed-in prices, it would be necessary to introduce an indexation of these maximum prices. For example, prices could be indexed to the adjustments of consumer tariffs, since this would already include compensation for inflation or exchange rate changes.

Box 3.4: Draft Water Law (2003)

(First Draft, July 2003) (Ley de Aguas, Anteproyecto Julio 2003): Draft Water Law (2003)

The 2003 CNE study “Propuesta Política Energética Indicativa – Subsector Hidroenergía” states: “The multiple functions delegated to different entities of the State for the sustainable use of the water resource cause difficulties in the resolution of conflicts in most of the cases, since the existing legal framework does not manage to balance the interests of all the potential water users and in particular those who would use water resources for electricity generation.”

Comments

Along with government institutions, territorial organizations, including regional municipalities and local governments, also participate in and comment on the granting of authorizations and concessions (see draft Water Law, Arts. 22, 79). Although comprehensive stakeholder participation is desirable and necessary for the sustainable use of water resources, the consultation process can delay and complicate the granting of a water concession.[39] However, there is no way to circumvent this process and a water authorization or concession is a prerequisite for a generation license from INE. Therefore the process of obtaining a water concession should begin at the earliest possible stage in the implementation process of a project.

Streamlining this process should be one of the tasks of CNE under its proposed ‘one-stop-clearinghouse’ function. Before the water concession can be applied for officially at MIFIC, a consultative mechanism facilitated by CNE may reassure an investor that outstanding issues will be addressed and a water concession will be issued.

Contradiction regarding granting water concessions and authorisations

As already mentioned earlier, according to the Law of Promotion of the Hydroelectric Sub-sector, hydropower projects with less than 1 MW capacity are exempted from any water concessions or permits (Art. 6) and according to the LIE, such hydropower plants also do not need a generation license.

However, there is a *contradiction* between Art. 6 of the existing “Law of Promotion of the Hydroelectric Sub-sector” and the draft Water Law, Arts. 81 to 83; these articles state that hydropower plants up to 1 MW need an authorization to access water resources.

Recommendations

1. To promote hydropower development it would be advisable to declare explicitly in the new Law or in its Regulation that hydropower development is an objective of national importance and is a “Mayor beneficio economico y social para el pais” which is suggested as one of the priority criteria in the new Law. (Tit. VI,

[39] Like in the case of the Ralco Project in Chile. See case study in the section 6.6 of annex 6.

Cap. I, Art. 72).

2. In order to specifically address the need for hydropower development, add the following text to the draft Water Law under Título VI, Capítulo I, Art. 68: "El MIFIC, ...debera tener en cuenta,.....y el Plan Indicativo de la Generación Sector Eléctrico de Nicaragua." MIFIC should keep in mind the Indicative plan for the Electricity Generation Sector of Nicaragua.

3. Adjust the draft Water Law Arts. 81 to 83 by deleting the provision requiring a water authorization for hydro plants below 1 MW, in accordance with the provision of the existing Law of the Promotion of the Hydroelectric Sub-sector, Art. 6.

4. CNE should not only actively participate in the mediation process between hydropower developers and the other stakeholders in a multipurpose project but also should take the lead in defending the position of interested hydropower developers. This dialogue should be guided by the principles stated in the draft Water Law (Tit. III. Cap. I).

5. CNE should raise public awareness that sustainable use of water flow for electricity generation will ultimately benefit consumers by stabilizing energy tariffs, protecting the environment by reducing greenhouse gas emissions, and reducing dependence on imported fossil fuels.

Box 3.5: Law of the Electrical Industry

Law No. 272: Law of the Electrical Industry

(LIE, Ley de la Industria Eléctrica, No. 272)

The LIE provides a considerable number of obligations and rights relevant to hydropower development. Some of them are analyzed and commented on below.

(a) Functions of CNE (Art. 12)

The National Commission of Energy (CNE) has been given the following tasks by the LIE:

- Prepare, review, and evaluate periodically the strategic plan of the energy sector, particularly the energy balance, demand and supply, conservation of energy, pricing policies and subsidies in the energy sector (including subsidies for consumers of less than 50 kilowatt-hours (kWh) per month), the policies of electricity coverage of the country (including rural electrification), and the policies and strategies for financing and investing in the energy sector.
- Develop the profiles and if necessary pre-feasibility and feasibility studies for the formulation of strategy and energy planning.
- Issue criteria and publish investment opportunities in energy projects, taking as a reference the strategic plan for the sector and the likely environmental impact.
- Develop and submit the draft laws of the sector to the executive.
- Promote and stimulate the participation of the private capital investments necessary for the power development of the country.
- Promote relationships between the financial organizations and the private sector in order to evaluate and verify the sources of financing and propose strategies for financing in the public and private sectors.
- Administer and regulate the Fund for the Development of the National Electrical Industry (FONDIEN).
- Promote policies and strategies that allow the use of renewable energy sources for electricity generation.

Comments

The LIE mandates CNE to assume the role of a protagonist and promoter of renewable energies in Nicaragua, including hydroelectric development at national and international levels.

The consultant obtained a partial inside view of CNE's hydropower-related promotional activities during his three visits; this view is necessarily not complete and does not claim to be correct in all its aspects. It is the impression of the consultant that CNE is keen and highly motivated to fulfill its legal mandate regarding the promotion of renewable energies. CNE is particularly motivated to promote the entire range of hydropower development (including rural electrification), private sector involvement in small and medium grid-connected hydro projects, and the indicative planning of large hydro projects for future development like SIEPAC.

While the unit of CNE for rural electrification (Dirección de Electrificación Rural) is fully operational, its capacity seems to be entirely committed to the implementation of the PERZA and the UNDP/GEF PCH projects. Hence there is lacking not only a suitable strategy on how to develop projects in the range of 1 to 25 MW, but also the capacity to fulfill the tasks related to promotion of that range of projects. Therefore, fulfilling the tasks related to setting up and implementing the proposed "one-stop-clearinghouse" function of CNE, particularly for projects larger than the ones handled so far (including El Bote and El Ayote), requires significant effort from all parties involved.

However, it *should not* be the function of CNE to *elaborate* technical project profiles, pre-feasibility studies, and feasibility studies as outlined in the LIE Art.12, but to outsource and supervise their execution. In particular, preparing projects in the MW range requires both sufficient personnel and adequate professional experience that can only be gained during the execution of many projects. This experience does not yet exist in Nicaragua.

Hence, CNE is in a dilemma: it is obliged by law (LIE Art.12) to fulfill tasks that it actually cannot fulfill due to the shortage of personnel, lack of experience, and, probably, of a sufficient budget. There is no doubt that CNE has professional expertise in the hydroelectric field but this capacity is limited and will probably be fully absorbed by the ongoing rural electrification projects PERZA and UNDP/GEF-supported PCH projects, which are just beginning. At the same time, the lack of national planning and engineering expertise in Nicaragua is obvious when looking at the studies for small-scale hydropower in the MW range which were carried out exclusively by foreign consultants.

In September 2002, CNE created an investment guidebook for investors interested in the electricity sector in Nicaragua. The guidebook is available in print, on CD-ROM, and on the CNE Webpage (www.cne.gob.ni). Besides information on Nicaragua's geothermal, wind power, and biomass potential, the guide also provides generic information on mini, small, and large scale hydropower opportunities. It presents a list of 13 large hydro projects ranging from 15 to 425 MW, 15 small projects ranging from 1 to 14 MW, and 26 mini hydro projects (out of the portfolio of 30 plants elaborated under the UNDP/GEF project) ranging from 0.150 to 1.5 MW.[40]

However, the guide does not provide specific information for hydropower investors in terms of the legal and regulatory framework, the incentives offered by the government, financing, or technological aspects.

Recommendations

1. To cope with the mandate given under Art.12, particularly regarding small hydro development, the CNE has two options:

- To increase its own capacities in terms of personnel and qualifications in order to cope with the given tasks. This would not only require a considerable increase in the budget, but it would also be difficult to recruit sufficiently qualified and experienced personnel in a timely manner.
- To outsource the tasks to national or international consultants. This option would also require considerable funds and would lead to a situation wherein CNE does not generate in-house expertise for supporting and controlling functions.

The following solution lies between the two extremes: Increase or reassign personnel specifically to cope with the development of a portfolio of small hydro projects which can be offered to the private sector, but minimize the involvement of CNE in the execution of studies, which will make available staff required to control and guide externally contracted expertise.

2. To implement projects from the project portfolio that is presented in CNE's investment guide requires systematic development of a hydropower program for small-scale projects of up to 5 MW for immediate

[40] In the printed version of the Guidebook, page 24 (Chapter III Recursos Energéticos) is missing.

realization, and for projects of larger capacities once the draft Water Law goes into force.

It is recommended that CNE approache bilateral or multilateral donors for capacity-building and technical assistance with grid-connected, small-scale hydro projects implemented by the private sector or through public-private-partnerships (PPP).[41] Such external technical assistance programs would have to serve the following objectives:

- Strengthen CNE's capacity in its "one-stop clearinghouse function" to cope with the future challenges of small- and large-scale hydro projects in all its aspects.
- Support CNE in developing an attractive package of small hydropower projects that can be implemented immediately under the given legislation (up to 5 MW), through updating of existing studies and identifying additional sites.
- Contribute to the establishment of a true "hydropower culture" in Nicaragua by building up and supporting the formation and capacity building of national consultants—consultants who will be be a professional source of help to CNE, INE and the private sector for planning, engineering, construction, and maintenance.
- Support the necessary tasks of raising public awareness and disseminating information about renewable energies in general and the hydropower potential in particular, emphasizing its potential benefit to the country.

3. Elaborate and publish an investment guide for small hydropower that nominates CNE as *the* "one-stop-clearinghouse" for hydropower development in Nicaragua. It is important that hydropower development has a name and an address in Nicaragua that is synonymous with CNE. In line with our recommendation to find a middle course between getting too deeply involved in the technical details of feasibility studies and outsourcing this task completely, the proposed investment guide not be too specific about technical details. It should provide comprehensive and correct information on the legal requirements to obtain the licenses, concessions, and authorizations, on the procedure for tenders, on bank requirements for project financing, and on government incentives offered to interested investors. A proposal for the guide contents and structure is given in the annex 6.4.

(b) Sustainable financing of CNE's operation

According to Art. 13., funds will be assigned for the operation of the CNE from the national budget of the Republic. Are these funds sufficient and permanently available to fulfill the assigned tasks?

According to the Law No. 272 (Ley Organica), Art. 13, the INE has resources which seem to be more secure than CNE. INE enjoys administrative and financial autonomy from government agencies, and is under the direct oversight of the Nicaraguan president. INE receives funding through a service charge of up to 1.5 percent on the invoiced activities of the concessionaires and holders of distribution licenses. CNE is mandated to manage the National Electricity Fund (FONDIEN), which, however, is earmarked for rural electrification. This consultant found that promotional activities for small hydropower projects with private investment capital cannot be financed by FONDIEN and would have to come out of the core financing budget of CNE.

Recommendation

Consider INE's financing model for CNE to enable it to carry out its functions in a sustainable way.

(c) Tariffs

The tariff structure for the final consumers has to be approved by INE, and is based on the principles of economic efficiency as well as of financial feasibility. The tariff will also have to take into account the price policies for electrical energy given out by the CNE (Art. 112). The INE has all the tools needed for preferential tariff treatment of renewable energies, including the Norm of Tariffs (Norma de Tarifas), which regulates the cost transfer to the tariffs of the purchase and generation of electricity (for example, by setting maximum

[41] Germany may be approachable for such a program. The consultant recently had the chance to talk the responsible desk officer in GTZ, who recommended that CNE be encouraged to approach GTZ.

prices—see Norm, 3.4.2).

The rate of discount used is the prevailing opportunity cost of capital in the capital market, but if this discount is not considered suitable, one will have to be fixed by the INE on the basis of yields from activities in Nicaragua of similar risk (Art. 117). The choice of discount rate for fixation of tariffs can create certain long-term risks for investment projects. Specifically, the admitted rates of discount ("valor de mercado") do not necessarily reflect the real cost of capital in the long term. For example, the discount rate imposed by INE (the rate also demanded by CABEI) for the project El Bote was 14 percent; the rate was regarded as to too high for such a project given the fact that ownership is not within the private sector but with an NGO.

The influence of the discount rate on government subsidies is presented in the following example (following table) taken from the sensitivity analysis of the project El Bote.

Influence of Discount Rate on Subsidy Requirement

Price in the Spot Market (US$/kWh])	Tariff applied in El Bote (US$/kWh)	Interest Rate (%)	Discount Rate (%)	Subsidy Required (%)	Observations
0.04	0.20	7	10	12	
0.04	0.17	7	10	17	
0.055	0.20	7	10	1	Opción mas favorable para el fortelacimiento de proyectos de energías renovables a nivel nacional
0.055	0.17	7	10	6	
0.04	0.20	7	14	23.4	
0.04	0.17	7	14	27.5	
0.055	0.20	7	14	14.2	Opción mas favorable para el fortelacimiento de proyectos de energías renovables a nivel nacional
0.055	0.17	7	14	18	

At the moment, INE does not give much help in setting tariffs for isolated areas. While INE has been given the task of reviewing and approving proposed tariff schemes in these areas, no guidelines yet exist to serve as a basis for this task. There are also no guidelines either on service quality for off-grid connections or on the management of the transition to grid service of existing isolated systems.

(d) Temporary licenses

The realization of studies for power stations using renewable energies and the studies for transmission facilities require a Temporary License granted by the INE for a maximum term of two years. Art. 68 of the present Law establishes the procedure for granting this license. A fee is paid to INE of 0.1 percent of the total investment.

River flow data can be regarded as reliable if measured over a period of about 20 years. Therefore, if flow data have to be gathered, the period of 2 years is too short for hydroelectric projects. The present Law does not provide for an extension of the Temporary License and it is understood that that a new Temporary License would have to be applied for and the License fees would have to be paid again.

Recommendation:

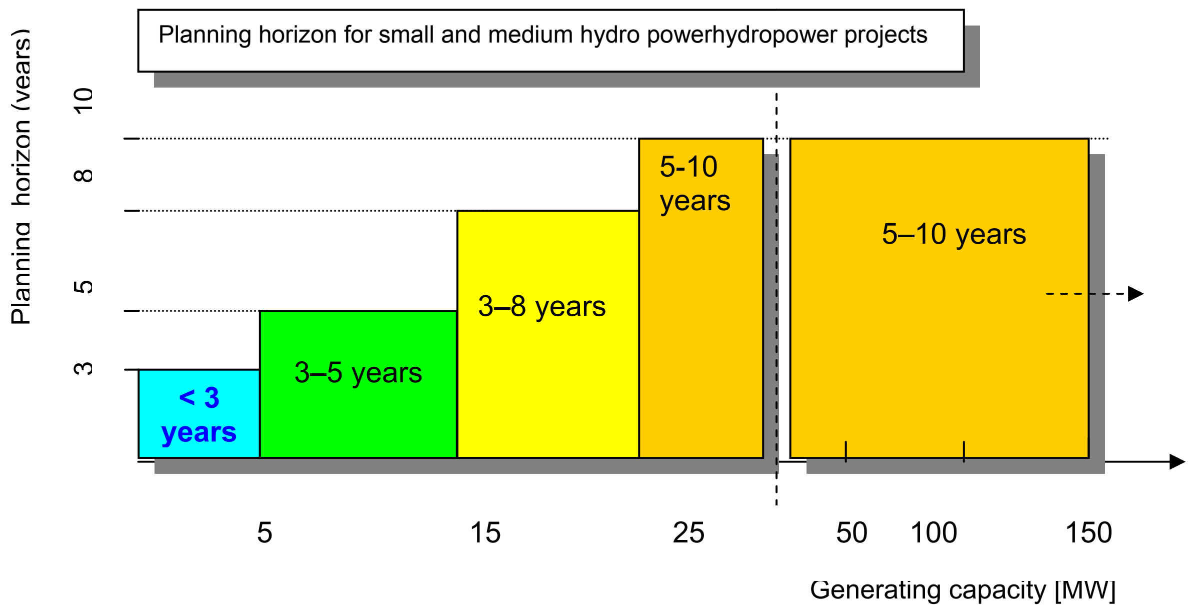
The term for a Temporary License for hydropower should be granted for up to five years, if an investor applies for it. Alternatively, the option should be introduced to extend the license at the investor's request at no additional cost.

(e) Generation forecast and contracts

Art. 87 of the LIE obliges each distributor to have a PPA with generators located nationally, or in another country through import or export contracts that cover a percentage of the predicted demand. On December 1 of every year, a distributor must have firm contracts that cover 80 percent of the anticipated demand for the following year and 60 percent of the anticipated demand for the subsequent year (Regulation, Art. 172)

This requirement clearly favors thermal electricity production unless the LIE condition to maintain contracts with a forecast of twenty-four months is skipped or modified in favor of longer planning horizons, at least for hydropower projects. Otherwise distributors would not consider the hydropower option due to the long planning periods of 2–4 years for a small hydropower plant (see the following figure).

Planning Horizon for Small and Medium Hydropower Projects



(f) Options for hydropower generation

- Options for the private investor or developer
  - Generation and commercialization in off-grid systems

    Create an integrated utility and commercialize hydroelectricity (generation, transmission, distribution, and sale). Such a utility must connect its isolated system to the SIN if INE orders to do so (LIE, Art. 31).
  - Generation and connection to the SIN (or SIEPAC)

    Generate run-of-river hydroelectricity, own the secondary transmission line to connect the hydropower plant to the SIN (LIE, Art. 26), and sell electricity according to Presidential Decree 279-2002 on the spot market.

    Create a utility to generate, transmit (wheeling charges may apply), distribute, and sell hydroelectricity in a local grid outside the concession area of the distribution concessionaire (in the "open area")—provided that generation capacity does not exceed 10 MW (LIE, Art. 34). Sell surplus electricity to the SIN through the utility's own secondary transmission line under the provision of Decree 279-2002.

    Generate hydroelectricity and sell it based on direct contract to a large consumer if capacity is > 2 MW (as of January 2005 >1 MW) and < 10 MW. (LIE, Art. 31, 49)

    Generate medium and large hydroelectricity and sell it to the distribution concessionaire based on contract (PPA) or export electricity based on international contract.
- Options for the distribution concessionaire:

Invest in a hydropower plant with capacity below 10 MW and transmit (wheeling charges may apply), distribute, and commercialize hydroelectricity in its own concession area (LIE, Art. 34).

Recommendations

1. Adjustment of the definition of a Large Consumer (Gran Consumidor) from a present minimum demand of 2 MW to 1 MW as of January 2005 will increase the opportunities for development of small hydropower plants with capacities larger than 1 MW.

However, further lowering of the minimum demand of a Large Consumer to 500 kW (as in Guatemala) would open up additional market opportunities and increase the attractiveness of mini hydro plants below 1 MW. A community or a commercial center can be recognized by INE as a Large Consumer (Regulation of LIE, Art. 49) that may choose to buy electricity on the retail market from the local distributor or on the wholesale market based on fixed contracts, obtaining additional supplies on the spot market (Art. 47).[42]

2. A Large Consumer can connect directly to the transmission system (Regulation of LIE, Art. 50). In this case there is no obligatory contractual relationship with the distribution concessionaire and the Large Consumer gets instructions directly from Centro Nacional de Despacho de Cargo (CNDC) which also controls these direct contracts. It may be worthwhile to analyze the consequences of reducing the lower limit of 69 kV for transmission lines in order to reduce the wheeling costs which would have to be charged on the tariffs.

3. Consider increasing the hydropower generation limit from 10 MW (LIE, Art. 31) to 20 MW, but only for electricity generation based on run-of-river hydro plants or wind power plants. This will increase the attractiveness of investments in hydropower (and wind power as well) for private investors as well as for the distribution concessionaire Union Fenosa

Summary of licenses, concessions, and permissions

3.75 Table 3.1 below summarizes the present situation with regard to the granting of licenses, concessions, and permits for hydropower plants.

Table 3.1: Summary of Licenses, Concessions, and Permits for Hydropower Projects

Generating capacity of hydropower project (MW)	Generation license (from INE)	Water concession (from MIFIC)	Environmental permission (from MARENA)	Direct contracts with Large Consumers possible (limits determined by INE, contracts administered by CNDC)
0,1 – 1	✓	✓	✓ *	No
1 – 5	✓	✓	✓ *	With consumers > 2 MW **
5 – 15	✓	Pending	EIA	✓
15 - 25	✓	Pending	EIA	✓
> 25	✓	Pending	EIA	✓

Note:

✓ Can be obtained under the existing legal and regulatory framework
EIA Environmental Impact Assessment Study required
* Only permission without EIA
** Only with consumers with demand above 2 MW and voltage of at least 13.8 kV, as of January 2005 above 1 MW.

3.76 The Table 3.2 compares the legal and regulatory framework for hydro development in Nicaragua with other countries.

42 Changes of the respective regulations have to be announced at least 12 months before, hence the recommended adjustment could get effective sometime in 2005.

Table 3.2: Comparison of Legal and Regulatory Framework in Nicaragua with Other Countries

Success factors for hydropower development	Legal framework and practice/experiences in other countries	Existing legal framework and practice in Nicaragua
(1) Water rights and water usage fees	No water concession is required for plants < 1MW. If water or head is needed by other project of national interest, water right is revoked and hydro project is duly compensated. Such risk can be reduced by a water resources masterplan and capacity building in water resources planning.	Law 476 (Promotion of Hydroelectric Subsector) stipulates the following: • Hydropower schemes below 1 MW do not need a water concession, but will get a permit for 15 years (according to new draft Water Law). • From 1 to 5 MW a simplified procedure applies to obtain a water concession from MIFIC. • Water concessions can be granted for up to 30 years and are extendable and transferable. • Existing water concessions were suspended in 2002 until the draft Water Law has been approved.
(2) Land acquisition and resettlement policy	Governments assist in negotiation with stakeholders. Developers can rely on the application of standard government land prices (or long-term lease fees) and compensation fees for crops.	Land issue is not regulated in the existing legal and regulatory framework.
(3) Environmental clearances	Simplified environmental examinations have been defined by a number of countries for small hydro plants between 3 and 6 MW.	Law 217 (General Law of the Protection of Environment and the Natural Resources) stipulates the following: • The law requires the issue of an Environmental Permission from MARENA. • Power projects < 5 MW do not need an EIA. • Power generation plants > 5 MW, irrespective of its energy source, require an EIA.
(4) Grid connection policy	Grid operators are always obligated to accept the generated power from small private hydro producers.	Decree 279-2002 and Resolution 07-2003 stipulates the following: • There is preferential dispatch of wind and hydropower, limited to 5 percent of the maximum national demand. • Incentives payment are made for nondispatchable energy of 70 percent of the difference between the hourly wholesale price of the electricity (including auxiliary contracts, services, and the the spot market) and the hourly price of the spot market.

(5) Import policy for electromechanical equipment	Duty-free import of electromechanical equipment and components must be granted to SHP developers for a successful and sustainable hydropower development.	Law 476 (Promotion of Hydroelectric Sub-sector) stipulates the following: • For new hydropower projects the law exonerates equipment, materials, and other accessories for generation, transmission, and distribution for isolated systems from various taxes and duties for up to 15 years.
(6) Company registration and foreign investment policy	Full documentation of the company background, information of the sources of funds as well as the signing of an implementation agreement (with security fees or bonds) is required by most host governments. In some countries, restrictions for foreigners have been specified in order that the exploitation of small hydro resources can be taken up by local investors and sponsors. Successful small private hydro programs are mostly based on a build-own-operate concept.	- CNE has developed a pre-qualification procedure for project tenders in order to screen suitable developers. - There are no restrictions for foreign investment in the energy sector.

Viability and Relevance of Hydropower Development

Barriers and recommendations for their removal

3.77 Despite the considerable efforts of the government and CNE to create an enabling environment for hydropower development, it is only recently that some internationally supported programs have been initiated and have come on stream. There are still barriers and obstacles of various kinds hampering hydropower development. In the following section, barriers are analyzed, commented upon, and recommendations advanced to remove them.

3.78 The identified barriers include the following:

- Legal barriers
- Economics barriers
- Technical barriers
- Lack of strategy.

Legal Barriers

3.79 The consultant’s analysis of the legal situation in Nicaragua identified some current legal deficiencies. The main legal barrier for hydropower development is the suspension of the existing water rights law (Law 440). There is presently no legal basis for granting water rights for hydropower projects above 5 MW. As an interim solution, hydropower plants below 5 MW can obtain a water concession. This situation has been caused by a public dispute over the value of water and water access rights in Nicaragua. Box 3.6 gives some details on the issue of water rights.

Box 3.6: Potential Conflicts Over Water Rights and Value of Water

The reduction of water availability due to climate change is a serious threat for any hydropower project. This risk cannot be mitigated by short term measures. Only long term mitigation measures like reforestation and sustainable management of endangered watershed areas can help reduce negative climate effects at the local level.

This risk may affect all water users in a specific watershed area, and it should be shared fairly among all of them, since all concessionaires in a multipurpose water project are part of a symbiotic system of drinking water supply, irrigation, flood control measures, and hydroelectricity generation. If the water use is carefully planned and the interests of all stakeholders equally considered the water project will be beneficial for all parties involved. Such a participatory planning process must take into account the risk of a natural reduction of water flow and put in place a mechanism to share the consequences equitably as well as planning for an increasing water demand caused by the growth of the affected population and its economic activities. Otherwise conflicts and competition for water rights will occur.

There is a relevant example in Nicaragua of this sort of conflict over water rights between hydropower generation and irrigation purposes. This conflict came up when the initially balanced situation in the Rio Viejo (Sébaco) Valley was disturbed by a series of events, like reduced water flow due to dry spells, increased demand for irrigation caused by increased economic activities of the local population, and finally the question of water rights once Hidrogesa was privatized and further hydropower development would take place in the Rio Viejo Valley. In the Rio Master Plan Study from 1996, the future situation was analyzed and the study concluded that the water abstraction from the river for irrigation (mainly rice production) would increase from 0.61 to 3.18 cubic meters per second, that is, from 20 million to 100 million cubic meters per year in the “near future” (no exact year is given).

That study also gives a hint of the possible value of water in that area: it varies between nil and US$0.04 per cubic meter depending on the crop (mainly rice), production standards, and the market for the products. Based on these assumptions, the value of the additionally abstracted water of 80 million cubic meters per year for irrigation purposes is estimated to be up to US$3.2 million.

On the electricity production side, this abstraction of water needed for irrigation of 80 million cubic meters per year would result in the loss of 34 GWh per year from the downstream hydropower plant Carlos Fonseca (Santa Bárbara). Based on an assumed average tariff of US$0.1 per kWh, this would represent a nominal loss of US$3.4 million for Hidrogesa.[43]

This example illustrates that the potential investors may be discouraged by water shortages due to competition for limited or decreasing water resources. It also shows the importance of a participatory planning process and an effective system for monitoring the rules and regulations to be established.

3.80 In annex 6, the national water policies of the Philippines and Chile are presented.

3.81 In the **Philippines**, in spite of large water resources from 421 rivers, there is increasing competition in the development of water resources. What was once considered an unlimited natural resource is now becoming a scarce commodity in some areas. The use of water has grown steadily. This long-term upward trend is related to a wide variety of factors, including changes in population, technology, and socioeconomic conditions. Furthermore, the quality of water resources is increasingly vulnerable to pollution which threatens its availability and sustainability for various beneficial uses. While precipitation supplies most of the water required by agriculture, it frequently needs to be supplemented

[43] There was in fact a loss in electricity production in the Santa Bárbara Plant in 2002 and 2003 of some 30 percent. It is not know precisely whether this was due to the increased water abstraction for irrigation or the decrease of water flow due to dry spells.

by water diverted from streams or stored in surface impoundments (dams) or underground aquifers.

3.82 In the Philippines, hydropower potential is one of the several energy resource options that have been given preference in meeting the countries energy requirements.

3.83 The increased pace of development of the country in the early 1970's has made it necessary for government to rationalize the water resources sector. Among the major actions taken are the articulation of basic water policies, the codification of all water laws, and the creation of an independent agency to formulate guidelines to implement the laws and policies on water resources development and management.

3.84 All of these actions are based on the fundamental concept that the water, like all other natural resources, belongs to the state. This was first expressed in the 1935 Constitution, then in the 1973 Constitution, and again in the 1987 Constitution of the Philippines.

3.85 The vision of the Philippine National Development Plan for the twenty-first century is to create a modern society, raise the quality of life of all Filipinos, and bequeath to society an ecologically healthy state for the enjoyment of future generations. Among the first acts of the plan Council (now Board) was the formulation of basic policies and guidelines to govern the control, conservation, development, and utilization of the water resources of the country.

3.86 In summary, these policies are as follows:

1. The authority and responsibility for the control, conservation, protection, development, and regulation of utilization of the water resources of the country resides in the state. These water resources include, among others, groundwater, surface water, and water in the atmosphere.

2. Priorities for the use of water when developing water resources shall reflect current usage of water and shall also be responsive to the changing demands for water which occur under development conditions.

3. All water development projects shall adopt a multipurpose concept that includes the river basin or closely related river basins in development planning. Single-purpose projects shall only be implemented when they are compatible with the multipurpose concept and can be incorporated into the contemplated basin-wide development program.

4. Identifiable beneficiaries of water resources development projects shall bear an equitable share of repayment costs commensurate with the beneficial use derived from the project.

5. A continuing program of basic data collection, manpower development, and research shall be maintained since these are indispensable components of water resources development.

6. The National Water Resources Board shall formulate the guidelines, procedures, programs, rules, and regulations needed to implement the policies on water resources.

3.87 These policy statements are essentially incorporated in the Water Code of 1976 and it's implementing rules and regulations.

3.88 In the second case study, **Chile** is pursuing a rigorously liberal policy that is summarized in the Annex 6.6.

3.89 Besides the water rights issue, there are a number of legal barriers hampering the implementation of hydropower projects as outlined in middle of chapter 3.

Economic Barriers

3.90 Financing of renewable energy projects, and particularly of hydro projects, is very often regarded as one of the main barriers to project implementation.

3.91 As the financing institution E+Co. puts it:

> "Technology is not the problem.
> Business models are not the problem.
> Demand for the product is not the problem.
> Ability to pay is not the problem.
> The problem is a shortage of seed capital, insufficient funding to provide services to enterprises, and too little next stage patient capital."

3.92 This statement is based on the experience of E+Co. that developers often do not have sufficient financial resources to bridge the financial gap until the project is approved and financing of the project is obtained from a local or regional Bank.

3.93 The simple truth is that a "good" project—well planned, economically feasible, and supported by an enabling legal environment—gets financing relatively easily. It seems that the lack of financing is not the problem, but access to existing financial resources is. In other words, there is a lack of good projects rather than a lack of project financing. Nevertheless, the high upfront cost for renewable energy remains as a major barrier.

3.94 There are different views on the part of banks and developers when it comes to financing of hydropower projects.

3.95 When a bank hesitates to finance a project, it is mostly due to a high perceived risk. The reasons for that risk are seen in a lack of sufficient collateral of the investor (for example, CABEI requires 150 percent!), lack of confidence in the client, in the technology or in the business model (for example, no PPA signifies a poor business model), or lack of confidence in the underlying technical data and engineering design that guarantees the satisfactory operation of the plant during the payback period. Sometimes there is also a lack of confidence in the buyer of the electricity.

3.96 From the investor's point of view, attractive financing conditions for a hydro plant are usually credit terms with a grace period of 1 to 2 years, an interest rate of not more than 6 percent to 7 percent and a payback period of at least 10 years, but preferably 15 to 20 years. Banks often ask governments to guarantee a credit, though such guarantees are difficult to obtain.

3.97 The criteria for a developer to be successful in obtaining project financing obviously include the following:

- Solid professional engineering design based on reliable flow data
- Elaboration of a sound project business model, preferably based on a PPA at fixed tariffs
- Presence of experienced project developer with sufficient equity or access to such in order to carry out the preparatory ground work
- Ability to secure maximum support from the government through direct or indirect subsidies.

3.98 What can the government do to encourage the private sector investing in the hydropower sector?

3.99 Apart from the incentives provided by the existing laws, there are other forms of support or subsidies that the government can offer though CNE, such as the following:

- Helping an investor to navigate successfully through the bureaucratic requirements to obtain licenses and concessions from INE, MARENA, and MIFIC
- Facilitating the acquisition or lease of the necessary land
- Taking over fully or partially the financing of access roads as a rural infrastructure development measure
- Facilitating access to preferential credit terms for the financing of transmission lines or even taking over completely the financing of these
- Facilitating access to foreign technical assistance through international support programs
- Facilitating the introduction of the green certificate mechanism for renewable energy projects in Nicaragua that will increase the economic viability and competitiveness of such projects.

3.100 There is finally the barrier of the low rating of Nicaragua in terms of access to international financing that can only be removed over the medium term within the context of the overall efforts of the government to improve the economic performance of the country.

<u>*Recommendations:*</u>

1. The government should enable CNE to fulfill the "one-stop clearinghouse" function by providing a budget adequate to sustain the operation of CNE.

2. CNE should prepare hydropower projects by helping to collect reliable flow data and elaboration of feasibility studies (using its own personnel or hired consultants). 3. CNE should support developers in securing access to financing by assisting in the procurement of licenses and concessions, land acquisition, and access to foreign technical assistance.

4. CNE should consider providing implicit subsidies through financing of transmission lines and access roads.

3.101 Financing an access road can be justified in certain cases since it helps to improve rural infrastructure in remote areas by providing easier access to local and regional markets, opening new transport opportunities, and better access to information and communication, as well as triggering socioeconomic development. If the Nicaraguan government (or ENTRESA) were to own the transmission lines, no upfront investment would be required and only wheeling charges would apply. This would reduce the overall investment cost for a hydropower plant by around 20 percent (Table 3.3). Even the provision of concessionary terms for financing of transmission lines though the government would reduce the risk and financing cost of a hydropower project.

Table 3.3: Typical Costs of Transmission Lines

Type of trans-mission line (HV)a	**Average Cost (US$/km)**		
	Brazil b	Bolivia, Peru	Caribbean Region
Three phase	12,000–15,000 (without distribution)	10,000–12,000	10,000–12,000
Single phase	7,000 (with distribution)	7,000–10.000	8,000–10,000

a. High Voltage level usually > 110 kV, in Nicaragua >69 kV.
b. *Source:* "Appropriate Use of Energy in the Agricultural Sector de Minas Gerais" TA Project with CEMIG, Minas Gerais, Brazil, supported and implemented by GTZ/Projekt-Consult GmbH).

Technical barriers

3.102 Hydropower is the largest and most mature application of renewable energy. Twenty-two percent of the world's electricity production comes from hydropower installations, many of which are small hydropower plants (SHP) of less than 10 MW. In Europe, for example, there are more than 17,400 SHP plants installed. Despite a decrease from 86 percent to 60 percent of total renewable energy capacity installed, SHP will remain the largest contributor by far to the European energy market.

3.103 Small hydropower is not simply a reduced version of large hydro plant. Specific equipment is necessary to meet fundamental requirements with regard to simplicity, high-energy output, maximum reliability, and easy maintenance by nonspecialists.

Lack of reliable hydrologic data

3.104 In Nicaragua, the hydropower potential has been studied in detail since the 1970s, but only for medium and large size hydropower and only at a master plan and pre-feasibility level. As a consequence, there are hundreds of potential hydropower sites known but only few of them have been studied in detail up to design level. The overwhelming majority of project sites remained at reconnaissance or pre-feasibility level only.

3.105 The reasons for this are manifold and interrelated. When the hydro potential was studied in the 1980s, there was no specific government policy to develop renewable energy resources and international investors looked at large hydro purely as an investment opportunity. As a result, only the most promising sites were studied in detail. For these sites, sufficient hydrologic data are available. However, for most of the other identified sites, there are no reliable data based on stream gauging to enable calculation of flow duration curves. Despite INETER's network of more than 300 meteorological stations of different types (of which an unknown number are out of service), the data basis for most of the identified sites is weak. However, there are methods of reconstituting incomplete flow measurements (see annex 6 section 6.8).

Recommendations:

1. CNE should coordinate closely with INETER to secure and improve the river flow measurements with priority on their project list in the investment guide. That requires the following immediate steps:

    - Analyze the availability of river flow data for each project on the lists and identifying data gaps.
    - Determine jointly with INETER whether to rehabilitate stations or to install additional stations where flow data are missing.
    - Reconstitute the missing data for the relevant projects.

2. The latter activity may require that CNE has to acquire suitable software for flow measuring data evaluation as well as training in applying the various methods.

Lack of local technical expertise

3.106 There is little local experience in the field of small and medium hydro projects. In the past, there were not many chances to learn hydro development on the job, since there were not many projects to learn from and master plans and feasibility studies for hydropower projects have been carried out mainly by foreign experts.

3.107 With the execution of the present rural electrification programs, there are ample opportunities for on-the-job training of hydro specialists in the field of mini hydropower. For large projects above 25 MW, CNE's activities will be limited to setting the legal framework, providing guidance for developers, and giving details of government support and incentives. The detailed project development for such projects will have to be outsourced and left to either specialists contracted by CNE or to potential developers or their contracted specialists.

3.108 However, in the range up to 25 MW approximately, there are no learning opportunities for national hydro specialists, unless there are projects coming up in that size range. And for these small hydro projects the availability of national capacity in site evaluation, planning, and, to a limited extent, in engineering is of utmost importance for CNE in order to fulfill with competence its mandate in the field of hydropower development.

Recommendation:

3.109 Capacity building should be incorporated as an essential component in the proposed development program for hydropower projects in the ranges of 1 to 5 MW and, in the medium term, 15 to 25 MW.

Lack of an adequate strategy

3.110 CNE successfully coordinates the current rural electrification programs in the mini hydroelectric sector up to 1 MW. Both current programs, PERZA and PCH, are implemented by CNE with support from the World Bank and from UNDP through the recruitment of additional personnel as well as through technical and financial assistance from other donors (such as COSUDE and others who may come on board later). Nevertheless, there is lacking a consistent dissemination and promotion strategy to develop not only the mini hydropower sector for rural decentralized electrification but also the small hydropower sector to meet the growing capacity demand in the national grid SIN and to develop the large hydropower sector to meet future demand in the Central American grid SIEPAC.

3.111 Given the potential contribution of hydropower to the national energy sector in all market segments, it will be conducive to its evolution to develop a "hydropower culture" in Nicaragua consisting of a set of steps and mechanisms to be brought about and established over a longer period of time. The required consecutive and parallel steps and activities are put forward in the section dealing with recommended policies.

Benefits of hydropower development

Macroeconomic benefits

3.112 The main and obvious macroeconomic benefits of exploiting indigenous renewable energy resources are the monetary savings on the import of oil and oil products. The volatility of fossil fuel prices affects negatively both GDP and economic growth. This is a reality which is widely known and accepted by policy makers, but seldom related to the development of renewable energy sources as a mitigation strategy.

3.113 In cases in which the fuel price fluctuations are charged onto the consumer, the employment of renewable energies in the national energy mix helps to stabilize the tariffs in proportion to the share of renewable energy increases in that mix. Developing national hydropower resources also provides opportunities to export hydro electricity to neighboring countries once the Central American grid is in a position to accept power.

Political and social benefits

3.114 There are political benefits—although difficult to quantify—resulting from being less dependent on oil price fluctuations and from enhanced energy supply security. A country with less dependence on oil is more secure and less vulnerable to external political influence.

3.115 At the social level, there are benefits coming from increasing of national skills (engineering, technology, maintenance, and planning) in the field of renewable energy, particularly in the hydropower sector. Increasing deployment of indigenous energy sources creates new jobs and employment, whether directly in the planning and operation of hydropower systems, or indirectly in the service sector by stimulating manufacturing, creating need for energy service companies, capacity building, and so forth. Hydropower electricity serving isolated rural areas increases electricity coverage in rural areas. It also offers new opportunities, not only for income generation but also for improved access to information, education, and health by replacing or reducing the use of traditional fuels like kerosene, candles, and firewood.

3.116 Socioeconomic benefits can derive from economic development through access roads in remote areas and job creation in the affected areas as happened in the area surrounding the hydropower plant Centro America.

3.117 Bringing electricity into rural areas improves living conditions and reduces the tendency to migrate from rural into urban areas.

3.118 Table 3.4 gives an indication how the Nicaraguan government's objectives are met by a hydropower plant, based on the project El Ayote.

Table 3.4: Evaluation Criteria of Different Alternatives for the Electricity Supply of the Population of El Ayote

Criteria: development objectives	Priority	Alternative	
		Network extension only	MHP connected to the network
(1 = max., 3 = min.)		1 2 3	1 2 3
Increase electrical coverage	1	1	1
Reduce subsidy levels for required investment	2	2	3
Include private sector in rural electrification	3	2	1
Stabilize for short term and reduce tariffs in long term in the rural sector	4	2	1
Reduce the amount of foreign exchange utilized in energy generation	5	3	1
Increase the use of renewable energy sources in energy supply	6	3	1
Maximize/optimize the use of local renewable resources	7	3	1
Establish supply models for rural electrification sustained by renewable energy	8	2	1
Stabilize and improve security of the national network at its end points	9	3	2
Increase capacity at the national level for planning, implementation and management of renewable energy projects	10	3	1
Total		24	13

3.119 This simplified qualitative analysis shows how the development objectives of the government for rural electrification are met by two options (1) only grid extension, and (2) grid-connected hydropower plant. In the case of El Ayote, it turns out that the hydropower option has clear advantages over the pure grid extension.

Technological benefits

3.120 The following are the main technological benefits of hydropower development:

- Distributed generation helps to stabilize the voltage level in weak branches of the grid and decreases technical losses. This also increases the overall supply security in the grid.
- A dam type hydropower scheme eliminates the danger of flooding as a result of river regulation.
- Building up national capacities to identify, plan, construct, and operate small hydropower plants increases technical skills in the countries. This raises the general level of qualification of technical personnel in the country. These personnel can then apply their skills in other service areas thereby enhancing the local quality of life.

3.121 These benefits will create the basis for future involvement of local engineers and technicians in the planning, implementation, and operation of mini and small hydropower plants.

Environmental benefits

3.122 The environmental impacts of a hydropower plant usually have to be studied and documented in an EIA. Impacts are studied in a number of areas including hydrology, water quality, geomorphology and soils, erosion and sedimentation, terrestrial and aquatic biology, land use and conservation of reservoirs, access roads and transmission lines, as well as social impacts like resettlement of people in affected areas.

3.123 For run-of-river schemes however, the negative impacts are often negligible and are outweighed by the benefits.

3.124 Major environmental benefits of hydropower plants are flood control by dams and water control for irrigation purposes, and in the case of basic rural electrification, reduction of the use of dry cells and batteries for radios, TV, and communication, and to a limited extent a reduction in the use of firewood. Other benefits are related to increased health conditions and home security of the users by replacing candles, kerosene lamps, and open fires.

3.125 Another major environmental benefit, however, is the avoidance of CO_2 emissions and the associated economic gains from the new mechanism provided by the Kyoto Protocol. A hydropower plant of 1 MW with an electricity production of 4 GWh per year (50 percent availability) avoids (on average) the follwing quantities of emissions:

- 3,500 tons of CO_2 if electricity is produced with a coal fired plant
- 2,650 tons of CO_2 if diesel fuel based plant is used
- 2,000 tons of CO_2 if the plant is gas fired.

3.126 Although the clean development mechanism (CDM) mechanism is well known and already partially used in Nicaragua, the following section looks at the specific future benefits for hydropower development in Nicaragua.

Introduction to the Clean Development Mechanisms[46]

3.127 The Kyoto Protocol established the "flexible mechanisms." These allow countries to achieve reductions where it is the lowest-cost option to do so. The mechanisms comprise international emissions trading and the so-called project-based mechanisms. International emission trading is the trading of rights to emit greenhouse gases between

[46] From: J. Troni, 2001, "Hydropower within the context of a new carbon economy," *Hydropower & Dams* Issue Six, EcoSecurities Ltd, UK, 2001, and International Rivers Network & CDM Watch, November 2003, "Large Hydro still a large problem," Status Note on Large Hydro and the Clean Development, Mechanism for COP9.

capped countries. Under the project-based mechanisms, emissions reduction from specific projects can be traded.

Clean Development Mechanism

3.128 This is the project-based mechanism relating to developing countries. These countries are outside the international reduction target of 5.2 percent, and therefore emission reductions are created outside the boundary of capped countries. Projects will always have the possibility of attracting revenues for emissions reductions, providing these satisfy certain conditions. The CDM allows for the banking of emissions reductions from 2000.

3.129 For any new hydropower investment, there are now two possible revenue streams: conventional through electricity sale and environmental through carbon trading. Providing projects fulfill the eligibility requirements as set out in the Kyoto Protocol and subsequently refined in later negotiations, good possibilities exist for carbon trading. Emissions reductions for CDM projects are tallied for a maximum of 21 years, with a revision to the carbon quantification every 7 years, or a maximum of 10 years with no revisions.

Project eligibility requirements

3.130 The key eligibility requirement for CDM, as set out in the Kyoto Protocol, is "environmental additionality." This means that reductions in emissions should be in addition to any reductions that would occur in the absence of the certified project activity. Since environmental additionality can be difficult to prove in some cases, some buyers of carbon credits may require proof of "investment additionality," which means that additionality is proved by using financial data from the project to assess whether the carbon value makes the project viable. Projects under the CDM must conform to the sustainable development agenda of the host country government.

3.131 In the latest round of negotiations, it was agreed that small-scale clean energy projects (less than 15 MW capacity) would be fast tracked into the carbon trading system. The negotiating text does not specify whether large-scale hydro is acceptable under CDM, and it is likely to be left to the host country governments to decide whether they will accept such projects.

3.132 But there are some major concerns about the nonadditionality of large hydro projects, especially some of the projects already approved by Certified Emission Reduction Unit Procurement Tender (CERUPT), Netherlands. In addition there is a dispute among various governments and NGOs as to whether large hydropower plants should be considered at all as a climate-change mitigation option. And recent discussions within the World Commission on Dams concluded that there are several climate change problems related to large hydro dams (see Box 3.7 below).

Box 3.7: Climate Change Problems Related to Large Hydro Dams

"As the CDM approval process nears the point at which the first projects may soon be registered, large hydro projects continue to be a concern. In addition to the millions of credits already being claimed by CDM large hydro projects, many more have signaled an interest in using the CDM. At the same time, concern about the non-additionality of large hydro projects has been borne out by the validation options for the Dutch CERUPT projects and the baseline methodology review of other large hydroelectric projects, underlining the need to exclude them altogether. Also disturbing is the backing down by the European Union from its previously progressive positions on large hydro in the CDM. The EU once sought to exclude all hydro projects larger than 10 MW from the CDM, yet they are now the most active of all Annex I Parties in using the mechanism to develop large hydro projects, through the Dutch CERUPT program and through their investment in the World Bank's Prototype Carbon Fund (PCF).

Moreover, the EU is proposing to give large hydro projects access to the European Emission Trading Scheme (ETS) without even a requirement for World Commission on Dams criteria to be met. By allowing large hydros to sell credits into the ETS, the world's largest carbon market, the EU will make big dams a much more attractive target for carbon finance. It will also signal that the EU accepts large hydro projects—without any quality controls on their social and environmental impacts—as a sustainable and renewable energy source, and a part of their climate strategy. Previously the most progressive player regarding large hydro projects in the CDM, the European Union has now become the biggest problem…

...Large hydro has an extremely poor social, environmental and economic record yet it continues to be a popular technology under the CDM, a mechanism with a mandate to promote sustainable development. Concerns that many CDM large hydro projects would be non-additional are being borne out, with a number of the first dams being shown to be blatantly business as usual projects, some of which have employed questionable methods in their attempt to establish additionality. Parties to the Kyoto Protocol with a commitment to using the CDM as a tool to promote sustainable development and protect the climate should agree to exclude large hydro projects from their CDM portfolios and make the WCD criteria a mandatory screen for any small hydro projects they may consider. It is also critical that the EU apply these criteria to its ETS."

Source: International Rivers Network & CDM Watch, November 2003, "Large Hydro still a large problem," Status Note on Large Hydro and the Clean Development, Mechanism for COP9.

The main buyers so far

3.133 The main buyers so far are as follows:

1. The World Bank Prototype Carbon Fund (PCF) was set up in 1999 with a fund value of US$150 million. Investors are a mix of government and the private sector and are involved in the electricity, energy, oil, financial, and manufacturing sectors. On average PCF pays US$3 for 5 tons of CO_2.

2. The Dutch Government has commitment to invest about US$600 million through a series of greenhouse gas mitigation programs and initiatives. Among these is the Dutch carbon purchasing program (CERUPT, Emissions Reductions Unit Procurement Tender—EruPT). An average price of around €5–7 per tonne of CO2 is paid. Two additional carbon purchasing schemes under EruPT opened in 2002. These focused on the following issues:

   a. Clean energy projects in developing countries (under the CDM).

b. Small energy projects, up to 15 MW, for on-grid and off-grid wind, solar, mini hydro, and geothermal energy.

Example

3.134 *The Surduc–Nehoiasu hydro project in Romania.* Emissions reductions were bought by Senter, Netherlands, over the five years of the compliance period 2008 to 2012. Eighty-five percent of the funds will be paid once the PPA is signed and 15 percent on delivery. The price paid for the emissions reductions is €5.0 per tonne of CO_2. The emission reduction units represent 612,631 tonnes of CO2, so the price paid is €3,063,155. The Surduc–Nehoiasu hydro plant is a partially built run-of-river scheme which will have 55 MW of capacity and an annual output of 152.7 GWh. The total project costs are US$62.3 million, of which the total contract value of offered ERUs is 4 percent of the project cost.

3.135 An overview of more examples of hydropower CDM projects is included in Table 3.5 below.

Process for capitalizing on carbon credits

3.136 Until the point of project implementation, there are two key stages in the carbon cycle: the carbon assessment, and validation and registration. A carbon assessment or baseline study is necessary to assess whether the project is eligible under the CDM and to quantify the potential for carbon revenues. Validation is the process by which an independent third party approves the baseline and quantification study as credible. Validation is a necessary step in registering the project with the host country government and buyers. The project should be near financial closure, so as to maximize the project's credibility to potential buyers and to the host country government. Once the parties are ready to execute the document, a carbon purchase agreement is signed. This is a contractual obligation to buy or sell credits, similar to a PPA. The carbon transaction may be negotiated on a year-by-year basis, or on a forward trade basis (for which there may be some discount to account for performance risk). Carbon credits, the tradeable commodity generated under the CDM, are issued after the emissions reductions have taken place. This follows a verification exercise, which takes place at predefined intervals, by an independent third party. Verification of the emissions reductions requires a monitoring procedure for the emissions reduction to be put in place. A body set up to oversee the CDM, the CDM Executive Board, will issue carbon credits for projects under the CDM.

Other policy drivers

3.137 National and international policy drivers are emerging as result of the internationally agreed caps on greenhouse gas emissions. In particular, Europe, post-Kyoto, has seen the emergence of a multitude of directives, carbon taxes, energy taxes, and renewable energy support policies. A new renewable energy directive requires member states to ensure that 12 percent of gross internal energy consumption and 22.1 percent of electricity consumption comes from renewable energies by 2010.

3.138 Renewable energy support policies are typically being formulated in terms of renewable energy supply quotas, such as the U.K.'s Renewable Obligation Certificates (ROCs), which oblige electricity suppliers to produce 3 percent of output from renewable energy sources by March 2003, increasing to 10.4 percent by March 2011. Hydro projects up to 20 MW are acceptable under ROCs.

3.139 A parallel trading scheme in renewable energy production is being driven largely by green consumer demand. Renewable Energy Certificates (RECs) are denominated in MWh, and have been trading in the region of €3 to 5 per MWh. In this scheme there have been transactions of renewable certificate between Nuon, the largest electricity distributor in the Netherlands, and Hidroeléctrica Papeles Elaborados, a Guatemalan owner and operator. This represents the first deal involving a developing country. Main features of this deal are as follows: The scheme is an 8.2 MW run-of-river hydro project. The project maximizes hydro generation on the Aguacapa River, which registered an average discharge of 7.2 to 7.5 cubic meters per second from 1971 to 1993. No damming system is required for the project, since the flow is diverted from the river to the new 8.2 MW plant, using the same diversion system currently used for the old 1.4 MW plant. The project was completed in early 2000. Nuon has committed itself to purchasing 100 per cent of the environmental benefits for the next ten years.

The next steps

3.140 As the compliance period for the Kyoto Protocol draws nearer, there will be increasing rewards for emissions reduction activities. Carbon trading systems are beginning to emerge: the Netherlands has started a trading program, the UK will begin trading in 2002, the EU in 2005, and a U.S. coalition of 15 private sector companies are driving the formation of a carbon-trading system in the United States. At some point in the future it is likely that these global efforts to reduce greenhouse gases will merge.

CDM activities in Nicaragua

3.141 Nicaragua has a CDM Memorandum of Understanding with Finland and with Canada and has concluded a Memorandum of Understanding with the Netherlands for the development of CDM projects.

CDM projects in Nicaragua

3.142 So far only one CDM project is under development in Nicaragua by the World Bank's Prototype Carbon Fund (PCF). The project involves the construction of an electricity generation facility that will convert waste husks from rice milling into electricity. Participants are the World Bank PCF and Gemina Generador S.A. The gasses produced are CO_2, Methane (CH_4), Nitrous Oxide (N_2O) and the greenhouse gas reductions claimed are 212,395 tonnes CO_2 equivalent to (TCO2e). The crediting period is 21 years.

Conclusions

3.143 As demonstrated by the projects so far realized there are major options to improve the economic viability of small and medium hydropower schemes in Nicaragua. The financial input can be substantial, as one current option in Romania shows (ERUs offered from Senter), where up to 4 percent of the project costs are covered by the ERUs sold.

3.144 However, the environmentally and economic additionality of some hydro projects, and especially of the larger ones such as some of the CERUPT projects, are under dispute as to whether or not they are only business-as-usual options. Therefore, the selection of the projects, their careful assessment, and validation are crucial if they are to become an environmentally and economically viable option for Nicaragua.

Table 3.5: Hydropower Projects Currently Planned, Concluded, or Under Consideration as CDM projects by PCF and CERUPT

Status: Nov. 2003

Name/ Country	Type of project	Participants	Greenhouse gas reductions claimed (CO_2 tonnes)	Crediting period (years)	Price of credits (US$/TCO2e)/ Status of project
Chacabuquito hydroelectric project, **Chile**	Mid-size run-of river hydropower plant with capacity of 26 MW	PCF, Hidroelectrica Guardia Vieja, Mitsubishi to buy CO2 rights for resale	2,812,000	21	3.5
La Vuelta and La Herradura hydroelectric project, **Colombia**	Construction of two linked subprojects: La Vuelta (11.7 MW) and La Herradura (19.8 MW)	Electric Power Development Company, Japan; Empresas Publicas de Medellin (EE.PP.M), MGM	1,559,984	21	The developer is still seeking approval for the baseline and monitoring methodology for this project (as of January 9, 2003)
Penas Blancas hydroelectric project, **Costa Rica**	35.4 MW hydroelectric project	CERUPT (Dutch Government's CDM credit procurement program)	806,800	10	This project has been selected as a supplier of carbon credits by the Dutch government
Rio General hydroelectric project, **Costa Rica**	39 MW run-of-river hydroelectric project	PCF, Oxbow Power Corporation	471,040 (of carbon) up to 2012	—	Under consideration by the PCF
El Canada hydroelectric project, **Guatemala**	43 MW run-of-river hydroelectric plant on the Samala River	PCF	3,030,000	21	Public comment period closes on May 11, 2003.
Webuye Falls hydroelectric project, **Kenya**	Construction of run-of-river hydroelectric power plant, Webuye Falls, Kenya	—	5,000	21	The project is now theoretically in Phase III of a four-phase process developed by UNIDO to assist African governments to develop industrial CDM projects.
Esti hydroelectric project, **Panama**	120 MW hydroelectric facility	Cerupt, AES Panama SA GE Energy AB (Sweden) Skanska International Civil Engineering AB	3,575,927	10	This project has been selected as a supplier of carbon credits by the Dutch government.
Fortuna hydroelectric project, **Panama**	Increase installed capacity of Fortuna hydroelectric facility by increasing flow of water into the Fortuna reservoir	Cerupt, Empresa de Generacion Electrica Fortuna, SA	261,000	10	This project has been selected as a supplier of carbon credits by the Dutch government.

Bayano hydroelectric project, **Panama**	Add additional 86 MW to the existing Bayano hydroelectric facility, while also upgrading two existing 75 MW units to 87 MW	Cerupt, AES Panama SA GE Energy AB (Sweden) Skanska International Civil Engineering AB	366,923	10	This project has been selected as a supplier of carbon credits by the Dutch government.
El Gallo hydroelectric project, **Mexico**	30 MW power plant at the existing dam of El Gallo on the Cutzamala River in the state of Guerrero	PCF	1,480,157	21	Seeking baseline methodology approval as of Sept 25, 2003.

4

Policy and Strategies for the Promotion of Hydroelectric Projects (Task 4)

Strategy Considerations

4.1 There is no doubt that hydropower development has a huge potential to meet a considerable share of future electricity demand in Nicaragua. To meet the long-term demand, hydroelectric projects totalling some 700 MW of generating capacity are waiting to be developed.

4.2 The increased exploration of the hydropower potential will contribute to moving from thermal-energy-dominated generation to a more sustainable, environmentally friendly and macro-economically beneficial electricity generation mix.

4.3 The strategy to develop the hydropower sector can be formulated as follows:

4.4 **The main objective of hydropower development is to establish a conducive environment that makes maximum use of the feasible hydropower potential.**

4.5 The achievement of that objective requires:

- An integrated sector approach
- A sufficient time horizon (minimum 10 years)
- Specific strategies for the different market segments.

4.6 The government of Nicaragua has declared that hydropower development is an important part of an energy policy that promotes the exploitation of renewable energies. However, legal, financial, and technological barriers still exist and reduce the attractiveness of hydropower for private developers. To overcome these barriers, the government, through CNE, is required to implement or delegate specific activities for the short-, medium-, and long-term outlook. Some of these activities are specific to hydropower development whereas others are of a general nature.

4.7 General activities that serve the entire hydropower sector are as follows:

- Establish a set of legal and fiscal incentives and privileges for investors that can be adjusted according to benchmarks in the energy sector but do not put an investment at risk in the long run.
- Introduce the green certificate system into the energy market to improve the competitiveness of renewable energy and hydropower systems.
- Establish an effective interinstitutional cooperation mechanism between ministries, agencies, authorities, committees, and so forth involved in the licensing and authorizing process for hydropower development.
- Establish and strengthen the "one-stop clearinghouse" ("single window") principle at CNE to support interested hydropower developers, to minimize bureaucratic bottlenecks, and to coordinate between government authorities and the private investment community.
- Increase public information and awareness on the merits of hydropower development for Nicaragua (PR campaigns, public hearings, and informal training in schools).
- Provide vocational training for the operation and maintenance of hydro plants.
- Introduce formal training in colleges and universities (in the longer run).

4.8 Hydropower plants can serve all segments of the Nicaraguan electricity market, be they rural isolated grids, the national grid SIN, or the upcoming Central American system SIEPAC.

4.9 The development of these market segments requires the following specific activities:

(1) Rural decentralized electrification (less than 1 MW)

4.10 Rural electrification is mainly the domain of NGOs, self-help organizations, and communities. It is not attractive for private sector involvement due to the low electricity consumption, low purchasing power of the target groups, and low load factors of the hydropower.

- Promote the work of NGOs, cooperatives and communities in the field of mini-hydropower development for rural electrification.
- Build up local expertise for planning, construction, operation, and maintenance of complete mini-hydro plants (up to 1 MW).
- Initiate technology transfer of micro- and mini-hydro turbine technology (mainly for Pelton and crossflow turbines), using proven mature designs.
- Support local manufacturing of pico- and micro-hydro turbines (up to 100 kW) in, for example, workshops and craft centers.

- Promote local manufacturing of hydromechanical structures, like sluices, valves, gates, and penstock.
- Promote local fabrication of posts and electric accessories for the local low-voltage distribution grid.
- Import the more sophisticated components, like electronic load controllers, from experienced producers.
- Facilitate nonformal capacity building in operation and maintenance of small hydropower plants up to 25 MW.

(2) Grid-connected small hydropower (1–25 MW)

4.11 This market segment is interesting for national private investors. To develop that sector, the following additional activities are necessary:

- Prepare or update the pipeline of projects and present it to interested investors (hydropower investment guide).
- Update or prepare feasibility studies for the projects in the updated pipeline.
- Assist private investors in obtaining licenses and concessions.
- Provide tailor-made information and training to the staff of financing institutions to educate them in technology and risk assessment.

4.12 The consultant believes that there is presently no need to elaborate a new hydropower master plan. Instead, update the project pipeline, improve its reliability by correcting project data, and increase the level of project planning by upgrading projects from pre-feasibility level to feasibility level.

(3) Grid-connected large hydropower (over 25 MW)

4.13 This is the potential market for larger hydropower development targeted at international investors.

4.14 In addition to the implementation of the above mentioned strategy, which would considerably improve the investment climate in Nicaragua, CNE is required to assist developers with any legal and environmental aspects but particularly those dealing with any problems arising from the draft Water Law.

4.15 The set of activities discussed above is not complete, but it indicates the type of intervention required to establish an environment that is conducive for hydropower development in Nicaragua. Some of the proposed strategy elements are already implemented in Nicaragua, especially in the field of micro and mini hydropower with regard to decentralized rural electrification; but many other elements, particularly those related to small and large hydropower development, need improvement or are completely lacking.

4.16 The consultant believes that the creation of a favorable environment for hydropower development is a long term task with a horizon of 10 plus years, and it will be that long before a hydropower industry is sustainable and can be fully integrated into a country. This reflects the experience of pioneering countries in hydropower like China, Nepal, Sri Lanka, and Brazil.

Conclusions

4.17 Based on this review and analysis of the hydropower sector in Nicaragua the following main conclusions can be drawn:

i. There is a large untapped hydropower resource which is worth developing, particularity considering the country's dependence on imported oil products for electricity generation.

ii. Experience with hydropower plants is limited to micro and mini hydropower projects during the recent past and the two large hydropower plants of Hidrogesa.

iii. There are a large number of identified hydropower projects, but only a few of them have been studied with satisfactory results. Most of these studies were either done as desk studies or at pre-feasibility level only.

iv. The hydrologic data base for many of the identified projects is weak, and data from the hydropower sites are either missing or incomplete. Basic data of published project lists are often contradictory.

v. The existing legislation allows only for the development of hydropower plants of up to 5 MW. Before projects with larger capacities can be developed, the draft Water Law has to be in place.

vi. The government of Nicaragua has made significant efforts to create an enabling environment for hydropower development. However, there are still barriers and obstacles discouraging private developers from engagement in this sector.

vii. CDM offers improvement of the economics of hydropower investment and should therefore be utilized whenever possible.

viii. The hydropower potential is adequate to serve all segments of the electricity market, with rural decentralized small grids, grid-connected hydropower to feed into the national grid SIN, and large hydropower with the potential for export once SIEPAC commences operation.

ix. Based on that market segmentation, the consultant proposes concentrating further study on the small hydropower market of 1 to 25 MW with emphasis on the two subsegments 1 to 5 MW and 5 to 15 MW. These segments seem to be more attractive for private investors in the short and medium term than the larger projects from 15 to 25 MW that require a longer-term planning horizon.

Nevertheless, the proposed hydropower development strategy includes also looking at these upper-range small hydropower plants as well as promoting large projects in view of the future market opportunities that SIEPAC will offer to market participants.

Recommendations

Recommendations on legal and regulatory issues

4.18 The following section summarizes the recommendations developed in chapters 3 and 4.

Box 4.1: Law of Promotion of the Hydroelectric Sub sector

Law No. 467, 29.8.2003: Law of Promotion of the Hydroelectric Sub sector

Recommendations

1. Consider extending the validity t omore than 15 years for small hydropower plants.
2. Remove the 1 percent tax on capital for hydropower projects.
3. Adjust the draft Water Law to accord with the provision of the Hydroelectric Law by deleting in Arts. 81 to 83 the need for water authorization for plants below 1 MW.

Box 4.2: Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

Presidential Decree 279-2002 and the Resolution of INE No. 07-2003

Recommendations

1. If the existing Decree will remain in its present form, clarification is required as to how the preferential prices for wind and hydropower will be calculated and who is going to pay them. Further, the precise definition of the circumstances under which the premium on the spot market price will be paid must also be clarified.
2. For run-of-river hydro, the 5 percent ceiling should be omitted and the text in Resolution 07-2003 changed accordingly.
3. Redefine in Resolution 07-2003 the term run-of-river scheme using the Relative Criteria B1 (volume of storage relative to design flow of hydropower scheme), which seems already to be in common use in Nicaragua (used at Santa Bárbara).
4. Review the option to establish the legal basis for PPAs for small hydropower plants with fixed feed-in tariffs.
5. Additionally, negotiate with INE (and Union Fenosa) for elimination of the payment of wheeling charges for capacity, which are presently contained in the selling price on the spot market.
6. If the Decree will be amended to include maximum feed-in prices, it is necessary to introduce an indexation of these maximum prices. For example, prices could be indexed to the adjustments of consumer tariffs, since this would already include compensation for inflation or exchange rate changes.

Box 4.3: Draft Water Law

(First Draft, July 2003) (Ley de Aguas, Anteproyecto Julio 2003): Draft Water Law

Recommendations

1. Declare explicitly in the new Law or in its Regulation that hydropower development is an objective of national importance and is a "Mayor beneficio economico y social para el pais" which is suggested as one of the priority criteria in the new Law. (Tit. VI, Cap. I, Art. 72).

2. In order to specifically address the need for hydropower development, add in the draft Water Law under Título VI, Capítulo I, Art. 68: " El MIFIC, ...debera tener en cuenta,.....y el Plan Indicativo de la Generación Sector Eléctrico de Nicaragua." "MIFIC…should keep in mind...... and the Indicative Plan for the Electricity Generation Sector of Nicaragua.

3. Adjust the draft Water Law Arts. 81 to 83 by deleting the provision requiring a water authorization for hydro plants below 1 MW, in accordance the provision of the existing Law of the Promotion of the Hydroelectric Sub-sector, Art. 6.

4. CNE should not only actively participate in the mediation process between hydropower developers and the other stakeholders in a multipurpose project but should take the lead in defending the positions of interested hydropower developers. This dialogue should be guided by the principles stated in the draft Water Law (Tit. III. Cap. I).

5. CNE should raise public awareness that sustainable use of water flow for electricity generation will ultimately also benefit consumers by stabilizing energy tariffs, protecting the environment by reducing greenhouse gas emissions, and reducing dependence on imported fossil fuels.

Box 4.4: Law of the Electrical Industry

Law No. 272: Law of the Electrical Industry

(1) Recommendation

1. Increase or reassign personnel specifically to cope with the development of a portfolio of small hydro projects which can be offered to the private sector but restrict the level of involvement of CNE in the execution of studies to the minimum, which preserves staff to control and guide externally contracted expertise.

2. To implement projects from the project portfolio that is presented in CNE's investment guide requires developing systematically a hydropower program for small-scale projects of up to 5 MW for immediate implementation, and for projects of larger capacities once the draft Water Law goes into force. Apply for technical assistance for such a program from international donor organizations.

3. Elaborate and publish an investment guide for small hydropower that nominates CNE as *the* "one-stop clearinghouse" for hydropower development in Nicaragua. It is important that hydropower development has a name and an address in Nicaragua that is synonymous with CNE.

(2) Recommendation

Consider a type of financing model similar to one used for INE to enable CNE to carry out its functions in sustainable way.

(3) Recommendation

A Temporary License for hydropower should be granted for up to 5 years, if an investor applies for it. Alternatively, the option should be introduced to extend the license at the investors request at no additional cost.

(4) Recommendation

1. Adjustment of the definition of a Large Consumer (Gran Consumidor) from a present minimum demand of 2 MW to 1 MW as of January 2005 will increase the opportunities for development of small hydropower plants with capacities larger than 1 MW. Consider the further lowering of the minimum demand of a Large

Consumer to 500 kW (as in Guatemala).

2. It may be worthwhile to analyze the consequences of lowering the lower limit of 69 kV for transmission lines in order to reduce the wheeling costs which would have to be charged on the tariffs.

3. Consider increasing the limit from 10 MW (LIE, Art. 31) to 20 MW, but only for electricity generation based on run-of-river hydro plants and wind power plants.

Recommendations on barrier removal activities

Economic Barriers

Recommendations:

1. The Government should enable CNE to fulfill the "one-stop clearinghouse" function by providing an adequate financial budget to sustain the operation of CNE.

2. CNE should prepare hydropower projects through collection of reliable flow data and elaboration of feasibility studies (with its own personnel or hired consultants).

3. CNE should support developers in securing access to financing by expediting licenses and concessions, land acquisition, and access to foreign technical assistance.

4. CNE should consider providing subsidies through financing of transmission lines and access roads.

Technical barriers

Recommendations:

1. CNE should closely coordinate with INETER the immediate steps to be taken to secure and improve the river flow measurements for those sites with high priority on their project list in the investment guide.

2. This activity may require that CNE acquire suitable software for flow measuring data evaluation as well as training in applying the respective methods.

3. Capacity building should be incorporated as an essential component in the proposed development program for hydropower projects in the ranges of 1 to 5 MW and, in the medium term, 15 and 25 MW.

Recommendations on development strategy

4.19 As outlined in the report Task 2, it is recommended to concentrate hydropower development in the short term on the promotion of those projects that have a chance to attract the interest of the private investment sector (provided that the existing difficulties with the interpretation of Decree 279-2002 and the Law of Promotion of the Hydroelectric Sub-sector are solved). This is the SHP market segment of 1 to 5 MW.

4.20 The segment that will also attract private national investors is 5 to 15 MW, for which, however, the draft Water Law have to be approved before any development will happen. This sector is attractive for consortia of national investors.

4.21 In the segment 15 to 25 MW there two projects, Larreynaga (17 MW) and Pantasma (24 MW), which have already attracted the interest of investors and which need to be proactively pursued by CNE.

4.22 The segment of projects over 25 MW consists of the 13 projects suggested by IFC, of which the projects Valentin (28 MW), El Carmen (100), Pirdra Fina (42), and Correinte Lira (40) are planned for implementation in the period 2003–2014 according to the Indicative Program of the Electricity Sector.

Annex 1

Selected References

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2. CNE. June 2003. Power Point Presentation, Perspectivas para las Inversiones requeridas en el sector eléctrico, Managua.

3. CNE. February 2003: Propuesta para la política energética del país, Borrador.

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5. Coyne et Bellier (contacted by INE). March 1984. Estudio de Factibilidad de la Amplicación de la Planta Hidroelécrica Centroamérica y Revisión del Estudio de Factibilidad del proyecto Larreynaga.

6. INETER. December 1988. Catalogo de Estaciones Meteorológicas de Nicaragua.

7. INETER December 1999. Catalogo General de Estaciones Hidrométricas.

8. Acuerdo Presidencial No. 279-2002, Junio 19, 2002. (Sobre la promoción de desarrarrollo de proyectos Eólicos y de Filo de Agua).

9. World Bank. August 2001. Sustainable off-grid electricity service delivery mechanisms—Study funded by the Public-Private Infrastructure Assistance Facility (PPIAF), Nicaragua.

10. INE. March 1977. Concesiones otorgadas y proyectos a ser ofertados a la iniciativa privada, Managua.

Annex 2

Relevant Hydropower Assessment Studies at CNE

At the Library of CNE, the following documents are available and were (partially) reviewed by the consultant:

1957–58: Tuma River Development, Pre-Feasibility Study, Electro Consult, Milano, Italy

1967: SIN—Santa Bárbara, Feasibility Study, Electro Consult, Milano, Italy

1967: SIN—Plan General de Desarrollo 1966–1985, Electro Consult, Milano, Italy

1972: Río Grande de Matagalpa: projects Paso Real, Nicaragua, Aguas Calientes, Copalar (consultants Edgar Quitana, Saul Gutiérrez)

1975: National Power Study 1978–1988, Pre-Feasibility Study, IECO; Rio Grande de Matagalpa, Río Coco, Río Viejo

1977: San Juan River Hydroelectric and Navigation Project, Pre-Feasibility Study, Dep. of Interior cofinanced by UNDP and IDB

1977: Copalar (Canadian International Project Managers Ltd., CIPM)

1980: Plan Maestro de Desarrollo Eléctrico 1977–2000 (Lahmeyer, Germany/International Engineering Company Ltd., United States)

1980: Larreynaga (company Shawinigan)

1982: Mojolka (company Montreal Engineering)

1983: Complejo Hidroeléctrico del Río Y-Y (Presa Mistrock, Planta San Juan), Informes Técnicos y Económicos (Technoimport Bulgaria)

1984: Río Grande de Matagalpa, Estudio de Cuencas Vecinas (Organización de Construcción de Copalar), INE

1985: Las Canoas, Middle Río Viejo, (SWECO)

1986: Larreynaga, Estudio Geofísico

1984: Estudio de Factibilidad de la Ampliación de la Planta Hidroeléctrica Centroamerica y Revisión del Estudio de Factibilidad del Proyecto Larreynaga

1985–86: Upper Río Viejo: Los Potrerillos and Paso Mariano (Feasibility Studies) SWECO International

1985–87: Middle Río Viejo: Las Canoas, El Zopte, SWECO International

1993–96: Master Plan Río Viejo: La Sirena, Los Calpules, Montegrande, (Swedpower/ Norconsult)

1993: Los Calpules, Tender Documents, SWECO International

1995–97: Plan de Acción para el Manejo de Recursos Hydricos, Donante: Gobierno de Dinamarca

1995: Central Hidroeléctrica Yasica (1-2 MW), Feasibility Study, company CEYSA)

1996: Master Río Viejo, (Final Report 1996), Swedpower/Norconsult.

2001: Assessment of Hydroelectric Generation Alternatives, SWECO (financed by IFC)

Annex 3

Guidelines for the Elaboration of Inventories, Pre-feasibility and Feasibility Studies

(Guía general respecto al alcance y la exactitud de estudios para proyectos hidroenergéticos)

Nivel: Inventario	Nivel: Pre-factibilidad	Nivel: Factibilidad
Alcance: nacional/regional	Alcance: cuenca o tramo de río	Alcance: un solo proyecto
Objetivo: Establecer, en forma de catálogo, las posibilidades para desarrollar los recursos hidroeléctricos	Objetivo: Determinar el desarrollo integral óptimo para una cuenca o un tramo de río	Objetivo: Demostrar la factibilidad técnica, económica y financiera de un proyecto
Topografía: Requerimiento mínimo fotografía aérea por lo menos 1:60.000, preferiblemente 1:25.000, para interpretación estereoscópica (geométrica, geológica, agronómica). Control vertical y perfiles de río mediante medición de altímetro. Mapas con curvas de nivel mediante interpretación fotogramétrica cubriendo posibles diques y represas (para elevación, área, curvas de volumen). Estudio de campo del corte transversal en el dique, central eléctrica y otras obras hidráulicas para los mapas topográficos a 1:5.000 con curvas de nivel de 5 o 10 m.	Topografía: Medición fotogramétrica del área de la represa, precisión altimétrica correspondiente a escalas de 1:5.000 hasta 1:25.000 con curvas de nivel de 2 o 5 m. Verificación de topografía de 1:5.000 en el sitio mediante cortes transversales adicionales. Enlace de las mediciones (y las mediciones del nivel de agua) con redes geodésicas regionales o nacionales.	Topografía: Mediciones de las estructuras in situ y compilación de mapas a escala 1:2.000 con curvas de nivel de 2m con áreas circundantes a escala 1:5.000 con curvas de nivel de 2 o 5 m. Verificación de los perfiles, áreas de la represa/curvas de volumen y mapas preparados durante estudios previos.
Hidrología: Series históricas de las descargas de 30 años aprox., ya sean registradas en el sitio (o cerca a éste) o reconstituidas mediante regresión con base en datos de lugares cercanos y/o modelos de precipitación / caudal del río. Evaluar la probabilidad de periodos de deficiencia de caudal del río, incluidos en las series. Curvas estimadas de probabilidad para los	Hidrología: Verificar las series sobre caudal del río establecidas a nivel de inventario. Derivación de datos hidrográficos con diversas probabilidades para el derramadero y los trabajos de desviación. Análisis detallado de todas las mediciones de cargas de sedimentos llevadas a cabo después del inventario, para mejorar la estimación de las ratas de	Hidrología: Poner al día los datos derivados previamente respecto a series meteorológicas y de caudal del río, hidrografía de inundaciones/crecientes, y ratas de deposición de sedimentos, incorporando todos los datos adicionales obtenidos después del estudio anterior.

Nivel: Inventario	Nivel: Pre-factibilidad	Nivel: Factibilidad
Alcance: nacional/regional	Alcance: cuenca o tramo de río	Alcance: un solo proyecto
picos de caudal y volumen, eventualmente basados en análisis regionales. Evaluación de los datos regionales existentes respecto a transporte de sedimentos para estimar las ratas de acumulación en la represa. Valoración aproximada de los balances de precipitación / evaporación en el área de la represa.	acumulación y el diseño de algún tipo de estructura para atrapar o separar los sedimentos. Determinación de la relación entre las etapas de descarga en los diques/las represas y en las centrales eléctricas, con base en las lecturas / interpretaciones del personal en los indicadores y mediciones de las descargas.	
Geología: Reconocimiento del terreno /de superficie para permitir interferencias necesarias respecto a profundidad de aluviones, factores tectónicos, disponibilidad de materiales de construcción, formaciones previas y estabilidad de las laderas y pendientes en el sitio del dique y en el área de la represa. Eventualmente alguna investigación subterránea para proyectos grandes, utilizando métodos geofísicos, para ser conservada en el inventario una vez finalizada la selección preliminar.	Geología: Investigación subterránea mediante métodos geofísicos (resistividad sísmica y/o eléctrica) para obtener una interpretación más exacta respecto a las condiciones de los fundamentos para estructuras hidráulicas pesadas. Verificación de las evaluaciones previas sobre estabilidad de las laderas y pendientes y formaciones permeables en el área de la represa y del dique. En circunstancias especiales, perforación mecánica limitada en sitios específicos en caso de proyectos mayores.	Geología: Extensivas investigaciones subterráneas mediante perforación mecánica en localizaciones de grandes estructuras y trabajos subterráneos (túneles, cavernas), suplementado por canales y medidas de exploración en los límites del dique, a lo largo de los túneles y en el área de la central eléctrica subterránea. Verificación detallada de las evaluaciones previas respecto a la estabilidad de las laderas y pendientes, formaciones permeables y disponibilidad de material de construcción.
Entorno social: Información agronómica y demográfica suficiente que permitan cuantificar el área de terreno agrícola y el número de empresas comerciales inundados y el número de familias o personas a ser reubicadas. Evaluación cualitativa de los problemas potenciales debido a la erosión en la cuenca del río, alteraciones a la flora y fauna acuática, peligros de salud, destrucción de vestigios arqueológicos, aspectos legales, etc.	Entorno social: Estudios de campo para incrementar el nivel de inventario de los estimativos respecto a reubicación e inundación de terrenos para la agricultura y empresas comerciales. Reporte del estimado impacto ambiental (IEE).	Entorno social: Verificación de los estimativos de prefactibilidad con respecto a reubicación e inundación de terrenos para la agricultura y empresas comerciales. Evaluación detallada de los beneficios en el entorno social y de los problemas potenciales, incluyendo recomendaciones para su solución. Preparación de planos detallados para medidas a ser ejecutadas durante la construcción y la operación del proyecto. Reporte de la evaluación de impacto ambiental (EIA).
Diseño: Consideración de diversos trazados para el proyecto, incluyendo variaciones para la ubicación del eje del dique, alineación del canal y la localización de la central eléctrica. Uso de tipos generalizados de dique (relleno de tierra, relleno de roca,	Diseño: Consideración de varios trazados para el proyecto (niveles máximos de operación y localización de la central eléctrica), teniendo en mente el desarrollo integrado del tramo del río o de su cuenca. Variaciones alrededor del diseño tipo pivote (pivotal design)	Diseño: Optimización económica de las principales características del proyecto tales como carga suplementaria debido a inundación/ diluvios /creciente (capacidad de compensación del reboce y elevación de la cresta del dique) dimensiones de los trabajos de

Nivel: Inventario	Nivel: Pre-factibilidad	Nivel: Factibilidad
Alcance: nacional/regional	Alcance: cuenca o tramo de río	Alcance: un solo proyecto
dique de concreto a gravedad), estructuras hidráulicas y equipo electro-mecánico, evitando diseños no-convencionales con intenciones de reducir costos (por ej. proveer válvulas de bypass sincronizado en vez de tanque de presión). Criterios estandarizados para la selección de capacidades instaladas nominales y niveles de operación de la represa. Presentación en forma de dibujo sencillo mostrando el trazado general y cortes transversales de las estructuras principales, suplementados por una hoja con datos técnicos.	(altura del dique, capacidad instalada) para permitir su optimización. Aplicación de soluciones específicas para las características principales del proyecto tales como trabajos de desviación, dique, derramadero, canales, central eléctrica. Presentación de uno o dos dibujos con hoja de datos técnicos.	desviación, diámetro del túnel, etc. Análisis preliminar de la estabilidad para estructuras mayores. Consideración especial de métodos de construcción y de la planificación y su influencia en los costos del proyecto. Detalles de los dibujos que hagan posible derivar los volúmenes y costos, incluyendo también los caminos de acceso y las instalaciones en los sitios de la construcción.
Costos: Criterios coherentes y procedimientos estándar con el fin de obtener costos estimados homogéneos para las componentes del proyecto, los costos indirectos y contingencias. Unidades individuales o costos totales representados como funciones de variables específicas del proyecto, con base en información de abastecedores y los costos actuales de obras civiles contraídos en proyectos realizados. Estimativos de los costos de operación y mantenimiento basados en las experiencias en proyectos existentes. Desglose de los costos en trabajos, equipo y materiales, en moneda local y extranjera.	Costos: Procedimientos estándar para estimar los costos, similares a los aplicados en el nivel de inventario, eventualmente con mayor disgregación entre las componentes del proyecto.	Costos: Utilización de los procedimientos estándar aplicados durante los estudios de inventario y prefactibilidad como referencia básica para un estimativo detallado de los costos. Determinar la composición de las unidades de costo de los principales artículos de construcción, tomando en consideración la capacidad de los trabajos locales, funcionamiento del equipo de construcción, costos para el suministro y manejo del material, condiciones meteorológicas, acceso, etc. Combinar los costos estimados y el programa de construcción para obtener el programa de inversiones.
Evaluación: Cálculo de la producción energética y capacidad disponible durante el periodo en el cual las series de caudales del río fueron medidas o reconstruidas, tomando en consideración la elevación de la represa, relaciones entre área y volumen, evaporación y filtración, características del funcionamiento de la turbina, desarrollos existentes /actuales de la cuenca del rio y otros usos (irrigación, suministro de agua, control de inundaciones), utilizando políticas de operación	Evaluación: Determinación de la producción energética, de la disponibilidad en cuanto a capacidad y energía y otros beneficios para variantes del proyecto (alcance de las alturas del dique y capacidades instaladas), aplicando procedimientos similares a aquellos utilizados durante el estudio inventarial, eventualmente incorporando en alguna forma un modelo de optimización, para llegar a un desarrollo integrado de la cuenca del rio o del tramo, con lo cual se obtendrían los máximos	Evaluación: Enfasis en la demostración de la factibilidad técnica del proyecto de construcción. Igualmente respecto a las consideraciones financieras, tomando en cuenta la planificación estimada para las inversiones y las posibles fuentes de financiamiento. Evaluación económica esencialmente como parte del proceso de planificación del sistema, en el cual se examina en detalle la integración operacional del proyecto al sistema de generación que existe.

Nivel: Inventario	Nivel: Pre-factibilidad	Nivel: Factibilidad
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independientes del sistema, o sea, simplificados. Evaluación de la energía y otros beneficios para obtener estimativas de beneficio de una red y valores de unidad de kW y kWh para proyectos y alternativas, aplicando el procedimiento de la ubicación de costos para proyectos de propósitos múltiples.	beneficios totales de la red. Perfeccionamiento del esquema, en particular una evaluación más detallada de la capacidad instalada es esencialmente el tema de un estudio que abarca todo el sistema.	
Cada uno de los tres niveles provee datos para el continuo proceso de planificación, el cual a su vez produce la base técnica y económica para: identificar cuencas o tramos de río para estudio al nivel de prefactibilidad seleccionar proyectos individuales para estudio al nivel de factibilidad decidir la realización de un proyecto		

Annex 4

Example for a Small Hydropower Guide

INTRODUCTION

THE PLACE OF HYDROPOWER DEVELOPMENT IN THE NICARAGUA POWER SECTOR
Historical Data
Hydropower Potential
Identified Hydropower Projects

SMALL HYDROPOWER TECHNOLOGY AND PROJECT CYCLE
General Classification of Hydropower Resources
Classification of Small Hydropower
System Components of Small Hydropower Installation
Typical Components of a Small Hydropower Installation
Small Hydropower Project Cycle

FINANCIAL VIABILITY OF SMALL HYDROPOWER PROJECTS
Investment Opportunity for Small Hydropower
Investment Costs for MHP

SMALL HYDROPOWER AND THE ENVIRONMENT
Distinction between Large Hydropower Plants and Small Hydropower Plants
Hydropower Development and CO2 Credits
Typical Effects of Small Hydropower Development on the Environment and its Mitigating Measures

POLICIES AND REGULATIONS
Relevant Laws on Small Hydropower Development
Incentives that benefit MHP Developers
Government Agencies Involved in Small Hydropower Development

Annex 5

Case Study Philippines: Water Resources Policies

By: Dr. Lope R. Villenas of the National Water Resources Board, presented at the 3rd Annual Seminar-Workshop on Mini-hydropower Development of the Department of Energy held on September 15–17, 1998, in Baguio City.

Introduction

The Philippines by nature is endowed with abundant water resources. Its average annual rainfall is about 2,500 millimeters. It has about 421 principal rivers with drainage areas ranging from 41 to 25,649 square kilometers and 59 natural lakes, aside from numerous individual streams. Groundwater reservoirs covering some 50,000 square kilometers are found extensively in the plain areas.

In spite of these, however, there is an increasing competition in the development of water resources. What was once considered an unlimited natural resource is now becoming a scarce commodity in some areas. The use of water has grown steadily. This long-term upward trend is related to a wide variety of factors, including changes in population, technology and socioeconomic conditions. Furthermore, the quality of water resources is increasingly vulnerable to pollution which threatens its availability and sustainability for various beneficial uses.

While precipitation directly supplies most of the water required by agriculture, it frequently needs to be supplemented by water diverted from streams or stored in surface impoundments (dams), or underground aquifers. Dam is a barrier constructed to hold water back and raise its level serving as source of water supply, irrigation, power, recreation, flood control and other purposes. In the Philippines, hydropower potential is one of the several energy resource options that have been given preference to fill in the countries energy requirements.

The increased pace of development of the country in the early 1970's has made it necessary for government to rationalize the water resources sector. Among the major acts taken are the articulation of basic water policies, the codification of all water laws, and the creation of an independent agency to formulate the guidelines to implement the laws and policies on water resources development and management. All of these actions are based on the fundamental concept that water, like all other natural resources, belong to the state. This was first expressed in the 1935 Constitution, then in the 1973 Constitution, and again in the 1987 Constitution of the Philippines.

The vision of the Philippine National Development Plan for the 21st century is to create a modem society, raise the quality of life of all Filipinos and bequeath the society in an ecologically healthy state to future generations.

Among the first acts of the Council (now Board) was the formulation of basic policies and guidelines to govern the control, conservation, development and utilization of the water resources of the country.

In summary, these policies are:

1. The authority and responsibility for the control, conservation, protection, development, and regulation of the utilization of the water resources of the country belong to the State. These water resources include, among others, groundwater, surface water, and water in the atmosphere.

2. Priorities in the use of water in the development of water resources shall reflect current usage of water and shall also be responsive to the changing demands for water which occur under developing conditions.

3. All water development projects shall be undertaken on a multi-purpose use concept using the river basin, or closely related river basins approach. Single purpose projects shall only be implemented when they are compatible with the multi-purpose concept and can be incorporated into the contemplated basin-wide development program.

4. Identifiable beneficiaries of water resources development projects shall bear an equitable share of repayment costs commensurate with the beneficial use derived from the project.

5. Continuing program of basic data collection, manpower development and research shall be maintained since these are indispensable components of water resources development.

6. The National Water Resources Board shall formulate the guidelines, procedures, programs, rules and regulations to implement the policies on water resources.

These policy statements are essentially incorporated in the Water Code of 1976 and it’s implementing rules and regulations.

Institutional Framework

The authority and responsibility for the control, conservation, protection, development and regulation of the utilization of the water resources of the country belong to the State. This is accomplished through the creation of various government offices which undertake most of the water resources programs and projects in the country.

A very important requirement, applicable to all persons and entities, is the need for a water permit from the National Water Resources Board to use the waters of the State.

The government organizations may be generally characterized in three ways. One way is on the particular aspect of water resources for which the agency is responsible. Thus, there are offices dealing mainly with each of the sectors of water supply, irrigation, hydropower, navigation, pollution, watershed management, etc. The exceptions to this are the Councils, Boards and Development Authorities whose major role is to coordinate the efforts of the specialized implementing agencies.

A second method is to characterize the source of operational funds of the agency and in this manner, there are two groups. The first group consists of the Departments, Bureaus and other offices whose operational expenditures come from general revenues or taxation. The other group is composed of the government-owned or controlled corporations which are revenue generating because of the services that they provide. To the latter group belong the agencies on water supply, irrigation and hydropower.

A third way of classifying the agencies is by their respective geographical area of responsibility or coverage. Thus, there are national, regional as well as local agencies.

For purposes of administrative supervision, all water resources agencies are placed under twelve (1 2) of the more than eighteen (1 8) executive departments of the national government. In the case of the government-owned or controlled corporations, Councils, Boards and development' authorities, supervision is only exercised at the policy level. This is generally affected by appointing the Head of the Department as the Chairman of the Board of directors of the agency that is being supervised. The Departments exercise direct line supervision, authority and control over the respective bureaus and other offices under them.

At the national level, the National Economic and Development Authority coordinates the activities of all sectors. The water resources sector is coordinated by the National Water Resources Board. For regional activities, there are regional councils and authorities.

Development Strategy

All development activities of the government in respect to water, energy and related land resources are pursued in accordance with the Philippine National Development Plan.

A. Water Resources Development Strategy

The vision for water resources in the Plan 21 is a sustainable water management to provide affordable water for adequate needs including its proper disposal.

Among the various challenges in the said plan related to water resources sector is a necessity for the development and implementation of sustainable policies, programs and projects. This is coupled by the need to provide a harmonious and coordinative approach to water development at the same time create a favorable environment to promote both private and public sector participation to increase investment.

The plan states that the long term general strategy in water resources planning for the different regions of the country is based on the following principles: (a) water is a limited sources that must be conserved and managed efficiently; and (b) water has an economic value in all its competing uses and shall be treated as an economic good; capacity and willingness-to pay therefore be taken into consideration in pricing water.

The long term general strategies the plan are the following:

1. The principal strategy therefore is to create an independent authority with sufficient powers and resources that will formulate national policies in water resources management, regulation (quantity, quality, economic and service efficiency), utilization, planning and conservation.

   a). Pursue a sustainable development of water resources through appropriate policy and legal reforms, particularly in resource exploitation, allocation, prioritization and optimization.

   b). Promote an integrated approach to link social and economic development with protection of natural water sources and ecosystems that is decentralized, participatory and community-based which is conducted at the most appropriate level.

   c). Implement policies through decentralized operations within a national framework cognizant of the policy of devolution and community-based approaches in water management. As such, address the need for capacity building and training in the local levels in development planning, operation and maintenance.

   d). Support the creation of river basin authorities to effect integrated water resources management. Each basin authority shall develop a master plan for the area.

2. Encourage private sector participation in all aspects of water resources management, utilization and development.

   a). Promote market-based incentives for water conservation.

   b). Create one-stop-shop for water resources development.

   c). Provide incentive programs for private sector investments on all water resources development initiatives.

3. Anchor irrigation development on food security through self-reliance and uplift the socio-economic conditions of farmers in support of the social reform agenda program.

4. Strengthen forest protection efforts including reforestation activities through community-based projects.

5. Develop a pricing mechanism that takes into consideration full cost recovery and other externalities while balancing the same with the public's capacity and willingness to pay.

6. Develop an extensive information-education campaign that will raise the level of awareness of the public that water is a limited resource and that it is an economic good that has a corresponding price.

7. Rationalize and institutionalize data collection system for efficient and effective flow of information.

8. Pursue and strengthen the strict enforcement of environmental laws, rules and regulations and adopt stiffer penalties for violators.

9. Prioritize research and development on applicable and appropriate technologies for water conservation, sanitation and pollution control.

10. Encourage rain water harvesting and impounding and prioritize the development of surface water resources to relieve stress and pressures on groundwater.

11. Integrate gender concerns in all water resources development and management policies and programs.

B. Energy/Hydropower Development Strategy

The Philippine National Development Plan for the 21" Century shows that hydropower generation was tapped as one of the indigenous sources of energy that was vigorously explored, developed and utilised to reduce dependence on imported energy sources. The Plan 21 also indicates that power generated by various mini-hydro facilities totaled 1,028.8 GWH since 1992. This displaced 1.34 million barrels of fuel oil equivalent, corresponding to a foreign exchange savings of US$25.85 million. As the country's mini-hydro potentials remain largely untapped, efforts are geared towards promoting investment in mini-hydro development.

The Plan 21 vision related to hydropower is a sufficiently developed indigenous, renewable energy resource to meet the increasing energy requirements of the country. The challenge for developing indigenous and renewable sources for energy self-sufficiency is considered a continuing task in the energy sector. As such, identifying the factors that currently constrain the accelerated development of indigenous and renewable resources and addressing these constraints is important.

Plan 21 states the long-term strategies of the energy sector. Some of these strategies related to hydropower are as follows:

a). Integrate environmental, safety and socio-cultural concerns in the planning and implementation of energy programs and projects.

b). Promote extensive development of indigenous and renewable energy such as hydropower, geothermal and biomass energy in power development for increased private sector participation in view of their renewability, environmental compatibility and sustainability.

c). Mitigate the impact of carbon dioxide emission and increase sustainability of indigenous energy resources through intensifying reforestation and watershed management activities.

d). Intensify R&D for all energy options while addressing safety and environmental issues.

e). Develop a national siting policy for energy projects/facilities in consonance with zoning and environmental policy/guidelines.

f). Adopt a pricing strategy including consideration of externalities, that shall make renewable energy including hydro, geothermal, ocean, solar, wind and biomass resources stable and competitive with coal, gas, and fuel oil.

g). Improve efficiency and accountability in all energy activities.

h). Develop economically sustainable energy system for rural electrification.

i). Intensify energy conservation and use of energy - efficient technologies through DSM and other energy conservation programs.

Coordination of Water Resources Activities

As mandated by its charter and subsequent Legislation, the National Water Resources Board, formerly known as National Water Resources Council, is the government coordinating agency for all water resources development activities. lt was created to assume responsibility for achieving a scientific and orderly development of all water resources of the Philippines consistent with the principles of optimum utilization, conservation and protection to meet present and future needs.

In pursuance of the above mandates the main thrusts of the NWRB's operational program are directed to the major functional areas of policy formulation, program/project evaluation and coordination and regulation of water appropriation and utilization.

Policy initiation is achieved in consultation with concerned water-related agencies through Task Forces and Technical Committees under the auspices of the Board to thresh out specific problems and issues related to water resources development and management.

Program review by the Board is limited to broad appraisals and does not intend to extensively double check the detailed technical calculation. This broad appraisal purports to determine the extent of considerations given to all water resources problems in the project area. Likewise, all the agencies are responsible for technical accuracy.

Water Use Regulation

To rationalize the utilization, development, conservation and protection of the nation's water resources, regulation of water use is pursued within the context of the Water Code of the Philippines.

A. Regulation of Water Appropriation and Utilization

Water use regulation is effected through administrative concession or “water permit system.” The water rights functions of the Board involve generally:

- i). Issuance of water permit for the diversion and use of water, both surface and groundwater;
- ii). Resolution of conflicts regarding water use; and
- iii). Prescription of rules and regulation governing water use, conservation and protection.

The water permit is the document attesting to the privilege of a person to appropriate and use water. In determining whether to grant or deny an application, the Board considers the following: protest filed, if any; prior permits granted; the availability of water; the amount of water needed for beneficial use; the possible adverse effects; land-use economics; and other relevant factors.

In order to prevent the occurrence of land subsidence, well interference, salt water intrusion and other problem related to excessive groundwater extraction, no person is allowed to drill any well without first securing permit to drill from the Board.

Under Provincial Water Utilities Act of 1973, Water Districts are authorized to adopt rules and regulations governing drilling, maintenance and operation of wells within its territorial boundaries subject however, to the review and approval of the Board. These rules are not only intended to efficiently utilize and conserve water supply sources but also preserve water quality.

To protect existing water resources from the adverse effects of projects on the quality of water, it is now required for a water right applicant to get an Environmental Compliance Certificate (ECC) prior to the granting of water rights.

B. Regulation of Water Utilities Operation

Corollary to its regulatory and quasi-judicial functions of the Board, pursuant to Sec. 1 1 (c) of PD 1206 dated 6 October 1977, also regulates the operation of water utilities to ensure that only qualified persons and entities are authorized to operate waterworks system for the supply of safe and potable water to the public at reasonable rates. This involves:

- i). Adjudication and/or granting of Certificate of Public Convenience for the operation of public waterworks systems; and
- ii). Review/approval of water rates to be charged by waterworks operators.
- iii). Monitoring of Water Appropriation and Utilization

As a central regulatory and coordinating body for water resources development and management, the Board has institutionalized its enforcement and monitoring capability to effectively pursue the following operational activities.

a). Field inspection of completed structures to monitor compliance by grantees of water rights and Certificate of Public Convenience;

b). Field monitoring of water withdrawals by water rights/CPC grantees too ensure the efficient and beneficial use of water; and

c). Periodic inspection, testing and calibration of water meters/discharge measuring structures for accuracy and efficiency.

Permitting Requirements

The instructions for water permit applications are as follows:

1. As required under the provisions of the Water Code, no person shall divert or appropriate water without first securing a water permit from the National Water Resources Board.

2. The following may file an application for water permit:

    a). Citizens of the Philippines of legal age;

    b). Associations, duly registered cooperatives or corporations organized under the laws of the Philippines, at least 60 percent of the capital of which is owned by the citizens of the Philippines; and

    c). Government entities and instrumentality, including government owned and controlled corporations

3. Water Permit Applications must be filed with the Office of the DPWH District Engineer, the NIA Provincial Irrigation Engineer, NPC Regional Managers or the L@A Water District General Manager whichever is designated as agent by the Board in the province where the point of diversion is situated.

4. All applications shall be filed in the prescribed form, sworn to by the applicants and supported by appropriate requirements for different purposes. For hydropower, the requirements are as follows:

    a). Duly accomplished Water Permit Application and Notices.

    b). Land ownership (any of the following: Certificate of Title, Tax Declaration, Lease Agreement, Deed of Sale, Certification from Local Government Unit to utilize the source, etc.)

    c). Certificate of Registration from SEC with Articles of Incorporation (if Corporation of Association); Certificate of Registration in case of Cooperative, DTI Registration in case of Single Proprietor.

    d). Vicinity Map/Location Map with scale of 1:1 0,000 or 1:50,000 showing the exact location of the point of dimension.

e). Brief description of the project stating among others how water will be used, amount of water needed, power to be generated, amount of water to be discharged back to the source, measures to be taken to avoid water pollution, scheme of development, etc.

f). Environmental Compliance Certificate or Certificate of Exemption from DENR.

g). Initial permit from the Department of Energy per R. A. 7156, otherwise known as the "Mini-Hydroelectric Power Incentive Act".

Annex 6

Case Study Chile: El Codigo de Agua y la Hidroelectricidad

La base legal

La base sobre la cual se ejecuta la política hídrica del país, es el Código de Aguas, dictado en 1981, con un fuerte sesgo pro mercado, ya que privatizó la propiedad del agua y, por primera vez en la historia de Chile, los separó del dominio de la tierra para permitir su libre compra y venta.

Dicho Código define al agua como un bien nacional de uso público, cuyos derechos de aprovechamiento son concedidos por la Dirección General de Aguas (DGA), organismo dependiente del Ministerio de Obras Públicas. Una vez otorgados estos derechos, el Estado no interviene más, permitiendo que la redistribución se realice a través de transacciones entre particulares en lo que se ha dado en llamar "el mercado del agua".

Detalles

El objetivo de la ley es de generar derechos de propiedad sólidos sobre los usos de agua y se expresó, en primer lugar, en la propia constitución política de 1980 (art.19 N°24, inciso final), que estableció que "los derechos de los particulares sobre las aguas, reconocidos o constituidos en conformidad a la ley, otorgan a sus titulares la propiedad sobre ellos."

Asimismo, en el Código

i). se eliminó toda posibilidad de caducar por parte de la administración los derechos de agua, suprimiéndose toda norma que pudiera debilitar la propiedad sobre los mismos, en especial las potestades de la autoridad que pudieran afectarla. Ejemplo de esto último era la posibilidad de declarar área de racionalización y suspender los derechos existentes (art. 35 C.A. 1967), o restringir los usos más o menos libremente durante los períodos de sequía (art. 332);

ii). se reinstauró la obligación de registro de los derechos de agua ante los Conservadores de Bienes Raíces, como forma de asegurar la titularidad de los derechos (art. 309);

iii). se estableció normas para regularizar los derechos no inscritos (art. 1 y 2 de las disposiciones transitorias);

iv). se fijo criterios y presunciones para la determinación de las características de los derechos antiguos (art. 309, 312 y 313);

v). y se entregó a los usuarios la propiedad de las infraestructuras de distribución de las aguas (art. 202 y 212).

El marco jurídico-económico vigente en el país se orienta claramente a privilegiar el uso de mecanismos de mercado. En especial, en el caso del uso de agua, está concebido para favorecer la reasignación de los recursos a través de la conformación de un mercado de derechos de aprovechamiento.

De acuerdo con lo anterior las actividades productivas consideran el agua como un insumo más y cada uno de los sectores usuarios se desarrollan en un marco sectorial consistente, con regularizaciones e incentivos específicos (hidroelectricidad, uso doméstico, riego). El papel del Estado se orienta a definir un marco regulatorio e institucional y, por razones de equidad social, apoyar el abastecimiento de agua para los consumos básicos a los sectores más débiles de la sociedad.

Problemas

Fue precisamente este Código el que introdujo la figura de los "derechos no consuntivos" de agua, destinados al desarrollo hidroeléctrico, cuyas aguas no se consumen con el uso y son devueltas (hipotéticamente) a los ríos, sin perjudicar a los demás usuarios. La normativa, sin embargo, es lo suficientemente ambigua como para que los conflictos que puedan suscitarse con los derechos de otros sectores, como el agro por ejemplo, no sean completamente resueltos. De hecho, fallos recientes, negativos para los regantes, han contradicho principios previamente establecidos, aunque siempre en favor de las hidroeléctricas. Así ocurrió en el caso de Pangue con la cuenca del río Bío Bío.

Sin embargo, el aspecto más delicado de lo que está ocurriendo en el sector, remite a los derechos de aprovechamiento. Tales derechos son concedidos en forma gratuita y a perpetuidad, de forma que el particular que los posee no está obligado a declarar cómo y cuándo usara el agua. No existe, además, costo alguno por su no utilización, por lo que pueden ser conservados con fines meramente especulativos. Las aguas son tratadas, así, como un bien estrictamente privado, cuya transferencia, transmisión, adquisición o pérdida por prescripción se efectúa según las normas del Código Civil. Los derechos de agua entonces, son los únicos derechos de propiedad en Chile que se otorgan gratuitamente y sin ninguna clase de exigencias, al contrario de otros sectores donde se paga patentes o impuestos.

Las leyes no contemplan el concepto de Caudal Ecológico Mínimo, sin el cual será muy difícil en el futuro resguardar los flujos hídricos con finalidades sustentables. Tampoco se integran otros usos como los In Situ, que apuntan al aprovechamiento de ríos para fines recreacionales, de navegación, turísticos y paisajísticos.

Desde fines de 1992, en el Congreso esta pendiente un proyecto de ley para modificar este Código por ser extremadamente permisivo y facilitar la acumulación de derechos de agua sin un uso previsible en el tiempo.

El sector eléctrico considera como trabas para el desarrollo de nuevos proyectos la poca claridad que existe sobre los derechos de agua. En este sentido, un operador del SIC señaló que esta situación desencadenó una incertidumbre que no permite iniciar proyectos hidroeléctricos en la actualidad. A su vez, el ILD (El Instituto Libertad y Desarrollo) indicó que el proyecto que modificará en parte el actual Código de Aguas establece una patente por el no uso de los derechos que tienen las generadoras, lo que irá en desmedro del sector. "Todas las centrales necesitan de dicho permiso mucho antes de realizar los estudios y ahora deberán pagar por éste, antes de saber si el proyecto es rentable o no, lo que será un problema que generará menos oferta".

Otro aspecto que indirectamente tiene que ver con la disponibilidad de agua es la modificación del cálculo de potencia firme que realizó la Comisión Nacional de Energía CNE, en el marco del rediseño de la política relacionada con las centrales hidroeléctricas, con el fin de hacer que esos proyectos sean amigables con su entorno. Al respecto, Francisco Courbis, gerente general de la eléctrica Colbún, señala que el nuevo procedimiento de cálculo de potencia firme va en la dirección de hacer que las centrales hidráulicas sean no viables económicamente, incluso hace no viables los embalses. "Todo lo que sea hidráulico lo castiga fuertemente, lo cual es una señal económica adicional a las que ya ha dado, para privilegiar las centrales térmicas".

Annex 7

Run-of-River Versus Storage Power Schemes: Options for Definition

General Description

The main characteristic of a *run-of-river* scheme is that it does not stop the river flow, but instead only uses the currently available flow for hydropower generation. The disadvantage of run-of-river schemes is that water can not be carried over from rainy to dry periods of the year. In other words, only part of the available river flow can actually be used for hydropower generation. On the other hand, run-of-river schemes are preferable from the point of view of environmental concerns, as river flow patterns downstream of the hydropower installations are not affected and there is no need for flooding of the valleys upstream of the installations. However, run-of-river schemes with a diversion weir may cause drying up of riverbeds between intake and powerhouse, especially during periods with low flow and high demand.

The main characteristic of a *storage* scheme is that it makes use of a dam to build up a reservoir of water. The water is then released through turbines when power is needed. The advantage of this approach is that river flow can be accumulated during rainy periods or times with low demand, and be released during dry periods or times with high demand. The main disadvantage of storage schemes is the environmental impact of changing the river flow pattern and accumulating water in a reservoir, which affects aquatic life in the river, vegetation near the river and reservoir, and downstream water users. A further disadvantage is that reservoirs may fill up with sediments after some years, which will again reduce the potential energy output of the hydropower plant.

There are also *hybrid forms* of these two main types of hydropower schemes. An example is a run-of-river scheme where water is accumulated in a forebay on a daily basis to cover daily peak demand. Since such forebays are often artificial tanks or ponds, the fluctuating water level is not an environmental concern. Moreover, in run-of-river schemes with diversion weirs such small storage can help avoiding surge flows otherwise caused by rapidly changing demand patterns.

Definitions

In some legislation distinction is made between storage and run-of-river schemes, which require clear definitions. There are different approaches for such definitions depending on the context and objectives. In countries like Switzerland for example, where environmental concerns have high priority for the general public, only a hydropower scheme without the possibility to store water can benefit from preferential tariffs. In some countries, however, it may be useful to broaden this definition, for example in cases where significant peak demand occurs, or where hydropower can help avoiding burning of fossil fuels and thus has environmental benefits that may outweigh environmental concerns related to a small storage. For such cases an approach is needed with one criterion, or a set of criteria, that limit the size of the storage and thus the potential adverse environmental impacts. Both absolute criteria and criteria that are defined relative to other characteristics of the scheme may be used. Absolute criteria, such as volume of storage in cubic meters, are usually preferred as they are easier to apply. Relative criteria, on the other hand, allow a more differentiated approach adapted to specific conditions and sizes. In practice any combination of absolute and relative criteria may be used. If more than one criteria are applied it should be clarified which of the criteria is relevant in case of conflicting criteria.

Absolute Criteria:

Volume of storage: The volume of the storage may be limited to a fixed number, for example 1 million cubic meters.

Surface of storage: The surface area of the storage may be limited to a fixed number, for example 1,000 square meters.

Height of dam: The height of the dam may be limited to a fixed number, for example 5 meters.

Fluctuation of water level: The difference between the minimum and the maximum water level in the storage may be limited, for example to 2 meters.

The obvious difficulty of all the absolute criteria mentioned above is to find the acceptable limit value that can reasonably be applied to a great variety of hydropower schemes.

Relative Criteria:

Volume of storage relative to design flow of hydropower scheme: The volume of the storage may be limited to the amount of water needed to run the hydropower plant at full capacity over a specific period, for example 6 hours.

Volume of storage relative to average load: The volume of the storage may be limited to the amount of water needed to run the hydropower plant at average load over a specific period, for example 1 day. The difficulty here is to objectively predict the average load in the design stage of a concrete project.

Volume of storage relative to river flow: The volume of the storage may be limited to a specific, average river flow over a specific period, for example 1 day. The difficulty here is to objectively determine these river flow values for a concrete project.

Volume of storage relative to location of hydropower scheme: Certain areas may be determined, such as natural reserves, where no storage at all is allowed, whereas in other areas storage of limited size is accepted.

Annex 8

Reconstruction Methods of Incomplete Flow Measurement Series

Under certain conditions, an incomplete series of flow measurements can be reconstructed. The most common approach is a reconstruction based on a series of measurements at locations with similar characteristics in combination with rainfall data.

In the past, various computer software packages were developed to calculate missing measurements based on the aforementioned approach using more or less sophisticated interpolation and correlation methods. However, the results of these programscan only be good if the input data is of sufficient quality, which in reality is often not the case.

Therefore, the first challenge is to determine whether the available measurement series can be used, or whether they contain systematic errors. Therefore the condition and specific location of the measuring station needs to be examined. The next challenge is to find at least two and preferably three or more other measuring stations that can be used for interpolation. These stations must be located in catchments that have characteristics similar to the catchment of the station where measurements are to be reconstructed. This again requires careful examination of local conditions. Furthermore, rainfall data of the catchments of all measuring stations is required. All data to be used should be verified regarding potential systematic errors before interpolation and correlation calculations are conducted.

Experience shows that in practice such interpolation and correlation may well be done manually, for example using spreadsheets and graphs, which has the advantage that systematic errors are less likely and that a more pragmatic approach can be applied. If a computer program is used it is important to understand exactly what the program is doing with the data. Generally the rule is that simpler models should be preferred if the input database is weak, for example if only a few characteristic parameters of the catchments are known. In any case, results of computer programs should always be verified by manual comparisons and sample calculations. Furthermore, a sensitivity analysis should be conducted whereby the main input parameters should be varied to assess their sensitivity.

Methods of flow measurements

A broad variety of methods for flow measurements have been developed and are used in practice. Some of these methods are suitable for single measurements only (For example. the salt dilution method, float method, or current meters), whereas others are suitable for continuous measurements over longer periods. In the following, only methods that are suitable for *continuous measurements in the field* are discussed. The common characteristic of these methods is that a physical feature in the river is used to control the *relation between water level and discharge* in the river. The following features are commonly used:

Control sections: Natural or artificial control sections may be used, whereby a rocky portion or large boulders or rock outcrops provoke a drop in water level so that the upstream water level becomes independent of backwater effects from downstream. Generally, the section where the upstream head measurement is to be taken should be sufficiently long without major changes in profile, bends, or obstructions to allow regular flow without major turbulence at the point of measurement. In irrigation canals this condition is usually fulfilled without difficulty; in natural rivers however it may be difficult to find a suitable natural control section.

Measuring weir: A weir with a defined overflow section (a rectangular, trapezoid, or triangular section) is installed in the river to provoke a limited accumulation of water. Behind the weir there should be a small storage where the water level can be measured. The difference in elevation of the water level and the weir crest is then used to calculate the discharge based on known formulas. This method is less suited for larger rivers as a weir that can resist larger river flows requires significant river training works.

The parameters for the calculation of the discharge based on the measured water level can be determined through hydraulic calculations or calibration measurements. There are different ways to measure the water level for the above-mentioned flow-measuring methods:

Manual measurement: This is the simplest method, as it is very easy to read the water level from an installed measuring device.

Float: This method has been widely used in the past as it is simple, relatively reliable, and provides continuous measurements. A float is installed in a shaft that is connected to the river or canal. The movements of the float then are directly transmitted to a graphical recorder.

Echo sounder: An echo sounder may be used to measure the water level in regular intervals. These instruments are accurate and reliable as long as the water surface is undisturbed and there are no floating objects at the location where the measurement is taken. The main disadvantage of the echo sounder is that due to its high electricity consumption it can not be operated with batteries and thus is less suitable for remote locations.

Pressure gauge: The sensor of the pressure gauge is installed in a vertical pipe section that is installed in the water. Fluctuations of the water level cause changes of pressure in the pipe which are measured by the pressure gauge.

Measurements taken with echo sounder and pressure gauge are usually recorded on a digital data logger, which can store data over several months to years, depending on the frequency of measurements taken. The data can then be downloaded from the data logger to a laptop.

A major disadvantage of automatic measuring methods is systematic errors, which for example can result from unplanned influences on the measuring station. There is a risk that a malfunctioning of the measuring station may be discovered only long after it first occurred. The problem of digital recording systems is rapid technical development, which makes it difficult to keep the same system over longer periods.

The advantage of manual measurements is that at the time when the measurement is taken the condition of the station can be checked. The disadvantage may be the relatively large amount of manpower needed, especially in the case of stations at remote locations. Furthermore, there is risk of errors in manipulation of the measuring devices and misreading. Generally for flow measurements at remote locations either manual reading by a person living near to the measuring station or the use of a pressure gauge is recommended. The market price of a pressure gauge including data logger currently is in the order of €800 to €1,000 (excluding installation costs and probe protection tubing).