# Establishing National and Regional Standards & Code of Practices for Micro-hydro Sector

## REPORT


Sponsored by
Winrock International, USA

Compiled by
Energy Forum - Sri Lanka

Under the
U.S. Agency for International Development
(USAID) - SARI-ENERGY Cooperative Agreement

July, 2006

## Project Partners

Energy Forum - Sri Lanka
Alternate Hydro Energy Center (AHEC), IIT Roorkee -India
Alternative Energy Promotion Center - Nepal

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**Code of Practices for Micro-Hydro Sector**

## 1. Background

The SARI/Energy Round II Regional Workshop on 6-8 September 2004 in Sri Lanka on Micro-hydro conducted by Energy Forum with the participation of delegates from India, Sri Lanka and Nepal reviewed the national and regional level practices of micro hydro industry and best practices. The workshop focused on Rationale and Establishment of Quality Programs for micro-hydro power systems in the SARI countries.

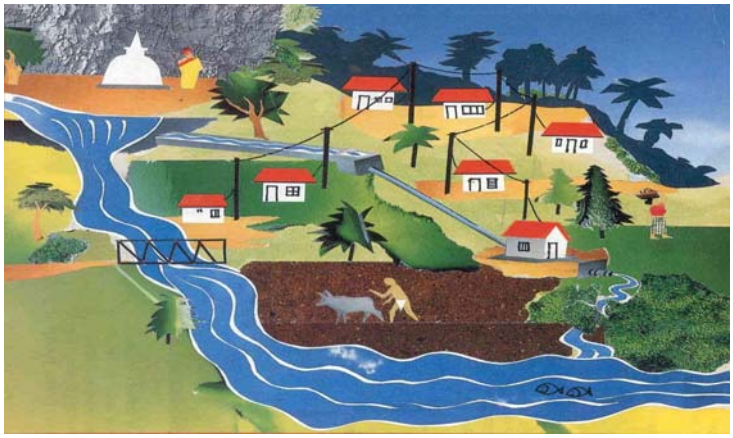

Fig 1: Micro Hydro Site

The Energy Forum together with the AHEC-IIE, India and AEPC-Nepal were authorized by the participants to coordinate the activities to develop the micro hydro national standards in Sri Lanka, Nepal and India respectively. The new project was awarded to the Energy Forum to facilitate those activities under the SARI/Energy Small Grant Round III. Accordingly, the Energy Forum formed a regional secretariat to monitor and oversee the activities of the project with a view of developing national standards and regional harmonization process.

### 1.1. Sri Lanka

Sri Lanka is a small country in the sense of the limited hydro power potential compared with Nepal and India. Therefore the market for micro hydro power is not that large for a massive base of project developers and equipment suppliers to be built. On the other hand the government is not financially strong enough to handle projects without foreign grants and loans. As a result, rural electrification using micro hydro projects has not become a commercial business. The poor coordination between the government institutions also helps the situation become worse.

But the community has understood the above situation and been adopted to suit the conditions of the country. They have been able to minimize the cost of projects due to their own contribution in construction in a well organized manner. A project is built, owned and operated by a volunteer society formed among the electricity consumers of a particular village. Tariff collections, loan repayments and maintenance of the project are totally handled by the society. World bank funded RERED (Renewable Energy for Rural Economic Development) scheme has become very successful in Sri Lanka under these conditions.

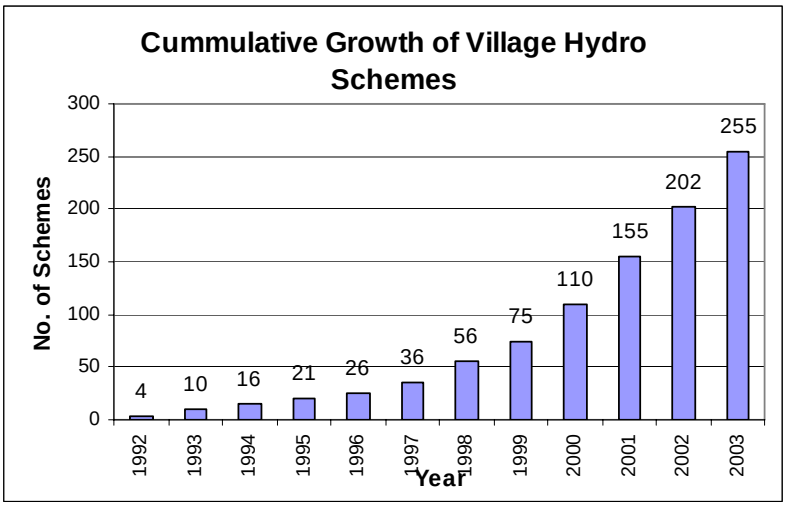


Fig 2: Commutative Growth of Village Hydro Schemes in Sri Lanka

### 1.2. Nepal

Nepal one of the richest countries in water resources potential (about 6000 rivers and rivulets) has a long history of micro-hydro development. People in the rural areas used to build water mills for harnessing waterpower for the purpose of processing agricultural products. The formal use of hydropower was initiated at around the decade of 1960s in the micro-hydro sector in Nepal with the support of United Mission to Nepal (UMN).

The evolution of the standardization process in Nepal was started, rather in a limited manner, from the late eighties. Intermediate Technology Development Group (ITDG) and the Agriculture Development Bank of Nepal (ADB/N) initiated a joint program in order to enhance the technological base of the micro-hydro installations in the country. Electrical guidelines for the electrical installation were drafted with broad participation of the manufacturing sector in Nepal. The United Nation Development Program (UNDP) initiated Rural Energy Development Program (REDP) in 1996 and started supporting micro-hydro development focusing on its holistic development approach. It has developed some useful guidelines in supporting the micro-hydro implementation like micro hydro implementation guidelines, community mobilization guidelines, environment management guidelines, vulnerable community development guidelines etc.

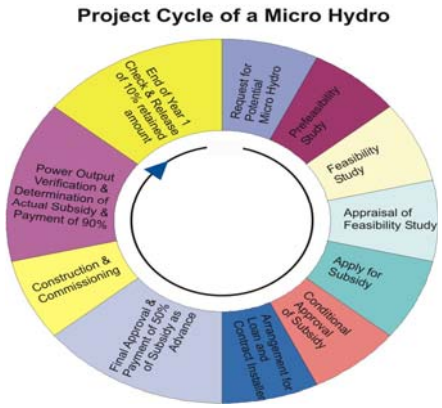


Fig 3: Project cycle of a micro hydro sector in Nepal

Standardization of micro-hydro and other rural energy technologies got real momentum only after the establishment of Alternative Energy Promotion Centre (AEPC). AEPC has been established by His Majesty's Government of Nepal (HMG/N) under the Ministry of Science and Technology (MoST) in 1996 to promote of rural energy technologies in the country. AEPC with the support from Energy Sector Assistance Program (ESAP) of Danida has prepared Micro hydro policies, procedures and guidelines for the implementation of Micro hydro schemes. Two programs namely Rural Energy Development Program (REDP) supported by UNDP and WB and Energy Sector Assistance Program (ESAP) supported by DANIDA and NORAD are very much successful in Nepal. REDP supports community based micro-hydro projects where as ESAP supports private as well as community based micro-hydro projects. Both the programs are executed by AEPC.

### 1.3. India

India has very-wide geographical, hydrological and meteorological variations in its entire length and width. In the North there are young Himalayas with fragile geology, snow filled area and in south area have stable, geology with two spills of rains.

It has immense hydropower potential (over 150,000 MW) out which only about 30,000 MW has been harnessed. Micro hydro which are not in many numbers, presumably due to the barrier in the form ambitious grid extension to remote/ rural areas, with the commitment of making available electricity to even remotest area. About 8000 sites are poised for micro hydropower set.

Govt. of India in active cooperation each state government is attempting to provide electrically to each household by the year 2009. Govt. is subsidizing the basic installation but operation and maintenance is expected to be done by local communities. In many parts of the country franchise to the local villagers/ communities is being offered. A policy support through national electricity policy, renewable energy policy, electricity act, for rural electricity is in place at this time.

With the availability of micro hydropower standards there shall be ease in procurement, installation and O&M by the state Govt. / NGO, village communities, consultants who are finding this standard useful. These may be over 6000 in nos in coming years.

## 2. Introductions to the Project

The project was to facilitate and setup the national technical committees in Sri Lanka, India and Nepal to develop national micro hydro standards. A regional technical committee explored the opportunities for developing regional micro-hydro standards. The ultimate goal of the process was to harmonise standards and establish quality programs in the sector and expand the micro-hydro market and provide sustainable energy services to the end users.

### 2.1. Objectives

One of the main objectives of the project was to develop national standards on micro hydro sector in Nepal, India and Sri Lanka and followed by identifying the ways and means of harmonizing the developed standards towards establishing regional

standards. The project aimed to address the indirect objectives such as reduces trade barriers within the SARI region for micro-hydro energy technologies and services as well as ensure sustainable existence of micro-hydro schemes in the region.

## 3. Methodology

The technical committees were formed in each country to pursue national and regional level activities to establish and harmonize standards. The country representatives and technical experts to serve on the technical committees at national & regional level were identified. A working modal was identified to develop a regional strategy for standards harmonization and participating in a standards secretariat.

## 4. Activities

### 4.1. Establishing Technical Committees

After establishment of the Regional Secretariat at the Energy Forum, the project partners signed the MOUs to setup national secretariats and facilitate the activities in the respective countries. Base on the guidelines provided by the MOU, the technical committees were nominated by the National Secretariat. The Technical Committees (TC) consisted of subject matter experts, working under the direction of the National Secretariat. The Regional Secretariat provided physical and financial supports.

The Technical Committee was a team of professionals drawn from different institutions in the micro hydro sector and institutions dealing with standards in each country. The TORs for the technical committees were setup by the respective national secretariats.

#### (i) Technical Committee - Sri Lanka

1. Dr. Nishantha Nanayakkara, Chairman - Consultant, Energy Forum
2. Mr. Jayantha Nagendran, Renewable Energy for Rural Economic Development Project
3. Mr. Ranil Senaratne, Fentons (Pvt.) Ltd.
4. Mr. P.C. Hettarachchi, Village Hydro Suppliers and Manufacturers Association
5. Mr. Harsha Wickramasingha, Energy Conservation Fund
6. Mr. Jayantha Gunasekara, ITDG - Practical Action
7. Mr. Kapila S Abeygunawardana, Sri Lanka Standards Institution
8. Mr. P. L.G. Kariyawasm, Ceylon Electricity Board
9. Mr. G. B. Wimalratne, NERD Centre
10. Prof. Priyantha Wijetunge, Public Utility Commission of Sri Lanka
11. Mr. Cyril Gunathilake, Federation of Electricity Consumers Societies

#### (ii) Technical Committee - Nepal

1. Dr. Madan Bahadur Basnyat, Executive Director AEPC- Chairperson
2. Mr. Devendra Prasad Adhikari, MH Expert (Management) ESAP- Member
3 Mr. Brijesh Mainali, MH Expert (Electrical) ESAP- Member

4. Mr. Thakur Raj Devkota, MH Expert (Civil) REDP- Member
5. Mr. Surendra Bhakta Mathema, Representative from manufacturers-Member
6. Mr. Shreedhar Devkota, MH Expert (Mechanical) SHPP- Member
7 Mr. Bir Bahadur Ghale, Representative from owners- Member
8 Mr. Ram Prasad Dhital, Energy Officer AEPC - Member Secretary

**(iii) Technical Committee - India**

1. Prof. J. D. Sharma, Electrical Engineering Department, IIT - Chairman
2. Dr. P. Sexena, Director, Ministry of Non-Conventional Energy Sources
3. Mr. Anil K. Chopra, Director, Ministry of Non-Conventional Energy Sources
4. Mr. A. K. Tyagi, Uttaranchal Renewable Energy Development Agency
5. Prof. O.D. Thapar, Expert
6. Mr. Marki Loya, Director, Arunachal Predesh Energy Development Agency
7. Mr. S. Odyuo, Department of Irrigation and Flood Control
8. Mr. R.K. Verma, Sai Eng. Foundation
9. Mr. V. Ramasubramanian, Sahyadri Energy Systems Private Limited
10. Mr. Sonam Dawa, Ladakh Ecological Development Group
11. Mr. P.D. Nair, Viyyat Power Pvt. Ltd.
12. Mr. A. K. Goel, Small Hydro Engineers Consultant
13. Mr. K.J. Dinesh, LANCO Group
14. Mr. K.C. Arora, Pentaflo Hydro Engineers
15. Mr. T.K. Modak, Joyti Ltd.
16. Mr. S. K. Roy Choudhury, Ushamil Private Limited
17. Mr. B.S. Saini, Gita Flow Pumps India Pvt. Ltd.
18. Dr. J.T. Khirsagar, Kirloskar Bros. Ltd
19. Dr. R. P. Saini, AHEC, IIT
20. Mr. Arun Kumar, AHEC, IIT - Convener

### 4.2. Developing National Standards in India, Sri Lanka and Nepal

The technical Committee in each country drafted National Micro-Hydro Standards. Different strategies were used for drafting that explained in the preamble of the draft reports which already submitted to the WI. Apart from the TORs, the technical committees followed certain ISO standards and guidelines implemented by respective countries. eg: Quality systems accreditation ISO 9000 etc. are quite common in India. Product certifications are carried out by Alternate Hydro Energy Center (AHEC), IIT Roorkee. Furthermore, the micro-hydro sector in Sri Lanka is mainly linked with the RERED Project and hence the World Bank specifications are already in place. The Technical Committee of Sri Lanka considered the RERED specification as the baseline of the drafting national standards and sought the ways and means of further develop. The drafts covered code of practices, standards for certain electro-mechanical components, software applications for management practices, training requirements and monitoring measures. The developed drafts targeted multi stakeholders such as project administrators, financing institutions, project developers, verification engineers and accreditation institutions.

### 4.2.1 Sri Lanka: Code of Practices

The Sri Lanka Micro Hydro Standards were developed having ensured the financial and technical capability of implementing projects under the ownership of community organizations. The document was proposed to be developed as a code of practice rather than standards. In Sri Lanka micro hydro standards are not only for the reference of consultants and contractors but also for the electricity consumer societies.

It also provided guidelines for following activities.

- Controlling mechanism in place of RERED project
- Comfort to banks and societies while financing projects
- Code of practice for manufacturers and consultants
- Sustainability of the Industry
- Guideline for Public Utility Commission in regulation measures

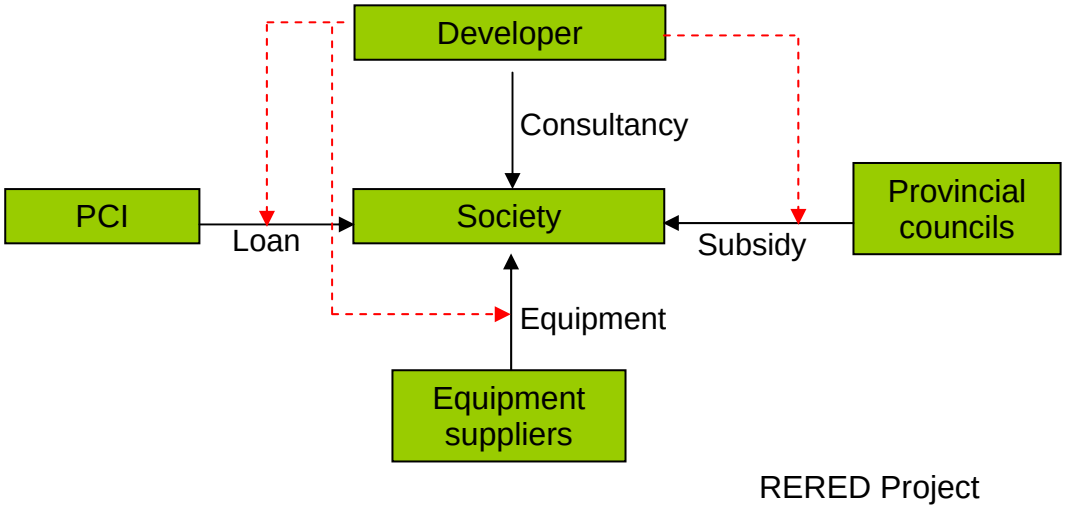


Fig 4: Current Practice of MH sector in Sri Lanka

Following table gives the main factors were considered while developing standards:

| Factors | Details |
|---|---|
| Affordability | • financed by loans, subsidies and less equity<br>• finalized within a short duration<br>• constructed at extreme working conditions<br>• Implemented with less facilities<br>• Labour intensive projects |
| Verifiability | • Using existing facilities in Sri Lanka.<br>• Limited number of inspections.<br>• Judgmental tool for the society |
| Quality | • Documentation<br>• Project Management<br>• Components of the project<br>• Electricity supply |

| | |
|---|---|
| Safety | • Consumers<br>• Operators<br>• Machinery<br>• Household appliances |
| Sustainability | • Project<br>- with demand growth<br>- hydrology pattern<br>• Industry<br>- developers<br>- manufacturers |
| Applications | • Guideline for developers<br>• Hand book for consultants<br>• and manufacturers<br>• Source document for electricity consumer societies<br>• Reference for other stakeholders (Banks, Provincial councils) |

The general idea was quality assurance must be a key concern of code of practice. It was quite impossible to verify the quality since developers and manufacturers do not provide the necessary details. Therefore, it was suggestion that it should enforce the developers to provide those details, then they will involuntary tend to assure the quality of the project.

The Sri Lanka report highlighted the design standards in three categories; Civil work, Electro-mechanical equipment, Distribution network. The design aspects of a micro hydro project and the draft contented following themes.

- Design parameters
- Requirement of components
- Structural dimensions
- Equipment selection criteria
- Equipment ratings
- Sample calculations

The design parameters of key areas such as overall design, civil work, Electro-mechanical equipment and distribution network of a project also defined in draft the report. Overall design parameters defined as follows:

- Number of households (N) > 15
- Power allocation per household (P) > 150 Watts

- Distribution loss (L) < 10% of net generation
- Allowance for demand growth (G) = 20% of present demand
- Design capacity (C) > [N*P]*(1+G)*(1+L) /1000 kW
- Minimum power generation > 25% of design capacity kW
- Overall Efficiency > 60%
- Design flow (F) > C/[H*0.6] cumecs ; H-gross head
- Flow released to the natural stream > 20% of design flow
- Catchments area (A) > (F*/R*k) ha ; R=Annual rainfall

The essential standard designs of main construction work such as Weir, Channels, Forebay Tank and Penstock and electro-mechanical components and their specifications were listed out with performance parameters which can be accepted.

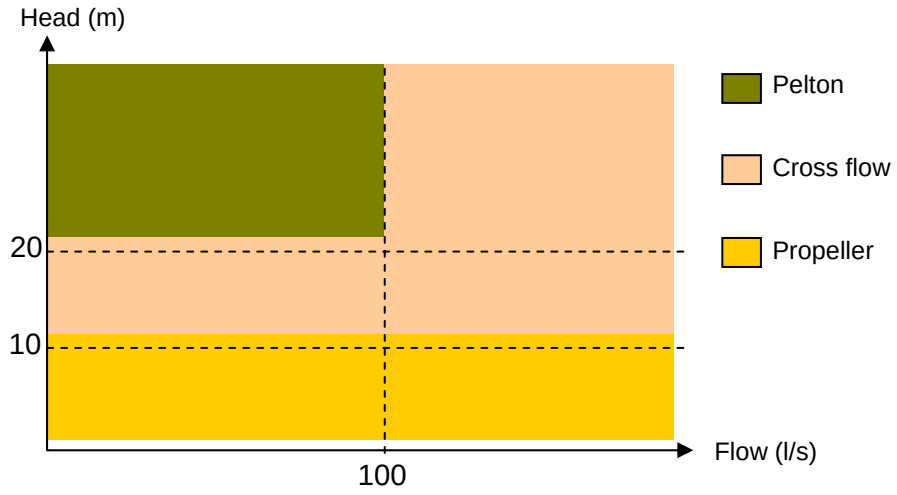


Fig 5: Parameters for the turbines

The report defined the acceptable control systems which can be applicable for any micro-hydro systems in the region. The protection and safety arrangements of the micro hydro systems were also one of part of parcel of the developed Code of Practices.

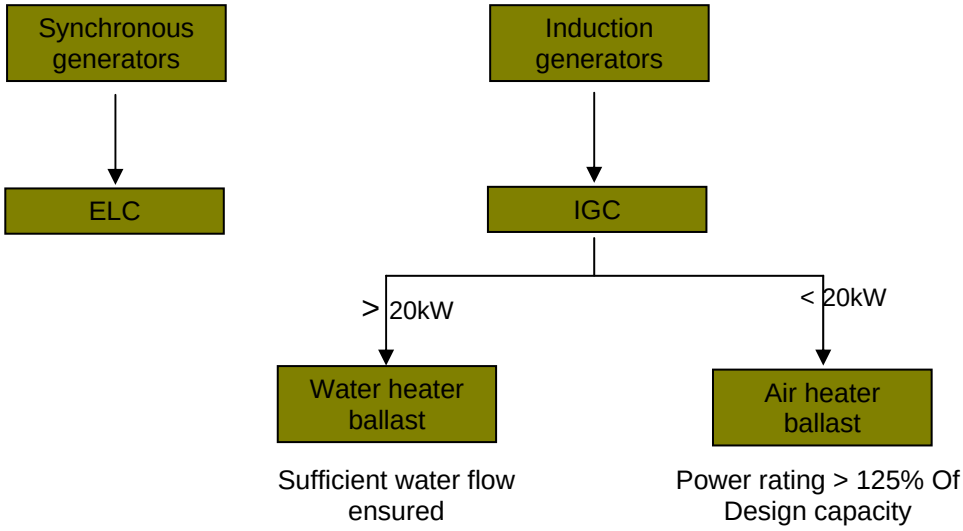


Fig 6: Acceptable Control System

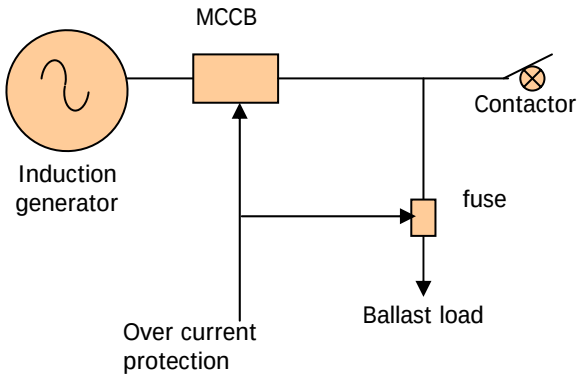


Fig 7: Protection and Accessories

Finally, the standard specification for the distribution line and a manual for operational and maintenance activities also included to the report.

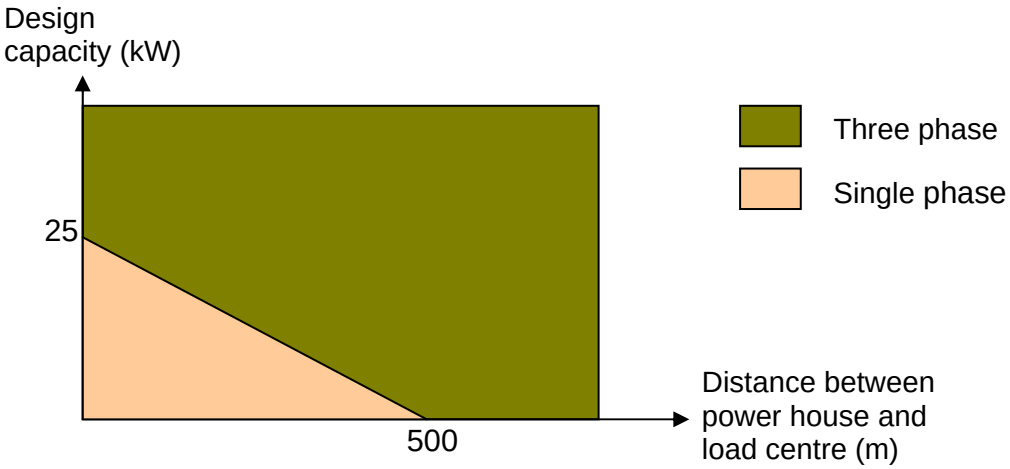


Fig 8: Selection of type and route of the distribution line

### 4.2.2 Nepal: National Standards

The Nepal's national standard was based on available publications and feedback from the stakeholders. The national standard highlights technical specification for survey, design, fabrication, manufacturing installation as well as checklists for quality monitoring. It also mentions existing implementation modalities for both REDP and ESAP approaches.

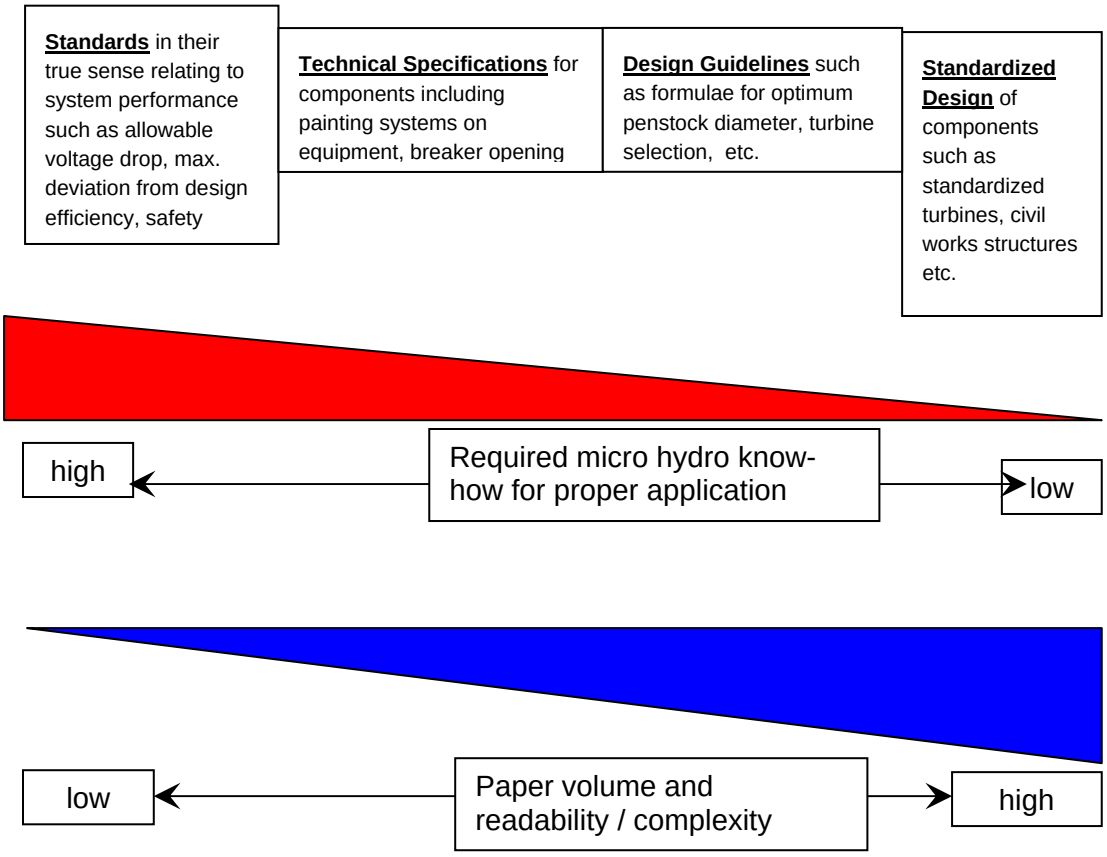


Fig 9: Distinction between standards, specifications, design guidelines, standardised design and their implications

The standard development was a part of the total quality assurance system. The system addressed fully the process from the site identification to operations supported by capacity building activities with all the required guidelines, manuals, institutional set-up and delivery mechanisms.

The quality assurance system was dynamic in nature and the provision had made to incorporate the new innovations, utilized existing practices, and knowledge. The system was updated based on the feedback on periodic basis. The implementation and delivery modalities were framed in such a way that quality was pulled itself by the system. The micro-hydro owner community was made conscious on the need of the quality. The owner community in the first places demands the quality. The subsidy was calculated based on the measured power output. It ensured that the designed power output is delivered which is the one of the major objectives of the standards. The quality of the system was enhanced through providing guidelines,

expert systems, design aids and trainings and there all ultimately help to pull the quality of the micro-hydro system.

In the quality assurance system, all the concerned stakeholders are the part of the program. The following table illustrates the role and responsibility of the different stakeholders on the quality assurance system.

| Stakeholder | Role | Responsibility |
|---|---|---|
| Developer, community | Demanding quality, consultant selection for study design, contractor selection from installation | Ownership lies with the developer, community |
| Support organization | Facilitations on various activities to the developer/community | Make sure the community understood the process |
| Consulting companies | Survey, design | Adoption of standards, guidelines |
| Installation companies | Supply and installation | Agreed power generation, one year guarantee, and adherence of the standards |
| Technical Review Committee | Assessment of survey, design, and feasibility | Ensure quality is adhered. |
| Alternative Energy Promotion Centre | Updating/preparing standards, guidelines, and modalities | Feedback, review and make sure the quality assurance system is implemented. |

The quality assurance system including the standards is self-regulatory in nature. It can be clearly seen from the above table that the regulatory role is divided into the different stakeholders and the AEPC is playing a central but coordinating role rather than the regulatory.

The consultants, manufacturers, installers, donors, government organizations, service providers (service center, NGOs) have well accepted the standards and guidelines developed by AEPC.

#### 4.2.3 India: National Standards

The scope of the Indian standards mainly focused on planning, design, manufacture, tests at works, testing at site and commissioning of power generation equipment including turbine, drive system coupling from turbine to generator and/or mechanical device, generator, generator controller, switchgear and power distribution system; spares for five year operation of the plant; special tools, etc. Corresponding component of all the turbines and associated equipment and spares shall be of the same material, dimension and finish and shall be inter-changeable.

The purpose of the present technical standard and specification is to improve the quality and safety of the electricity services provided by micro-hydro installations. The aim is to achieve the following:

(i) *Guaranteed Output:* Plant owners and end-users are to receive, what they had ordered from suppliers in terms of available power capacity.

(ii) *Reliable Operation:* During a specified service life, the micro-hydro installations should not suffer from frequent outages and repairs but should provide a high-quality continuous electricity service.

(iii) *Safety:* electricity can be dangerous for people equipment and property even when generated in small plants and quantities. Adequate protection shall be provided, not only at the powerhouse & generating equipment, but also at the consumer end as well as throughout the electrical transmission (including transformers, surge arrestors etc.) a micro-hydro installation can destabilize and cause collapse or seriously damage hill slopes and associated property due to flooding and overtopping of canals and basins. Therefore, adequate design considerations shall be applied to the water conveyance system and associated structures.

(iv) *Cost-effectiveness*: in fully meeting the above requirements. Electricity services may become expensive and unaffordable for rural dwellers. Compromises mainly in the field of convenience of operation and ease of maintenance are to be made in order that micro-hydro installations remain a cost-effective means for providing electricity service.

The Micro-Hydro Standard had been prepared to define the quality requirements of Micro-hydro design, supply and installation works so that competitive bidding for a given set of quality, finish and performance. The ultimate responsibility for quality, reliability and safety remains with designers, suppliers, installation teams, or operating agencies. It was recommended that design, construction, electrical or mechanical installation, operation, maintenance and repair works be carried out and/or supervised and checked by qualified technicians or engineers only.

**4.3. National Consultative Workshops**

Each part of the draft was reviewed by relevant practitioners, and other experts in the sector at national level. Based on the expert views, stakeholder inputs and public comments, the draft had been revised by the TC. The mechanisms used to obtain the comments such as e-mail conferences, discussions and workshops.

Finally, partners of the project organized a national consultative workshop in each country on the country standards held on following dates.

1. National Consultative workshop - Nepal - 23, March 2005
2. National Consultative workshop - India - 10, September 2005
3. National Consultative workshop - Sri Lanka - 18, July 2005

The national secretariat of India, Alternate Hydro Energy Centre (AHEC), IIT published the finalized report as "Micro Hydro Quality Standards" in September, 2005. The Energy Forum as the national secretariat under this project for the Sri Lankan Code of Practices of the Micro Hydro brought the Sri Lanka Standard

Institute (SLSI) to the process of establishing national standards and the procedures for the formal publication is being implemented by the SLSI.

### 4.3.1 Gaps were identified

#### 4.3.1.1. Testing Facility

Efficiency measurement is prerequisite for good performance of any hydro power projects. Setting up testing facility is costly and private manufacturing company often abstains from testing and measurements. New ways for cost effective measurements are to be found and testing facility should be set up accordingly.

#### 4.3.1.2. Appropriate Hydrological Model

The present model for hydrological analysis is very rough and considers only the size of catchments area and the geographical location in the country. This method may be useful for very large catchments, but for small catchments the runoff depends very much on the local division between forest, agricultural land, bare rock, etc. and to get a more precise assessment an appropriate model looking at this aspect is needed.

#### 4.3.1.3. Training Needs for Installation and Fabrication

Nepal Micro Hydro Development Association with the support of AEPC, ESAP and REDP has been providing Micro-hydro Operators and Managers training. Training guidelines have also been prepared but no such training has been conducted for installers and fabricators except on-the job training. There is an urgent need to train people working in the field of installation and fabrication for performance improvement of the system as a whole. In Sri Lanka, the Federation of Electricity Consumers Societies is implementing a program to train the leaders of community based village hydro projects on leadership, Financing Management and Operational & Maintenance. ITDG-South Asia, Energy Forum are key organizations who give training for manufactures and project developers. The RERED Project facilitates some of the capacity building programs, but training packages should be developed further.

#### 4.3.1.4. Accreditation/Certification

Nepal Micro Hydro Development Association provides training completion certificate and they internally do evaluate the participants. But there has not been clear linkage between Council for Technical Education and Vocational Centre (CTEVT) and the training institutions. Accreditation and certification procedures are lacking in Sri Lanka and India also.

### 4.4. Study on Opportunities for Regional Micro-hydro Standards

As the Regional Secretariat of this project, the Energy Forum appointed a consultant to review all three Technical Committees of India, Nepal and Sri Lanka for exploring opportunities to establish regional standards in the micro hydro sector. The

consultant reviewed developed National Standards in each country to identify the similarities and differences.

### 4.4.1. Comparison

As far as the national micro hydro standards of the three countries are concerned, they were similar enough to formulate a regional standard with little modifications to the mother documents. Though, the country standards had petty differences due to the different socio-economic, political and other conditions of the countries. The observations of the consultant as follows:

**A). Concept-wise differences**

There are several terms like standards, specifications, guidelines etc. which all seems to be same but have identical meanings. Nobody may clearly distinguish all those terms and as a result, all three documents contain standards as well as specifications and guidelines. In general, each of the countries seems to have their own understanding about 'standards' concept and they have prepared their documents according to those understandings. This understanding has differed from country to country with respect to the group of people who refers this document. The basic requirement for developing a regional standard is to develop a common understanding among the three countries.

**B). Format-wise differences**

Overall formats of the documents were almost similar in case of Sri Lanka and Nepal while the Indian one is clearly different. As far as the Nepal/Sri Lanka format is considered; different groups of readers if any, may find rather easy to select the relevant portion of the document to read. It will not be a problem for projects with single contractor and single source of funding which is the normal practice in India, but the Nepal format was better to develop a regional standard into which we can absorb the content of the Indian and Sri Lankan standards as well.

**C). Presentation wise differences**

It is an obvious difference which can be seen in any two documents prepared by two different authors. The same fact can be presented in different manners which will be more or less user friendly. None of the documents could be quoted as the best in form of presentation. In each document, bullets, tables, figures, charts are used in different compositions etc. Sample calculations are given in Sri Lankan document while Indian one had used pictures for explanation. Any way all those features should have encountered in the regional standard document as necessary.

**D). Specification-wise differences**

This is the most critical type of difference which cannot be analyzed in a simple manner and hence it will be analyzed in a separate table.

### 4.4.2. Analysis of the Differences

Comparing the similar or corresponding chapters of the three standards documents, the following list of differences were identified as the important issues to be

considered when preparing regional micro hydro standards. Only the specific differences were taken into consideration in order to minimize the size of the table.

| Description | Sri Lanka | India | Nepal |
|---|---|---|---|
| **Hydrology** | Catchments area calculation is enough | Flow duration curve is necessary | |
| **Design flow** | May be greater than the minimum available flow | If exceeds minimum flow alternative power supply should be available | Must be lower than the minimum available flow |
| **Sustainability with flood** | Not mentioned | Minimum return period of the design flood is 20 yrs for <30kW projects, 50 yrs for the rest | |
| **Compulsory release from weir** | 20% of the base flow | Not mentioned | |
| **Gravel and sand traps** | Not mentioned | | Both or at least the gravel trap is necessary |
| **Freeboard allowance** | 20% of the channel height | Not mentioned | Min (300mm, half of the water depth) |
| **Forebay tank** | Width – at least 5 times that of the channel | width – that of the trash rack<br>length – that of the side spillway | Capacity - adequate to store 15 seconds of the design flow |
| **Position of the penstock intake** | 3 times of penstock diameter below the water surface | 2 times of penstock diameter below the water surface,<br>0.2m above forebay floor | Not mentioned |
| **Slope of the trash rack** | Not mentioned | | 3:1 (horizontal: vertical) |
| **Maximum leakage** | Not mentioned | 2 l/s | Not mentioned |
| **Penstock material** | PVC | Steel, PVC, HDPE | PVC, steel |
| **Head loss** | No limitation | Maximum 10% | |
| **Turbine type** | Pelton and cross flow types are recommended | Selection criteria is complicated | Pelton / cross flow types are recommended |
| **Turbine efficiency** | Not mentioned | Specified with respect to the capacity | Specified with respect to the type and capacity |
| **Coupling arrangement other than direct couple** | Only belt drives are recommended | Belt drives are recommended having the ratio limited to 1:3 | Gear boxes are also recommended |
| **Generator** | Synchronous | No selection | Synchronous is |

| | | | |
|---|---|---|---|
| **type** | generators are recommended only for high capacity plants | criteria | the recommended type for all projects, type of excitation is specified with respect to capacity |
| **Supply type** | 3 phase is recommended for capacities over 25kW | | 3phase is recommended for capacities over 10kW |
| **Controller type** | ELC / IGC only | Flow governors are recommended as well. | ELC / IGC only |
| **Ballast type** | Water heaters are recommended for projects over 30kW | Water heaters are recommended for projects over 5kW | Type selection is not mentioned. Rating of the ballast is specified. |
| **Protection** | Protection level should be higher if electricity is used for motoring purposes. | Protection level depends upon the capacity of the plant as well as the availability of motors | Protection level depends upon the capacity of the plant. |
| **Distribution line** | Distribution is limited to low voltage (400/230) | Medium voltage transmission/distribution is also specified | |
| **conductors** | Overhead conductors only | | UG cables are also recommended |

In addition to those specific differences, the following general differences occur as well.

- In Sri Lankan standards, author had tried to use figures as far as possible instead of descriptions to specify any component while Nepal and Indian authors had elaborated the same thing in a described manner. For example, the design standards of weir is given in Sri Lankan paper using weir dimensions and concrete grades while the Nepal standard says the weir should withstand the flood with a return period of 20/50 years.
- Nepal and Sri Lankan standards were seemed to be more country specific with compared to the Indian standards. The Indian standards were rather general and easy to be applied somewhere else other than India. Further, the stringency of Indian standards is quite high. It encountered a lot of instructions and guide lines which would help a developer to carry out a project.

Nepal standards consist of two additional chapters which are not available in other two documents. The last chapter is just about their present micro hydro practice and hence it has little importance on formulating regional standards.

The draft report on similarities and differences circulated among the regional stakeholders through Technical Committees and obtained their responses. While doing so the consultant reached a consensus with the partners on the format of the standards, concepts of practical use, and the terminological definitions. Base on the consensus reached, the draft regional standards report was prepared.

### 4.5. Regional workshop on Micro-Hydro Sector

The Energy Forum organized a regional workshop on 26th March, 2006 inviting the representatives from three technical committees and local experts in the micro hydro and standardization sectors to review the draft regional report.

The Regional workshop focused on two major objectives:
1. Review the draft regional standards and
2. Establish a follow up plan of the each country and identify a possible action plan for establishing regional standards.

There were 25 participants at the workshop representing all three countries.

## 5. Description of Problems Faced by the Implementers

1. At the initial stage of the project, most of the time consumed for negotiating with the partner organizations to identify suitable modalities to administer the national secretariats.

2. Some of the Technical Committee members in the three countries were busy with their own schedules. Therefore, fixing meetings and communication with them were not an easy excise. As result, the draft national reports were not finalized within the project timeframe as agreed in the contract between the EF and Winrock International.

3. The project partners are in the process of establishing national standards and closely working with respective authorities. However, establishing regional standards would be a part and parcel of marketing practices which have to be promoted among the manufacturers. The issue was discussed at the regional workshop and possibility of developing MOUs between the SAARC countries need to be further investigated.

## 6. Sustainability

All the partners of the project played a major role in the sector. They interacted with all other stakeholders in the sector and influenced the main players of the sector to follow the developed standards and ensure the quality system and practices in the sector. Project administrators, manufactures, project developers and financial institutions were very keen to accept the developed standards in order to ensure the sustainability of the sector.

## 7. Recommendations

In the discussion, the current status of the developed standards in each country was reviewed by the participants. Following suggestions and recommendations were highlighted in the forum.

### 7.1. Nepal

1. Based on the developed standards, the user friendly training manual should be developed for targeting project developers and other stakeholders.
2. The standards and relevant documents for certification should be translated to the local languages
3. Nepal Standards is also recognize as a code of practice rather than mentioned as standards
4. Implementers are not always engineers though they may be qualified technicians
5. The components mentioned in the document compatible with Nepal National standards
6. Nepal Government has given mandate to the AEPC to develop guidelines and other relevant procedures for the off-grid sector though AEPC is not a standardization Institution

### 7.2. India

1. Apart from the developed standards, the best practices in the sector should be documented
2. Ministry of Non-Conventional Energy Services and IIT could recommend these standards to impose as national standards by the Board of Indian Standards (BIS)

### 7.3. Sri Lanka

1. Developed code of practices to be further reviewed and compared with the RERED project specifications which are very much familiar to practitioners in the sector
2. Sri Lanka Standards Institute (SLSI) is in the process of re-formatting the developed code of practices and to will forward to the public comments stage. (Distribution of the draft among key stakeholders within 01 month after being rationally advertised.)
3. At least 3 months period should be allocated for the comments
4. Once it finalized by SLSI, the document should be shared with Provincial Councils which can use this as guideline for their funding purposes

### 7.4. Regional

1. Electro-mechanical components are very similar in three documents, but civil work doesn't have common as documented in three countries
2. Best practices and case studies from each country should be reviewed before going for a regional code of practices. This had been done in the regional workshop under SARI /Round II project. The report should be referenced.

3. Terminology differences also to be addressed in the common document.
4. The draft regional document can be used as benchmark of the regional harmonization and negotiations through MOUs could be the preliminary stage of the process of regional standards.
5. There is a separate committee on SAARC Standards. More information about the process should be obtained form national standards institutes of each country.