

23. Energy Sector

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Abbreviations

ADB	Asian Development Bank
ASCE	American Society of Civil Engineers
ASTM	American Society for Testing Materials
B/C	Benefit Cost Ratio
DANIDA	Danish International Development Agency
DCPT	Dynamic Cone Penetration Test
DDC	District Development Committee
DHM	Department of Hydrology and Meteorology
DOED	Department of Electricity Development
EIA	Environmental Impact Assessment
EMAP	Environmental Management Action Plan
EPC	Environment Protection Council
FAR	Financial Administration Regulation
GIS	Geographic Information System
GLOF	Glacier Lake Outburst Flood
HMGN	His Majesty's Government
ICB	International Competitive Bidding
ICIMOD	International Centre for Mountain Development
IEE	Initial Environmental Examination
ILO	International Labour Organization
INGO	International Non-governmental Organization
INPS	Integrated Nepal Power System
IPP	Independent Power Producer
IRR	Internal Rate of Return
ISA	Initial Social Assessment
IUCN	International Union for Nature Conservation
kW	kilowatt
MHSP	Medium Hydro Screening Project
MOPE	Ministry of Population and Environment
MOWR	Ministry of Water Resources
MW	Megawatt
NCB	National Competitive Bidding
NDC	National Development Council
NEA	Nepal Electricity Authority
NGO	Non-governmental Organization
NPC	National Planning Council
O&M	Operation and Maintenance
PDF	Power Development Fund
PDP	Power Development Project
PIP	Project Implementation Plan
SAP	Social Action Plan
SIA	Social Impact Assessment
UK	United Kingdom
USACE	US Army Corps of Engineers
USAID	United States Aid for International Development
WB	World Bank
WEC	Water and Energy Commission
WECS	Water and Energy Commission Secretariat
WHO	World Health Organization
WRC	Water Resource Council

Glossary of Terms

Act	A law of Nepal passed by the parliament and approved by His Majesty the King.
Deregulation	The process of devolution of power sector entities from traditional governmental control to private entrepreneurs
Executing Agency	The ministry, department, statutory body, state corporation or local body responsible for the overall management of a project including production of project outputs, achievement of project objectives and accountability for the use of government resources.
Guideline	A recommended set of procedures or requirements which effort should taken to comply with. Guidelines in the PWDs generally follow international best practices.
Implementing Agency	The agency responsible for the procurement and delivery of specific project inputs and their conversion to project outputs. It is usually a unit within the Executing Agency's organisation structure e.g. department or division.
Independent Power Producer	A private enterprise responsible to produce electric power through its own funding
Large Hydropower	Hydropower plants with capacity above 300 MW
Line Agency, Sectoral Agency	The unit in HMGN designated to assume executive responsibilities for an economic or social sector (e.g. roads, health). It is usually a ministry or department.
Local Body	A Village Development Committee (VDC), District Development Committee (DDC) or Municipality with powers and responsibilities as defined in the Local Self-Governance Act, 2055.
Medium Hydropower	Hydropower plants with capacity ranging from 5 MW to 300 MW
Peaking Station	Hydropower plant with storage facilities to be operated to meet peak demand only
Plan	In the context of the PWDs, a plan may be: 1. a description (including text, maps and data tables) of proposed infrastructure development in a specific area over a given time frame to meet stated objectives (e.g. district transport master plan). 2. a list of projects put forward for approval and budget. The term 'plan' is often misused in that many so-called plans are really programmes (e.g. annual development plan).
Power Development Fund	A fund dedicated to power development that may issue loans and credits to the hydropower developers
Power Purchase Agreement	Formal agreement between the Nepal Electricity Authority and Independent Power Producers to supply and purchase of the power from the proposed hydropower plant
Programme	A set of activities or projects approved and scheduled over given time period to meet certain objectives (e.g. five-year road periodic maintenance programme).

Project	A specific infrastructure development activity with a starting point and end point intended to accomplish a specific objective. Donors' use of the term 'project' can sometimes be misleading. In donor terms a project is often a group of closely-related infrastructure and supporting institutional development activities (e.g. construction works plus technical assistance) funded by a single loan.
Project Manager, Project In-charge	The person appointed by the executing/implementing agency responsible for the day-to-day management of a project, and exercising the authority assigned by the executing/implementing agency and HMGN regulations. The term also applies to the person in a contractor's organisation who is responsible for executing a construction contract. The person in consultant's organisation responsible for executing a consulting contract is normally called the Team Leader. The terms 'Project Manager' and 'Project In-charge' are interchangeable.
Regulation	A set of rules, instructions and bylaws which have been established by HMGN to clarify, regulate and control the powers and duties established under various acts. Most acts have an accompanying regulation that assigns responsibilities and authorities to government officers and describes procedures which must be followed.
Screening and Ranking	System of coarse and fine screening of potential hydropower sites which are studied at reconnaissance level applying a set of criteria for comparison and ranking
Small Hydropower	Hydropower plants with capacity ranging between 100 kW to 5000 kW
Stakeholder	Any person, group or company that has an interest in or will be affected by the activities or impacts of a project. Stakeholders always include project beneficiaries and project affected persons.
Standard	Technical specification or other requirement which have been established by HMGN sectoral agencies for controlling the level of service, planning, design and construction of public works and which must complied with unless exceptional circumstances prevail.
Survey License	Formal licence issued by the Department of Electricity Development to agencies interested to develop the hydropower plant to carry out survey and investigation works
Users' Committee, Consumers' Committee	A group of persons formed in the project area, usually at the village level, to complete a specific labour-intensive works and to take over responsibility for the operation and maintenance of the completed works. The works are executed through an agreement with the implementing agency similar to a contract. The terms 'users' committee' and 'consumers' committee' are interchangeable.

23. Energy Sector

23.1 Introduction

23.1.1 General

Power sector has an important role to play in the overall development of Nepal. Unfortunately the per capita power consumption of Nepal is the lowest among the ten least energy consuming countries in the world. This scenario can be changed by harnessing the immense potential of hydropower available in the country.

HMGN has set the following objectives for the development of the power sector in the Ninth Five Year Plan.

- To produce sufficient hydro-electricity at cheaper cost and meet the demand for agriculture, industry, transport, domestic, commercial and miscellaneous sector;
- To produce a large amount of quality and reliable hydro-electricity and to meet domestic demand at an affordable price and export it at a competitive price;
- To link up rural electrification with rural economic activities and support the growth of the rural economy;
- To reduce rural and urban disparity in electricity supply as well as to maintain a regional balance;
- To pay special attention to the environmental aspects of hydro-electricity development and to develop hydroelectricity reducing its adverse effects on environment to a minimum level.

The Ninth Plan also states that the development of the power sector in the next 20 years will be geared towards the following activities :

- Efforts will be made to develop hydro-electricity projects and to raise the share of hydroelectricity in the total energy consumption in Nepal from the current 1 percent to 3.5 percent;
- For export purposes, efforts will be made to implement mega multipurpose projects such as Pancheswar, Karnali and Sapta Koshi installing 22,000 MW.
- To ensure a reliable supply system, a balance will be maintained between the development of storage and run-of-river hydroelectric projects;
- Policies will be adopted to implement small hydroelectric projects on a priority basis by mobilizing people's participation at the local level and by involving NGO's;
- To increase efficiency of service delivery, involvement of the private sector in the production, distribution and management of electricity will be increased. For this purpose, the Nepal Electricity Authority will be broken down into three agencies such as electricity production, national transmission network and distribution system and will be gradually privatised;
- Encourage private investment in the electricity by creating a favourable environment for the private investors. Policy reforms and amendments in prevailing legislation will be made and the one window system will be made more effective;
- Policies to maintain or promote the involvement of domestic with foreign investors will be adopted. For this purpose, a conducive environment will be created to promote investment of the domestic capital market resources in the power sector, including the establishment of a power development fund;
- The participation of the private sector in the development of power will be made competitive and transparent.

In terms of figures the government of Nepal, during the period of ninth five year plan aims:

- i. to complete the construction works of 306 MW medium scale hydropower projects and 3775 kW small scale projects.
- ii. to initiate 1718 MW medium and big scale hydropower projects by ensuring the participation of both public and private sectors.
- iii. Besides, it also aims to construct 1024 km long additional high voltage transmission lines and 6067 km other transmission lines to expand the electricity service to nearly 1.1 million additional people of the country.

In order to meet the set target various acts, rules, regulations and policies were promulgated, existing acts amended and different institutions established (Department of Electricity Development, Tariff Fixation Commission etc.).

Efforts are presently being made:

- i. to complete the construction works on one medium size (Kali Gandaki 'A' - 144 MW) and a few small scale hydropower projects
- ii. to materialize participation of private sectors in hydropower development, and
- iii. to bring export oriented hydropower projects to the implementation stage.

So far following achievements have been made :

- Completion of a small hydropower project (Jhimruk - 12.5 MW);
- The initiation of construction works on Kali Gandaki 'A' (144 MW);
- The upgrading of Trisuli Devighat hydropower project (12.2 MW)
- The construction, extension & rehabilitation of transmission lines;
- The partial completion of strengthening of distribution system;
- The partial completion of survey, feasibility study and engineering design.

23.1.2 Institutional Arrangement

1. The 'Ministry for Water Resources (MOWR)' is the prime government agency with primary jurisdiction over the power sector. It is responsible for framing legislation, has regulatory oversight for power generation, transmission and distribution and issuing licences for NEA and private entities operating under electricity act.
2. The Department of Electricity Development (DOED) established in 1993 has the responsibility of developing hydropower and attracting private investors, administer the legislation imposed by MOWR. It currently has the following functions:
 - i. Electricity industry regulatory function
 - ii. Private power development promotion and facilitation function and
 - iii. Technical support function to MOWR.
3. The function of "Tariff Fixation Commission" is to review and approve retail electricity tariff structures. It was established in 1993 to make the procedure of making electricity tariff systematic and transparent by keeping out of government control.
4. Nepal Electricity Authority (NEA) is responsible for generation, transmission and distribution of electricity and in negotiating and working with private power companies. NEA's roles include: system planning, power purchase, integrated grid maintenance and development and scheduling and dispatch.
5. Councils and Commissions an integral part of government, e.g.:
 - National Planning Commission (NPC)
 - Water and Energy Commission (WEC)

- National Development Council (NDC)
- Water Resource Council (WRC)
- Environmental Protection Council (EPC)

are responsible to establish consensus on major policies and strategies, which effluence power sector development.

6. Independent Power Producers (IPPs)

Independent power producers are responsible for planning, financing, construction and operation of hydropower plants through private financing. They enter into power purchase agreements with the Nepal Electricity Authority and sale power produced to Integrated Nepal Power System (INPS). This is relatively new arrangement and has major prospect in power sector in future.

23.1.3 Donor Involvement

Local resources available in the country are not adequate to harness hydropower and to meet the power demand. Donor involvement is hence imperative in this sector. The major donors involved at present are the World Bank (WB), Asian Development Bank (ADB), KfW (Kreditanstalt fuer Wiederaufbau), DANIDA and the Overseas Economic Cooperation of Japan.

The World Bank, through power sector efficiency project, is involved in increasing the supply capacity of NEA, restoring NEA's financial viability and institutional performance and enhancing energy conservation measures. The bank, through power development project (PDP), aims to establish a power development fund (PDF) and expand NEA's rural and transmission and distribution network.

Asian Development Bank (ADB), through rural electrification, transmission and distribution project, intends to increase rural electrification and improve the performance of NEA at the serve times.

Kanchanpur rural electrification project, Marsyangdi-Pokhara 132 kV transmission line project and Hetauda-Bardighat 220 kV transmission line project. The Overseas Economic Corporation of Japan is co-financing Kali Gandaki 'A' Plant and has been involved in large scale transmission and distribution reinforcement project in Kathmandu valley.

23.2 National Hydropower Development Policy

23.2.1 General

In order to address the fundamental issues facing power development particularly in light of the abundant water resources and efforts to attract foreign investment, HMGN is in the process of developing a new hydropower development policy, 2058, the latest version of which was circulated in June 22, 2000.

While the hydropower policy is still evolving, the latest version highlights a number of significant changes compared to the previous policy (Hydropower Development Policy, 2049). Amongst the prominent features of the new policy are:

- It advocates a new institutional structure, more clearly separating regulatory and promotional functions, provide greater clarity in commitment of the HMGN to general institutional reforms including deregulation and private investment in distribution,
- It gives a more detailed enumeration of the royalty's structure,
- It provides a more detailed exposition of the rules for repatriation of equity return for project involving foreign investors, and
- It considers the role of hydropower in rural electrification.

23.2.2 Legislation

In order to make arrangements for the rational utilization, conservation, management and development of water resources and to determine beneficial uses of water resources, preventing environmental and other hazardous effects thereof and also to keep water resources free from pollution, the government of Nepal promulgated following acts policies, and regulations:

- Hydropower Development Policy, 1992,
- Water Resources Act, 2049 (1992) (Nepali and English version),
- Electricity Act 2049, (1992),
- Electricity Regulation 2050, (1993).

A number of other acts and legislation which govern the activities and indirectly affect the power industry include:

- Industrial Policy, 1992,
- Foreign Investment and Technology Transfer Act, 1993,
- Company Act,
- Land Acquisition Act 2034, (1977),
- Land Acquisition Guidelines, 1993,
- Forest Act, 1993 and 1995 Amendments, and
- Agricultural Development Bank Act.

Guidelines, regulation and acts that are directly related with environment and thus indirectly affects the development of power sector include:

7. National EIA Guidelines (1993), (developed by NPC in collaboration with IUCN)
8. Environmental Protection Act, 2053, (1996),
9. Environmental Protection Regulation (1997),
10. Environmental Guidelines of Water Resources and Energy Sector (1997) (Draft),
11. Other multilateral guidelines including the World Bank's Operational Directives for Environment Assessment,
12. Guidelines for Initial Environmental Assessment of Water resources and Energy Projects, WECS Report no. 6/3/161294/1/1, Sequence no. 459, updated November 1995,
13. Guidelines for Environmental Monitoring of Water Resources and Energy Projects, WECS Report no. 6/3/161294/1/1/ Sequence no.460, updated November 1995,
14. Guidelines for Environmental auditing of Water Resources and Energy Projects, WECS Report 6/3/161294/1/1/ Sequence no.461, updated November 1995, and
15. Network Resource Guide, Gender Analysis Section, WECS Report no. 3/2/090/96/1/1/, Sequence no. 482, November 1995.

Regarding the pollution standards for air, water, land and noise are concerned, the Ministry of Population and Environment (MOPE) is presently developing national standards. In their absence, standards such as WHO, ILO and standards available from multilateral agencies are utilized.

Hydropower Development Policy and Water Resources Act 2049 (1992) are formulated to provide legal provision to ensure proper utilization, protection, management and development of surface and ground water resources, to counter adverse environmental impacts due to such utilization and to protect water resources from pollution. The act lays down provisions relating to utilization of water resources, formation of water users' committees, prioritization of water utilization, licensing, utilization of water resources for hydropower, land and property acquisition for utilization of water resources etc.

Electricity Act 2049 (1992) is formulated to respond to the changing power development and demand scenario in Nepal. It was anticipated that, through the promulgation of this act, private investors can be attracted to the country and export possibilities of the hydropower is encouraged.

Nepalese Legal Provisions on Hydropower Development is compiled for all departments, offices, projects etc. to undertake all kinds of hydropower development related works with the objectives of generating and supplying hydropower to meet the demand of the people and the industries as well as to motivate the private sectors and render assistance in the conservation of environment.

Nepal Electricity Authority Financial Administration Regulation is formulated to undertake all kinds of its works by Nepal Electricity Authority and all its offices and project, and major projects related to construction of infrastructure.

Environment Protection Regulation 2054 (1997) intends to regulate the environmental considerations for carrying out initial environmental examination (IEE), environmental impact assessment (EIA) and environmental monitoring, which are mandatory in most of the medium and major hydropower projects.

Land Acquisition Act, 1977 is promulgated to amend and consolidate existing legislation pertaining to land acquisition. The act lays provisions relating to HMG's power to acquire land, procedures and actions regarding land acquisition, compensation valuation, public notification, devaluation of ownership, methods of acquisition, time limits for distribution of compensation, etc.

23.3 Guidelines and Standards

Table 23.1 Principal Power Sector Reference Documents

Area	Published Documents	Agency Responsible
Policy	<i>Hydropower Development Policy, 1992.</i> <i>[A new policy framework has recently been submitted to the Cabinet by the MOWR to further encourage domestic and foreign capital investment in this sector and to exploit Nepal's hydropower potential (Kathmandu Post 20, November, 2000)].</i>	MOWR
Legislation	<i>Water Resources Act, 2049 (1992)</i> <i>Electricity Act, 2049 (1992)</i> <i>Electricity Regulation 2050 (1993)</i>	MOWR
Standards and Specifications	National Pollution Standards are being developed for air, water, land and noise. In their absence International Standards are being used.	MOPE WHO, ILO
	Manuals of standards and criteria for planning water resources projects. Water resources series no 26	DOED, UNO
Planning Guidelines/Manuals/ Norms	Civil Engineering Guidelines for planning and designing of Hydroelectric Development	American Society of Civil Engineering (ASCE), 1989

Design Guidelines/Manuals /Norms	• Civil Engineering Guidelines for planning and designing of Hydroelectric Development	American Society of Civil Engineering (ASCE), 1989
	• Engineering and Design – Hydropower	Department of Army Corps of Engineers, USA, 1985
	• Dams and Development – The Report of the World Commission on Dams, 2000	World Commission of Dams
Construction Guidelines/Manuals	<i>Civil and Electromechanical Works Guidelines, 1996</i>	Mead and Hunt
Operation and Maintenance Guidelines/Manuals	<i>Manuals are supplied by the individual suppliers and manufacturers</i>	Manufacturers and suppliers

23.4 Key Processes in the Project Cycle

The major processes in a hydropower development project cycle consist of four main phases viz. planning and programming, pre-construction, construction and post construction. Details are shown in the flow chart for typical project stages (Figure 23.1). Among them planning and programming phase is carried in as the very first step of the project cycle. During this phase hydropower projects are identified and investigations on the selected projects are carried out such as reconnaissance, pre-feasibility and feasibility studies. Feasibility study will also include preparation of initial project implementation plan.

The feasibility study report along with initial project implementation plan will be discussed among the related authorities, for which a panel of experts are formed. Based on the panel's opinion additional investigations are carried out and their results are incorporated in the report. It is then submitted for its approval, budgeting and inclusion in the forthcoming programmes. Once it is approved for implementation, the detailed project implementation plan will be prepared and the project will either be implemented by the government itself or floated among the private investors and local bodies including NEA.

The owner (Investor) will now apply for a development licence at DOED and, on its receipts, start its pre-construction works on its own or hires a consulting firm or a team of consultants for that purpose. The firm/team will now carry out the definite investigations to extend and supplement the information developed during feasibility investigation. These include the detailed topographic surveys and foundation exploration to determine the exact location of project structures and works. These information provide the base for preparing the detailed engineering design and specification of the entire project including access road, camps and other infrastructure, making their cost estimates, starting actions for land acquisition, resettlement, power evacuation and arranging construction management and environment monitoring and mitigation plans. Detailed design, costing and tendering of access road is prepared at first, so that it can be constructed during the time when other detailed designs are prepared necessary steps are taken during this period for securing the financial arrangements and prequalify the contractors.

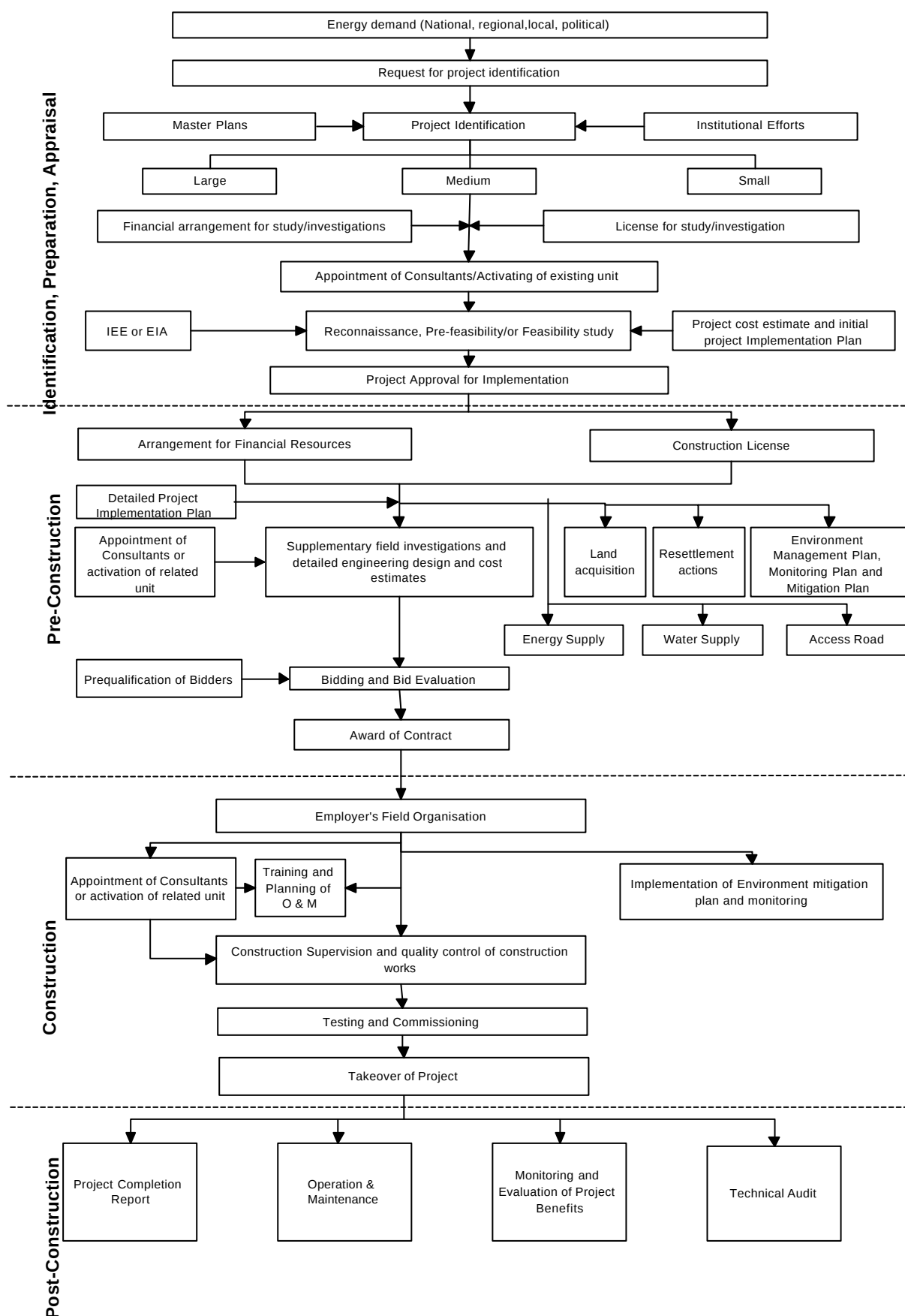
The next step will be the preparation of tender documents based on the detailed design, specifications and costs as mentioned earlier. This is done separately in three to four packages viz. support facilities, civil works, electro-mechanical works, transmission and distribution works. The tender documents consist of the contract conditions and engineering documents. Based on these documents notice of tender will be issued, tender applications evaluated and the contracts are awarded as per the prevailing rules by FAR or the rules based on FAR (in case of NEA).

The award of contract follows the construction works for which a separate administration unit is established. This unit administers the entire construction works, carried out construction

supervision and quality control of the construction works, prepares manuals and guidelines for operation and maintenance and provide training on it. This is done in most of the cases together with the consultants which is appointed prior to the construction works. As-built drawings are also prepared during this phase.

Commissioning of the project will take place as soon as the project is completed. The last phase of the project cycle consists of post-construction works. During this phase operation and maintenance works are carried out as per O&M plan by the technical staff trained specially for this purpose during the construction period. A completion report will be prepared, the overall evaluation of the project implementation and monitoring and evaluation of project benefits are carried out and technical on the performance of the project will also be conducted at the completion of the project.

Fig 23.1 Flow Diagram of the Energy Project Implementation Stages and Their Activities



23.5 Planning

Planning is the first step of a hydropower development cycle. During this cycle the project identification, reconnaissance, pre-feasibility, feasibility study, environmental and social assessment and initial project implementation plan are completed in order to obtain project approval, budget sanction and inclusion in the implementation programme.

23.5.1 Identification

Development of hydropower starts with the identification of the project. This, is usually done by preparing the Master Plans through assistance of the donor agencies or financing institutions. Such Master Plans have already been prepared for several Nepalese basins for storage type power projects. In these plans several hydropower projects ranging from small to large size have been identified. They are primarily based on the topographical maps (scale 1:25,000 or 1:50,000) prepared by HMG in co-operation with FINNIDA and JICA, other topographical maps (scale 1:63,360 i.e., 1" = 1 mile), district maps (1:125,000 and 1:250,000) and regional and zonal maps (1:250,000 or 1:500,000).

Major factors that are used for identifying the storage types of projects are:

- a suitable river gorge section so that the dam crest length can be kept to a minimum
- presence of a wide valley behind the proposed dam site, so that the reservoir volume can be maximized
- presence of a suitable gradient etc.

Projects thus identified by the Master Plans are sent through a course screening and ranking processes based on the technical and environmental parameters (Table 1). Projects identified earlier by other than Master Plans are also included in this screening and ranking process. From this a limited number of suitable projects are identified and ranked appropriately. These are then passed on for fine screening and ranking process based on their economic strength e.g. Benefit/Cost (B/C) ratio, Specific Energy Cost, Internal Rate of Return (IRR) etc. (Table 2). These parameters are evaluated based on the topographical survey and map production (1:1000) as well as hydrological, geological, geotechnical, engineering and environmental investigation and the detailed layouts of the project.

Table 1 Coarse Screening and Ranking Criteria

S.No.	Item	High	Moderate	Low
1	Access road length			
2	Transmission length			
3	Storage (% of annual flow)			
4	Hydrological risk			
5	Geological/geotechnical risk			
6	Environmental/socio-economic risk			
7	GLOF risk			
8	Sedimentation risk			
9	Financial Risk			

Table 2 Fine Screening and Ranking Criteria

S.No.	Name of the Project	Installed capacity in MW	B/C Ratio	Specific Energy cost in USC/kwh	Internal rate of Return (%)	Project Cost in Million US\$	Rank
1							
2							
3							

The techno-environmental aspects are quantified by assigning them a score. These scores are then compared with B/C ratio in a matrix. The projects are then ranked according to the total scores received from the techno-environmental and the economic aspects (B/C ratio).

In case several projects are identified as suitable from both the aspects, then they are further classified into small, medium and large hydropower projects.

These projects are now ready to be picked up for pre-feasibility and/or feasibility studies. It is a normal practice that both of the studies are carried out in most of the donor funded and/or large projects while only the feasibility studies are done in the small and/or privately owned projects. In both the cases, it is necessary that a licence is obtained from the Department of Electricity Development as per Electricity Act, 2049 (1992) and a unit (Governmental, Non-governmental, Firm) or a team of consultants is assigned for the studies.

23.5.2 Reconnaissance Study

Reconnaissance study is normally a first step of project planning. The study is concerned with identification as well as investigation of hydropower projects which are suitable for the supply of power to an identified power market.

The studies are organised similar to pre-feasibility and feasibility studies, but with lesser details and accuracy. The main activities of reconnaissance studies comprise of mobilisation of expertise from all the main sectors e.g. hydropower engineer, hydrologist, geotechnical expert, other sector specialists, support personnel etc. The team will start with collecting relevant data e.g. general data, power market, hydrology, topography, geology and geotechnical engineering, environment, socio-economy etc. from the secondary resources like contoured topographical maps (1:50,000 or 1:25,000 or better scale), aerial photographs, satellite imageries etc. Based on the available data and information the hydropower engineer defines the main project components and proposes a tentative layout of the project in the desk study. The desk study plans require verification of the proposed project layout and structures in their natural surroundings, terrain features. During field verification stage, geotechnical conditions are noted, data on infrastructure, settlements, materials etc. are recorded, environmental and socio-economic conditions are assessed and multipurpose uses of the land and water resources are addressed.

Using the secondary and primary data and information the hydropower engineer confirms the project concept and formulates the project with all necessary drawings, showing the general layout, main sections and salient project features, elements and structures.

A preliminary cost estimate is also prepared which in addition to construction cost also include all pre-construction costs, field investigations, engineering, acquisition of water rights, land and right of way, management, owner's cost etc.

An implementation schedule is also prepared during the study. Based on it and the cost estimate simple economic parameters are produced to rate the economic capability of the project e.g. cost per kW installed and/or cost per kWh. These are then used for ranking of projects and comparison with other similar projects.

The reconnaissance study report will conclude with a statement on the viability and suitability of the project and recommendation for further studies and investigation.

23.5.3 Pre-Feasibility Study

The purpose of pre-feasibility investigation is to select and appraise possible projects worthy of further consideration. During pre-feasibility study, alternative solutions are studied and tested in order to improve the project plans. They are carried out along the same line as the reconnaissance study except that the projects are already been located, identified and given names. Pre-feasibility investigations are usually based on available information and data, supplemented by a minimum of reconnaissance field surveys. An Initial Environment Examination is also carried out during the study. Finally pre-feasibility study report is prepared in which firm statements on the suitability of the project will be made based on the techno-economical as well as socio-environmental aspects.

Based on the pre-feasibility study decision will be made as to whether or not to continue further investigation with the project. In case the decision is positive, the next step would be to conduct feasibility study.

23.5.4 Feasibility Study

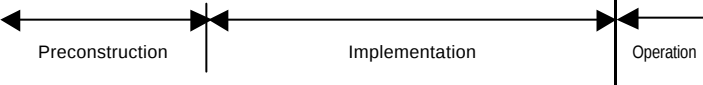
Feasibility study is carried out in order to determine the technical, economic and environmental feasibility of the project. For this purpose a desk study is carried out based on the available information, data, maps, aerial photographs etc. It will be followed by a brief site visit to verify the data collected during the desk study, to locate and assess the suitability of hydropower component sites proposed by previous studies and to examine the potential alternative sites. On the basis of desk study, brief site visit and in discussion with the related officials, project alternatives are selected and recommended for feasibility level studies in an Inception Report. It will also include the detailed programme for full Feasibility Study. On the acceptance of the Inception Report the actual full fledged Feasibility Study will be carried out, during which detailed field surveys are conducted to collect detailed information on socio-economy, power market, tariffs, environment, topography, hydrology and sedimentology and geology, geotechnics and geography related matters. Studies are also made on the potential access roads and route of electricity evacuation. Based on these data socio-environmental and techno-economic analysis are made for the various alternatives proposed at the inception phase and final decision is taken for one of them. Accordingly project layout and designs are prepared for the selected alternative, which becomes then the basis for subsequent project implementation.

The study will include analysis of resources to estimate the net economic values to be produced, the costs of development, construction, operation, maintenance and replacement and to assess the impact of implementation of the project on environment and the costs of mitigating the effects. It will also include the analysis of the practicability of the plan and appraisal of the revenue, from which reimbursement of construction costs and payment of annual operation, maintenance and replacement costs will be derived. The analysis will be based on the data collected during the period of desk study and field investigation. In general, data on socio-economy, power market (demand), tariffs, environment, hydrology, topography, geology and infrastructure are collected. Environmental Impact Assessment (EIA) is carried out in parallel with other field investigation. Analysis of these assessment will produce an EIA scoping report which will include the details of field investigation, analysis of data, assessment of impacts and design of mitigation measures. The EIA activities will be documented in a separate EIA Field Report.

Based on all these investigations and studies, project layouts will be finalized, engineering designs will be prepared, implementation plan will be formulated, cost for project implementation will be estimated and economic and financial analysis will be carried out. The results, conclusions and recommendation should be documented in a Feasibility Study Report. The feasibility study report will provide the necessary information from which the owners can decide whether or not to proceed with implementation of the project. It also serves as application documentation for the development license. The report will also provide a basis for appropriateness of funds and for negotiation of loans from financing institutions or donor agencies for detailed design and construction of the project.

An Initial Project Implementation Plan will also be included in the Feasibility Study report. In it, the type of construction works and facilities, construction sequence and overall scheduling of the activities involved in the implementation of the project are briefly described in form of a bar chart (Figure 2).

Table 23.2 Hydropower Implementation Schedule

Key Processes	Year							
	1	2	3	4	5	6	7	8
Reconnaissance study								
Pre-feasibility Study								
Feasibility Study								
Definite Plant Study								
Definite Plans								
Final Design								
Tender Documents								
Tendering and Contracting								
Construction								
Equipment Design and Manufacture								
Erection and Commissioning								
								

23.5.5 Environmental Assessment

In a hydropower project efforts should be made to minimise the actual physical disturbance and their effects on project planning as well as the negative impacts which may result from project implementation. While the first effects can be handled by selecting solutions, layouts, features and structures that create least disturbance on the environment, the second effects can be minimised only by detailed planning which might often increase the cost of the project so severely that its implementation may not be economically viable. The extent of these effects and the mitigation measures should be determined by an initial environmental examination (IEE) for up to 5 MW or by a more detailed Environmental Impact Assessment (EIA) for larger projects.

The objectives of an IEE study are:

- to identify, predict and evaluate both the beneficial and adverse impacts on bio-physical, socio-economic and cultural aspects of the project area that are likely to arise from the implementation of the project, and
- to formulate the mitigation measures in order to minimize the adverse impacts and enhance the beneficial impacts.

The IEE study should be carried out in accordance with the National Guidelines for EIA of Hydroelectric Projects (1995), National Guidelines for EIA of the Forestry sector (1992), Environmental Protection Act (1996), Water Resources Act 1992), HMG Standards of Pollution Control and Abatement, regional and local regulations, the World Bank Operational Directives on Environmental Assessment, and related legislation.

The methodology that is used to assess environmental impacts include:

- Field observation

- ii. From group discussions,
- iii. Interview with key informants
- iv. Laboratory analysis of water sample and
- v. Survey of local fish market.

During the study physical environment (climate, topography and geology) and biological environment (vegetation forest type, wild life, fish and fisheries and water quality) are assessed, impacts on them are studied and mitigation measures and their costs to reduce them are suggested. Beneficial impacts are also studied during this period. Consulting engineers specialised in this field are generally assigned to such jobs. Specialists from the universities are often engaged in their capacity as specialists in their fields.

The objective of the IEE and EIA., thus, is to provide decision-makers with necessary and sufficient information needed to decide whether the project can proceed to detailed design or should be abandoned at the feasibility / EIA stage.

The EIA level field investigations, therefore focuses on gathering sufficient information. Based on them the environment affected by the project is determined and possible environmental impact resulting from project implementation are analysed and studied. It is conducted during the time when the project feasibility study is being prepared.

The EIA study includes an EIA scoping report as per National EIA Guidelines, 1999, which, after having reviewed by a meeting, will be made available for general public and other related institutions. Once the decision is made and financial resources are ascertained additional studies should be made to fully document the baseline conditions and multi-year trends so as to accurately establish the details of Mitigation and Environment Management Action Plan (EMAP). Based on these data final specification of the EMAP and the monitoring plan will be prepared. This will proceed along with the detailed engineering work.

The detailed environmental management action plan includes:

- Pre-Construction Mitigation Management
- Construction Mitigation Management
- Operation Mitigation Management

During the stage of Pre-Construction Mitigation Management, a final EMAP for the construction and operation phase will be prepared. It will encompass mitigation actions and procedures related to the permanent acquisition or leasing of land for construction and operation of the project, for access road and for transmission facilities.

A GIS based software tool must be developed and used to closely monitor the mitigation process.

Operation Mitigation Management includes the measures/programmes, that have to be implemented by the government or licences as agreed upon by them once the project is in operation.

Along with the Environmental Management Action Plan, sub-plans have also to be developed at the Detailed Design Stage (to finalize EMAP). This includes:

- Acquisition, compensation and resettlement plan,
- Public and worker health and safety plan,
- Restoration and re-vegetation plan,
- Wildlife management plan,
- Watershed management plan,
- Fisheries impact and management plan,

- Community relations, social mitigation and enhancement plan,
- Peaking release public safety plan.
- Other environment activities which have to proceed at the detailed design stage (before construction) include:
 - EIA of accers road,
 - Transmission line,
 - Civil tender documents (environment section).

An institutional set-up is created for the implementation and monitoring of environmental management.

The environmental management authority should consist of (i) the contractor (ii) NEA and (iii) local agency consisting of local leaders, teachers and members of grass-roots and NGOs, whereby the role of each group is well defined.

A detailed Environmental Monitoring Plan will be made during the pre-construction phase. Following monitoring parameters will be used for this purpose:

- Record of the frequency in the number and type of animals.
- Any spectacular changes in camp sites,
- Changes in water quality,
- Change in population,
- Number of pot hole latrines constructed and used,
- Sale of kerosene,
- Increase in fire wood consumption
- Increase/decrease in the number of tea shops.

While carrying out the construction mitigation management the full package of mitigation measures (physical, biological and social) will be implemented during the construction.

The impact of project implementation on the environment will be monitored and evaluated as per environmental monitoring plan during the post construction period.

23.5.6 Social Assessment

Social assessment is carried out to study the negative as well as positive impacts of the project on the socio-economy of the local people. The impacts are assessed both in local and regional level, whereby local level impacts will be mainly due to acquisition of land, construction activities and operation of the project and regional level impacts will be due to opportunities and changes occurring from the project activities.

Assessment is done based on the review of secondary and primary data, study of relevant literature and maps made available from central bureau of statistics and related ministries (Health, Agriculture etc.) line ministries.

Field data are collected by using the tools e.g., questionnaire/Interview, Socio-economic checklists, focus group discussions with local residents, observation of the site.

23.5.7 Reports

23.5.7.1 Reconnaissance Study Report

The report often starts with an executive summary or synopsis. The stated purpose of the project is referred and documented. All main project data and information are also referred and documentation provided on the components and parameters used in the planning process.

The chosen layout and the main project features and components are described and illustrated by drawings, including discarded solutions and alternatives. The project report also covers and indicates implementation cost and time aspects. The report concludes with firm statements on the technical, economic and environmental feasibility of the project.

23.5.7.2 Pre-feasibility Study Report

The pre-feasibility study report will also be comprehensive and cover all the aspects as in feasibility study report, though the depth of details will be somehow lower. None of the data are left unmentioned. If data are lacking or a purpose is considered non-essential this will be clearly stated and reasons given. If simply ignored it will only raise questions in the future.

Statement is made in respect to technical economic and environmental feasibility of the project(s).

Once the pre-feasibility study has been concluded and the project is found to be attractive for further consideration, the next step in the investigations of the project is the feasibility study. Hence the pre-feasibility study report will close with firm statements on the suitability of the project in development context and its practicability for the stated purpose. A concise recommendation on the project's further development role will also be given.

23.5.7.3 Feasibility Study Report

The feasibility study report shall comprehensively document the feasibility study investigations, findings and the information they are based on and attest firmly to the quality of the study. The report will contain firm statements on technical, economic/financial and environmental feasibility and recommendations on project suitability and outlook.

23.5.7.4 Environmental and Social Reports

A separate report on environment and social aspects will also be prepared in which all related aspects, as described in the section 23.5.5 and 23.5.6 will be described in details. Recommendations will be made on the plans, programs and mitigations measure to be considered in order to avoid adverse impacts during pre-construction, construction and post-construction phases of the project.

23.5.8 Project Implementation Plan

The basis for the Project Implementation Plan (PIP) is the feasibility study. It starts with the decision making on whether to go ahead with the implementation of the project. This depends normally upon the technical and economic feasibility, rentability of the project and the socio-environmental benefits the project might bring about.

Once the decision for implementation is made, the approval of the project for construction from the DOED is sought and arrangements for availing fund for the detailed engineering and construction is explored.

Once the funding is arranged, Consultant will be appointed to carry out detailed studies of the project called definite plan Investigation. Its objective is to assemble and carefully co-ordinate design data to ensure that all elements of the project are considered relative to the best available information and to enable designs to be based on the best available data. For this purpose the data developed during the feasibility study are extended and supplemented. This is done through detailed hydrological and topographic surveys as well as foundation exploration. These surveys will determine the exact locations of the project structures and works. They are subsequently used for preparing the final designs and specification.

The tender/contract documents will be prepared on the basis of the final design and specification. During this period the process of tendering for the construction of access road and the process for pre-qualification of potential contractors for the rest of the project works are undertaken. Parallely, pre-construction works such as land acquisition, resettlement, preparation of Environment Management and Monitoring plans are also undertaken at this stage.

This will be followed by the award of contracts on all civil, mechanical and electrical works including the construction works on project site facilities.

The construction works start with the civil components followed by the supply and installation of mechanical equipment and then the construction of transmission line. Prior to the construction works, consulting engineers are appointed for the construction supervision and quality control as well as to give training and prepare O&M plans. At the end of their construction the projects will be tested, commissioned and finally handed over to the owner. An evaluation of project implementation is made at the end.

During the operational phase regular O&M works are carried out as per the O&M plan prepared during the construction period.

As per need the monitoring and evaluation of project benefits are also carried out during this period. But this is normally not done, at least, in the privately owned projects. A format for Project Implementation Plan and construction schedule is given in Figure 23.3.

23.6 Engineering Design

23.6.1 Identification of Alternatives

Alternatives are looked for Hydropower Project, Access Road to the Hydropower Project and Power Evacuation from the Hydropower Project.

The process of study of alternatives starts from the reviewing of the project site identified by the previous studies (by MHSP, DOED etc.). The review during desk study is based on the available maps, aerial photographs, field visit and photographs.

Figure 23.3. Project Implementation Plan and construction Schedule

[illegible]

During review process additional potential alternatives will be identified and recommended in the Inception Report to consider them during the field investigation.

The alternatives for hydropower project, access road and power evacuation are evaluated in terms of the following parameters:

Table 23.4 Parameters for Evaluation of Alternatives

Hydropower Project	Access Road	Power Evacuation
• general arrangement and layout • geology • environmental aspects • power and energy benefits • power evacuation • cost estimate and • financial analysis	• alignment description and layout • geology and geotechnics • Socio-economic aspects • environmental aspects • cost estimate	• existing switching stations • future expansion of high voltage transmission lines in the nearest vicinities • Environmental aspects • Cost estimate

On the basis of investigations carried out during the desk study, site visit, site confirmation and in consultation with the related officials (MHSP, DOED), project alternatives should be selected in the inception phase and recommended for feasibility level studies.

The recommended project alternative is further investigated during the field survey. Various options within this recommended options are considered and once the geological and geotechnical field investigation starts coming in, the layout and arrangement of structure are fined tuned.

23.6.2 Desk Study

Desk study is carried out during the inception phase of the engineering design. During this phase secondary data are collected such as topographic and geologic data from the respective maps and aerial photographs, hydrologic and meteorology, existing gauging stations, MHSP reports, geologic data and maps, documents from WECS, NEA, DOED, ICIMOD, INGOs and NEA's proposed grid expansion plan in the project area. Collected data are reviewed, information gaps are identified and checklists are prepared to make a brief site visit to fulfil the gaps.

23.6.3 Brief Site Visit

Brief site visit (site reconnaissance) is conducted following the desk study.

Objectives of the site visit are :

- to locate and assess the suitability of hydropower project site (proposed by previous studies, e.g. MHSP) and
- to examine potential alternative sites.

Site visit is conducted by a team of experts comprising of hydropower engineer, geotechnical engineer, engineering geologist, highway engineer, survey engineer, hydrologist and environmental engineer.

Data collected from desk study and site reconnaissance are the basis for reviewing the project site identified by previous studies and confirming additional alternative potential sites.

23.6.4 Detailed Field Survey

Survey programme is developed during the inception phase of the detailed engineering design. The objective of the field investigation is to collect detailed information on the project regarding:

- Topography of the project area
- Hydrology and sedimentation of river flow and
- Geology, geotechnic and geophysics related matters.

23.6.4.1 Topographic Survey

Topographic surveys are conducted for both the project area and the access road. They are carried out on the basis of existing topographic maps, aerial photographs and national geodetic points and benchmarks of the national survey network of Nepal. Suitable survey equipment such as autolevel, theodolite, EDM, total station and GPS instruments shall be used for the topographical survey.

Topographic survey is carried out with the following objectives :

- To prepare the longitudinal profile of the water surface of the river,
- To obtain the gross head for power generation,
- To establish necessary ground control points,
- To prepare topographic maps of:
 - The project area
 - The proposed sites for civil construction.

Topographic mapping is carried out with the objective of preparing maps and sections of the project area. Data reduction, preparation of maps and cross-sections and cartography should be carried out by using the computer software such as AutoCAD, CREDO or AutoCIVIL.

Following, maps and aerial photographs are used during the detailed topographic surveys and mapping:

- 1:63,360 scale (1" = 1 mile) map, having a contour interval of 100 ft.
- 1:125,000 scale map, contour interval 250 m.
- 1:50,000 and 1:25,000 scale topographic maps, contour interval - 40 m and 20 m respectively
- Aerial photographs that are available are at approximate scale of 1:50,000.
- Software used are : AutoCAD, CREDO, AutoCIVIL etc.

23.6.4.2 Geotechnical Investigation

Geological and geotechnical investigations have the following objectives:

- To obtain information on the site specific geological conditions in order to assess the suitability of particular type of structures at particular locations,
- To conduct detailed geological mapping and investigations,
- To determine the strength and other properties of the locally available materials,
- To assess the quality and quantity of construction materials required.

The geological and geotechnical investigations include, but not limited to:

- Geological mapping,
- Core drilling,
- Construction material survey,
- Lab testing of core sample and construction materials,
- Seismic refraction surveys.

Following computer softwares, maps, techniques are used for geological, geotechnical and geophysical investigations:

- Topographic maps with scale 1:50,000 or 1:25,000 are used for geological mapping
- Softwares used are : CREDO, AutoCAD, AutoCIVIL etc.
- Scales of maps are : 1:500, 1:1000, 1:10,000, 1:25,000, 1:50,000.
- Techniques used are:
 - Standard geological mapping techniques (to map the rock exposures and deposits in the project area) and
 - The techniques based on Barton's Q-system. (to classify system and quantify the properties of rocks).

Geological field investigations comprise:

- Drilling of drill holes by rotary method,
- Conducting dynamic cone penetration test (DCPT) and permeability tests by constant head as well as by Lugeon methods in the drill holes.
- Laboratory investigation according to ASTM, AASHTO or other internationally accepted standards.

23.6.4.3 Hydrological Investigation

Hydrological, meteorological and sediment investigation have the following objective:

- establishment of database,
- establishment of floods and their return periods,
- establishment of sedimentation data.

Meteorologic data in terms of precipitation is collected from the nearby stations. The weighted average annual precipitation over the basin should be calculated by using Thiessen polygon method. Hydrological data are collected from the gauging station established in the vicinity of the project area. Cross-checking of the flows is made using current meter during field survey period.

Sedimentation data are collected from the sediment samplings at the proposed head works sites. The data are analysed in the laboratory and presented in grain size distribution curve.

Water surface profile should be computed for:

- Development of stage/discharge relationship.
 - At the headwork site and
 - At the powerhouse site.
- Estimation of pondage capacity at headworks.

HEC-2 computer program (developed by USACE) may be used for the purpose. Necessary cross sections, profiles and topographic data will be surveyed and roughness characteristics of the river bed will be assessed. Photographs and line sampling may be useful for the determination of the roughness parameters.

Flood frequency analysis should be carried out for estimating floods with specific return periods. These data are used for the sizing and design of diversion works and the permanent structures. Frequency Analysis by Craeger's coefficients, empirical techniques and the WECS/DHM model are used for these analyses. Statistical analysis of the gauged stations will be carried out where such records are available.

Low flow analysis is carried out to evaluate the characteristics of the river discharge with regard to duration and return period for flows of specified levels. These analysis are used in the determination of the compensation flow requirements at the headworks. The technique of regression analysis or WECS/DHM model are used. For continuous simulation of duly discharge, a daily flow rainfall - runoff simulation model is used. For estimating long term

monthly flow sequences, a stochastic auto-regressive model is used. For estimating firm and average energy a daily simulation programme such as DAILYGEN may be used. Flood hydrographs are computed by using HEC-1 computer model. For Nepalese catchments, low flow analysis may be rapidly assessed using HYDRA software recently developed by Centre for Ecology and Hydrology (UK), ICIMOD and DHM.

Hydrologic and meteorologic data are obtained from:

- Publications of Department of Hydrology and Meteorology,
- Ranking study of MHSP,
- Reconnaissance study.
- Reference hydrology is derived from the nearby gauging station, where staff gauge records are available,
- Precipitation is obtained from the method based on "Thisen polygon method"
- Sediment yield value is estimated from "Himalayan sediment yield technique"

23.6.5 Project Layouts, Designs and Drawings

In the reconnaissance level, preliminary designs and drawings are prepared to show the general layout, main sections and structures only. More detailed designs and project layouts are presented during the project engineering design phase once the final decision is made on one of the alternatives proposed at the feasibility phase. These layouts and designs form the basis for subsequent project implementation. For this completion of field investigation, topographical survey, geotechnical investigation and analysis of hydrological data are carried out.

The extent and detail of engineering designs made in connection with feasibility investigations are normally just sufficient to assure the reliability of the project plan and a guarantee that the project can be built at the estimated cost. Engineering designs of the project are prepared mainly in the project components e.g.

- River transfer and diversion
- Regulation works
- Intake and waterways
- Power house and appurtenant facilities
- Transmission lines and substations
- Permanent site installations.

During the preparation of design/dimensions are established, the main and auxiliary project equipment are described and performance specifications for the complete outfitting of the power plant are prepared. Hydro-mechanical as well as electro-mechanical and auxiliary equipment :

- Turbines and valves
- Generators and switchgear
- Transformers, power cables, switchyard and substations
- Auxiliary equipment for monitoring, protection, control etc.

More detailed design are made during the pre-construction period. They will cover:

- The detailed mapping of head works and power house (1:200), profile of all cross drains,
- Cross sections of river intake site and at tail race and along the canal alignment,
- Establishment of more permanent benchmarks at headworks and powerhouse sites,
- Transmission line route alignment,
- Access and project road alignment design,
- Hydraulic, structural and hydro and electro-mechanical design,

- Transmission line and sub-stations,

In the case of civil and structural engineering, detailed designs are prepared with no input from the contractor. In the case of hydro and electro-mechanical equipment the manufacturers do their own detailed designs based on the specifications as given in the Tender Documents. The owner's role in this case is to control and approve the manufacturer's design.

Detailed design must make certain that the various project components will withstand the stresses they will be subjected to from loads and climatic and other conditions. The Designer shall ensure that approved standards and norms are used in the design, that only accepted material quality shall be used and that specified safety margins are employed in the design.

In the case of civil works detailed designs and work drawings are done as a direct continuation of the final design made during the pre-construction phase. It is important that construction drawings are available when the contract is awarded for civil construction.

Design for machinery and equipment should show the exact location in which they are to be placed, limiting dimensions, if any, and design characteristics such as required capacity and performance under specified conditions (performance specifications), etc. Final designs are developed for all project works. The designs should be sufficiently detailed to provide the basis for writing performance requirements and specifications.

The objectives of drawings is to reflect the scope of the engineering design. The drawings are prepared to such a detail and scale that the contractor can base his work on them directly without having to prepare additional details by himself. They should show the location and dimensions of all component parts of the structures. They should be based on thorough considerations of foundation and other natural conditions, the capacity and function of the structures and accepted engineering practices with respect to allowable loads, stresses, strength of materials, materials to be used, suitable construction processes, and similar factors.

Drawing details will include:

- | | |
|--|---|
| • Structural dimension and layout information, | • Diversion facilities (1: 1000), |
| • Interface with other structures, | • Head works (1:400, 1:200; 1:1000), |
| • Member size and arrangements, | • Headrace tunnel and surge tank/forebay (1:100; 1:10,000), |
| • General drawings (scales - 1:1000, 1:10,000, 1:25,000 and 1: 50,000) | • Powerhouse (1:100, 1:1000), |
| • Construction facilities (1:10,000), | • Powerhouse single line diagrams, |
| • River cross section, | • Switchyard and transmission line (1:50,000 or 1:63,360). |

23.6.6 Cost Estimates

Cost estimate is prepared using the "analytical method", whereby the cost of labour, materials and equipment are considered. Analytical method is the generally accepted method of the international construction industry. In this method, the work to be performed is broken down in to various items of work. Each work item is then analysed to determine the materials, man power and equipment necessary for its accomplishment and the costs involved therein.

Cost estimates will be carried out in conjunction with the construction planning and scheduling activities.

Prior to the estimating of project cost, the existing cost database (e.g. the ones of MHSP and other hydroelectric and road construction in Nepal) is reviewed, current wage rates for labour in project area is obtained from the district level wage rate fixation committee, information on pricing for materials and services in Nepal (e.g. cement, fuel, truck transport, construction, duties, tariffs etc.), costs of materials and equipment from outside Nepal and costs of infrastructure components (e.g. road and building construction) are obtained.

Unit rates for the various items of works are worked out on the basis of detailed rate analysis based on prevailing norms. The unit rates for the materials, labour and equipment are evaluated on the basis of district rates (specified by the district level wage rate fixation committee. Appropriate contingency, contractor's overheads and profit and VAT provisions are applied. The unit rates for special items (e.g. radial gates, plane still gates, penstock liner etc.) are worked out on the basis of price quotations from manufactures. This applies for the unit rates for electro-mechanical equipment as well. Appropriate factors are applied to these unit rates to derive the unit rates for the base year of consideration.

The unit rates for the transmission line, switch yard and substation should be based on the average per km length constructed under the aegis of NEA. It is substantiated by a price quotation from local company and other transmission line and substation projects.

The cost of preparatory works (Permanent and temporary facilities, operator's village and construction power, project and access roads) should be evaluated by standard engineering works.

Other indirect costs to cover the items such as contractor's site management, travel expenses, insurance, vehicles, home-office expenses, overhead, profit etc. should also be estimated.

Also lumpsums estimates for general items should be based on the records and experiences wherever appropriate.

Taxes and import duties (on equipment and materials) should be separately estimated.

Final total costs should be estimated by adding the contingencies, unexpected risk and a certain percentage of total costs for engineering and construction management as per standard practice.

In general following rules are applied for the contingencies:

Works	Contingency (%)
• Civil works in waterways	25% of construction work
• Other civil works including access road	15% of construction work
• Electro-mechanical, hydro-steel structure, and transmission line	10% of construction work
• Coverage of general item and preparatory works including establishment of diesel plant	8% of construction work
• Coverage for administration and engineering construction including detailed design and investigation of the project	10% of construction work
• Coverage for land acquisition and compensation	1% (of the direct cost)

A cash flow is developed and used to calculate interest during construction and discounted cash flow studies. The detailed cost estimate is used to confirm economic and financial analysis and forms basis for budgeting and tendering.

23.7 Pre-Construction

Activities, that are carried out during the pre-construction stage, are very important and, in fact, the pre-requisites for the successful completion of any hydropower projects. These activities are carried out as soon as the necessary financial resources are made available for the constructional and other related works. The major activities are listed below:

- Based on the feasibility study report, application will be forwarded to the Department of Electricity Development for obtaining a construction licence,
- On the receipt of the licence the related unit of the organisation will be activated or a firm of consultants will be appointed as per FAR guidelines or internal regulations,
 - o To conduct the detailed field investigations wherever necessary,

- o To prepare detailed engineering design, cost estimate, bid documents and contract packaging,
- o To pre-qualify the bidders
- o To make the bidding and bid evaluation,
- o To procure the essential goods,
- o To award the contract.
- Actions will be initiated, in cooperation with related government institutions (mainly district development committee) and the land owners, to acquire the necessary land for the project,
- Arrangements will be made in cooperation with the DDC for the resettlement of the people living in the proposed project area,
- Access road will be constructed to link the existing road to the project site,
- Potential bidders are selected through prequalifying them as per the prevailing rules,
- Project works (contracts) of the entire scheme are divided into a number of discrete contract packages,
- Tenderers are called from among the prequalified bidders for the contract packages and contracts are awarded to one or various contractors/suppliers as per the rules mainly based on FAR,
- Arrangements are made to provide electricity and water supply to the project site,

A team of experts from various disciplines and sectors will be formed to develop environment management plan, environment monitoring plan and environment mitigation measures

Environment management plan will consist of:

- Acquisition, compensation and resettlement plan
- Public and works health and safety plan
- Restoration and revegetation plan
- Wildlife management plan
- Watershed management plan
- Fishing impact and management plan
- Community relations, social mitigation and enhancement plan
- Peaking release public safety plan.

Environment monitoring plan will consist of:

- Baseline and pre-construction monitoring
- Construction phase monitoring
- Operation phase monitoring

Environment mitigation measures are prepared for pre-construction, construction and post-construction phases.

Mitigation Measures for pre-construction phase includes educational programme (to create awareness, to make aware of opportunities and impacts of project, to enhance/provide skill etc.)

Mitigation measures during construction include:

- organising workshops to create awareness among the work force and project staff about the local social, cultural and religious practices,
- holding talk programmes on social evils (prostitution, gambling, drinking etc.),
- appointing public relationship officer to prevent clashes between work force and local people.

- taking safety measures during construction works,
- establishing medical clinics fully equipped with medicines and staff etc.

Mitigation measures during Operation phase include:

- providing counseling services to overcome the psychological impacts on local people left by the outside workers during construction,
- providing special training to upgrade the business skills obtained during construction phase,
- convincing newly rich people to involve in the developments of local economy.

23.8 Implementation Modality

The implementation modality of a hydropower project depends on the size, nature and owner of the project and the donor community.

Most of the medium and large projects are funded by the donor communities. In such projects the implementation modality is fixed by their own guidelines. Accordingly expatriate consultancy services are also provided by them. To build up the local capacity, however, it is now HMGN's practice to ask for the association of local consultants for the services to be provided by them. Similarly, in the procurement of works in ICB, the involvement of local construction company has been sought.

In the government owned hydropower projects, the works are done through the procurement of works and goods following ICB or NCB procedures depending on the magnitude of works. Procurement procedures and standard bidding document of works, goods and consultants are confined elsewhere in PWDs Parts II and III.

In short, the implementation modalities among others for the energy sector will include the following:

- Institutional strengthening of DOED and NEA,
- Guidelines and SBDs to be followed during implementation,
- Method of procurement of consultants both local and expatriate,
- Method of procurement of goods and works through both ICB and NCB,
- Standard conditions of contract,
- Particular conditions of contract as applicable to individual projects,
- Any other relaxation or concession applicable to procurement of works, goods and services.

23.9 Construction

23.9.1 Construction Works

Construction works start with the agreement between the employer on one side and the contractors and suppliers on the other. The contractors and suppliers manage their own operations, which are monitored by the employer's field organisation. This organisation also co-ordinates the construction works and the activities of various contractors and suppliers. It also manages the various contracts, inspects the performance and quality, monitors the progress, supervises construction and installation and approves bills for payment. Services which normally come under the employer's jurisdiction and responsibility include security, guards, handling of visitors, public relations, health services, sanitation, communication, transport etc. Prior to the commencement of the main construction works, the preparatory works consisting of the construction of offices and quarters and the installation work of materials of the distribution line are carried out. Upon receipt of the employer's order to commence the works the civil works contractors commence the preparatory works comprising of the construction of their temporary buildings/camps, access roads and establishment of the temporary power supply

system. The main construction works commence with the civil works, which is followed by the electro-mechanical and lastly the transmission and distribution works.

They comprise of procurement of electro-mechanical equipment and their erection, erection and commissioning of transmission line and sub-stations and/or upgrading of switching equipment at existing sub-station.

In general a firm of consultants is appointed to carry out the construction supervision and quality control, environmental monitoring during the construction of work.

Parallely, the environmental and social impacts of the constructional works are monitored and controlled by a team of environmental group led by an environment coordinator under the jurisdiction of the employer. The group consists, generally, of personnel relating offices, non-formal education coordinator, facilitators, local community leaders, who train implement and monitor the socio-environmental activities during the construction phase.

One important activity, that is carried out during the construction phase, is to provide training on O&M to a number of personnel to ensure a smooth operation of the project after it has been commissioned. This part is important because experienced O&M staff is not easy to come by for hydropower installation in remote areas and staff having the necessary training and experience is simply not available in the area.

Training programs for operational staff consist of a general part as well as a part prepared for the project at hand. The various positions to be covered are identified and the required minimum educational level given. Job descriptions are made for the various positions and the number of trainees proposed for each position. Selection of candidates for training is made from groups having the required educational background. Screening is performed looking for suitability, reliability and motivation.

23.9.2 Operation and Maintenance Planning

Planning of operation and maintenance is often part of the employers' assignment for hydropower projects. In general the employer's consultant coordinates the manufacturer's directions for use of the equipment, including descriptions, specifications and instructions, and prepare programs for operation and maintenance of the complete installation.

Major maintenance work should be planned for and restricted to periods when generating units can be taken out of service with out causing shortage in the supply system.

Routine maintenance is also planned. It usually follows a calendar program, which, on a day-to-day basis, shows which maintenance work to do. A detailed description of the work, scope and performance is given. Tools, materials and spare parts involved are also included in the work program.

Planned maintenance programs are today adapted for and run on personal computers, from which the daily maintenance tasks are obtained. With the completion of the activities as mentioned above, the project is commissioned in parts or in full and handed over to the employer.

The commissioning and take over of the entire project is followed by a project completion report prepared by the personnel of employer's field organisation or by its consultants. It should contain among others:

- General description history and feature of the projects,
- Investigations additionally carried out, their reasons and the results,
- Detail of changes made in the design, their reasons and results,
- Details of project administration regarding contracts, organisations, safety, accidents and medical treatment, employment, supply and erection accounting etc.,
- Details of construction including preparatory works, construction plant and equipment, access roads, transmission line and their quality control and tests,

- Details must be supplemented by tables, maps, figures and drawings including 'as built' drawings.

23.10 Operation and Maintenance

Operation and maintenance (O&M) of any hydropower project are the most important activities that are carried out during the post-construction period, i.e. from the time after the commissioning of project to its entire life. Benefits as envisaged in the feasibility study report can be achieved only, and if only, these parts of activities are done by the trained staff as planned and prescribed during the construction phase of the project.

In the privately owned hydropower projects, O&M manuals on electro-mechanical parts are prepared on the basis of related documents made available by the suppliers and/or manufacturers, while for the civil parts they are made separately based on the available standards, norms and specifications. The project staff must follow these mandatory manuals strictly.

In the government owned hydropower projects too, O&M works are planned on the basis of available documents and shortcut manual are also prepared, but they are not strictly implemented.

Since the O&M works are site specific, no general guidelines or manuals applicable to all hydropower projects are available.

In donor assisted projects these works are done as per the manuals prescribed by the donor institutions.

23.11 Benefit Monitoring Evaluation

Benefit monitoring evaluation is one of the essential activities that is carried out at a regular interval during the post-construction period. Its main aim is to verify to what extent the assumptions on expected output made during the appraisal phase of the feasibility study match with the actual results, and to use them as tools for improving the out comes of the project. Technical auditing is one of the activities, which are carried out to ensure that the plant is providing the expected performance as envisaged by the design. These activities are carried out by a team of experts comprised of sociologist, economists, environmentalists and technical specialists of various disciplines. The time interval is fixed depending upon the size of the project and the extent and seriousness of impacts it can bring about.

In case of Nepal, these activities are being seriously carried out in the private hydropower projects financed by the donor countries or institutions, whereas the same are missing in the government owned projects. This situation has to be improved by allocating adequate fund for the above activities.