SMALL HYDRO POWER – NABARD'S INVOLVEMENT AND FUTURE OUTLOOK

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SMALL HYDRO POWER

Since the ancient times, falling water as a source of energy had been in use, but only at the beginning of the nineteenth century with the invention of the hydro turbine the use of hydropower got a new impulse. The basic principle of hydropower is to take water from a certain high level to a lower level resulting in generating water pressure, which can be used to do work. The water pressure generated is utilized to move a mechanical component which converts the potential energy of the water into mechanical energy. Hydro turbines convert water pressure into mechanical shaft power, which can be used to drive an electricity generator, a grinding mill or some other useful device.

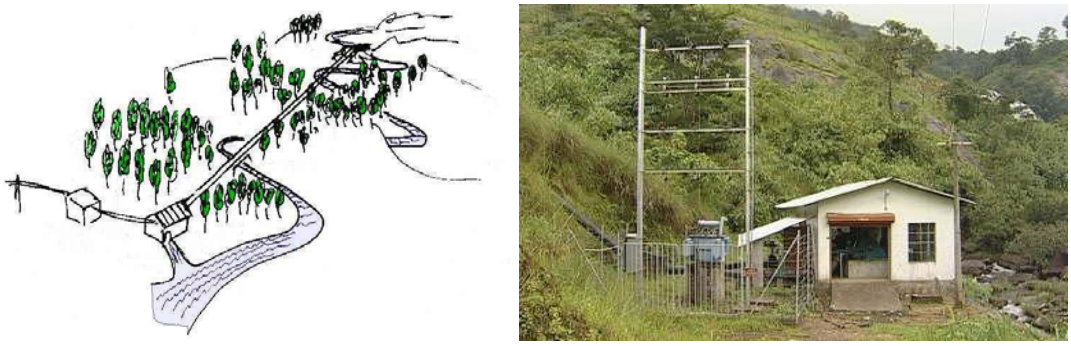

Fig: Small Hydropower plants

Hydro power plants are generally classified into small, mini, and micro hydro power plants, based on the generating capacity of the plant. Different countries adopt different generating capacities for classification which is evident from the following table.

Country	**micro** (kilowatts)	**mini** (kilowatts)	**small** (megawatts)
United States	< 100	100 - 1000	1 - 30
China	-	< 500	0.5 - 25
USSR	< 100	-	0.1 - 30
France	5 – 5000	-	-
India	< 100	101 - 1000	1 -25
Brazil	< 100	100 - 1000	1 - 30

Source: Moreire, J.R. & Poole, A.D. (1993) *Hydropower and its constraints*. In: Johansson T.B. et al, (1993) *Renewable energy : sources for fuels and electricity* (ISBN 1-85383-155-7)

IMPORTANCE OF SMALL HYDRO POWER

Hydropower is a very clean source of energy. It is also renewable. It does not consume but only uses the water which can again be used for other purposes. The use of hydropower can make a contribution to savings on exhaustible energy sources. Assuming an efficiency of 38 % for the conversion of oil into electricity, each 600 kWh of electricity generated with a hydro plant is equivalent to 1 barrel of oil.

Small Hydro Power can be established even in interior nooks and corners, especially in hilly areas for local energy requirements i.e. obviating the need for elaborate transmission arrangements. Thus, it is especially suitable for decentralized requirements. Further, it is possible to have much greater community involvement in the planning, execution and ownership of the structures. This facilitates better maintenance and operation. Also, it leads to creation of lot of local livelihood opportunities.

With all the above benefits, NABARD is promoting small hydro power as it contributes to participatory and sustainable rural development.

NABARD's INVOLVEMENT SO FAR

Quantum of Support

NABARD has so far been financing only the State Government departments and Corporations installing small hydro power systems, out of its Rural Infrastructure Development Fund (RIDF). A summary of the total number of Small Hydel Projects financed by NABARD since 1999-2000 (RIDF VII) is indicated below:

Table: 1:Summary of NABARD sanctions **(Rs. Crore)**

State	**RIDF VII** (2001-2002)		**RIDF VIII** (2002-03)		**RIDF XI** (2005-06)		**Total**	
	No.	**Sanc.**	**No.**	**Sanc.**	**No.**	**Sanc.**	**No.**	**Sanc.**
Arunachal Pradesh	2	32.80	-	-	2	56.72	4	89.52
Bihar	-	-	17	60.15	-	-	17	60.15
Madhya Pradesh	1	37.71	1	35.10	-	-	2	72.81
Uttaranchal	-	-	-	-	-	-	0	0
Andhra Pradesh	-	-	-	-	7	25.37	7	25.37
Assam	-	-	-	-	2	46.14	2	46.14
Total	**3**	**70.51**	**18**	**95.25**	**11**	**128.23**	**32**	**293.99**

As can be seen from the Table –1, these projects have been financed in the Himalayan region of Arunachal Pradesh and Assam, besides in other areas of the Andhra Pradesh, Bihar

and Madhya Pradesh States. The projects have been in the range of .25 to 5 MW. The State-wise details are given below:

Table:2:List of Hydel Projects sanctioned under RIDF

(Rs. in lakh)

Tran-che	Sr. No.	Name of the Project	No. of units (No x MW)	District	Potent-ial MW	Project Cost	NB. Loan	Govt. contri.
	Andhra Pradesh							
RIDF XI	1	Devaramadugu		E.Godavari	1.20	568.57	245.64	12.93
	2	Cheedipalem		V.Patnam	1.10	609.06	288.86	15.20
	3	5.5 KM d/s Lower Sileru		Khammam	3.00	1330.30	883.79	46.51
	4	Metlapalem		E.Godavari	1.20	600.48	275.96	14.52
	5	Vetamamidi		E.Godavari	1.20	599.67	275.19	14.48
	6	Pinjarikonda		E.Godavari	1.20	600.00	275.50	14.50
	7	Valsampet		V.Patnam	1.10	612.35	291.98	15.37
	SUB TOTAL				**10.00**	**4920.43**	**2536.92**	**133.51**
	Arunachal Pradesh							
	1	Angong Small Hy- dro Power	3 x 1.5	Upper Siang	4.50	3470.00	2915.08	153.42
	2	Cons. Subung Small H/Power	3 x 1.0	East Siang	3.00	2949.77	2757.16	145.11
	SUB TOTAL				**7.50**	**6419.77**	**5672.24**	**298.53**
	Assam							
	1	Myntriang I (2x3000 KW)	2 x 3.0	Karbi Anglong	6.00	4036.70	2790.52	0.00
	2	Myntriang II (2x1500 KW)	2 x 1.5	Karbi Anglong	3.00	2755.70	1823.95	0.00
	SUB TOTAL				**9.00**	**6792.40**	**4614.47**	**0.00**
	TOTAL FOR RIDF XI				***26.50***	***18132.60***	***12823.63***	***432.04***
RIDF VIII	**Bihar**							
	1	Tejpura	1.50(2x 0.75)	Aurangabad	1.50	718.06	496.93	221.13
	2	Dehra	1(2x0.5)	Aurangabad	1.00	583.87	410.26	173.61
	3	Sipaha	1(2x0.5)	Aurangabad	1.00	543.05	381.33	161.72
	4	Belsar	1(2x0.5)	Jehanabad	1.00	570.01	400.91	169.10
	5	Walidad	0.70	Jehanabad	0.70	372.06	260.15	111.91
	6	Arwal	0.50	Jehanabad	0.50	317.77	221.68	96.09
	7	Dhelbagh	1.50(2x 0.75)	Rohtas	1.50	719.85	506.26	213.59
	8	Nasrignaj	1(2x0.5)	Rohtas	1.00	607.65	420.71	186.94
	9	Paharma	1(2x0.5)	Rohtas	1.00	555.29	390.01	165.20
	10	Sebari	1(2x0.5)	Rohtas	1.00	568.14	399.11	169.03
	11	Jaingra	1(2x0.5)	Rohtas	1.00	577.30	403.70	173.60
	12	Sirkhinda	0.70(2x 0.35)	Rohtas	0.70	494.85	347.16	147.69
	13	Amethi	0.50(2x 0.25)	Rohtas	0.50	323.88	226.01	97.87
	14	Rampur	0.25	Rohtas	0.25	221.43	153.41	68.02
	15	Natwar	0.25	Rohtas	0.25	213.43	147.72	65.71
	16	Rajapur	0.7	Supaul	0.70	346.57	242.09	104.48
	17	Triveni	3	W.Champar an	3.00	1345.65	607.58	528.07

	SUB TOTAL				**16.60**	**9078.86**	**6015.02**	**2853.76**
	Madhya Pradesh							
	1	Indira Sagar ower House	3 x 5	Khandwa	15.00	6197.83	3509.87	2687.96
	TOTAL FOR RIDF VIII				***31.60***	***15276.69***	***9524.89***	***5541.72***
RIDF VII	**Arunachal Pradesh**							
	1	Liromoba Mini Hydro Elec.		West Siang	0.00	2792.18	1042.74	515.52
	2	Pacha Small Hydro Elec.		East Kameng	0.00	2988.79	2237.44	145.02
	SUB TOTAL				**0.00**	**5780.97**	**3280.18**	**660.54**
	Madhya Pradesh							
	1	Small Hydel Power Project	2 x 5	Jabalpur	10.00	4550.34	3771.27	405.45
	TOTAL FOR RIDF VII				***10.00***	***10331.31***	***7051.45***	***1065.99***
	GRAND TOTAL				***68.10***	***43740.60***	***29399.97***	***7039.75***

NABARD SYSTEMS & PROCEDURES

NABARD follows an elaborate system of financing and monitoring such investments, on a project approach. Detailed Project Reports are prepared by State Government Departments and submitted to NABARD along with the administrative approval and technical sanctions from the competent State Government authorities. NABARD takes up a detailed techno economic appraisal of such DPRs, through its own expert staff or by employing outside consultants as per needs. The technical appraisal looks at the necessary clearances e.g. environmental, etc., besides scrutinising the technical designs. The most important thing about the economic appraisal is that it is a social cost benefit analysis, i.e., it is based on the concept of economic rate of return (ERR), instead of the financial rate of return (FRR).

Projects are phased for completion over 3-5 years and bar charts are prepared for project management. Monitoring is done by NABARD on both field and desk bases, so that cost and time over runs are minimised.

IMPLEMENTING AGENCY

The implementing agencies have been departments of the State Governments, e.g., State's Power Generation Corporation, Department of Hydro Power Development, Tribal Power Company Limited, etc. Care is taken to ensure that the implementing agency has sufficient manpower, expertise and infrastructure for undertaking execution of the project. It must have sufficient number of Engineers/staff at various levels to plan, implement and monitor the project.

QUALITY CONTROL

This is one of the important components, which is considered while implementing the projects. The Project Implementing Department is required to undertake desk/field monitoring and quality control tests as per the internal instructions/manual of Implementing Department. The reports of the inspecting officer/quality control tests and compliance thereto are retained

on record by Project Implementing Division and a copy of the same is made available to NABARD whenever required.

The manufacturers supplying electrical equipment and components have to give guarantee/warranty certificate towards the quality of the equipments and components supplied.

DESIGN DETAILS

Although there are bound to be variations in design as per the site requirements, it can be generally said that the water is brought from diversion point from the river (source) through intake channel to sluice gates for extraction of silt and than it is taken to the Fore bay tank through power canal. It is then taken to the power house through pressurized penstock pipes to run the Hydraulic turbines. These are generally Horizontal Francis turbines and there are synchronous generators of required capacity. The turbine discharge is disposed of to the river through a tail race channel. Most of the projects financed by NABARD so far have been designed based on the guidelines of Alternate Hydro Energy Centre(AHEC), IIT Roorkee.

Items of investment are Civil Works consisting of Intake and Weir Structure, Intake Channel, Sluice gate, Contour canal, Fore bay Tank and Spillway, Pen stocks, Power house, Tailrace Channel etc. and Electro- mechanical works viz installation of Horizontal Francis Turbines, Synchronous Generators, Switchyard equipment, distribution system and other related works. Besides Special T&P, On-site residential & non-residential buildings, Necessary road, bridges, Plantation, and other items crucial for the implementation of the project are included.

COST OF DEVELOPMENT

Cost of development of the projects differ from project to project depending on various factors such as site location, size of the projects, etc. The cost of development/installation in the NABARD financed projects have been in the range of Rs.0.44 lakh/kw to Rs.1.3 lakh/kw. The cost of generation which is taken as the annual operating cost per unit of electricity produced has been Rs.0.83/kwh to Rs.1.95/kwh. This compares very favourably with the figures of nearly Rs.10/kwh using other sources like diesel in some of the project areas. Hence, the annual operating cost is taken as O&M costs, depreciation costs, etc.

BENEFITS

The overall impact of the projects after its full implementation is generally taken as follows:

1. Assured supply of electricity to meet the demand of the rural people.
2. Improvement in irrigation and farm productivity.
3. Increase in income and employment from service sector units, cottage and micro level enterprises.
4. Saving in Expenditure on Deisel(DG Set) where in the cost of generation of electricity comes to approx. Rs.10/- per kWHr.

5. Productive use of time of the inhabitants of the project area presently wasted due to lack of electricity
6. Increase in educational standard, especially of children.
7. Improvement in standard of living and savings in medical expenditure of the inhabitants of the project area.

Serial No. 1, 2 and 3 are quantified in terms of money and used for the social cost benefit analysis or ERR calculations where as the other benefits although not quantified are used sometimes while deciding whether to finance the projects.

OPERATION AND MAINTENANCE

Post construction of the structures, operation and maintenance assume great importance. The agency taking the responsibility of operation and maintenance is decided at the project planning stage itself. In most cases, it is the project implementing agency (generally the States Government department) that takes the responsibility. In some cases, the contractor engaged by the project implementing agency does the operation and maintenance work at the initial stage, say for a year, after construction. The cost of operation and maintenance is tried to be met from the electricity tariff that is collected in tune with Govt. of India guidelines.

RISK FACTORS

Certain risk factors must be taken into consideration while planning the project so that adequate and appropriate measures can be taken. These types of structures are constructed/ built in difficult hilly/mountainous terrains. Common risk factors generally encountered are :

1. The Project site may be located in seismic zone.
2. The Project site may be prone to land slide and slips.
3. Obtaining of clearances and acquisition of land. Any delay will have an impact on the implementation of the project.
4. Financial assistance as grant from other sources viz., Ministry of Non conventional Energy resources (GOI), etc. Any delay on sanction of the project by them will hamper the progress of work.

Suitable conditions to these effects are incorporated in the Special Terms and Conditions of the sanction.

FUTURE OUTLOOK

Financing to State Government

NABARD has been supporting the State Governments since 1999-2000(RIDF-VII) out of its Rural Infrastructure Development Fund for taking up Small Hydro Power Projects. As indicated earlier, NABARD has so far sanctioned Rs.293.99 crore to the States Govt. departments for construction of 32 nos. of such projects. NABARD shall continue to finance such projects in future also.

Financing to Panchayat Raj Institutions(PRIs)

PRIs are important step forward in the direction of participatory development. As per NABARD guidelines, there is provision for financing to PRIs also. NABARD is exploring financing to PRIs for taking up Small Hydro Power Projects.

Financing to Private Producers

NABARD is considering for financing to the Private Producers also, for taking up Small Hydro Power Projects. Such Private Producers must have sufficient manpower, expertise and infrastructure for undertaking execution of the project. However, we have to keep in mind that in the case of private sector projects revenue from sale of power only can be taken for cost benefit analysis and financial viability decided on the basis of that. Hence, it would be extremely important to ensure that there are proper and well paying arrangements for evacuating the power through power purchase arrangements (PPA) between the independent power producers (IPPs) and the authorized distribution agency (e.g. SEBs) in the area if it is not a captive power plant. The various regulations for private producers, including those under the Electricity Act, 2003, also used to be complied to in such cases.