Workshop on
Capacity Development Program for Afghan Women
(Clean Energy Access)

Small Hydro based energy generation

G Anil
Head – Small Hydro Power Dn.,
Energy Management Centre,
Trivandrum 695017, Kerala, India.
E-mail: anilg@keralaenergy.gov.in
Objectives

- Small hydro Potential
- Concept
- Appropriate Technology options
- Decentralized power generation
The Concept of Hydropower

Potential Energy
(Mass of water located at a higher elevation)

Kinetic Energy
(Water flows as a result of the mass being at a higher elevation.)

Mechanical Energy
(Flowing mass of water turns a turbine runner.)

Electric Power in Kilowatts (kW)
(Turbine runner turns a directly coupled generator.)
Small Hydro Power Scheme
Introduction/Background

- Slow down in pace of development of large conventional hydro power over past two decades.
  - Financial constraints
  - Water disputes
  - Environmental & resettlement issues

- Promotion of small hydro (why?)
  - Ideal for the remote and inaccessible area electrification where grid power is not economically viable
  - Can improve the overall energy scenario of the country
Advantages of small hydro.

- Limited investment
- Short gestation period
- Environment friendly
- Pollution free
- Simple civil work
- Minimum operation and maintenance cost
- Operational flexibility
Classification of small hydro

- **World wide.**
  - USA ≤ 5 MW
  - UK ≤ 5 MW
  - India ≤ 25 MW
  - Sweden ≤ 15 MW
  - Colombia ≤ 20 MW
  - Australia ≤ 20 MW
  - China ≤ 25 MW
  - Philippines ≤ 50 MW
  - New Zealand ≤ 50 MW
  - Canada ≤ 20 MW
  - Erstwhile USSR <30MW

- **Indian Classification.**
  - Pico hydro ≤ 10 kW
  - Micro hydro ≤ 100 kW
  - Mini hydro ≤ 2 MW
  - Small hydro ≤ 25 MW
Potential of small hydro

- World potential: ~2,00,000 MW.
  - Installed capacity: 60,000 MW

- SHP potential of Afghanistan?
  (Hydro potential ~20,000MW-Kokcha, Amu & Panj rivers)

- Indian potential: ~15000 MW.
  - Installed capacity: ~1750 MW
  - Under implementation: ~500 MW
Status of power supply in Afghanistan

Domestic production  -  454 MW
(Hydro & Thermal)
11 HEPPs  -  253 MW
Thermal plants  -  ~60 MW
Imported power  -  ~64 MW
(Imports from 3 Northern neighbors)
Planning aspects generally cover the following areas.

- Identification of sites
- Assessment of power potential
- Environment and social aspects
- Topographical survey
- Hydro-meteorological investigation
- Geological investigation
- Construction material survey
Planning aspects – Identification of sites

- Small hydro is site specific

- Type of schemes
  - Run of the river
  - Canal drops
  - Dam toe
Run of the river SHP Scheme
Run-of-the-river schemes normally utilise the head and discharge of hilly streams, which uses water within the range of the natural river flow and generally has no reservoir or pondage to regulate the river flow. The components may include, Diversion weir; Intake structure and desilting chamber; Water conductor system; Fore bay with surplus escape; Penstock; Power house; Tailrace channel; Switchyard & transmission arrangement.
Schemes on the canal falls are located on existing or proposed irrigation channels utilising the canal discharges and head created by falls, to generate power. Two or three falls could be combined and aggregate heads utilised in a single power house.
- **Dam toe power house** utilises the head of an existing irrigation dam/barrage. These scheme have a relatively big reservoir that stores water in the rainy season and release it in the dry season.
Reconnaissance Study

Data Collection (Basic Reference Materials)

- **Topographic maps (Minimum Requirement)**
  - Detailed maps with a scale of at least 1/50,000
  - Landform, location of villages, slope of river, catchment area of proposed site, access road

- **Rainfall data**
  - Monthly and annual rainfall data of adjacent areas
  - Isohyetal maps

- **Hydrological data (Minimum Requirement)**
  - River discharge data from the adjacent areas

- **Socio-economic information**

- **Others**
  - Climate map
  - Distribution line map
  - Existing proposal from local government and residents
Assessment of Power Potential

- Power potential is the product of available head and quantity of water at any point of time and is determined by using the following formula:

\[ P = 9.81 \times Q \times H \eta \]

Where,
- \( P \) = Power output in kW
- \( Q \) = Discharge in \( m^3/s \)
- \( H \) = Head Net head
- \( \eta \) = Overall unit efficiency (0.75 to 0.9)
Hydrological Data and Flow Prediction

Flow Prediction Using Area-Proportion Method

- If there is an existing measuring station along the same basin of the potential sites, we can translate the river flow data at the measuring station to that at the potential sites.

\[ Q_A = \frac{A_A}{A_E} \times Q_E \]
Planning aspects – Hydro-Meteorological Investigation – contd.

- For Canal drop and Dam toe hydroelectric schemes:
  - Historical data on hydrology & other information to be gathered from the project authorities.
  - At least two years discharge data (observed) is required for small hydro.
Geological Investigation

- Minimum geological investigation for medium and high head schemes should be carried out:
  - Diversion structures
  - Power channel
  - Penstock
  - Power house
Structural Components

- **Weir and Intake**
  - **Weir:**
    - Obstruction in the river to raise the water level to divert water to the headrace
    - May not Require a high dam or a big reservoir
  - **Intake:**
    - Structure to take water from the river
Structural Components

- **Settling Basin/Desilting Tank**
  - A pond to collect and flush out sediments and other suspended materials
  - To prevent suspended materials from entering the waterway and eventually the turbine
  - It is sometimes omitted in cases where inflow sand and soil is minimal.
Structural Components

- **Headrace Channel**
  - Conveys water from the intake to the forebay.
  - Usually an open canal made of concrete, but sometimes it is made of soil and/or pipes.
Structural Components

- **Forebay (Head Tank)**
  - A pond-like structure at the top of the penstock to regulate fluctuations in the water.
  - A spillway/surplus escape may be connected to the forebay.
  - It also functions as a final settling basin for suspended materials in the water.
Structural Components

- **Penstock**
  - A pipe to convey water under pressure from the forebay to the turbine
  - A steel pipe in the case of high pressure
  - Hard vinyl chloride pipes and FRP in the case of low pressure

- **Anchors & Saddle blocks**
  - Anchor blocks are provided at every bends and near expansion joints
  - Saddle blocks are provided near every pipe joints
Structural Components

- **Powerhouse**
  - A shelter for the electro-mechanical equipment (turbine, generator, controllers and panels)
  - Sufficient space for dismantling the equipment during repair and maintenance activities is to be provided
Electro Mechanical Equipments

**Turbine & Generator**

**Turbine:**
- Converts the water flow energy to rotational power.

**Generator:**
- Generates electricity from the rotational power of the turbine.
2 jet horizontal Pelton turbine

(High head application~100m+)
Vertical Pelton Turbine (5 jets)
Vertical Francis Turbine
(Head range 30m-100m)

Vertical Kaplan Turbine
(Head range 2m -30m)
Cross flow turbine
(Head range 10-40m)
Micro Cross flow turbine
(Cross section)
Test bed
Structural Components

- Switch Yard
  - Grid Connected
  - Stand alone Type
2x55kW MHP commissioned @ Mankulam by EMC
Decentralised power generation

- Isolated areas
- Too far from electricity grid
- Non grid connected TG systems
- Thru Local Govts./NGO/ Private participation/ Cooperative model
MHP in Afghanistan

60kW Micro-Hydropower Plant funded by USAID brings Electricity and Economic Growth to Dodarak Village
1,200 residents gain access to electricity for the first time.
Jalalabad, Afghanistan  |  Friday, May 15, 2009
THANK YOU