The results from three small schemes in three different continents
How can Small Hydropower Stimulate Local Economy

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Content

- The Riksheim hydropower development on the Norwegian West Coast, 90 years since commission
- The Kaziba hydropower scheme in the Kivu province in the Democratic Republic of Congo, 10 years since commission
- The Tangir hydropower scheme in Pakistan Himalaya, Gilgit District, 10 years since commission
- The present small hydropower strategy in Norway
The Riksheim Hydropower scheme

- Developed in several phases. Phase 1 (450 kW) commissioned in 1917

- Drivers for construction were increasing electricity demand from small workshops and the need to create more jobs

- Rural electrification included to utilise surplus energy and enhance budget constraints
Organisation and planning for the future

- The Sykkylven Municipality organised a committee to plan, finance and construct the hydropower plant
  - Registered demand from industry in 1915 was 120 kW,
  - Estimated electricity demand from industry and the population in 1925 was 600 kW

- The Municipality decided to construct a 450 kW plant
  - Local companies and workforce strongly involved in construction, which was hampered by limitation in available technology and budget
  - The intake and penstock was designed for a 2 MW plant, and already in 1920 another turbine of 750 kW was installed.
Financing

- The plant was financed by the Municipality after they received strategy loan from the Norwegian Government.

- Introduction of a programme to use and make money on the surplus power:
  - substitute kerosene oil for light with electricity

- To meet operation cost, budget constraints and need for new capital for upgrading the plant, tariffs were gradually increased. The tariff increase was not an easy task because many costumers had problem paying the bills.
The Riksheim power station the heart of the community

- Development of employees in the industry
  - 1930: 140
  - 1987: 1600, which is 1/4 of the total population in Sykkylven.

- The furniture industry has been the most expansive, and today it exports to several countries in Europe as well as the USA, Australia and the Middle East.
The Kaziba Hydropower Scheme, Kivu Province, Democratic Republic of Congo

Kaziba power station

Kaziba Hospital

The Luzinzi River

Kaziba power station

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Available electricity in the “old” days

- Three diesel-units with a total output of 50kW secured the electricity supply in emergency periods.

- Normally they could afford to run one 6 kW diesel unit three evenings during a week.

- The other evenings they had to rely on solar energy, which did not supply the hospital with more electric energy than for basic light.
Benefit during construction

- A classical example of long lead time for a hydropower scheme
  - 8 years development
- 150 families had income in intensive construction periods
- The workers got training in carpentering, concrete reinforcement, concrete mixing, tool repairs
  - They got jobs in other construction work afterwards
- Strategy for training of operators included from day 1
Benefit during construction

- Women also made money by supplying most of the sand for the concrete work for the dam, part of the feeder channel and the power house. Here they are paid by the coming manager of the power station.
The 125 kW Kaziba Hydropower plant

- The plant is designed to meet variation in head and water flow in the river
- To achieve this flexibility a double Francis turbine was chosen

The belt has the same function as a gear and allows for a cheap and low weight generator
The Kaziba Hydropower plant

- The available head is 6.8 m, but during flood tail water will rise more than the head water.
- The 125 kW turbine is a double Francis and with a draft tube it can always utilise the available head between the headrace and tail race channel.

- The double Francis is very flexible to variation of flow, and can be operated between 10 and 100% of capacity.
- The belt has the same function as a gear and allows for a cheap and low weight generator.
Taking care of flood and sediments

The intake, the 350m head race channel, power station and 150 m tail race channel are designed for floods up to 150 m$^3$/s by river training works in the river bed. Average flow in the dry season is 1 m$^3$/s
Reliable electricity – new options

- The local inhabitants made money during the years of construction and had also hope of electricity supply for their homes.
  - 3 villages and 200 houses has been connected for basic light
  - The market place got light
- Part of the electricity consumption in the Hospital was planned to be during night time to allow for selling more electricity to:
  - Households
  - Small workshops
Lessons learned

- Use of appropriate technology does not mean that the technology is old. It will normally result in longer lead time, but benefiting a local workforce and also training for operation.

- The benefits from a scheme can only be seen after the completion.
  - The power station has been in operation during periods of war, and at a time when the trained operators had none to consult to solve problems. The plant is still in operation, and supplies the Hospital with cheap and reliable electricity.
Lessons learned

- Selling electricity to nearby villages introduces constraints, which can be difficult to handle.

- Our experience is that the villagers should approach the plant owner as a group and buy electricity as a group. Any purchasing of materiel must be the group's own responsibility. It is also their responsibility to maintain their system, and to distribute the electric power that is available for them. The plant owner can give the necessary professional assistance.

- The tariff can successfully be compared to the alternative cost of getting light from kerosene.
The Tangir Hydropower Scheme, Pakistan Northern Areas

- The Northern Areas of Pakistan includes some of the highest mountains in the world.
- Snow melting is the main source for runoff in rivers, and most rivers have severe sediment loads, which effectively reduces lifetime of turbines.

- There was a desperate need for an electro-mechanical maintenance workshop and skilled workers to keep the electricity supply reliable.
- Norway and Pakistan entered into a programme in 1989 for reliable small hydropower generation to meet electricity need. The programme included a maintenance workshop, upgrading of existing small plants and construction of one new plant.
The Tangir Hydropower Plant

- Identified in 1989 and commissioned in 1996.
- The Tangir river carries little sediments
- The installed capacity is 1.2 MW, but the intake, feeder channel, penstock and power house is prepared for another 1.2 MW unit.

- A maintenance workshop has been established in Gilgit town 4 hours drive from Tangir. It is designed to repair 8-10 power stations annually. When time come and repair is necessary, the Tangir plant will also benefit of the workshop's service to secure reliable power supply
Benefits of the hydropower implementation

- The head race channel secured irrigation water so more land than was lost for construction could be developed.
- Before the plant only ¼ of the population of 30,000 had access to electricity, but with extensive power failures and load shedding.
- Today 100% have access to reliable electricity supply.
Electricity improved health

- Today, firewood is still the main source for cooking and heating, but electricity has substituted kerosene for light.

- Electricity has become an important secondary source for heating, and for cooking.

- These changes are related to the introduction of the Angethi stove, which reduces use of wood considerably.
  - The new energy technology has made life more pleasant for Tangiris, especially the women.
Benefits of the hydropower implementation

- The electricity has facilitated everyday life of women in various respects. Since women spend more of their time indoors than men, they reap the main benefit of the "clean energy". Electric light as well as the closed Angethi oven are more gentle to eyes and throats of those who spend time indoors than the old kerosene lamp and the open fireplace.
Benefits of the hydropower implementation

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- The first mission report for the hydropower programme expressed: “electricity will improve the standard of living by reduction of open fires in the houses, as soot and smoke from lights and open fires are a major source of inconvenience”. This has been fulfilled.
Benefits of the hydropower implementation

- The operation of the plant can benefit from experience gained over decades of channel construction and the direct use of waterpower for flour mill operations.
- New fodder mixture can be introduced in agriculture.
  - The new electricity supply has made it possible to introduce alfalfa in the Tangiri farming system, so agriculture will become more profitable and sustainable.
The hydropower project and local economic growth:

- 60 new saw mills put in operation

- Existing small-scale manufacturing of furniture in Tangir are expanding and new workshops are developed.

- The saw mills and the carpentry adds value to a local resource (timber), which was formerly exported in a raw form.
  - In a local development perspective, any value added produced in this way should be appreciated.
  - Pick-ups filled with tables and chairs ‘made in Tangir’ are heading for markets in nearby towns.
Norway's Small Hydropower Strategy
The Strategy for Small Hydro

- The Norwegian definition of small hydro are hydropower with capacity less than 10 MW

- Why a strategy
  - Need to improve Norway's Power Balance
  - Generate more electricity from renewable resources
  - Option for Local Industrial Development
  - Prosperity in rural Norway
The Strategy for Small Hydro

Tasks

- Improve knowledge on the potential for small hydro
- Improve licensing procedures
- Reduced tax
- Evaluate option for an electricity certificate market or other support systems
- Guidebooks from NVE
- Pilot projects in selected municipalities
- Competence building
- Strategy budgets in NVE for R&D projects. 54 R&D projects in progress
Small hydropower plants have a prosperous effect in rural Norway

- Being an owner of a small hydropower plant where state of the art are used in planning, construction and machinery, the farmer can still have time for farming and operate the electricity generating plant by his cell phone.

- Help conserve the landscape we like to see as tourists.
Information to Stakeholders

- NVE has produced a guidebook for the inexperienced hydro developer guiding him on the initial planning, the licensing, financing, construction and operation phase.

- NVE carried out 23 seminars in 2004 and 2005 highlighting small hydro options and constraints. Total 2500 participants

- First seminar 2006 Monday 13th of March: 250 participants
Environment

- The landscape
Small versus large hydro

- 500 GWh could be produced by one large hydro
- 500 GWh can be produced by 100 one MW schemes
- The sum of many small schemes may have more severe environmental impacts than one large
- Small hydropower also need reservoirs. Run of river plants depends on others with reservoir capacity
Number of small hydropower plants in operation

Year

1929 1946 1990 2005

Number of plants

Below 1 MW
1-10 MW
MAIN CONCLUSIONS

- Projects should be constructed in areas with documented potential for economic growth and option for rural electrification.
Small hydropower a driver for local economic growth:

- The generation must be reliable.
- The operation and maintenance is highlighted, and cost included in the tariffs.
- Cheap loans are necessary to establish a small hydropower plant since all investment is in day one, while the income to meet repayment of loan is spread over many years.
- In a developing society the electricity generation must be looked upon as the means for other activities, not as an income option alone.
Want to learn more?

Please visit booth no 1310, entrance A

Thank you for your attention

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