Austrian Development Co-operation

Evaluation of

Small Hydro Projects in Namche Bazaar (Nepal) and Rangjung (Bhutan)

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1. EXECUTIVE SUMMARY

1.1 Background

Small Hydro development has been recognized at an early stage to be of considerable importance to the Himalayan kingdoms of Nepal and Bhutan, since no other natural resource is known in these countries of comparable abundance. Electricity from natural resources such as hydro constitutes an environmentally acceptable and a reliable resource. Its utilization is generally considered economic in the long rather than the short term.

Austria has been a key player in the early stages of rural electrification in both, Nepal and Bhutan. After more than 20 years of involvement in the sector, it desired to evaluate its own work. The assignment to carry out such evaluation was awarded to an outside consultant in a competitive process, and the present report is the result of the work done under this assignment.

1.2 The Namche Bazaar Small Hydro and Rural Electrification Project

1.2.1 Introductory remark

The Namche Bazaar project, as defined by the Austrian input, is much more than a small hydro plant. It includes high tension transmission, the entire distribution network and house installations, as well as training of personnel and institution building. Also, a reforestation component and drinking water supply system have been added. Thus, it constitutes an autonomous rural electrification project in which Austria has been involved almost 25 years, and has taken almost complete responsibility during a time period of more than 15 years.

1.2.2 History

The beginnings of the project reach back to 1976. The first power scheme was initiated by the Austrian export industry, with the objective to establish a scheme for reference purposes. It was initially agreed that Austria would provide the electro-mechanical equipment, whereas from the Nepalese side, costs for all construction was to be taken over. However, the Nepalese government found itself unable to meet total construction costs. Detailed planning was concluded in 1979, and construction started after the signing of an agreement between Austria and His Majesty's Government (HMG) in 1983. However, in August 1985, the construction site at the Bhote Kosi was completely destroyed by a Glacial Lake Outburst Flood (GLOF) that originated from the Langmoche glacier. A feasibility study was later commissioned on the basis of a new site, and the new power scheme was implemented between 1988-1994.

An agreement was formulated in 1994 between the Austrian government and HMG with the objectives to establish a share holding company for the operation of the scheme. Training of personnel had started much earlier. 12 young men were trained, who today constitute the work force of KBC. In the institution-building task, the NGO Eco-Himal, on behalf of the Austrian government, was involved for a period of more than 6 years, up to the end of 2000. During the same period, design flaws of the scheme were rectified as far as possible, to improve operational reliability.

1.2.3 SHP Namche Bazaar Project Status by the end of 2000

Today, the electricity company KBC operates the scheme all by itself. The company has now five years of experience in power generation, transmission and distribution, with related tasks such as maintenance and associated administration. The area within the reach of the project is fully electrified. A population equivalent to about 3'000 permanent inhabitants is served.

Consumers benefit from very reliable electricity at low cost, and technical installations are of a high standard of safety. The acceptance rate of electricity has been 100%; all households within reach, except for three, are connected.

The level of wood substitution achieved is about 30%.

Economic activity is tourism oriented to a large extent. Businesses are almost always family-based, with supplementary labour hired if necessary. The most prevalent commercial activity is the small shop or lodge. Some new ventures are totally electricity dependent, and have arisen as a direct impact of the project.

1.2.4 Evaluation Results

- To plan and implement the Namche SHP was a very ambitious undertaking, given the extreme remoteness and climate of the project site, and practically from the beginning a difficult and strained relationship with partner institutions. In this situation, the achievement is considerable. The Austrian agency for Development Co-operation has shown persistence in bringing the project to a successful end.

- Despite the fact that the beginning of the project dates back to times when Austrian Development Co-operation principles and objectives were not yet firmly established, the approach over time reflects serious adaptation to today's objectives.

- Interventions from the Austrian side always had effectiveness as an objective. For the most part, effectiveness was achieved, but in some cases, contractors that were engaged failed to provide top-quality service, especially in the area of design, equipment supply and installation.

- The efficiency of utilisation of funds is difficult to assess: Taking the extreme remoteness and the altitude of the Namche SHP site into account, its cost are favourable when compared with another project example. In absolute terms, costs were exorbitant, at a level of more than 8'300 US$/kW[1] of installed capacity, including transmission and distribution networks. Total spending, including the institution building task, training and coaching, amounted to ATS 83.2 Million.

- In implementation, Austria has practically gone all the way alone, after attempts in the area of partnership and local participation had failed. There is not much evidence that considerable donor coordination, local participation and effective partnership with national government or non-government institutions took place. A certain degree of isolation was evident during the early construction phase, not in the least due to the extreme remoteness of the project site.

- While both sexes unequivocally enjoy having and using electricity, it has probably contributed most to improvements in the quality of women's lives.

[1] An exchange rate of 13 ATS for 1 $ was used.

- As regards the environmental impacts, the outcome of the Thame hydro project has been successful. There is no “dry river bed situation” during any period of the year, as a direct impact of the scheme, and scars from construction have disappeared due to a major reforestation effort.
- A positive environmental impact has been achieved, as planned, by the partial substitution of firewood by electricity for heating and cooking.
- The Namche SHP functions well under the management of KBC, despite a number of remaining flaws in the design and quality of civil structures and installations. KBC is technically capable and motivated to maintain and operate the scheme.
- Sustainability may be judged by the success of KBC. In financial terms, the operation is still critical. It has not been possible to develop the load factor to its maximum, and income from electricity sales is still insufficient. Depreciation, the main financial instrument to build up reserves and thereby attain financial sustainability, has not been possible at all so far.
- On the basis of audited accounts up to 1999, the cash flow that KBC generated was largely insufficient. However, in the most recent financial year ending in mid-July 2000, net surplus has increased by more than 300%. This is thanks to tariff restructuring that became effective on 17 July 1999. KBC must increase its net earnings still by a factor of 3 to 4 to achieve full financial independence and sustainability. A further step in this process has been taken by restructuring tariffs and user levels again, effective from 16 December 2000.
- Sustainability may also be judged by the stability and quality of KBC as an institution. KBC appears to be well established and well run on the operative level. On the level of strategy and long term business development, it lacks active leadership.

1.2.5 Lessons Learned for Sector Policy Development

Impact level

Electricity supply to rural areas can assist development activities and can substantially improve living conditions. In Namche Bazaar, numerous economic development opportunities have opened up on the basis of electricity and the growing tourism industry.

Small hydropower is the most effective means of electricity supply in remote rural

The example set by Austria with the Namche SHP was adopted at the national level. The Ninth Development Plan largely mentions the principles of the Namche institutional set up as the formula for future remote rural electrification.

Negative environmental impacts were kept in check, mostly by the reforestation activity which became a part of the project.

There is a positive environmental impact of the project in terms of fuel wood substitution at the household level and in the tourism industry. A still greater impact is possible by measures on the consumer side, such as energy saving and energy efficiency efforts.

Policy level

New interventions bear a lot of risk in terms of commitment required

The interventions for the implementation of the Namche SHP have been new in terms of current activities of the BMfaA at that time. The original intention for the project (to build a small hydro scheme) was very different from what the BMfaA ended up with after almost 25 years of interventions. The lesson learnt is that projects of such complexity as remote rural electrification require persistence and the means to see the intervention through.

A comprehensive and multi-level approach is advisable

A considerable number of other small hydro schemes in Nepal (and elsewhere) are today on an institutional basis that is by far not as solid and sustainable as the Namche Bazaar scheme today proves to be. To achieve this better result, Austria had to make inroads into areas such as local ownership and institution building. The lesson learned is: Interventions that have a significant impact need to be comprehensive. Interventions cannot be limited to the level of the project but have to be extended to the policy level.

The time required to achieve success is often underestimated

The time requirement for interventions in the areas of infrastructure and institution building cannot be stressed enough: The intervention in Nepal carried on for almost 25 years. Other examples show that significant results require 10+ years.

Considerable human and material resources are required

The previous lessons make it clear also that considerable human and material resources are required.

Setting priorities

Looking beyond the Namche Bazaar project, at the entire sector, it is relatively easy to conclude broadly that the Namche SHP, perhaps on a par with the Swiss Salleri SHP are among the “best” in the country. Both interventions were of a long term and comprehensive nature. Other donors have tried superficial interventions. Since resources are likely to be scarce, and on the basis of the negative experience of others, interventions of a long term and comprehensive nature should take precedence over short-term and superficial interventions,

Project Steering level

Context appropriate decisions and flexibility

Flexibility and openness to new issues coming up has been a constant feature of the interventions, and this was necessary to achieve project success. The lesson: Flexibility will be required to be able to act appropriately in the specific context.

Effectivity: Streamlined procedures and short reaction time

Most of the time-delay factors are outside the sphere of influence of the donor. The only area where the BMfaA can possibly make a difference is by streamlining its administrative procedures as far as possible, and by making sure that personnel on the various levels have the capacity to attend to matters on short notice.

Efficiency versus control

In small projects such as the Namche SHP, for reasons of cost, different tasks need to be executed by one single entity. This was done for efficiency reasons. It also resulted in the lack of independent control.

The lesson learned: Improved implementation efficiency bears the risk of less control. It requires competent and trustworthy partners.

Relationship with Austrian suppliers, consultants and others

The award of a supply contract is the basis for the relationship with any supplier. Quality and completeness of specifications determine the scope of supply. The difficulties encountered had largely to do with stipulations that were inaccurate and too general, which could not have been in the interest of the BmfaA.The lesson: It must be assured that contracts are very specific and that tasks are assigned in detail. Independent checking of supply and performance is important.

1.3 The Rangjung Small Hydro Project

1.3.1 Introductory remark

The Rangjung project, as defined by the Austrian input, differs from the Namche SHP in its scope and co-operation pattern. The project is limited to the generation facility. Transmission and distribution lines were not under the responsibility of the Austrian-Bhutanese co-operation. The Austrian supported Rangjung SHP was complemented by a national rural electrification project under DOP, the Bhutanese national utility, which established transmission and distribution lines with ADB and SNV (Dutch co-operation) financing and support. The Rangjung project is thus a fine example of donor co-ordination and integration of multiple inputs under the overall co-ordination of the partner government.

1.3.2 History

The Rangjung SHP project dates back to 1986 when the Austrian Development Co-operation responded positively to a request by the RGOB for assistance in the electrification of Eastern Bhutan. The Rangjung SHP plant with an initial capacity of 1.1MW was planned by DOP to complement the existing Indian-funded mini hydro plants which energised an existing grid of limited extension in Trashigang District. Following feasibility studies and detailed design, actual plant construction was started in 1993 with the Austrian Design Engineer providing site supervision and construction management.

Construction was already well under way when in March 1994 an increase of plant capacity of the Rangjung SHP in view of new frame conditions was deemed necessary. It was decided in August 1994 to double the capacity of the project in view of the low output of the two existing mini hydro plants supplying the isolated Eastern grid and to improve the economics of the Rangjung project. Due to the redesign, the plant was commissioned in January 1996 after almost ten years of joint project planning and implementation.

In 1996, DOP staff had observed considerable abrasion damage on the turbine runners at the Rangjung SHP. The problem was related to an insufficient capacity of the desanding facility whose size was not increased when it was decided to double plant capacity. For resolving the problem in the long run an additional desanding facility on the

headrace and the procurement of two new spare runners was planned. This work, partly funded by BMfaA, is currently on-going. Completion is planned for early 2001.

1.3.3 SHP Rangjung Status by the End of 2000

The Rangjung SHP has been operational for 5 years and load has risen sharply so that during the winter evening peak hours, load shedding had to be introduced in the isolated mini grid of currently 450km length and close to 4000 consumers, mostly rural households. Consumers complain about frequent blackouts and the inconvenience of load shedding. DOP is trying to rectify the situation by installing back-up diesel generators and by accelerating the interconnection with the 60MW Kuri Chhu hydropower plant which should be operational by the end of 2001.

1.3.4 Evaluation Results

- Objectives of the project have largely been achieved thanks to an effective co-operation effort between Austria and Bhutan and an above-average performance of Austrian engineers and suppliers, and the Bhutanese project partner DOP.
- Up to commissioning of the project in 1996, project costs remained within budget which is an outstanding achievement. Rehabilitation and repair work as a result of slope instability and excessive turbine wear increased total project costs by 21% to ATS 86.8 Mio (US$ 7.5 Million.). But even with the unfortunate rehabilitation work, specific investment costs of around US$ 3400 / kW still make the Rangjung SHP one of the most cost-efficient small hydro projects of the developing world built under a co-operation effort.
- The Rangjung project was conceived basically as an engineering undertaking without directly addressing today's chief objectives of Austrian development co-operation such as poverty alleviation, environmental conservation and gender-balanced development. Electricity supply was assumed to automatically have positive impacts on development.
- The Rangjung SHP supported rural electrification which is a development activity of high importance to RGOB. The project responded to the real needs of the targeted beneficiaries as is evident from the high connection ratios in the electrified villages: on average 40% of households in Trashigang district are connected; connection ratios reach 100% in the vicinity of the transmission lines.
- The technical sustainability of the Rangjung SHP is constantly threatened by floods and landslides, a fact which no design or protection measure will ever be able to fully remove.
- The economic viability of the plant will only be ensured when the Rangjung SHP is connected to the transmission line from Kuri Chhu HEP and an economic use of Rangjung excess power during off-peak periods is possible. Until such time, the Rangjung operation must be subsidised.
- The economics of the project remain modest and the EIRR is only 0.5%. The Rangjung project has thus not achieved the projected EIRR of 5.2% as per project approval documents of 1994. The reason for this lies in over-optimistic energy sales projections for the early years of plant operation and the extensive rehabilitation work.

- But rural electrification in Bhutan is not measured along these economic lines. Not only is electricity considered to be a basic need that has the potential to contribute to improving both the gross national product as well as the "gross national happiness", it is also considered a means to reduce the pressure exerted on the environment from excessive fire wood use.

- The Rangjung SHP project has brought about a significant shift in energy consumption patterns away from the traditional firewood and kerosene fuels to electricity. An electrified household uses about 25% less firewood than a non-electrified thanks to partial fuel wood substitution in cooking and water boiling.

- Consumers are using electricity mostly for domestic purposes, and little productive use has emerged. However, the population in the project area is much more enthusiastic and grateful about the project and its impacts than the economic and social indicators would suggest.

1.3.5 Lessons Learned for Sector Policy Development

Impact level

- If given sufficient time to get fully operational, electrification projects do have a positive impact on social development since electricity is linked to modern life and it has thus the potential to change the attitudes of the rural population.

- Quite to the contrary of expert opinion, a positive environmental impact of rural electrification in terms of fuel wood substitution at household levels can take place. In Rangjung this is due to the DOP strategy of providing high-powered connections at tariffs below generation costs.

- Economic development takes off on a slow pace following electrification of the project area as there is – in the case of Rangjung - only a limited number of economic niches available that can thrive through the use of electricity.

Policy level

- Human resources development (HRD) has been the most effective intervention that generated effects beyond the Rangjung project proper. But the training measures implemented are not comprehensive enough to substantially reduce the Bhutanese dependence on foreign expertise in small hydro development.

- The Rangjung project has successfully brought about a shift in Bhutanese project implementation concepts. Initially conceived as a turn-key project, the Rangjung SHP project was gradually converted into a partnership approach. The lesson learned is that development co-operation must interfere in partner concepts and believes in order to contribute to development and change.

- Sensitive, process-oriented issues and policy development can only become components of co-operation when credibility has been achieved through successful (hardware and input-oriented) projects such as the Rangjung SHP.

Project steering level

- BMfaA's in-house project steering and management - though time-consuming - proved to have the right pace for a development co-operation project. It allowed

the BMfaA to thoroughly consider development co-operation principles and objectives in all its decisions.

- When introducing a technology (small high-head hydro) into a new environment (the Himalayas), the quality of the design work can only be assured through regular independent reviews by other experts. Such “second- opinion” consultation should be an integral part of the project set-up right from the start and not only when failures have occurred.

1.4 Overall Comparison of Both Projects

1.4.1 Project Features

Project feature	Rangjung	Namche Bazaar
Intended power supply	To mini grid	Stand alone
Plant capacity	2.2 MW	0.63 MW
Plant type	High head, run-of-river	High head, run-of-river
Power transmission & distribution line length	450 km	13 km
People served (capita)	23’000	3’000
Installed capacity per capita served	0.1 kW	0.21 kW
Transmission distance per capita served	19.6 m	4.3 m
Total cost to Austria (ATS)	86.9 Mio	83.2 Mio
ATS per kW installed (power plant)	39’500	54’600
ATS per kW installed, incl. Transmission + Distribution	n.a.	132’000
ATS per capita	3’780	27’730

Figure 1: Technical and cost data for Rangjung and Namche Bazaar SHP

Technically speaking the two schemes are of the same type and both belong to the small hydro size range. Capacity-wise, Rangjung is about 3.5 times larger than Namche.

1.4.2 Achievement of Austrian Development Assistance Objectives

The question is which one of the projects have better served Austrian development co-operation objectives? The answer is that considerable achievement has been possible in both projects, but in different ways and on different levels.

While Rangjung significantly contributed to reaching Bhutanese rural electrification targets (physical infrastructure development), the Namche project stands out in terms of institutional model development in rural electrification but does little to physically improve rural electrification ratios in Nepal. This difference in achievement is a result of the different paths that the projects have taken through their long histories. Both pro-

jects assumed a pioneering role in establishing the Austrian development co-operation in the partner countries. Despite the different routes, both approaches proved to be relatively successful in terms of achieving development co-operation objectives:

- Project ownership has been achieved in both projects but at different levels;
- Sustainability is assured in both projects if certain conditions are fulfilled in the future

Intended beneficiaries as well as the environment have benefited in both projects but at different scales and depths.

1.5 Conclusions

From an engineering point of view, both projects have been implemented successfully, despite remaining design and implementation flaws. In the case of the Namche Bazaar SHP costs have been exorbitant. Overall, the efficiency of spending money appears to be better in the Rangjung project.

In Namche SHP, sustainability is directly in the hands of the beneficiaries. In financial terms, KBC has not achieved sustainability so far, but it is on a good course. The Rangjung SHP is under national ownership. Its sustainability does not depend on local initiatives but is determined by the strategy of the national government. The sustainability of the Rangjung SHP is threatened as soon as it no longer fulfils a vital role in electrifying Eastern Bhutan.

Both projects assumed a pioneering role in establishing the Austrian development co-operation in the partner countries. Despite the different routes, both approaches proved to be successful in terms of achieving development co-operation objectives. Environmental concerns are successfully addressed by both projects, mainly due to successful (but only partial) fire wood substitution. Social issues of gender equality and poverty reduction were not explicitly addressed in the implementation of the projects. However, it has become apparent that women, who are generally in the role of housekeeper, benefit more from electricity than men while economic opportunities are slightly more favourable for men.

The Namche SHP is one of the first examples in Nepal of private sector and community ownership in rural electrification. It is a successful pioneering project in this respect. The model developed in Namche Bazaar has implicitly been adopted for remote rural electrification in the 9th Development Plan of HMG. The Rangjung SHP was used by the Bhutanese partners to reduce the massive Indian dependence in the power sector.

In Namche, on a local level, the acceptance rate of electricity has been 100%. The same rate has been achieved in Bhutan in all areas within reach of the grid powered by Rangjung SHP. Human resources development (HRD) and concept development have been the most effective interventions that generated effects beyond the projects. Training measures implemented under the Rangjung and Namche SHP were mostly on the level of operational staff.

Development co-operation must be willing to interfere in partner concepts and believes, in order to contribute to development and change to the general benefit of the population and the environment. Sensitive, process-oriented issues and policy development can only become components of co-operation when credibility has been achieved through successful (hardware and input-oriented) projects.

1.6 Recommendations

1.6.1 ÖEZA Sector Policy

Small hydropower development should remain the general theme of Austrian assistance to the energy sector not only because of Austria's comparative advantage and the experience in the BMfaA with this technology, but more so because of the inherent potential of small-scale hydro electric development to induce change at the target population and its many inter-linkages with the environment, the economy and the service sectors as well as its positive impact on gender balanced development.

In concrete terms, the Austrian energy sector policy for Nepal, could manifest itself in the following:

- Co-ordination with HMG and other donors in the energy sector on balanced subsidy policies;
- Capacity building at meso and macro levels to further develop and disseminate the concept of community-owned hydropower and democratic rural electrification development;
- Development of technical concepts that enable a gradual adaptation of power supply to the growing power demand of communities and avoid establishing large capacity reserves during the early project stages;
- Capacity building in the field of project finance in collaboration with administrators of power development funds (to be provided by the World Bank and KfW, Germany), private investors and banks as well as GEF funding where applicable.

In Bhutan, the Austrian sector policy could be substantiated through the following:

- Development of decentralised organisational and management concepts for small-scale hydropower and rural electrification schemes in remote areas of Bhutan, suitable to reduce costs for DOP. Make maximum use of the Namche experience;
- Assistance to the development of the legal and administrative framework for the above decentralisation concept at national level;
- Capacity building for rural electrification and rural energy development planning at national level;
- Skills development at local private consultants in the field of plant design and construction;
- Capacity building in the field of project finance including the bundling of projects and funding agencies to increase financial volume and to reduce transaction costs respectively.

In both countries, co-operation on conceptual issues and capacity building will only be accepted by partners if funding support for physical infrastructure deployment is provided through Austrian facilitation. This need not and should not be pure grant financing for demonstration projects but should include loan funding, GEF contributions and private investment with guarantees by the donor. It is further recommended that the following aspects be observed when implementing the above policies:

- Comprehensive interventions will require a commitment for a long-term engagement where results cannot be expected within a two to three-year period but rather after five to ten years of co-operation.
- Administrative procedures of the Austrian development co-operation should be streamlined and given sufficient specialist resources such as for example through regular independent reviews of project designs and interventions.
- Regular collaboration and networking between Austrian partners in the two countries as well as with national and regional institutions and associations working in the same fields is imperative. Appropriate forums must be supported to this effect.

1.6.2 Regarding the Namche Bazaar SHP

A number of recommendations have been formulated in section 6.1.3 to provide an input, based on the evaluation results, to make still further improvements in:

- Organisational structure
- Operation and maintenance of the scheme
- Revenue development
- Accounting practises
- Strategic thinking about future developments

1.6.3 Regarding the Rangjung SHP

- Provide engineering support in rectifying the poor reliability and safety of supply from the Rangjung SHP and associated transmission and distribution grid;
- Maintain a residual flow in the by-passed section of the Karthiri River in order to reduce the negative impacts on the aquatic life, especially when continuously supplying maximum capacity to the Indian market;
- Make sure that a well-elaborated and easy-to-use maintenance plan (e.g., computer-based) is adhered to by Rangjung powerhouse staff and that a spare-part inventory is established.
- Improve recording and accounting of electricity generation and sales so that system losses can be evaluated and ultimately be reduced.

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LIST OF ABBREVIATIONS AND ACRONYMS

ADB	Asian Development Bank
AFC	Austrian Federal Chancellery
ATS	Austrian Shilling (currency)
BMfaA	Austrian Federal Ministry for Foreign Affairs (succeeded AFC in handling Austrian development co-operation in January 1995)
DOP	Department of Power, Ministry of Trade & Industry, Bhutan
Dzongkhag	District in the Bhutanese administrative system
EIRR	Economic Internal Rate of Return
ESSU	Electricity Supply sub-unit
ESU	Electricity Supply Unit (sub-entity of DOP Bhutan)
GEF	Global Environment Facility
Gewog or Geog	Block in the Bhutanese administrative system
GLOF	Glacial Lake Outburst Flow
GWh	Energy Unit 1'000 MWh = 1'000'000 kWh
HRD	Human Resources Development
HMG	His Majesty's Government (of Nepal)
IPP	Independent Power Producer (private sector generation)
KBC	Khumbu Bijuli Company Pvt. Ltd.
kW	Kilowatt = 1000 Watts, Power Unit
kWh	Kilowatthour, Energy Unit
MW	Mega Watt, Power Unit = 1000 kW
MWh	Mega Watt Hours, Energy Unit = 1000 kWh
NEA	Nepal Electricity Authority
Nu	Bhutanese Currency (at par with Indian Rupee)
NGO	Non-Government Organisation
NRs	Nepalese Rupee
RGOB	Royal Government of Bhutan
SHP	Small Hydropower Project
SHPD	Small Hydropower Directorate of NEA
SNP	Sagarmatha National Park (in the Everest/Namche area)
VDC	Village Development Committee (Nepal)

2. INTRODUCTION

2.1 Background

Hydropower is one of the most important resources for the ecologically sensitive Himalayan region both from the point of view of environmentally compatible energy supply as well as for the export market and the improvement of trade balances of Himalayan countries. The development of hydropower as a renewable energy source has been the cornerstone of Austrian Development Co-operation in Nepal and Bhutan. The Austrian aid budgets to the sector have been considerable over the last 15 years.

Figure 2: Location of ÖEZA Projects evaluated, on the Indian sub-continent

The Austrian engagement in the hydropower sector is embedded in today's main focal points of development co-operation such as poverty alleviation and resource protection. However, the Austrian projects are also characterised by the transfer of specific Austrian (hydropower) know-how and by Austrian economic interests.

2.2 Objectives and Scope of the Evaluation

Despite the extended support to the Nepalese and Bhutanese energy sectors by the Austrian Government, the usefulness and the impact of the 15-year long Austrian engagement has never been evaluated. A verification of the project achievements and the main project impacts was therefore overdue and a contract for an evaluation was awarded to ENTEC AG, Consulting & Engineering, Switzerland in September 2000. The main purpose of the evaluation is to quantify the relevance, the impact and the sustainability of the Austrian contribution and assistance to the sector. It is expected that the evaluation derives a number of policy guidelines for future interventions of the Austrian Development Co-operation in the energy sector.

The evaluation comprises three distinct areas of study:

- A qualitative and quantitative evaluation of the planned interventions, the achievements during project implementation and its impact
- The degree of sustainability of the mini hydro projects as achieved by the Austrian interventions and their complementary measures
- The suitability and acceptability of the policies, procedures and structures devised and implemented in the course of project implementation

The scope of the evaluation includes document study, key-informant interviews and field surveys of short duration for data collection and verification. A scientific assessment and evaluation of the main socio-economic and ecological impacts has not been undertaken due to budgetary and time constraints. Field surveys were conducted in October 2000 (by local experts using questionnaires) and in November / December 2000 (by international experts).

2.3 Methodology

Based on the specific questions of the terms of reference compiled by the BMfaA, a set of evaluation criteria and associated indicators have been defined (see Annex 1). The qualitative information and quantitative data required by the indicators have been gathered through document study, key informant interviews and field surveys at the power plants, the surrounding environment and at the districts connected to the power plants (see Annexes 5 for the questionnaires used and 6 + 7 for raw survey results of Namche and Rangjung respectively).

The results of the surveys and investigations were then compared with the stated targets in the planning documents and/or with the results and achievements of other programmes in the energy sector which are considered as the benchmarks and the best practice of the "industry". The analysis of the results, why the targets have been reached or not, why the Austrian projects did better or worse than the programs considered as "best-practice" was the main subject of the work. A number of instruments and methods have been used for the analysis:

- Project phasing: The projects were structured for the analysis work according to the various phases of the Austrian interventions which had led to particular decisions and processes (project identification and appraisal, project implementation, etc.). Key informants from Austria as well as from Nepal and Bhutan have been selected based on these different phases and milestones of achievements and decisions taken.
- Logical framework matrix: stated objectives, activities and expected output of the projects have been brought into a causal relationship. The matrix provided a way of checking whether the projects had been well designed and thought out and whether the expected outputs and impacts have been achieved.
- Institutional map: The relationship between the various organisations and institutions involved in the project are shown graphically. Such presentations provided a means to quickly gain an overview on who played what role and whether the Austrian intervention was targeted at the right levels and organisations to achieve the objectives.

The evaluation was carried out by a team of three international consultants with engineering, economic and socio-cultural backgrounds. This team was assisted on the one hand by local small hydro and social survey specialists in Nepal and Bhutan and on the other hand by a pool of experts at the home office of ENTEC, who were consulted for

specific know-how and “best practice” information in the fields of rural electrification, environmental impact assessment, institutional analysis and policy issues.

2.4 Project terminology used

Hydropower development is often referred to as Pico Hydro, Micro Hydro, Small Hydro, Mini Hydro, Medium Hydro and Large Hydro by the international development community, depending on the size in terms of installed output capacity, beginning from extremely small (around 1 kW for Pico) through Micro (commonly less than 100 kW), to Mini (less than 1 MW), or Small, (less than 10 MW), extending to Medium (up to 30 MW), and Large (above 50 MW). No consistent standard exists when it comes to the definition of the limits of each term. Moreover, other terms, such as Hydel (for Hydro electricity development), and “RE development using Hydro” (RE = Rural Electrification, but also Renewable Energy), are used for the same topic.

To add to the confusion, abbreviations used are commonly PHP, MHP, SHP, etc. MHP may refer to Micro Hydro Power, but also to Mini, and Medium sized hydro power.

In international usage, projects are most often identified by assigning the name of the river being developed to them. If not the name of the river, the name of the village closest to the power scheme site, is used. All this notwithstanding, for the two projects evaluated, the following consistent terms are used:

In Nepal: Namche Bazaar Small Hydro Project, **or Namche SHP**, because: a) it has most often been named like this throughout project history, and b) it reflects the scope of the project better by naming it after the main distribution area, rather than after the relatively small place of Thame, where the intake is situated. Also, Small is the correct translation of the term “Klein”(wasserkraft) used in the German language.

In Bhutan: Rangjung Small Hydro Project, or Rangjung SHP, because: a) it has most often been named like this throughout project history, and b) it reflects the more limited scope of the project, by naming the project after the site of the generating facility rather than the distribution area.

Other terms used: Scheme is a synonym to project, whereas Hydro Plant refers more specifically to the generating facility alone.

2.5 Structure of the report

Chapters 1 and 2 are summarising the results of the evaluation and give general information about the methodology used and the structure followed.

The analytical part is contained in chapters 3 and 4 for Nepal and Bhutan respectively. The chapters begin with the descriptive part, giving facts and figures as have emerged from the data collection and study. The order is chronological, from planning and implementation to the present day status. This is followed by analysis: Answers are given in response to the specific questions of the terms of reference, and in the sequence as given in the terms of reference.

Finally, since the evaluation of both projects has been regarded as a single coherent effort, facts and figures as well as evaluation results are compared in chapter 5. The attempt at applying the same yardstick to both projects has not been entirely successful, because the different nature of the two projects required different emphasis in evaluation. In the view of the authors this could not possibly have been avoided.

Conclusions and recommendations complete the report in chapter 6.

3. SMALL HYDRO PROJECT NAMCHE BAZAAR, NEPAL

3.1 Project History

Figure 3: Relief Map showing the Namche Bazaar SHP project area in the Sagarmatha National Park in Solu Khumbu District in Eastern Nepal.

The project area roughly covers the VDC areas of Namche Bazaar and Khumjung.

3.1.1 Project Identification and Appraisal

Early History[2]

The beginnings of the project reach back to 1976. The first power scheme was initiated by the Austrian export industry and it was based on a Norwegian study which had investigated several sites on the level of pre-feasibility. The objective of this initiative was

[2] From „Projektgeschichte des Kraftwerks Namche Bazaar; DI Hans-Georg Danninger, BMfaA, September 1995

to establish a scheme for reference purposes. From among the sites proposed in the pre-feasibility study, a site on the Bhote Kosi in the vicinity of the village Thamo was chosen. The company Verbundplan of Austria was commissioned with the detailed study for a 650 kW run-of-river scheme.

Negotiations were taken up simultaneously with the Finance Ministry of HMG, his Majesty's Government (of Nepal). It was initially agreed that Austria would provide six turbines with the associated electro-mechanical equipment, whereas from the Nepalese side, costs for all construction was to be taken over. In the course of negotiations, the Nepalese government found itself unable to meet total construction costs. The Austrian contribution was therefore limited to four units of the electro-mechanical equipment, but also expanded to include a financial contribution of ATS 3 Million towards construction cost. An agreement to this effect was signed between the Austrian Federal Chancellery and the Finance Ministry of HMG. At this stage, the Nepalese project partner NEA (Nepal Electricity Authority), had already initiated preparations for construction. Detailed planning was concluded in 1979, and construction started with the signing of the agreement 1980. the company Verbundplan undertook to provide some degree of construction supervision. The final design was submitted by Verbundplan in March 1982, and local construction started at the beginning of 1983. The consultants Posch + Partners were entrusted by the Austrian government to complete all remaining design works and to handle all necessary construction supervision in May 1985. It was estimated at that time, that the project could be completed by the end of 1987.

A natural calamity and a new project site

On 4 August 1985, the construction site at the Bhote Kosi was completely destroyed by a Glacial Lake Outburst Flood (GLOF) that originated from the Langmoche glacier and the Dig Cho lake at its foot, discharging flood water into the Langmoche Khola, a small tributary to the Bhote Kosi further upstream from the project site. The magnitude of the flood was unheard of at that time. Estimates put the flow volume at 2'000 m3/s, while the scheme was designed to withstand a flood of 100 m3/s.[3] It is apparent that any attempt in design and construction would have been futile to cope with such an enormous flood and as a consequence to the damage that had occurred, the site was abandoned. The financial loss to Austria was put at approximately ATS 2 Million. Fortunately, supply contracts for the equipment had not been awarded yet at the time of the incident.

In the course of the investigation of the damaged construction site, a new site was identified. This site appeared more favourable: it was removed from the unpredictable Bhote Kosi, situated on the Thame Khola. Also, in contrast to the previous site, the new site had the potential to be developed as a high head scheme. This appeared to be an advantage, because with a higher head less volume flow is required for the same output, thus also reducing the sediment removal problem.

The Austrian government, not having fulfilled its contractual obligations towards HMG at the time of the natural calamity, felt compelled to further assist NEA. A feasibility study was therefore commissioned on the basis of the new site. This established the techno-economic feasibility and was the basis for an amendment to the agreement with the Finance Ministry of HMG.

[3] Namche Bazaar Hydro Power Development: Outlining proposals for organisation, management and tariff structure, Posch+Partners, Innsbruck, Rev.1, February 1989

3.1.2 Project Implementation

Sharing of tasks between HMG and BMfaA

In the amended agreement of 1986, all tasks were assigned, not only for the construction of the Small Hydro scheme, but also for the transmission lines and the distribution network. NEA was to be responsible for overall project execution, and an Austrian consultant was charged with a supervision function in an advisory capacity to NEA.

Slow progress of construction

Construction began in 1988. Due to cumbersome and ineffective procedures[4] of awarding contracts, numerous delays occurred. Some of the contractors, lacking work experience under extremely remote high-altitude conditions, could not execute their tasks and contracts had to be re-negotiated. Also, difficulties in budget allocation from the Finance Ministry to NEA made it necessary to direct some of the work, especially transportation, through the consultant. The latter, in turn, caused further delays due to unavailability of his advice at the site, as and when necessary. In the view of the electrical contractor and the consulting engineer, the required administrative process with Austrian authorities also contributed to slow progress.

By July 1989 current planning foresaw construction of the powerhouse in the spring construction season of 1990, and considerable progress in the construction of transmission and distribution was to be made. At-site welding of the penstock pipes supplied from Kathmandu, was also to be done in spring 1990.

Tendering for the supply of the electro-mechanical equipment, on the other hand, was already done during 1986. The supply contract was awarded to the consortium Geppert/Fiegl+Spielberger for the hydraulic-mechanical equipment and electrical equipment respectively in December 1987. Acceptance inspection of the delivery was done at the works of the supplier in Austria in March 1988.

Costly transportation

More than one year later, the equipment, consisting of 5 containers of 20', and 122 cable drums, arrived in Kathmandu, via Calcutta, on 21 July 1989.

By this time, transportation of local materials, such as penstock sections and cement, was under way. However, the trade-treaty crisis with India and general inflation resulted in much higher cost of transportation than anticipated. A budget worked out in late 1989, and taking account of expected price increases, shows a total of 116.7 tons of cargo for STOL aircraft (Twin Otter) transportation and 90.8 tons of helicopter cargo, as well as 25.9 tons for porter carriage from Lukla to Thame, at a total estimated cost of ATS 5'500'000.--. This represents more than 10% of construction and equipment cost for local transportation alone!

Collaboration with SHPD

Due to the various difficulties encountered, and due to budgetary constraints, the collaboration with SHPD was under a strain at the best of times. With democratisation developing in the country in 1991 and the associated decentralisation and privatisation trends, SHPD ceased to play an executing role in the project, after it had formally done

[4] HMG regulations prescribe among other requirements, that at least three offers must be evaluated, and that the offer giving the lowest cost needs to be considered. Quality of work and reliability of the contractor are almost non-existing criteria in this procedure.

technical acceptance tests. However, this happened at a time, when transmission and distribution were incomplete. This forced the Austrian side to bring the project to an end by itself. Also, it opened up the opportunity for the discussion of local ownership models for the project with HMG.

Training of local personnel

Training of personnel had started 1992. 12 young men were trained for one year in a technical training institution in Kathmandu (BTTC), and selected members of the team were also trained in Austria, at a local electricity utility. After the basic training, on the job training took place at the site under the charge of the Austrian contractor responsible for transmission and distribution installation work. Also, a team of 5 were sent to Austria for a welding course, and the assigned manager of the utility received very brief management training in Austria.

KBC staff were also trained at BTTC in Kathmandu in the installation of drinking water and waste water schemes during 1998. In addition, the technical manager of KBC was trained for a short period in Austria.

Studies of possible institutional set-up for power scheme ownership and operation

The contract of Posch + Partners was extended as early as 1987 to include a study[5] on a possible institutional set-up for the operation of the Small Hydro scheme. The various tasks for the study included the following:

- the analysis of the institutional development of the organisation proposed to own, operate and manage the Namche Bazaar electricity system, including an outline of its legal basis
- the financial, social and economic analysis of demand and load management
- special measures required to substitute fire wood by electricity

A number of alternatives were evaluated against a set of criteria, and it was concluded that a joint ownership share company would be the most suitable. User associations, NEA and the National Park (SNP) were anticipated to become shareholders. The proposal broadly constituted the institutional model adopted by the Salleri-Chialsa Small Hydro scheme further to the South in Solu Khumbu. The study also included an analysis of the financial viability at different cost recovery levels. In order to increase the income from electricity sales at an early stage, a “positive” electricity connection model was proposed, i.e. it was suggested to connect relatively large commercial consumers with preference to generate income from sales of electricity.

Another, subsequent study[6] also favoured a role by SNP. It also was very critical of a role by NEA, citing a poor image on the local level and a disinclination in other cases towards the management of small, remote units. The study remained vague in its conclusions on the preferable legal form of the institution-to-be. However, the study was very clear on its advise against a Kathmandu based centralistic approach. At the same time, the view was expressed that for the years to come the government of Austria should play a major role in aspects of “social engineering”. Another notable view was expressed: The existing Namche Micro Hydro Scheme of 27 kW was proposed to be

[5] Namche Bazaar Hydro Power Development: Outlining proposals for organisation, management and tariff structure, Posch+Partners, Innsbruck, Rev.1, February 1989

[6] Khumbu Utility Management Study, Interdisciplinary Analysts, Kathmandu, June 1992

maintained in functioning order to protect the investment that had been done with UNESCO funding in 1983.

3.1.3 The establishment of KBC

However, progress at the institutional level was achieved only at a much later stage: Dr. Uitz, an Austrian expert, was entrusted to negotiate with HMG, in particular with the Ministry of Water Resources, the National Planning Commission and NEA, about the setting up of a "utility company" to take over the operation of the Namche SHP. An agreement was formulated in 1994 between the Austrian government and HMG with the objectives to:

- transform the project into a self-sustainable local institution with the capacity to manage all aspects of the rural electricity supply system in the project area
- optimise the overall socio-economic development of the project area through responsive interaction with an economically viable electricity supply system.

It was agreed that a share holding company was to be established, and that Eco Himal on behalf of the Austrian government and NEA on behalf of HMG were to be entrusted with all related activities. The share holding of NEA was established at 15%, the rest going to local users groups, cooperatives or/and non-government organizations. The amount of share capital on the other hand, was not mentioned.

It was further proposed in the draft agreement, that Eco Himal would initially hold the shares of the local user groups, to be transferred to the respective groups after their establishment. This clause was later disputed by HMG, and this resulted in further delays in implementation.

3.1.4 Initial Operation, Rehabilitation and Repairs

Testing and trial operation was initially planned to take place in 1993. However, the delays mentioned made this impossible. Also, the intake area and the storage basin required repairs. Joints in the concrete had suffered damage from frost and had to be renewed. Full load testing was not possible because consumers could not be connected due to the incomplete transmission and distribution network.

Regular operation from February 1995

Testing with connection to the grid could take place only in November 1994. Villages were connected step by step, and on 1st February 1995 regular operation and electricity sales started. The official inauguration took place on 9 October 1995 in the presence of the Nepalese Minister for Water Resources and the Austrian General Secretary of the BMfaA.

Various faults occurred in the power house during the early months of operation: The main circuit breakers of both machines could not take more than 200 kW load and needed to be exchanged. Also, the PLC control of one of the machines ceased to function already in May 1995 and needed to be sent to Austria. Other minor faults could be repaired within short periods, but the Austrian Engineer responsible had to cope with incomplete documentation.

The extreme climate takes its toll

In the period 1994-95, the penstock pipe was damaged twice. Welding seams developed leaks that were discovered by maintenance personnel of KBC. This was apparently caused by settling of foundations. Repairs could be done by a welder from Kathmandu. A part of the penstock foundations were in danger of sliding due to monsoon rains and measures to stabilise the steep slope were established by an Austrian geologist in November 1995.

In the first monsoon of operation it came to light that the desander could not cope with the sediment load. Several times heavy sediment deposit occurred in the desander and in the storage basin. In September, the storage basin was completely filled with sand. The flushing arrangement proved completely inadequate and the basin had to be emptied by hand. It took 120 men 5 days to do this!

Very bad weather in November 95 caused heavy damage on the transmission line. Heavy icing on the high tension cables caused two masts to tilt heavily. Mast foundations and stay cable anchorage proved to be inadequate. The tilting of the masts brought the high tension cable in contact with the ground and an earth circuit occurred. These damages could be repaired by the KBC team.

Earlier, an earth circuit occurred in the underground cable between Zarok and Syangpoche. A joint was faulty. Its location was difficult due to incomplete documentation.

A number of short circuit faults also occurred in the low tension distribution network, mostly due to poor workmanship during installation.

Regarding the condition of construction works and equipment, a detailed study was done in spring 1996[7]. The report critically assessed all components, summarised as follows:

- Unsuitable intake site with insufficient inclination of intake screen (Tyrolean weir)
- Desanding chamber of poor design, resulting in only partial settling of sediment
- Poor concept of storage basin bypass pipe, penstock aeration and shut-off valves
- A lack of well dimensioned flushing facility for the storage basin, resulting in a labour-intensive cleaning process.
- Turbine design faults: outlet apron too short (zu kurze Schachtpanzerung) resulting in a leaking of water between turbine housing and foundation; possible blow holes in turbine runner and advanced abrasion; indent in turbine spear valve, reducing efficiency; leaking penstock valve and nozzle of turbine.
- Sub-standard electrical installations and lacking safety protection of high tension installations and transformers
- Incomplete documentation.

KBC have done repair work as far as possible but it must be pointed out that the major shortcomings in the hydraulic design of structures remained unchanged.

Regarding the issue of incomplete documentation, the question is relevant, whether full documentation existed at one time. As a regular procedure, checking of documentation

[7] Bericht über den Besuch des Wasserkraftwerkes Thame Hydro Power Plant, Dr. DI W. König, 24.6.96

for completeness is done during commissioning. It was SHPD that had the task of accepting the scheme in the handing over process. If any document exists which would contain such details, it would apparently have to be with SHPD, or at the next higher level, with NEA, if it cannot be located at KBC.

The supplier of the electro-mechanical equipment, Geppert of Austria, was given a contract to do repair work on the turbines and the PLC controller earlier found defective, was replaced. Since the equipment had been supplied a number of years earlier, the supplier took the position that warranty had lapsed. Negotiations resulted in a price concession on the new contract, as stated by the supplier.

The runners of both turbines were replaced in 1999. The contract was awarded to EFG of Austria, from among five suppliers who were invited to provide their offers. In the view of the original supplier the supply contract went to EFG because of a lower price, but the fact that EFG had offered runners with buckets from forged steel may have played a role also.

3.1.5 Follow up

An agreement was formulated in 1994 between the Austrian government and HMG with the objectives to establish a share holding company for the operation of the scheme, and that Eco Himal on behalf of the Austrian government and NEA on behalf of HMG were to be entrusted with all related activities.

On this basis, Eco Himal was responsible for a period of almost 8 years to:

- Carry out and oversee completion of all remaining construction and installation work.
- Initiate, plan and carry out necessary repair and installation work to improve the reliability of the scheme.
- Negotiate with HMG and establish KBC with the objective of maximum local ownership, independence of NEA and full autonomy.
- Operate KBC with full responsibility and train staff on the job
- Build up the institution, administer and organise all areas of activity
- Hand over to local staff and provide services in an advisory capacity for a limited period of time.

The task of Eco Himal has ultimately been completed by the end of the year 2000. Eco Himal has shown considerable initiative in all phases of the project, and it has been able to mobilise resources, mostly in terms of expertise, to tackle a wide variety of problems and development issues. The BMfaA had to provide additional funding for the project at different stages. By the end of 2000 total spending has amounted to ATS 83.2 Million, including ATS 1.2 Million for the Namche Water Supply scheme, which is, strictly speaking not subject to the present evaluation, but which also constituted a part of Eco Himal's input.

It is noteworthy that Eco Himal also provided on the basis of its own initiative, electricity meters supplied by the Water Works and City Utility of Salzburg, and a remote control load switching system from BEWAG.

3.2 Project Approach and Performance

In the following chapter the programming approach for the intervention project is analysed, as well as the mode of cooperation and collaboration with local, government and non-government institutions. This is supposed to help systematically in answering the question how useful procedures and steering measures have been.

3.2.1 Objectives, Results and Activities of the Austrian Intervention

A logical framework as such was never prepared to describe the project in all its details. However, a logical framework matrix can be established on the basis of the tasks assigned to the consultants, suppliers and manufacturers. The logical framework matrix of the Austrian intervention and its initial intention is briefly as follows:

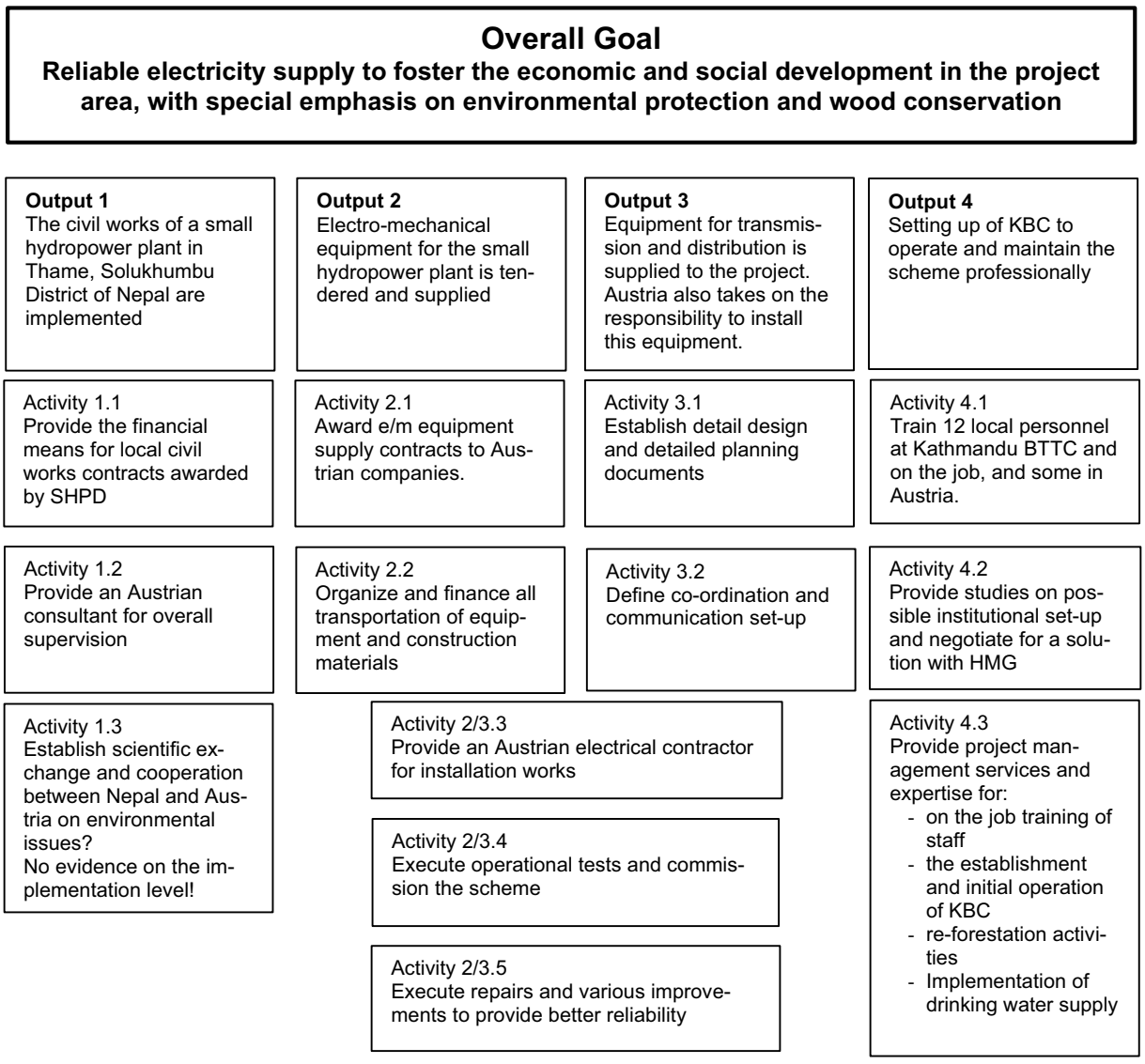

Figure 4: Log Frame Matrix of the Namche Bazaar Small Hydro Project

The Namche SHP was planned with a classical engineering approach whereby the main responsibilities for plant design, project management and site supervision and administration rested with the Austrian consulting engineer. Initially, SHPD the responsible branch of NEA, was to be overall in charge and responsible for all construction works. However, for various reasons and towards the end of the project, SHPD found itself unable to comply. This, and severe transportation problems, as well as a lack of sufficient on-site presence of the consulting engineer, led to delays in implementation. In order to conclude the project successfully, Austria took on additional financial obligations.

Thus, from a limited engineering approach, the intervention of Austria developed into a comprehensive approach of overall institutional and even regional development. This is substantiated by the fact that today, the Namche SHP has been succeeded by the Thame Valley Development Project, which is a new intervention of Austria, with overall development at its core.

3.2.2 Project Planning and Implementation Set-up (institutional map)

For the implementation of the Namche Bazaar Small Hydro Project, bilateral agreements were signed between the Austrian government (at that time AFC) and the Finance Ministry of Nepal. Execution of the interventions was delegated to executing agencies on both sides: in Nepal the SHPD (Small Hydel Power Directorate) under NEA, the Nepal Electricity Administration, and on the Austrian side to a Consulting Engineering firm Posch+Partners, Innsbruck, and at a later stage to the NGO Eco Himal, Salzburg. Various contractors on both sides were also engaged, to carry out specific components of the project and other tasks.

At the early phase of the project, during most of the construction, local participation was limited to tasks of transportation. The setting up of the Khumbu Bijuli Company, KBC, introduced a degree of local participation and of local ownership that was at that time unheard of in Nepal, perhaps with the exception of the Salleri-Chialsa Small Hydro scheme, where the Swiss Development Cooperation had pursued a similar model.

The institutional map, attempting to show the relationship of the various actors and stakeholders follows on the following page.

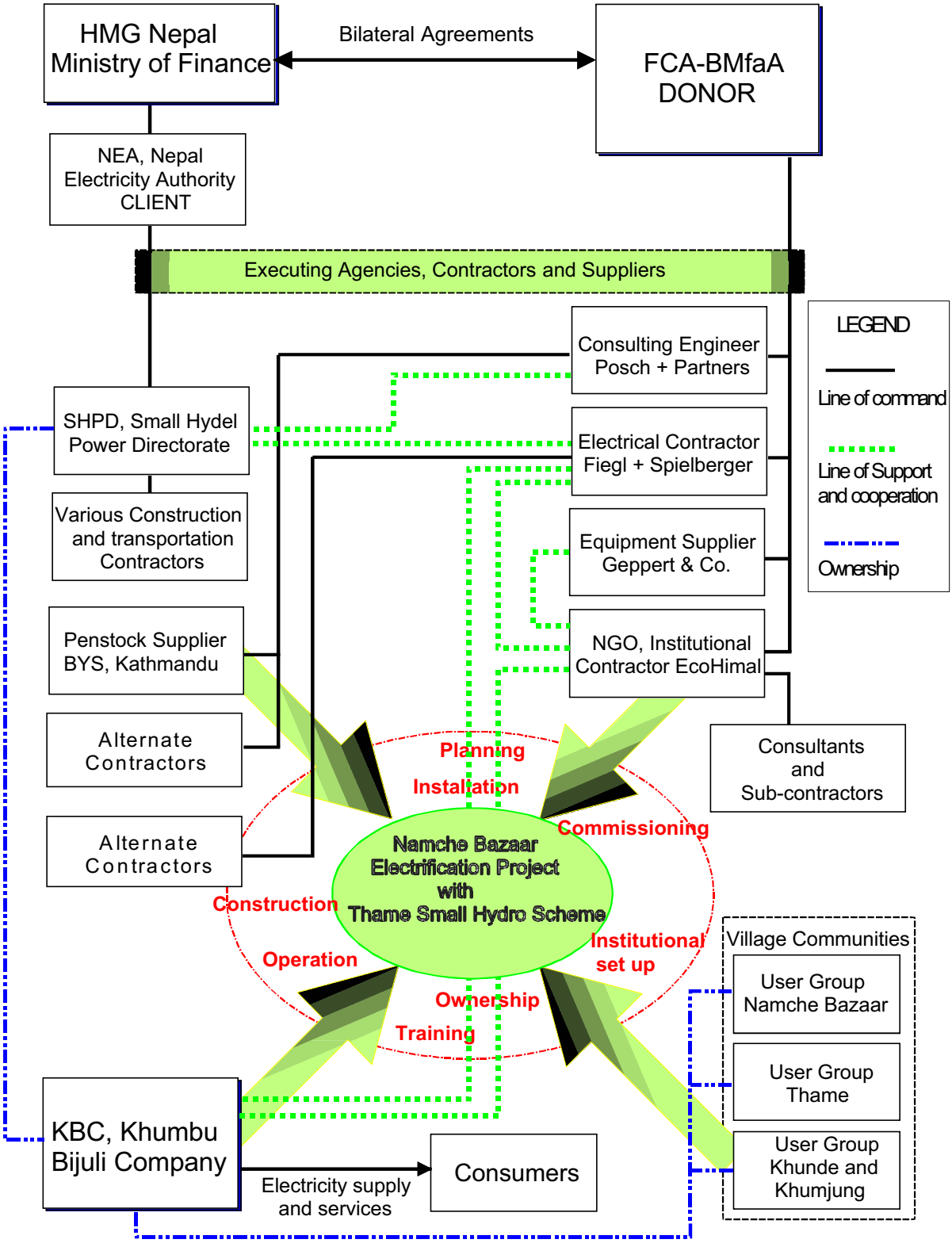

Figure 5: *Institutional Map of the Namche Bazaar Small Hydro Project*

The complexity of the institutional map results from the fact that over the duration of the project, various changes in the approach took place, such as:

- SHPD as the local and national project executing agency, phased out from active involvement before all works, particularly transmission and distribution, were finished. This forced the Austrian side to find other solutions. The consulting engineer and the electrical contractor began to subcontract remaining work directly with alternate contractors for transportation and erection works.
- The concept of local ownerships and the establishment of KBC as the operator and owner did not initially exist, but came up only after the main construction works were completed.
- The task of the consulting engineer Posch + Partners was taken over by the NGO Eco Himal because it was felt that the latter would be better suited for the institution building task.

Initially, the set up followed a classical engineering approach by which the client and national executing agency SHPD was supported and supervised by an Austrian Engineering Consultant, who also provided design inputs. Also, an Austrian Electrical Contractor did supply materials and was in charge of supervising the local erection contractors, who had been engaged by SHPD.

Both, the consulting engineer and the electrical contractor, had to take on additional tasks, such as subcontracting of work for transportation and erection directly, and staff training, as well as supply of additional materials. This meant a departure from the division of work between consultant (supervision) and contractors (execution). Also, when Eco Himal came into the picture, the lack of a clear division of tasks and responsibilities continued and new activities were directly acquired and executed by Eco Himal. This means that the BmfaA thereby transferred the control function of individual tasks to its main contractor, but retained the overall steering function.

3.3 The Present Status

3.3.1 Technical Features

The Namche SHP is a run-of-river high head project with a rated generating capacity of 630 kW. It consists of an intake with Tyrolean weir, desander, head race conduit in stone masonry carrying the water to a storage pond. The latter can be used for about 3 hours of full capacity generation during peak times. A bypass pipe with sluice gate connects the headrace canal directly with the penstock, just below the gate valve. The purpose of this is to feed water directly into the penstock while cleaning of the storage pond is going on, so that no interruption of power generation takes place. The draw-back is that water directly from the headrace canal is not free from sediment.

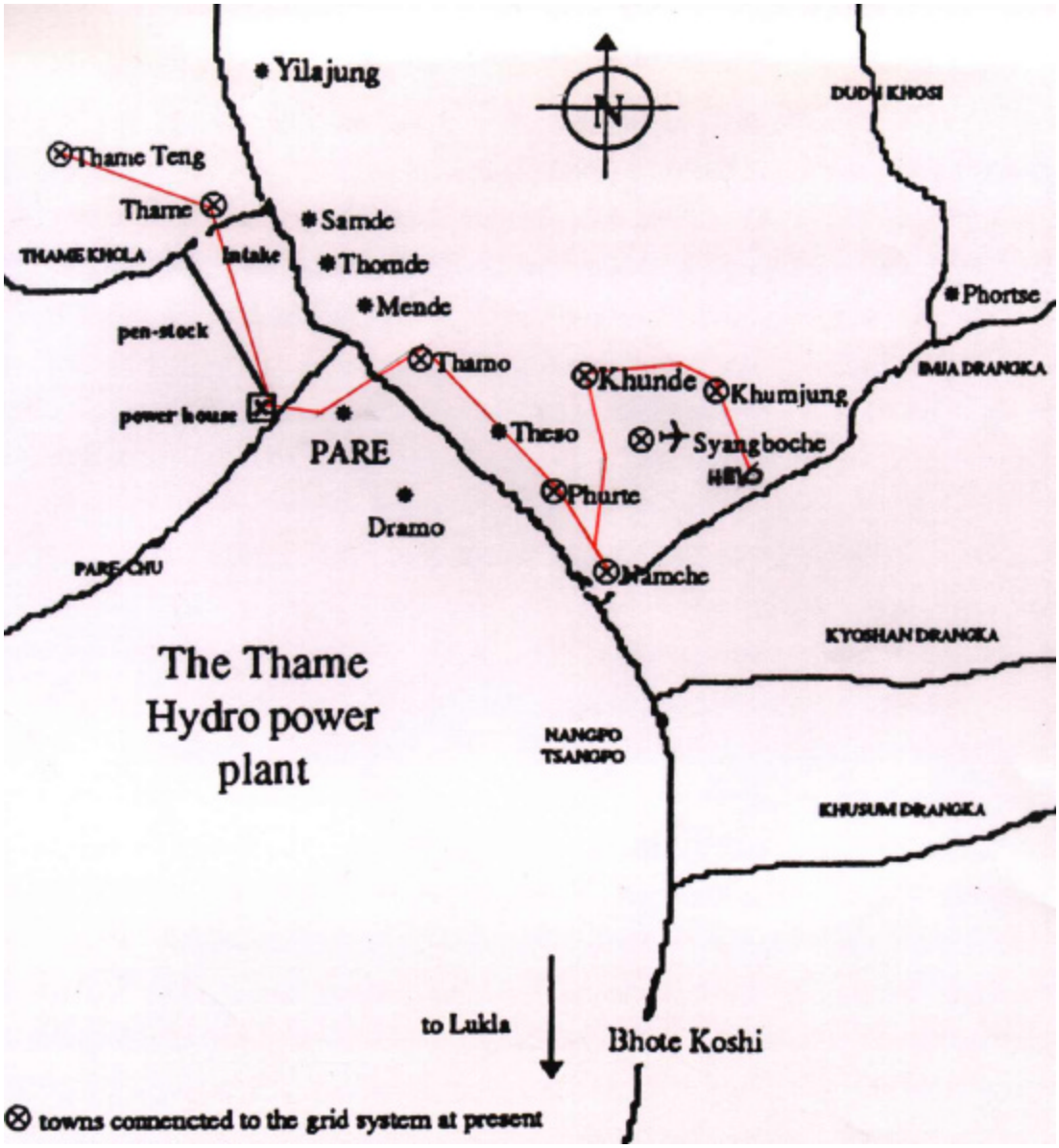

Figure 6: The area and villages covered today by the Namche SHP; the red line represents the transmission line

At the lower end of the storage pond, there is an intake grill to the penstock with a penstock valve chamber. The penstock valve is manually operated. The penstock is of welded steel, 450 mm diameter, 6 meter sections welded in situ, with a total length of 945 m. It is buried to protect it from frost. The penstock connects to a bifurcation at the power house which in turn connects to two Pelton turbines.

Figure 7: The intake area of the Namche SHP at Thame; in the foreground the desander

The turbines are double-jet, equipped with spear valves and jet deflectors. Each turbine is designed for a discharge of 180 l/s which results in a power output (electrical) of 315 kW (rated) at the design net head of 205 m. This implies an overall efficiency of 87%. At the time of visit, actual net head was 201 m, pointing to the fact that penstock pressure losses are higher than expected. This is due to calcination, i.e. building up of a layer of calcium inside the penstock.

Electricity is generated by two synchronous generators directly connected to the respective turbine shaft, operating at 1500 RPM/50 Hz and a voltage of 400 Volts. A power factor of about 0.95 is maintained.

A transformer brings voltage up to 11 kV and transmission is via a 13 km long transmission line, which consists of an overhead line with metal poles and underground cable in the vicinity of settlements. Transmission line poles were supplied locally, while overhead and und underground cables were part of the contract of Fiegl + Spielberger.

Electricity is distributed at present through 4 step-down transformers at the level of 400/230 Volts, entirely by underground cables. In November 2000 the number of connections was 672. This was reduced to 632 with effect from 16 December 2000, due to a new connection and tariff policy. Within easy reach of the transmission line and the existing distribution network, only three houses are not connected. Outside the area covered by the distribution system, about 20 households were provided with solar PV panels, subsidised by Eco Himal. Despite the subsidy, lighting provided by PV sets is

extremely expensive for the households.[8]

Figure 8: The two sets of double-jet Pelton turbines with synchronous generators, in the background the control and switch gear panels

Figure 9: Along the transversal course of the penstock, considerable slope stabilisation had to be implemented with high retention walls and shrub planting.

The Namche scheme is equipped with a remote control load switching system. 22 different switching programmes are possible, and KBC has started to introduce load

[8] Owners of PV systems pay a service fee of NRs. 260 per month for a 32 Watt panel. Average power provided by such a panel is about 3.5 kWh per month, resulting in a cost of NRs 74 per kWh, a factor of 10 higher than the commercial tariff of KBC!

switching with a twofold objective, a) to reduce peak-load problems, and b) to improve the overall load factor, by offering low tariff energy for specific purposes during off-peak hours.

3.3.2 Institutional set-up

KBC, the Khumbu Bijuli Company, owns and operates the generating facility, transmission and distribution system. Also included in the operation is a tree nursery and KBC has been entrusted with the installation and operation of the Namche Drinking Water Supply project. The operational set up is as per the following organisation chart.

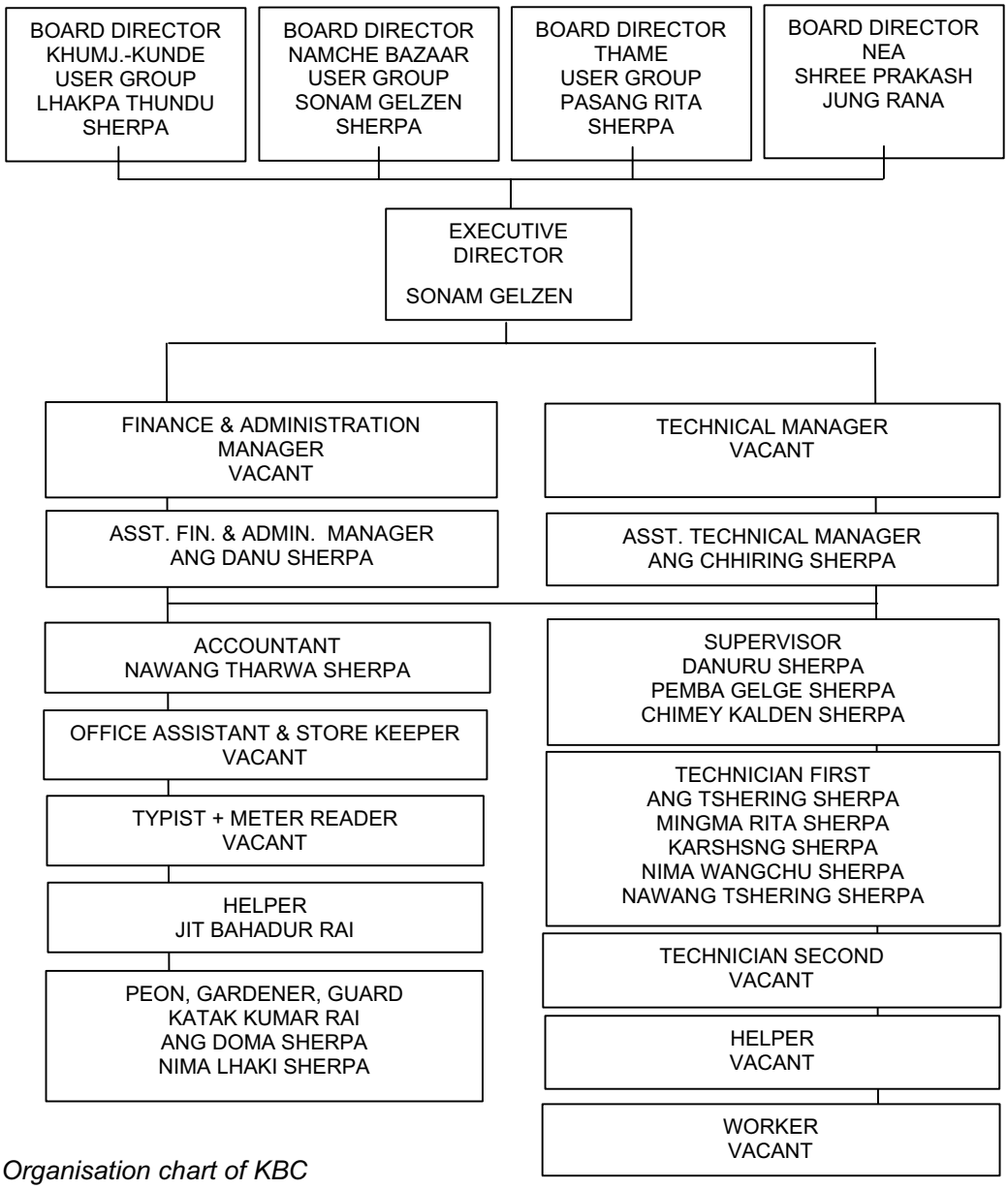

Figure 10: Organisation chart of KBC

It is to be noted that the actual management staff are not (yet) on the level matching their function. This is probably due to a pending board decision.

The assignment of the executive director is apparently a “political” assignment. The individual concerned is not actually performing the assigned function.

KBC has been established as a private limited company under Nepalese law. It is owned by four institutional share holders - 3 local user groups holding 28.3% of the shares - and NEA, holding the remaining 15% of shares. The company has an authorized share capital of NRs. 150'000'000, of which NRs. 137'660'010 is paid up and issued in lieu of the assets brought into the company by Austria (85%) and Nepal (15%). The 85% of Austria were given as a grant to the three local user groups.

3.3.3 Development of sales and income

In its first year of operation starting in February 1995, total generation was somewhat less than 1240 MWh. This represents an average load factor of less than 24%. In other words, more than 75% of the resource available could not be used profitably. Four years later (Feb. 98 – Feb. 99), total generation reached 1970 MWh, at an average load factor of near 40%. This represents an improvement of more than 15% annually, on the average. Figure 9 shows that minimum demand grows very slowly, while maximum demand grows faster. This means that the overall load factor is increasing only slowly, while a potential peak load problem develops. This is a very typical situation in isolated small electrification schemes. Fortunately, KBC is better equipped to cope with this situation than most other isolated schemes, because it owns a remote control switching system.

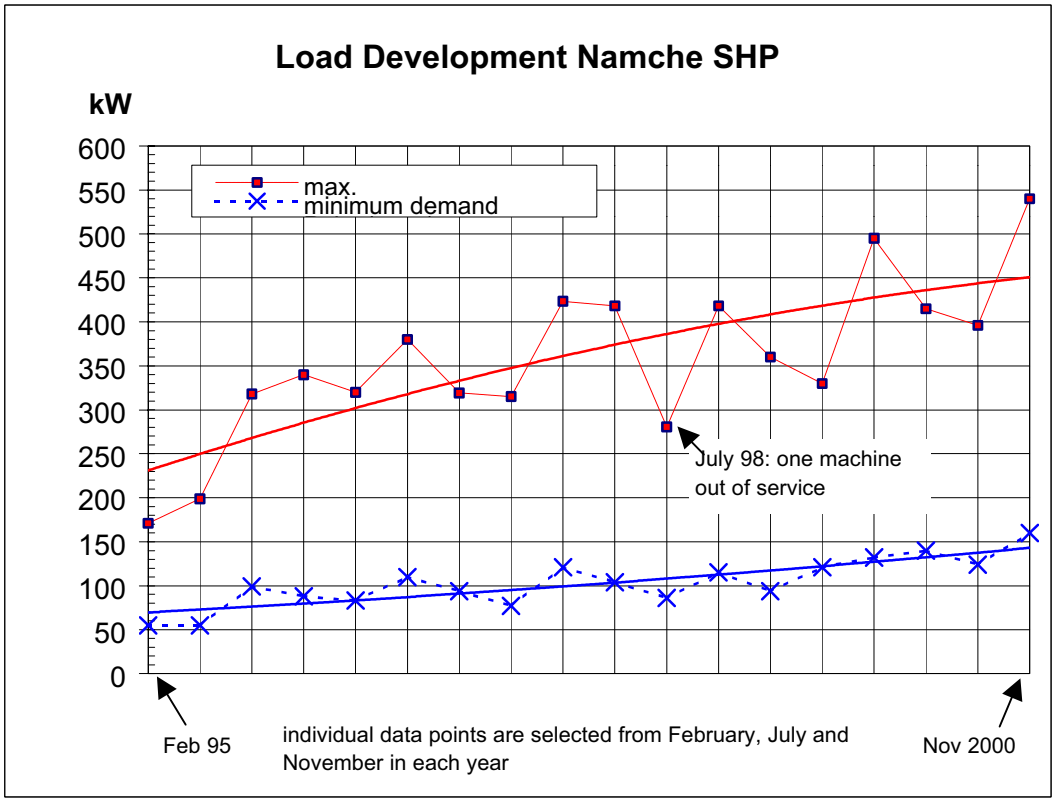

Figure 11: Trend of load development in the Namche SHP

In the two most recent years, KBC generated a gross income of NRs. 3'049'000 in 1998 and NRs. 3'734'000 in 1999, an increase of 22%. It had made modest profits, which were accumulated, and stood at NRs. 4'549'000 as of 16 July 1999. In the same period, operating cost including all salaries, increased from NRs 2'015'000 in 1998 to NRs. 2'349'000 in 1999. An increase of 16%, indicating improved productivity. In the most recent financial year, from July 99 to July 2000, gross income was NRs.

5'649'000, with expenditures of NRs 2'600'000, resulting in a gross profit of NRs. 3'485'000.

Year	Sales of electricity (NRs)	Data quality	Increase over previous year
2055	3'049'400	Audited accounts	-
2056	3'734'200	Audited accounts	22.5%
2057	5'640'000	Tentative[9]	51 %
P.S.: The financial year 2057 runs from 17 July 99 to 16 July 2000, etc.			

Figure 12: Recent development of sales income from electricity

In the electricity market of the Namche Bazaar area, there is considerable development potential. The use of this potential has already been very successful, as can be seen from the load development diagram (Figure 9), and the table on sales development (Figure 10).

Because of tourism constituting the single most important demand factor in the electricity market, there is considerable seasonal variation in demand. Despite an appreciable growth of overall demand, it has not been possible to reduce the level of seasonal variation. The difference between the month of lowest demand and the month of highest demand shows this fact clearly: In July 1996 maximum demand was 320 kW, while in November it was 380 kW. This is a difference of around 19%. In July 2000, which again was the month with the lowest peak demand figure of the year, 396 kW were recorded as the peak demand. In November 2000, the highest ever demand figure was recorded at 540 kW. This constitutes a difference of 36%. This reflects the growing dependence on tourism for the demand on electricity. This is a severe problem that needs to be solved to make use of the full income potential of the Namche SHP.

Also revealing is the typical daily load curve of the scheme. As is common in small isolated systems, much of the peak load is for lighting. This results in high loads during times when lights are needed, typically the early evening and morning hours.

The diagram (Figure 11) shows peaks between 7 and 8 in the morning and between 6 and 7 in the evening. KBC has been able to improve the load considerably during daytime hours between 9 in the morning and 4 in the afternoon. At night, between 22 and 5 hrs., the load is limited to purely lighting loads. With the remote load switching system recently installed, KBC is equipped technically to develop night time power use. It has already begun to experiment with electric storage heaters and large volume water heaters, for which it would offer a special rate, and would supply electricity only during slack night-time hours.

[9] Data supplied by KBC in March 2001

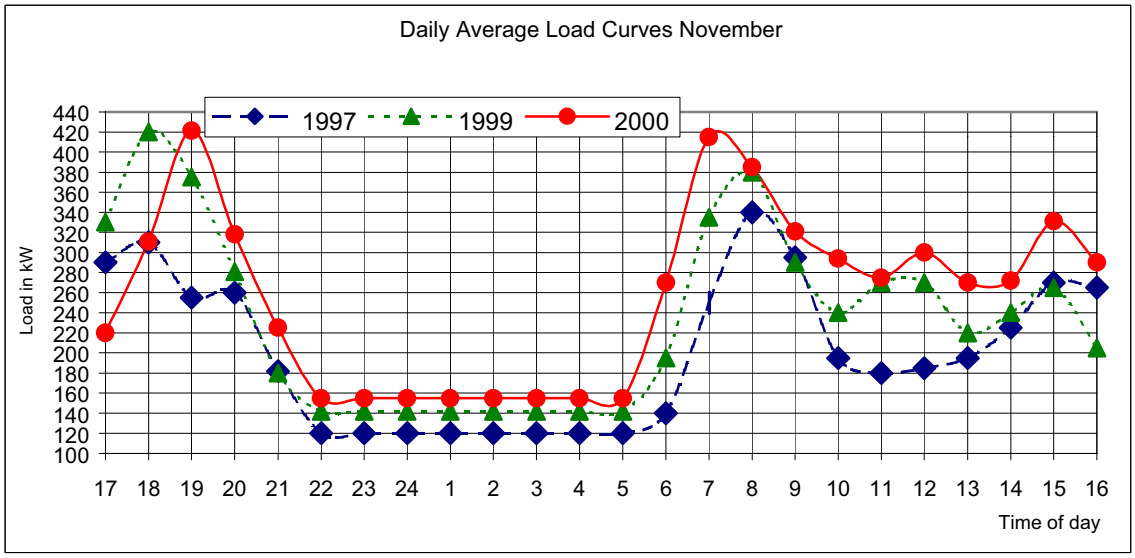

Figure 13: Namche SHP: A typical daily load curve in the peak (tourist) season

The number of electricity connections had reached 462 already in June 1995. It increased steadily to 672 in June 2000. Within the reach of the existing transmission system, this accounts for full electrification of the area. KBC is maintaining a tariff system in which there are nine different categories, depending on the power level of the connection. Three categories are for unmetered consumption. This means that consumers can use as much electricity as the respective connection permits against payment of a monthly flat rate.

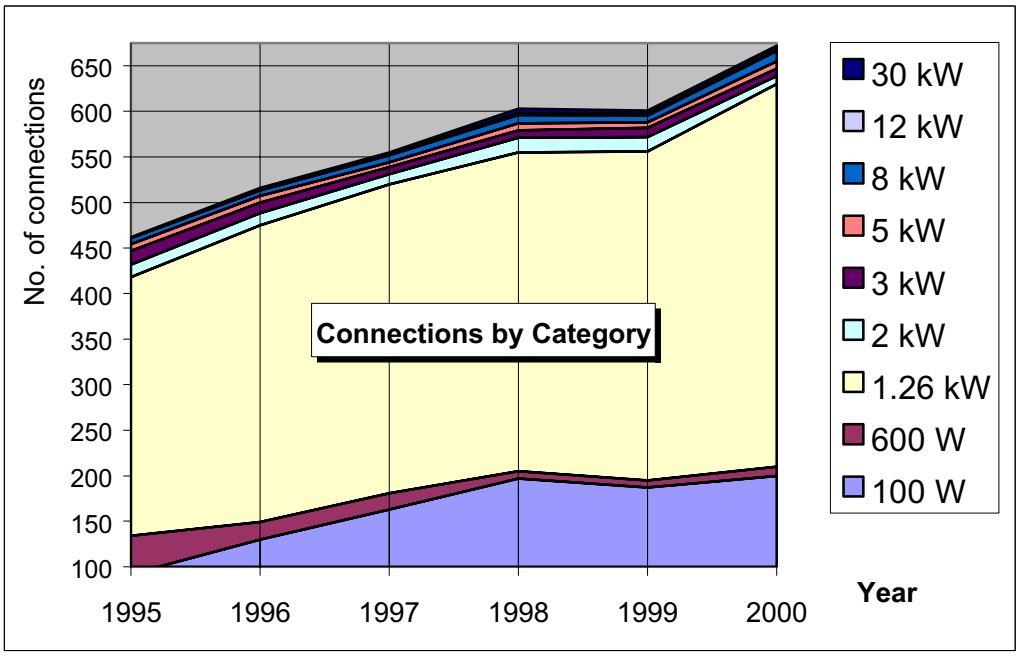

Figure 14: Namche SHP: Development of KBC electricity connections by load level category

Level 1 customers, for instance, pay a monthly flat rate of NRs. 60 for a connection of 100 Watt capacity. With this, a few light bulbs can be connected, and electricity, calculated on the basis of maximum possible consumption, is cheap at less than NRs.

0.90/kWh[10]. 200 customers are at present subscribed to this category. The most popular category is level 3. Connections are for 1.2 kW (which permits cooking) against a flat rate of NRs. 600.- per month. 420 customers subscribe to this level. Their electricity cost is even lower, if full use is made of the connection: a unit rate of less than NRs. 0.70/kWh[11]. Level 4 – 9 are commercial consumers with metered electricity, at a cost of NRs. 7.50/kWh at present, plus a marginal flat rate. Thus, more than 90% of consumers benefit from un-metered electricity connections.

Level	Power Watts	Flat rate Rs	Unit rate Rs	Energy meter	% of all connections
1	100	60		No	29.8%
2	600	300		No	1.5%
3	1'240	600		No	62.5%
4	2'000	200	7.5	Yes	1.3%
5	3'000	300	7.5	Yes	1.2%
6	5'000	500	7.5	Yes	1.2%
7	8'000	800	7.5	Yes	1.6%
8	12'000	1'200	7.5	Yes	0.3%
9	30'000	7'000	7.5	Yes	0.6%

Figure 15: Namche SHP, KBC tariffs in effect since 16 July 1999

The effective tariffs, shown above, became obsolete as of 16 December 2000, actually after the field evaluation took place, but before completion of the final report. It is therefore useful to include the new tariff structure.

Level Consumer category	Power subscription in kW	Flat rate Rs/month	Unit rate Rs/kWh	Energy meter	No. Of subscribers	% of all connections
1	0.10	60		No	193	30.5%
2	1.26	600		No	339	53.6%
3	4.00	300	7.5	Yes	80	12.7%
4	12.00	800	7.5	Yes	14	2.2%
5	30.00	3000	7.5	Yes	6	0.9%
total	1114.44				632	100.0%

Figure 16: Namche SHP, KBC tariffs in effect since 16 December 2000

The previously existing 9 connection levels were reduced to 5, and KBC is making sure, that small scale commercial consumers, typically lodges or house owners renting out rooms, subscribe to a metered connection.

Restructuring of the connection policy and the tariff have resulted in a slightly lower number of connections, without affecting the total number of consumers. Despite a re-

[10] equivalent to 0.19 ATS/kWh, (exchange rate of 1 NRs = 0.2 ATS at the time of evaluation)

[11] equivalent to 0.14 ATS/kWh, (exchange rate of 1 NRs = 0.2 ATS at the time of evaluation)

duction in the total number of connections, the proportion of metered connections has gone up from around 6 % to 16%. In the view of KBC, the new regulations do neither increase nor decrease revenues. In the author's opinion this is an unnecessarily pessimistic approach. Based on experience elsewhere, the change from non-metered consumption to metered consumption will result in a temporary reduction of consumption, because consumers experience a "shock" when suddenly the electricity bill relates to actual consumption. However, they get used to it, and consumption goes back to the previous pattern, but is now to be paid for. In the mid-term, the prediction is therefore, that revenue will go up. Also, ultimately, this is the chief objective of the restructuring exercise.

3.4 Specific Questions and Main Findings of the Evaluation

This section of the report addresses specific questions of the terms of reference for the evaluation directly. Findings are substantiated with the relevant evidence, where available. Otherwise, argumentative comment is made.

3.4.1 Programming

Agreement with the Austrian Development Cooperation Philosophy

Question Q1: How far do conception, implementation and results reflect the chief objectives of Austrian development co-operation, in regard to poverty alleviation, democratisation/ ownership development, ecological concerns and gender equality?

The first initiative that ultimately led to the Namche SHP of today, was motivated by the Austrian export industry. It was the intention to set up a reference project. However, how such a project reference was actually going to be instrumentalised is not documented.

Soon after planning activities had begun, a more partner-oriented chief objective was identified and adopted: “Ecological protection and wood conservation by the provision of reliable electricity to the villages in the area.” No explicit reference could be located to the other relevant objectives, but what was actually done reflects implicitly that social objectives were of importance.

By setting up KBC under local ownership, the intervention was clearly following the objective of democratisation and ownership development. The model developed was new for Nepal and it took considerable persistence in negotiations on the central government level to implement it. On the local level, the intended model was not at first very well understood either. Periodical reporting by Eco Himal shows that this was felt to be a problem, and various measures were taken to improve understanding. Public information campaigns were launched to explain the structure of KBC and the nature of its task. The representatives of the share-holding user groups were also invited to a number of seminars with the objective of imparting specific know-how regarding the functions of the board of directors of the company. Positive results of these most recent measures are not yet fully discernible, but it is evident that interventions were aimed at strengthening sustainable democratic structures.

Despite the fact that the beginning of the project dates back to times when Austrian Development Cooperation principles and objectives were not yet firmly established, the approach over time reflects serious adaptation to today’s objectives. Especially in the environmental field, the project has gone a long way in achieving targets. This is reflected by the re-forestation carried out and by the continuing activity of the tree-nursery also under the management of KBC.

3.4.2 Need-Driven Intervention

Question Q2: How far were the interventions based on actual needs of the rural population and on priorities and development plans of the partner countries: What impact did measures have on sector policy development of the partner governments?

To plan and implement the Namche SHP was a very ambitious undertaking, given the extreme remoteness and climate of the project site, and practically from the beginning a difficult and strained relationship with partner institutions. Bearing these conditions in mind, the achievement is considerable.

The reason for choosing such a difficult remote area was that with foresight, the increasing tourist influx was recognised to constitute a fast growing environmental hazard. It was also envisioned at an early stage, that a growing tourism-oriented service industry would be in need of electricity, and that, if electricity was available, positive occupational effects would result. In this sense, a latent, but nonetheless considerable local need was identified and fulfilled. Results today show that a considerable economic potential has been created with cheap and reliable electricity.

That a real existing need was meet is also supported by the fact that the acceptance rate of electricity connections has been 100%.

National priorities were implicitly followed with the Namche SHP. It was a declared national objective at that time to electrify all district head quarters and other important centres in remote areas. Namche Bazaar falls in the latter category.

The effect that the example of the Austrian intervention could have had, should show in one form or other in official documents. In Nepal, the relevant document is the "9th Plan, 1997-2002", prepared by the National Planning Commission of HMG. This document contains several relevant passages:

- The ongoing activities and completed projects in the sector of rural small hydro development comprised a total capacity of 2'600 kW in 5 projects. Austria is not mentioned explicitly, but has contributed with 23% to this achievement under extraordinarily difficult conditions.

- On rural electrification, the following statement can be found: "For enhancing the effectiveness of the rural electrification, user's groups will be involved in project formulation, implementation and operation. In the case of remote mountain districts, emphasis will be laid on micro and small hydel projects. Such projects will also be implemented mobilising local participation and through the involvement of NGO's" (end of quotation). Two things in this statement are notable:

    - That a need was felt on the level of the planning commission to "enhance the effectiveness" of rural electrification, and

    - That the way to do this, was plainly speaking by copying the Austrian approach.

    It is evident from this, that the example of Austria has influenced this passage, even though it may not have been acknowledged officially.

- In the ninth Plan, another 7 rural small hydro projects are planned, totalling 3775 kW. Compared to this, the Namche SHP, implemented during the 8th Plan, amounts to a portion 16%. This goes to show that targets in the 9th Plan have increased as compared to the 8th Plan.

In addition, the legislative process in Nepal has produced the Electricity Act (1992), the Water Resources Act (1992) and Electricity Regulations (1993). These acts contain clauses that favour small hydro development fiscally and otherwise. The Namche SHP may well have had a positive influence on the new legislation, although there is no hard proof.

3.4.3 Participation and Donor Co-ordination

Decision making and coordination mechanism

Question Q3a: What decision making processes and co-ordination mechanisms were developed with the partner government and other donors?

Question Q3b: What was the degree of local participation and of other stakeholders? What role did NGO's and the private sector play?

The bilateral agreement between Austria and Nepal of 1989 outlined a sharing of responsibilities as follows:

Nepalese side:

- Land acquisition
- Site installations with camp facilities
- Administration and permanent site management
- Execution of all civil works, with Austrian financial assistance
- Transportation within Nepal for the civil works materials
- Installation of the transmission and distribution systems

Austrian side:

- All design works
- Construction supervision and construction management as far as necessary
- Supply, transportation and installation of penstock and hydro steel structures
- Supply, transportation and installation of all required electro-mechanical equipment
- Supply, and transportation of all required materials for the transmission and distribution systems
- Training of personnel

Austria did not at any time have direct permanent representation in Nepal, neither on the ambassadorial level, nor by its Development Cooperation department. The typical ACB (Austrian Coordination Bureau) as is to be found in Bhutan for instance, is missing. Headquarters therefore had to rely on full delegation of authority to its contractors: Posch+Partners in the early stages of the project, and Eco Himal from 1993 to 2000. As a consequence, coordination with government and others was largely left in the charge of the contractors appointed. Only infrequent visits by head office staff took place.

The Austrian Agency for Development Cooperation's role was reactive rather than proactive. Despite this, it has shown considerable persistence in bringing the project to a successful end. All possible difficulties have been met in a constructive and decisive manner. Officials directly involved have shown considerable identification with the project and have provided firm and result-oriented leadership.

Failure of the local partner (SHPD) to perform its assigned role was for financial difficulties of HMG and not for the lack of Austria's performance or a lack of coordination. On the other hand, the Nepalese project management that existed during early phases of the project also blamed the Austrian consulting engineer for non-performance at various points in time. The lack of continuing involvement of SHPD must also be seen in the light of the political situation prevailing. A democratic revolution was ongoing at that time, and numerous government agencies were in effect put on hold. Inactivity at the project level is therefore comprehensible. It was the safest method to avoid exposure to a revolution-minded public. After the political situation had calmed down, it was too late for SHPD to resume a strong role. Legislation had been established in the mean time that made local ownership possible. This was the necessary legal basis for the Austrian initiative on the institutional level.

After most of the construction was completed, but before commissioning, a new agreement was formulated in 1994 between the Austrian government and HMG with the objectives to:

- Transform the project into a self-sustainable local institution with the capacity to manage all aspects of the rural electricity supply system in the project area
- Optimise the overall socio-economic development of the project area through responsive interaction with an economically viable electricity supply system.

Despite the agreements entered into, in implementation, Austria has practically gone all the way alone, after attempts in the area of partnership and local participation had failed. An exchange of information took place without doubt with a number of institutions, such as the National Park authorities, local government offices and central government institutions in Kathmandu, as well as with the ongoing SHP project Salleri Chialsa sponsored by Switzerland. Also, close cooperation in implementation was established with the leading mechanical workshop Balaju Yantra Shala (BYS), in Kathmandu. This reflects a policy of getting done locally what was possible. This is a merit of the project.

Otherwise, there is little evidence that considerable donor coordination, local participation and effective partnership with national government or non-government institutions took place. A certain degree of isolation was evident during the early construction phase. No permanent local presence (i.e. a Kathmandu office), and the extreme remoteness of the project site have very likely contributed significantly to this situation.

3.4.4 Techno-economic Evaluation of Namche SHP

Question Q4a: Are processes, structures, plants and equipment technologically adapted to the frame conditions (technically, economically and ecologically) and designed in a sustainable way?

What economic impact did re-designs and rehabilitation measures have?

Several criteria and indicators have been used to evaluate these issues:

Technical adequacy and status of installations

As outlined in chapter 3.3.1 the installations and their status is adequate, although with some flaws in design and execution which cannot be rectified. This is borne out by the fact that the frequency and severity of breakdowns has decreased over time. The plant has never before run as well as over the past few months.

Relevance of electricity supply for the energy situation in the project area

From the household survey, and information gathered during the project visit, it becomes apparent that the electricity supply from the Namche SHP has made major inroads into the traditional household energy pattern not only in the field of indoor and outdoor lighting. The heat requirements are still dominated by firewood. A growing substitution of firewood is taking place not only through electricity but also through LPG and Kerosene, particularly in tourism use.

The electricity from the Namche SHP serves a resident population of about 2'600. In addition, there are more than 25'000 tourists visiting the area every year, with an average stay in the area of say, 5 days. This would add about 347 to the resident population, so that we need to consider a capita figure of about 3'000 that is served by the Namche SHP.

Today, total production and use of electricity has reached 2000 MWh/year. This amounts to 666 kWh per year and capita, which is equivalent to 2400 MJ/capita/year, or 200 MJ/capita/month, double the value that has been calculated for the Rangjung area in Bhutan. In terms of other energy resources, such as fire wood, 200 MJ amounts to 27 kg per month, if it is assumed that wood burning is commonly done at about half the efficiency that applies to electricity use. The average requirement of energy for cooking in Nepal is said to be 8'200 MJ/capita/year[12]. Compared to this, electricity supplies almost 30% of the cooking need. This is a rough estimate of the situation, giving a realistic order of magnitude. It goes to show that the electricity supply provided is indeed very relevant, and most pronounced in the requirements of tourism.

Efficiency of Power Supply

Not at the moment, but soon, when the peak power demand reaches plant capacity, the efficiency of generation and distribution become important. With each percentage point of plant efficiency improvement or loss reduction, KBC income is increased by up to NRs. 1'000 per day, which is a direct increase in profit. It is a sensible management measure therefore, to keep an eye on overall losses.

Generation efficiency as initially measured during commissioning was according to the values predicted by the supplier. However, due to the heavy wear on the turbine (sediment abrasion damage), the efficiency has been decreasing gradually. This was rectified by the installation of new runners in 1999.

The head loss in the penstock pipe had been increasing over the years to a level that significant loss of power resulted. Instead of the rated output of 600 kW, only 580 kW could be generated. This phenomenon has resulted in an investigation of the cause of increased head losses. It was found that progressive incrustation of the inside walls of the penstock was taking place. The measure taken was cleaning of the penstock with a special process called pigging. A reduction of the head loss was achieved successfully.

Both measures combined, new turbine runners and cleaning of the penstock, have resulted in improved efficiency of power generation.

Transmission and distribution losses can not reasonably be established in the supply area, because 96% of all connections before December 2000 and 84% from this date onwards, are not metered. This makes it impossible also to monitor the efficiency of power transmission over time. Perhaps one reason why a strategy of 100% metered consumption should be adopted in the future.

[12] Source: Rural energy Study Nepal 1999, Heijndermans, ASTAE, World Bank

Adequacy of electricity supply

KBC provides a generally generous supply level of electricity. The most popular (420 consumers, or 62%, new 53.6%) single-phase connection of a household is for a maximum capacity of 1.26 kW. This policy of relatively ample supply capacity connections is favourable for encouraging the use of firewood substituting appliances such as rice cookers, hot plates, kettles and space heaters. Consumers that require more than 1.2 kW capacity can choose various higher levels, up to 30 kW. These connections are metered. The supply of electricity is adequate and unrestricted so far. However, as the first signs of reaching maximum generating capacity with demand appear, KBC will have to control the switching of various load categories. Fortunately, it has the technical means to do so with the remote control switching system installed in the scheme.

Safety of the plant and associated mini grid

There have been no accidents reported from the power house. The safety precautions and the protection schemes employed are in accordance with European systems. For the distribution systems and especially the house wiring, the same applies. Not one single accident was reported during more than five years of operation. This is mostly thanks to the consistent use of earth leak fault relays in all consumer installations, but also thanks to training and information campaigns.

Economic impact of repairs and rehabilitation of the Namche SHP

In terms of repairs and rehabilitation with an economic impact on the operation of the scheme, a number of measures could be identified that do indeed have a positive impact. Some other repair measures appear to be beneficial for the scheme and such measures were absolutely necessary, but these will also be of a recurring nature.

- Foundations of several high tension poles and stay cables were improved after the initial design and execution had proven inadequate. This has resulted in no further interruption in power supply, the avoided outages representing an economic improvement.
- Concrete joint sealing in the headrace and storage basin area has been improved with specially cold-resistant material and this has resulted in no further frost damage on a yearly basis, reducing maintenance cost.
- Slope stabilisation along the transversal path of the penstock has resulted in no further damage to the penstock. Continuity and reliability of power generation were improved. This also represents a better economic situation for KBC.
- Elaborate repair and rehabilitation works in the intake area were necessary due to severe damage after the monsoon. Under the prevailing conditions, this is a recurring activity that has become a regular part of yearly maintenance cost.
- The problem of using water from the Thame Khola with a heavy sediment load during the rainy season could be solved: A separate spring catchment was built, and water is diverted into the headrace canal of the scheme. Fortunately, this water is practically free from sediment also during rains and flow is sufficient for the full requirement in the rainy season. Water from the original intake thus is not used at all for as long as possible during the rainy season. This measure is promising to be very effective in avoiding further turbine runner abrasion.

- The replacement of the turbine runners has been necessary for quality reasons. It is economically effective, specially in combination with the use of water with less sediment load because it extends the life time of the runners considerably.
- The recent cleaning of the penstock pipe has improved plant output by at least 20 kW. This represents an additional re-established earning potential. However, the exercise is likely to be necessary again in a few years time. Since armatures in the penstock and associated cleaning equipment are in place, KBC should be able to do this work, as and when necessary, on its own.
- Not a repair activity, but an addition, is the installation of the remote control load switching system. This will be extraordinarily useful in the future to increase the earning capacity of the scheme, while managing peak loads without load shedding which would mean a loss of earnings.

  On the one hand, in technical terms, a large potential exists to build up the power factor, broadening the income base. A combination of technical measures (remote control load switching) and administrative measures (tariff differentiation, connection policy) will enable KBC to effectively pursue load development. On the other hand, the discontinuity of the tourism trade over the year will also set limits to full use of the generating potential.

3.4.5 Project Effectiveness and Efficiency

Question Q5: What is the result of the analysis as far as effectiveness of interventions and efficiency of allocated funds are concerned?

Effectiveness

Interventions from the Austrian side apparently always had effectiveness as an objective. For the most part, effectivity was achieved, but it must be assumed at high cost due to expatriate (Austrian) expertise required. In some cases, contractors that were engaged failed to provide top-quality service, specially in the area of design and supervision, equipment supply and installation.

A remarkable and positive case of fully achieved effectiveness is the institution-building task that was assigned to Eco Himal. The period of engagement of almost 8 years seems very long, and associated costs were high. However, what was attempted in terms of institution building was new for Nepal and in terms of technology for the local people. Also, another project example with a very similar comprehensive approach, the Salleri-Chialsa small hydro scheme, shows that time spent and cost involved were on the same order.

Efficiency of fund allocation

The efficiency of utilisation of funds is difficult to assess. In its implementation, the project has been plagued by natural calamities and economic crises in the region, as well as by high levels of inflation. Delays were numerous, and every delay has added to the cost of the project. The scope of Austria's input into the project was extraordinary and beyond the usual. It is possible to state relative rather than absolute efficiency by comparing with other projects in Nepal. When doing this, care was taken to make fair comparisons, i.e. project cost of compared projects were to have a comparable scope, and specific features of the projects needed to be known.

Project	installed capacity	Cost of construction	Cost US$/kW
Namche SHP	600 kW	65.1 Mio ATS	8'346
Tatopani SHP	1000 kW		4'970
Salleri-Chialsa SHP	400 kW		9'375
1 $ calculated at ATS 13.0			

Figure 17: Table showing costs of different SHP's in Nepal

The cost of construction of the Namche SHP was compared with two other projects in Nepal that were implemented roughly in the same time period. The cost of Namche are between those of Tatopani and Salleri-Chialsa. Was money relatively efficiently spent?

Tatopani benefits from road access and to some degree from better economies of scale. Also, no distribution network is included in the cost. It is therefore plausible that its cost is only 63% of those of Namche.

Salleri-Chialsa is about 18% more costly than Namche, despite the fact that it is less remote than Namche. On the other hand it is low head, implying higher unit cost, and it was built in two stages, which tends to increase cost.

Taking the extreme remoteness and the altitude of the Namche SHP into account, its cost are favourable when compared with the Salleri-Chialsa scheme. In absolute terms, as repeatedly mentioned, costs were high. However, many small schemes were implemented world-wide at this cost level.

Namche had local transportation costs of about US$ 700/kW, certainly a multiple of the cost in the other projects. The efficiency of money spent on transportation cannot be assessed because there is no firm basis for comparison.

3.4.6 Impacts on population and resource base

Question Q6: What are the economic, social and cultural impacts for the population of the project area? Which direct effects have occurred in terms of economic and industrial development; in particular what are the income and employment effects?

What impacts on the resources (water, land, pasture and forest) have resulted from the interventions e.g., on their exploitation and access and on the housing situation, health conditions and the social structure of the population? What impacts have resulted on welfare and education, mobility and migration, lifestyle and cultural activities. What is the current status of corresponding indicators and processes of the impact monitoring?

Residents in Namche Bazaar remember the period prior to the commissioning of the installation at Thame when only a small amount of electricity was supplied from a micro-hydro, and many residents had none at all. They articulate very clearly the changes that have occurred since the plant at Thame came on line. The survey followed a four-day shut-down of the plant for penstock maintenance. This further reinforced recollection of life without electricity.

Economic Impacts

The economic impacts of abundant cheap electricity have been quite marked. New economic activities that are completely dependent upon power have developed in the past five years.

Figure 18: Mostly tourists are customers of an e-mail business at Namche Bazaar

Two email shops have now operated for a year, one of which has an internet connection. At first it was used only by trekkers, but now local people also avail themselves of the service. One operator reported that his three computer configurations cost him a total of NRs 300,000 installed. He charges NRs 60 per KB to transmit, and NRs 20 to receive messages for clients. His daily income in the season is NRs 14,000 per day; around NRs 1,680,000 per annum. His running costs for the telephone line are NRs 1,300 per day. Originally his business was selling second hand books and some stationery items. Business was very slow, and now the email service is the main source of income. Now clients browse and buy the books while they are waiting to use the computers, so even the book business has benefited. The four day power outage was “a disaster” in terms of lost business.

Very successful, too, are the two laundry services that have opened. One operates out of a general store. Originally the entrepreneur bought the machines hoping they would prove a draw-card for his shop. The family’s normal business has not increased, but the laundry service now makes more money than the core business.

It is a level 6 consumer[13], paying NRs 4,500 per month on average for power. Most of the laundry customers are trekkers, but more and more local shopkeepers, who have no time to wash, use the service. During the four day outage (due to penstock clean-

[13] All references to the connection level in the survey results apply for the “old” system prior to 16 December 2000, because during the time of the surveys it was still in force.

ing) the proprietor stated that the business incurred significant losses, and “public life came to a standstill! Why was it done at the peak of the season?”

The two bakeries that serve both the trekker and the local market are large electricity consumers. Power costs are high, so outages are particularly damaging; one has a gas oven, and during outages uses LPG at 10 to 15 times the energy cost because he says the damage to consumer confidence is too great to be worth the risk of failure to supply.

The new local cinema also has stand-by generation. The family operating the facility returned from working in Japan and set up the operation. They paid NRs 500,000 for two sets of projection equipment, and for repairs since it was purchased. If more than 10 customers come, they screen a film, usually three times daily in season. Each show nets on average NRs1,500 , giving an annual income of around NRs 540,000. Market days are particularly lucrative; they screen only Nepali films, aimed at the population of Namche Bazaar and its surrounding market catchment area.

Other new energy dependent businesses are a sauna, a hot shower facility, a water bottling plant, and a pizza restaurant. All of these are tourist-oriented.

The shower service is interesting in that it is considerably more expensive than showers in the average lodge, but its owner defends her pricing with the observation that she offers “real showers with real hot water”, electrically heated, and unlimited, as opposed to the lukewarm wood heated bucket shower commonly on offer in lodges.

All these businesses are family based, though they employ extra casual labour as bakers, cleaners or shop assistants. Typically, the new enterprises have paid off the capital cost of the equipment they purchased (computers, washing machine and dryer, projection equipment) within one year. The exception is the sauna, which covers its costs, but does not make much money, as it has very high power demand. All owners stated that electricity is no longer a luxury, but a necessity of daily life. All stated that electricity is extremely good value for money.

Other entrepreneurs are using electricity to add value to conventional goods and services. Significant among these are the luxury lodges. One of these is not new, and was operating with its own generators prior to electrification. Its running costs are significantly reduced by using a local renewable energy source. This lodge, Japanese co-owned and targeted at the luxury Japanese market, is by far the largest power consumer. It is a level 9 consumer with a 30 kW connection.

Another luxury lodge opened for the autumn 2000 season in Namche Bazaar. Lighting is all electric. The lodge cooks with gas, kerosene and electricity. In the kitchen is a fairly typical array of appliances; mixer, blender, toaster, geyser, refrigerator and oven. There is also a vacuum cleaner.

All the guest rooms are warmed with oil-filled electric space heaters. There is abundant hot water in the attached bathrooms, benefiting from a low tariff provided through the remote control system recently introduced. A hairdryer is available for guest use. Laundry is done at the local laundry service. Wood is only used for space heating in the lounge area, more for atmosphere than for warmth; there is also an oil-filled electric heater for effective heating. They do not pay for wood, but an employee fetches it from out of the conservation area. There is a TV in the lounge, used for videos as a television signal is not yet available.

Formerly the proprietor and his family operated another smaller luxury lodge. The differences in the old and new lodges are in the ease of operation, lightness and cleanliness of the new lodge. The proprietor and his wife manage the lodge, but have five

male employees. One is Sherpa; the others are migrant seasonal workers from the Terai, who stay for nine months of the year.

Income and Employment Impacts

Namche Bazaar now has a more diverse employment profile than the rest of Solu Khumbu District, and is much less dependent upon subsistence agriculture and herding, though herds are still maintained as pack animals as well as for yarn, hides and meat.

Average monthly cash income per household in a sample of 33 was NRs 15,725. Lowest, mean and highest figures are NRs 600, 9,000 and 60,000. On a per capita basis the range is from NRs 300 to 15,000. Differences in economic status may not be so marked as this disparity may suggest, since the subsistence economy and barter systems still operate. The average personal monthly income equates to around US$ 555 per annum (at 1 US$ = NRs. 70), where estimated national per capita GNP in 1996 was US$ 210. No comparative baseline data are available but it is fair to surmise on qualitative evidence that the project has assisted growth in incomes.

The impacts of electricity on employment are marked, but the increase in job numbers is not as dramatic as the new economic activities might suggest. This is because the businesses that have arisen from the opportunities electricity makes available are still largely family-run. Certainly some new positions have been created, but they tend to be filled part-time by family members who are also undertaking other activities; for example, one laundry owner also earns money as a guide to trekkers during the season, while his wife runs the shop and his daughters help with the laundry after they have gone out in the early morning to gather dung to cook at home. They employ no external labour.

In the Namche Bazaar project area, the number of jobs per household surveyed averages 3.7 in a household averaging 5.5 persons, while in the Rangjung project area survey, there are on average 1.4 jobs in households averaging 6.7 members.

In all, the new businesses mentioned above have created 24 new non-family positions, 17 occupied by males and 7 by females. These positions are seasonal, and occupy the persons concerned from four to nine months of the year.

This shows that in the more mature market and the more reliable electricity supply situation of Namche Bazaar, there has been a comparatively favourable impact on the number and variety of employment opportunity, some directly linked to electrification.

However, lack of desirable employment opportunity continues to be a source of social concern, and still results in clusters of mainly male youths loitering in the bazaar with time on their hands. Asked to rank priorities for development and investment, both men and women in Namche Bazaar cited employment as either first or second priority of nine items, (water, food, housing, employment, health, education, electricity, transport, recreation and entertainment). In subsistence-based Trashigang, economic activity is not a choice, but a strategy for survival; both sexes ranked employment 8th, indicating instead priority concerns about water, food, health and education, much closer to the basics in the hierarchy of needs.

No-one instanced loss of employment through electrification. However, the fuel wood porters, often Rai or Magar people from the neighbouring middle hills and Terai, who carry fuel wood in from outside the National Park boundaries must be affected, given the consensus that fuel wood use has declined by about one third since the commissioning of the Namche Bazaar installation.

Impacts on the Household Economy

The advent of electricity has made quite profound changes to patterns of household energy use and expenditure. Baseline data for energy use prior to commissioning of the system is not available, but most people interviewed said they spent less on energy overall now than before. Fuel use patterns reported in the household surveys are shown in the table below. Blanks indicate that no user or main use emerged from the survey results.

Number of Users and Percentage Main Use of Household Fuels				
	Lighting	Cooking	Boiling Water	Space Heating
Candles	33			
Gas	0	9	5	
Kerosene	41	22	16	
Main Use %		*3*	*1*	
Fuel wood	25	59	43	55
Main Use %	*8*	*49*	*56*	*78*
Electricity	56	53	50	27
Main Use %	*87*	*46*	*43*	*22*
Other	6			6
Main Use %	*5*			

Figure 19: Household fuels used in the Namche Bazaar area

Significant is the relegation of kerosene from its former position as principle lighting fuel to that of an adjunct for cooking.

The decline in dependence on fuel wood is dramatic in the short space of five years. Electricity has made an astonishingly rapid ascent as most used fuel for cooking and boiling water in almost half the households surveyed. This is no mere conquest of cost; 46% of heads of households, and 53% of spouses named electricity as their preferred cooking fuel, citing cleanliness and convenience. *Ama Samuha* (Women's Group) representatives from Thamo and Thame complained that when the power supply was interrupted for maintenance, they had to adapt the family menu and their cooking patterns, and were quite aggrieved about this retrogressive requirement. "I lost my eyes", complained the President.

The *Ama Samuha* calculated that non-commercial households spend about 7% of their cash income on average on electricity, and believe that 60% of their energy requirements are now met by this resource.

Fuel wood may not be taken from living trees in the Park, and costs around 10 NRs per kilo to import from the now depleting buffer zones. Average wood-cooking household use is around 10 kg per day, giving expenditure of up to NRs 3,000 per month if commercial fuel wood is used exclusively. Most families say they gather and do not buy wood, but in fact, 63% hire labour to fetch the wood, which they then regard as free.

A wood porter typically costs NRs 150 per day. The wood, around 30 kg per day/load, is included in this price. Monthly costs, assuming usage of 10 kg per day, are around NRs 1,500. The wood porter is sometimes a family employee, undertaking other duties

such as herding on non-wood portering days. Some families hire a porter to work solidly two to three months in the off-season to deliver the year's wood supply.

By comparison, households reporting cooking mainly with electricity are for the most part Level 3 consumers, spending only NRs 600 per month on electricity. This includes lighting and other uses.

Also significant is the use of electricity by somewhat less than one quarter of the sample as their main source of space heating, notoriously the hardest use to displace fuel wood, with its appeal of flickering flame, and its association with warmth, hospitality and sociality.

The case history below illustrates one household's experience of impacts of electricity on the household economy.

Case History

A family of five in Khumjung are now Level 3 consumers, paying a fixed NRs 600 per month for electricity. The house is lit with electricity, and they have an electric cooking coil and a blender. They now use almost no fuel wood, since it is quick and convenient to cook on the coil, and they have learned to plan the cooking so that one is enough. Sometimes the children gather dung that they use in the old stove for extra warmth. They do not miss the appearance of the fire; it was smoky and made everything dirty, and besides, the house is now so bright.

Before they were connected, they used wood for some of their light requirements, and for cooking and heating. It cost them NRs 100 per day for the labourer they employed to fetch it. The house was lit elsewhere with kerosene wick lamps. Supply was sometimes short; they eked it out, using only about two litres a month, at a cost of NRs 50 per litre. Their total monthly energy cash cost was usually about NRs 3,100 per month. Their costs are now 20% of that sum.

The impact on the budget is not the only change; they have good light, and the house feels more spacious and pleasant. The children are learning better, and everyone feels more energetic and inspired to work since they had electricity. Their health has not really changed, but they feel better.

Social life has changed; before the youngsters used to gather in houses in the evening, and sing and dance. This has diminished; they are doing more homework.

But cultural and religious life are easier. There is lighting for festivals, and the lama can come at night now, and stay longer because there is good artificial light. The family remembers the old dark days, and wants to express thanks for the electricity that has given them new eyes.

…End of story…

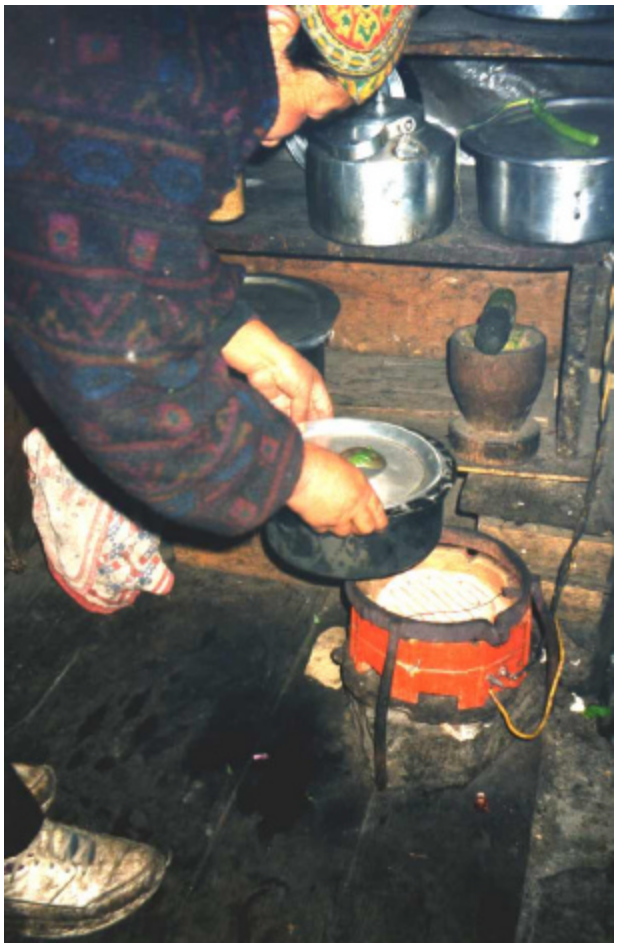

Figure 20: Locally available hot plate or electric coil in a local home

Electricity is correctly perceived as offering very good value for money in the household budget, and as being no longer a luxury, but a necessity of everyday life. In addition, there have been changes in the time spent fuel wood gathering; 78% spend less time, 19% the same, and only one household reports spending more time. In some cases, time has little opportunity value, but as seen from the number of sources of earnings per household in this area, people put “spare” time to economically productive use.

Ownership of Electrical Appliances

Ownership of electrical appliances is a good indicator not only of electricity use, but also a surrogate measure of affluence where it is difficult to obtain data about household income and expenditure. Householders recorded appliance ownership and use as shown in the Table Figure 21.

The penetration of consumer durables shown in this table is the more remarkable for the fact that there are no appliance service facilities in the project area. Appliances that fail are frequently simply written off, and the owner purchases a new item. No instances were reported where a failed appliance was not replaced with something of a similar function, suggesting that people value the qualities the appliance confers, and are willing and able to spend considerable sums and take quite heavy risks to secure those advantages. Namche Bazaar consumers did not indicate in the household survey that they find appliance expensive.

Ownership of Appliances		
Item	**Number of owners**	**Percentage of sample**
Light bulbs	30	100
Tube lights	30	100
Radio cassette deck	22	73
TV	11	37
Fan	4	13
Refrigerator	7	23
Space heater	13	43
Water heater	20	67
Hot plate, cooker	22	73
Iron	8	27
Mixer, grinder, blender	19	63
Power tools	1	3
Other	5	17

Data Source: Household Surveys, October-November 2000.
Sample size: 30

Figure 21: Ownership of electric appliances

Health Impacts

Impacts on health can be considered under two main headings, delivery of services, and health outcomes. Both are reported to be positive.

The project area is served by a hospital funded by the Hilary Commission in Khunde, Khumjung VDC. At the time of its foundation, Khunde was the largest village in the area, but has now been somewhat overshadowed by the more strategically located Namche Bazaar VDC and Khumjung village.

Though its location is not ideal for the main commercial hub, the hospital is very well appointed. It has always had electricity from a stand-alone generator, but had insufficient capacity to run all services simultaneously. It also has solar panels to lighting and water heating.

The hospital is equipped with and x-ray machine, 2 oxygen concentrators, and operating lamp, power microscope, ECG apparatus, ultrasound machine, incubator, opthalmascope and centrifuge. Connection to the Namche Bazaar system has enabled the hospital to acquire and run recent electrical equipment arrivals: a new electric-kerosene refrigerator for vaccines, a domestic refrigerator-freezer, a computer, microwave oven, oil filled heaters, an electric oven, water heaters, TV, video, a slide projector and a telephone.

There is a resident doctor and her family, and 3 local staff – a qualified nurse and two medical assistants, who serve a population of about 10,000 in the hospital catchment area.

Since the arrival of the minigrid, the hospital uses electricity for cooking, heating water and space heating, displacing the old coal/wood range that used to perform this func-

tion. Laundry is washed by hand using hot water, and dried in the sun to assist sterilisation. Rubbish, including surgical waste and sharps are disposed of on the “three B” system; burn, bash and bury.

The arrival of a reliable electricity supply has enabled the hospital to speed up throughput of the 30-50 patients who are present each day, as they can now see more than one patient at a time, and use more than one item of diagnostic or treatment equipment simultaneously.

The impacts of electrification on health outcomes are difficult to quantify as the hospital has not yet computerised its records, but staff assert that there is a change in the cases they see; they note that women under 30 do not squint like the women who grew up and cooked in smoky kitchens, and though upper respiratory infection is still prevalent, it is predominantly males suffering the effects of tobacco smoking rather than females suffering the effects of wood fires in the home.

Since the hospital opened in 1966, the birth rate has dropped from around 8 children per family to around 3, though this is not necessarily only an impact of electrification. Home birth is still the norm; around 15 babies per year are delivered at the hospital, and the presence of reliable electricity helps to make the service safe and readily available at all hours. The average age of death is considerably higher than the 52 for males and 54 for females averaged in the rest of the country; local people die on average in their mid to late sixties.

Education Impacts

With partial electrification of the school, dramatic changes have occurred to living, teaching and study conditions for both staff and students. Educational outcomes are also improved, with motivated students achieving better results, and students tending to remain longer at school as it attractions increase and the benefits of education are better known.

Case history

“Revolutionary changes” have occurred in education since electrification, says the Principal of the Khumjung High School, the only school in the two VDCs. The school offers Grades 1-10 education to 330 students, of which about 40% are female. Some 20 students are resident in the hostel, living too far from home to travel daily. The students from Namche Bazaar walk an hour or more each way over a saddle 3900 metres above sea level to attend school each day. Schooling is free, and the teachers distribute pens and books to the 20% or so needy children.

There are 11 classrooms, and 15 salaried teachers, most of whom are seasonal residents rather than locals. Prior to electrification it was hard to recruit and retain teachers, as the area is remote and offers few comforts. Teachers had to buy kerosene and collect fuel wood. A welcome outcome has been that now that the school is electrified, teachers have electric light and cooking facilities, better food, a radio cassette recorder, television for videos. Recruitment has ceased to be a problem, and they can read, prepare and mark lessons at night.

Figure 22: The Head Master of Khunde High School with an array of Media Equipment

Four of the eleven classrooms have electric light and power points, so the students can use videos for language and other training. The science laboratory has no electricity; one of the school's development plans is to electrify and warm all classrooms. Electricity has also made possible listening to the radio. This has proved very beneficial to learning; before, the children "did not know their own language and culture".

The students do not work much at household tasks at home, and most do their homework. Motivated students are performing better with the enhanced opportunities to study afforded by electric light; some are not interested and show no particular improvement.

The school leaving age seems to be higher, as parents and students are more aware of the needs for education. Most now leave at age 16 or 17, though girls tend to leave on average two years earlier than boys. The ratio of males to females becomes progressively higher in the last three or four years of schooling.

When electricity first came to the area, there was no particular teaching module to assist consumers to know about safe use, though the physics course contains some information. KBC distributed posters and gave some consumer education. Fortunately each home has an ELCB, which prevents accidents, and now people understand better about electricity, and learn at home.

A welcome development with electrification was the possibility of offering non-formal education in the evenings; many residents over the age of 40 had no educational facility available, before the School opened, and are now attending basic literacy and numeracy courses.

Environmental awareness is part of the school curriculum, and has increased since electrification. With it has come the ability to respond to environmental concerns. Even the simplest households are now using electricity not only for lighting, but also for cooking. Electricity has transformed education not only in the school, but education in the wider school of life.

…End of story…

Cultural Impacts

There can be no doubt that cultural, social and spiritual life have been affected not only by electrification, but also by the onslaught of outside influences that were in part responsible for the urgency for electrification.

Local people are resolutely positive about the nature and impact of these changes, and speak in terms of the new windows opening on to the world as reinforcing their confidence in their culture and customs, and of electricity specifically assisting them in the expression and preservation of their way of life. Only one person expressed offence about what is heard on radio or seen on TV.

The Chairman of the Monastery Society commented favourably on impacts on the religious life. Conditions are much easier, now, in the Gompa, especially in the kitchen, and in the availability of good light and pumped water. Before, during the major festival week, the monastery employed 10-15 people who worked all day every day carrying water 20-30 litres at a time from Namche Bazaar up to the Monastery, a vertical climb of about 400 metres. Water can now be pumped from the public supply, and this enables the monastery to focus on the religious aspects of the celebration, and frees them from logistical concerns of caring for the health safety and sanitation of the hundreds of guests and pilgrims who attend the festival.

The Gompa has electric light, a blender, and occasionally uses a rice cooker, though most cooking is still done with fuel wood donated by the village faithful. Before, they used pressure lamps run on kerosene donated by the villagers. At festival time, they required three or four pressure lamps for five to six hours daily, using about 1.5 litres each per day. When the lama was by himself he used a simple wick lamp, and used only 3-4 litres of kerosene per month. The Gompa is a level 3 electricity consumer, and the monthly charge of NRs 600 is met out of its own budget.

The impacts of electrification are as good as they are bad. There is a tendency for youth to be less interested in religious observance, but they come back to it as they mature.

Changes in social life see young people in the last two year in pool bars, which aggravate the tendency to gamble and get in to financial difficulties. There is also some noise disturbance down in the bazaar, especially associated with alcohol consumption., but this is nationwide phenomenon, and is only incidentally associated with electrification in his view.

The lama agrees that there has been change to cultural life, but sees this as part of the wider phenomenon of globalisation that requires management in terms of preservation of cultural identity.

Sociality has also generally increased since electrification; people visit each other in the evenings, because the light in homes is brighter, they can share entertainment, and street lighting helps them to see the way safely.

The police say that their job is facilitated by street lighting. The communities are on the whole law abiding, and the worst problem they face is usually local youthful drunkenness and disorder. Trekkers do not generally cause any offence or disturbance.

The President of the Sagarmatha Club, a youth group with mainly young male membership, states that the cultural impacts of electrification have been wholly beneficial from their standpoint. The Club practices song and dance, and puts on small shows in the Monastery, or larger programmes in a tent on the school grounds. During Visit Nepal ’98 year, they staged a concert for which an admission charge of NRs 100-150 was made, and they raised NRs 15,000 for activities. These include assisting students with

education expenses, running an AIDS awareness campaign, and participating in environmental clean-ups. They need electricity for sound and light to stage such cultural events. The group has made a CD of Sherpa song, which would never have been possible without electricity.

Maintaining the membership of the group is a problem, as many members leave the area to study. They believe that the presence of electricity and the cultural stimulus this facilitates is a factor in getting local people to return and participate in their own culture and society.

Both young and old, lay and religious in general reject the idea that their identity and culture is under electrical siege, and express a determination to harness electricity to their own cultural ends.

3.4.7 Gender aspects

Question Q7: How do the impacts compare in terms of gender balance? How has the work load of women and children changed? In what way have gender aspects been considered in design and implementation of the projects? What gender specific support mechanisms have been developed?

While gender considerations were not part of the implementation design brief, women do not feel that they were excluded from decisions in which they should have participated, and on the whole consider themselves to have been winners from the process of electrification.

Questions in the household survey about development objectives of the head of household and spouse of the head of household reveal harmony in setting priorities between head of household and spouse. In general Sherpa women identify strongly with their roles and exercise a greater degree of independence and self-determination than women of most groups in Nepal. The table below sets out relative ranking of development priorities. In most cases the head of the household is male.

In no case are the rankings more than one position apart. Electricity supply takes its place in the middle of the field, reflecting perhaps that people feel that basic livelihood and infrastructure are secure, and are looking to development of quality of life improvement.

Women did not express frustration over any aspect of electricity supply through the household surveys, though as businesswomen managing shops or lodges, and through the *Ama Samuha* they protested about the losses and inconvenience caused by seasonal maintenance outages as vociferously as their male counterparts.

Figure 23: Women of the Thame Women's Association being interviewed

Women participate fully as family members in the income generating opportunities that electricity has brought. Some enterprises are run by women; a bakery, a pizza hut, laundry service, shower and sauna service are all run by women who either live locally or have local matrilineal connections. Men, however, outnumber women four to one in new jobs held by non-family members.

Ranking of Development Priorities		
Item	**Head of House-hold**	**Spouse of Head of Household**
Water supply	4	4
Food production & prepara-tion (cooking)	7	8
Housing improvement	6	5
Employment opportunities	3	2
Health services	1	1
Education services	2	2
Electricity connection / supply improvement	4	5
Transportation facilities	7	7
Entertainment and recreation	9	9

Data source: Household surveys October-November 2000

Figure 24: Ranking of Development Priorities

Women work longer since electrification, but still say that they have enough time for themselves. A third of household respondents say they do housework and handcrafts in the evening, while three quarters say they talk, read, watch videos or listen to the radio.

The local women's group has been running for three years, and participates in religious festivals, runs a credit and savings programme for members, has kitchen garden and livestock raising programmes, and cooking courses for lodges. Electricity has facilitated their festival participation, and has changed and eased their cooking patterns. One of the more popular appliances is the kitchen blender, which is rapidly displacing the traditional butter churn used to make butter for special Tibetan tea. The appliances that feature in electrified household have a heavy bias towards women's labour saving.

Both sexes state that electricity supply is of highest importance to them. Most of all, (83%) they value the labour saving that has occurred, but also prize the health improvements through not having such smoky houses (37%), and the entertainment they can now enjoy (27%)

While both sexes unequivocally enjoy having and using electricity, it has probably contributed most to improvements in the quality of women's lives.

3.4.8 Environmental impacts

Question Q8: How were the sensitive ecological conditions and consequences taken into account and what measures for resource protection have been taken? What are the direct and indirect impacts of the energy supply through hydropower on the conservation of the natural resources (in the project area and downstream) and in the energy balance of the households, esp. fuel wood harvesting?

Background

In the past, the Khumbu area including the present project area was under dense forest cover. The old name of "Nauche" implies a "dense forest" in Sherpa dialect. The original area under forest in the Khumbu area is estimated at 5,500ha. Today, the relatively dense forest comprising natural stand, planted and regenerated ones is limited at only a few localities such as "Pare ko jungle" across Thamo, Phortse , Syangboche near "Everest View Hotel" , and Namche-Lukla corridor along the river banks of Dudhkoshi and outside the national park area.

Fuel wood is today obtained from forests mostly lying outside of the national park and some lying within the protected area permitted collectors. There are no private plantations. Generally fuel woods are collected during the spring and summer season. With the advent of electricity supply, the traditional pattern of energy use characterized by the heavy dependence on fuel woods has changed. In addition to the use of electricity for cooking and heating, alternative fuels are used increasingly, such as kerosene and bottled gas. The widespread use of thermos flasks, and the adoption of insulation in newly constructed houses adds to the wood substitution effect.

Loss of land and land use changes

For the construction of the Thame small hydro-electric plant, the major structural works of intake and powerhouse were constructed on barren and public grazing lands. There has been no loss of productive farmlands and houses. Due to the "run-of-river" scheme, no inundation has taken place, and burying of the penstock pipe and transmission lines along the open trail, and trimming instead of felling of tall trees along the alignment of the transmission line, there has been a minimal negative impact.

Also, there is no land use change that could be attributed to the electrification of the area.

Environmental Survey

An environmental survey has been carried out by the evaluating team's environmentalist. His main findings follow:

As there is regular supply of water from the spring catchment and from the Thame khola, there exist no chances of the river section going dry. This was confirmed by looking at the data of stream gauging by KBC.

Altogether 10 microinvertebrates river fauna species, 11 aquatic plant species have been identified in different sample sites. There was no record of fish species and submerged, floating leaved aquatic species. The average population estimation of river fauna indicated insignificant differences at sample sites above and below the power scheme, and at alternate sites.

In relation to the composition and distribution pattern of aquatic flora, comprising periphytons, aquatic moss and filamentous algae; samples taken at different sites also indicated insignificant environmental impact from the Thame hydropower plant on the river ecology and biodiversity status of the project area.

Status of erosion problems

The number of landslides in terms of gulleys and signs of overgrazing was found higher at the powerhouse site, the intake upstream, and at the downstream outlet, and relatively less in the access road and transmission line. This can be attributed to the impact of the GLOF in 1985 in Bhotekoshi river. The Thame stream is erosion prone and consists of relatively loose, calcareous moraine deposit soils in river bank sides, and it has sparse vegetation cover.

The fragility status of the access road site joining the intake and powerhouse site features relatively fewer gulleys/landslides and signs of overgrazing This implies relatively sound soil and water conservation and grazing management.

The transmission line alignment features a marginal extent of habitat disturbance and cases of overgrazing. This can be related with good forest management and adoption of environment friendly approaches during the construction phase.

The hillside and steep slope between the power plant intake and the powerhouse have been replanted almost completely. The entire area is fenced in to protect it from grazing cattle and mountain goats, and notice boards are in place to keep people out.

However at places just like near Phurtse along Namche-Thamo trail, in upper reach of eco Himal constructed Thame trail, there has been extensive quarry work to the extent that the local trail is damaged. This was done with permission of the Sagarmatha national park authority. Evidently, this indicates inadequate monitoring from concerned park officials. As the project area features more problems of wind induced rather than rainfall induced soil erosion, there is a need of adequate ground cover and shelterbelt plantation of tall trees such as silver fir and blue pine which are fast growing.

Impact of electricity usage on fuel wood consumption

Traditionally the forest of Khumbu area has been serving as a source of fuel wood and construction timber. The use of fuel wood is still persisting for cooking and room heating but in substantially reduced quantity among the electricity users. Protection of the National Park is much easier to implement since the advent of electricity.

Systematic reforestation

Started as a measure to correct scars from the construction period, reforestation has become a regular activity of KBC itself. A tree nursery is maintained with three full-time staff, and most construction damage is today overgrown with new trees. Reforestation of other areas is going on in collaboration with the village communities and with the Thame Valley Development Project.

3.4.9 Sustainability of project institutional structures

Question Q9: Which measures to achieve viability and sustainability of interventions have been taken? How far have relevant institutions and capacities been developed?

The Namche SHP functions well under the management of KBC, despite a number of remaining flaws in the design and quality of civil structures and installations. KBC is technically capable and motivated to maintain and operate the scheme. This is substantiated by the fact that also difficult repair jobs were carried out without outside assistance in the past year.

The Namche SHP has not achieved sustainability in financial terms so far

Sustainability may be judged by the success of KBC. If it is surviving and doing well financially, the project is sustainable. In financial terms, the operation of KBC is still critical. In the five years of operation, it has not been possible to develop the load factor to its maximum, and income from electricity sales is still relatively small. Depreciation, the main financial instrument to build up reserves and thereby attain sustainability, has not been possible at all so far. KBC sees itself in a very difficult situation in this area. Raising tariffs is very unpopular with consumers and meets with opposition. Also, it compromises levels of fuel wood substitution achieved.

Required earnings for financial sustainability

As mentioned above, KBC must be in a position to depreciate its assets in order to become sustainable. Depreciation will not guarantee sustainability, but in accounting terms, it is a first necessary step. To make depreciation possible, earnings must be much higher than at present.

An attempt is made here to show what the financial requirements are to establish a long term sustainable operation.

The assets of KBC are in the books with an amount of roughly NRs. 140’000’000, including “under construction assets”. This is equivalent to approximately ATS 28 Million[14]. A first problem is here, that assets are much lower than the cost of the project which stood at about ATS 50 Million for equipment, transmission and distribution. Another problem is that on the basis of Nepalese currency, replacement cost will ultimately be higher than original cost due to continuing inflation. Nevertheless, in terms of accounting, depreciation must be done on the basis of the book value of the assets.

There are different methods of depreciating which is not important at this point. However, what is important is a realistic time frame for full depreciation. 25 years is a life time often used for this purpose for small hydro schemes. With the straight-line depreciation method, this simply results in a depreciation rate of 4% per year. (100/25). The amount of depreciation which results from this is NRs. 5,6 Million, which must be covered by earnings.

[14] calculated with an exchange rate of 0.2 ATS for 1 NRs.

In addition, to account for the difference between the book assets and the actual value, KBC must generate profit/reserves of about an amount which is equivalent to depreciation. This adds up to a total cash-flow of about NRs. 10 Million. If it is possible to do this, KBC would accumulate reserves on the order of 250 Million over a period of 25 years. This amount could then be used for replacement of the entire scheme after 25 years, or a part of it at an earlier date for partial replacements.

At present, on the basis of the first two financial years of independent operation, the cash flow that KBC generated was roughly NRs. 1 Million on average. In the most recent financial year, ending in July 2000, cash flow generated amounted to around NRs. 3.5 Million, an increase by a factor of about 3. It is assumed that this is a result of the massive tariff increase at the beginning of the financial year. In the years to come, it must increase its net earnings again by a factor of about 3 to 4 to achieve full financial independence and sustainability.

The implications of this are serious, because only two means are available with the present plant to increase earnings: a) increasing the quantity of electricity sold by increasing the overall load factor, and b) increasing tariffs. A third means of increasing income is new activities, such as the water supply scheme. In fact, this has already contributed roughly half a Million Rupees to last years earnings for 9 months of operation.[15].

The load factor stands at present at about 41% overall. On the one hand, in technical terms, a large potential exists to build up the load factor, broadening the income base. A combination of technical measures (remote control load switching) and administrative measures (tariff differentiation) will enable KBC to effectively pursue load development. On the other hand, the discontinuity of the tourism trade over the year will also set limits to full use of the generating potential. It is unlikely that the present load factor can be more than doubled. This would nearly double the income to about NRs. 6 Million at today's tariffs.

From this follows that tariff increases and other measures would have to result in earnings of about another 4 Million. In the light of this, it is fair to say that, from the point of view of financial sustainability, the average price of electricity that is paid to KBC is much too low. It would have to be almost doubled as soon as possible, and inflation adjustments will have to be done periodically.

At a level of sales of roughly 2'000 MWh, KBC has realised gross earnings of NRs. 3.73 Million, according to the profit and loss account of the financial year that ended on 16 July 1999[16]. The resulting average price of electricity was therefore NRs. 1.86/kWh, about equivalent to 2.5 US cents per kWh. This is less than almost anywhere else worldwide! It explains, why income today is insufficient and why this is ultimately not sustainable.

Solutions

Answers to the problem are difficult but not impossible to find. New activities that are supposed to generate additional income like the drinking water supply scheme, have already shown some potential, as per the most recent information received. Tariff increases to the tune required will be difficult politically. However, the commercial tariff charged is still well below NEA rates, and a part of the answer is to work on the persistent transformation of non-metered consumers to metered consumption. To a degree,

[15] Income and cost information for the last financial year (mid 99 to mid 2000) is from KBC, dated March 2001, as a reaction to the draft report.

[16] This was the most recent reliable data at the time of the evaluation

higher tariffs will jeopardize wood substitution levels achieved. The process therefore has to be a cautious one.

However difficult it might appear to achieve the stated earning objectives, there are only two choices: a) achieve income levels shown as soon as possible, thereby becoming economically viable, or b) subsidise the operation of KBC in the long term. A realistic outcome is most likely somewhere between the two extremes. A considerable increase in income to a level that is still below the 100% target will permit partial depreciation and reserve accumulation and a subsidy of operations may not be necessary at all. It is conceivable that wealth accumulation that takes place in the project area, not in the least because of the opportunities that electricity opened up, can be invested in renewing and replacing the power plant in the long term future.

Institutional sustainability

Sustainability may also be judged by the stability and quality of KBC as an institution. KBC appears to be well established and well run on the operative level. On the level of strategy and long term business development, and in view of the gigantic task ahead as outlined above, it lacks active leadership. The role of the board of directors remains ambivalent. Given the existing set up, where consumers are represented in the board of KBC, it is difficult to see how these representatives could possibly identify fully with company interests rather than opposite consumer interest.

3.4.10 Project Steering

Question Q10: How effective have been the steering measures and the backstopping of the HQ and the co-ordinating offices? Which conclusions can be drawn from this for the steering of similar interventions in future?

Steering measures and backstopping have been adequate, otherwise it is unlikely that the project could have been brought to a successful end. It has become evident from the study of documents over the period of project implementation, that personal continuity from the side of HQ has been a big asset. Only with this was the required persistence possible. The task of BMfaA was made difficult by the lack of direct local and permanent representation. This may have been cost effective, but not ideal in terms of obtaining first hand critical information. It could only work on a basis of trust in the institutions to which all activities were delegated. It also implies that the steering role was reactive rather than pro-active, because action could only be taken as and when critical information was provided.

Lack of reporting cost information

Largely, HQ had to rely on periodical reporting. In this connection, no evidence could be found during the study of documents, that budget and cost information was supplied on a regular periodical basis. It is the evaluator's opinion that such information would have been an important component of reporting, and it would have made controlling more effective. Besides, it is exactly this requirement that is prescribed in the terms of contracts[17] awarded by the BMfaA.

The conclusion is that reporting of the current budgetary and cost situation should be integrated into regular reporting in projects of considerable complexity. Concurrence with contract clauses should be checked, and in case of non-compliance, corrective action should be taken.

[17] document referred to: Förderungsvertrag EH-Projekt 908-01-93-03-660-240-Nepal, …., Absatz 4.3.2

Contract documents are important

In a situation where all implementation activities are delegated through contracts, contract documents, from initial tender to supplier's and consultants contract agreements, become enormously important. In a legal sense, contractors need to fulfil what is stipulated in the contract; no more and no less. If the contract is superficial, incomplete or faulty, it is difficult or impossible to obtain top quality supply of goods and services. Also, legal recourse in case of suspected default is very troublesome and it may fail altogether due to a lack of specific stipulations.

Suppliers and contractors[18] agree that good contract documents are important but feel that specifications were in order. Checking the fulfilment of specifications is a process that starts with acceptance checks at the works of the supplier (Werksabnahme), and ends with acceptance of the installed equipment during commissioning. It did not become clear during evaluation what exactly were the results of this process. Apparently there was some gap in the procedure, either in actually carrying out the necessary steps, or in its documentation, or possibly both.

3.4.11 Lessons Learned for Sector Policy Development

Question Q11: What role do such interventions play in the development of a sector policy (of the Austrian development co-operation)? Which conclusions and recommendations can be drawn?

Lessons may be learned at various levels, but not all are naturally of the same relevance.

Impact of the intervention

Electricity supply to rural areas can assist development activities and can substantially improve living conditions. In Namche Bazaar, numerous economic development opportunities have opened up on the basis of electricity and the growing tourism industry.

Small hydropower is the most effective means of electricity supply in Nepal. Cost-wise, it appears that large hydro and micro hydro plants to have some advantage over small hydro.

Interventions in the field of small hydro for rural electrification require a long-term engagement (>15 years), especially in a situation where the institution building task finds itself in a pioneering role.

The example set by Austria with the Namche SHP was adopted at the national level. The Ninth Development Plan largely mentions the principles of the Namche institutional set up as the formula for future remote rural electrification.

Negative environmental impacts were kept in check, mostly by the reforestation activity which became a part of the project.

There is a positive environmental impact of the project in terms of fuel wood substitution at the household level and in the tourism industry. However, sustainable levels of fuel wood use cannot be brought about through electrification alone. In addition, energy saving measures in cooking and space heating are required. General economic development with an increase in purchasing power will help most. People will naturally switch to modern fuels when their opportunity costs for the long hours of firewood gathering exceed the costs of the modern, commercial fuels.

[18] Statement based on interviews with Messrs. G. Geppert of Geppert & Co., and B. Jud, of Fiegl + Spielberger

Policy Level

New interventions bear a lot of risk in terms of commitment required

The interventions for the implementation of the Namche SHP have been new in terms of current activities of the BMfaA at that time. The original intention for the project (to build a small hydro scheme) was very different from what the BMfaA ended up with after almost 25 years of interventions. The lesson learnt is that projects of such complexity as remote rural electrification require persistence and the means to see the intervention through. The partner is often weaker in terms of available resources. This implies that unexpected requirements will usually fall back on the donor.

A comprehensive and multi-level approach is advisable

A considerable number of other small hydro schemes in Nepal (and elsewhere) are today on an institutional basis that is by far not as solid and sustainable as the Namche Bazaar scheme today proves to be. To achieve this better result, Austria had to make inroads into areas such as local ownership and institution building. “Difficult” objectives such as democratisation for example, cannot be achieved in volatile political situations as were met, with a superficial input. This is probably also true for all other objectives in the human resource/social sphere. The lesson learned towards sector policy development derived from this is: Interventions that have a significant impact need to be comprehensive. Interventions cannot be limited to the level of the project but have to be extended to the policy level.

The time required to achieve success is often underestimated

The time requirement for interventions in the areas of infrastructure and institution building cannot be stressed enough: The intervention in Nepal carried on for almost 25 years. Other examples show that significant results require 10+ years. On the other hand, the government budgeting process is typically on a yearly basis and this results in an inadequate planning outlook. While the solution to this problem is beyond sector policy, the lesson learned is that a very considerable time requirement must be made clear and understood on all levels, and that the issue must be addressed on a higher level.

Considerable human and material resources are required

The previous lessons make it clear also that considerable human and material resources are required. Also, professional and social skills required of personnel engaged are considerable.

Setting priorities

Looking beyond the Namche Bazaar project, at the entire sector, it is relatively easy to conclude broadly that the Namche SHP, perhaps on a par with the Swiss Salleri SHP are among the “best” in the country. Both interventions were of a long term and comprehensive nature. Other donors have tried superficial interventions, for example by supplying various sets of electro-mechanical equipment, without any further intervention. These approaches have failed, not only in Nepal, but also elsewhere. Since resources are likely to be scarce, and on the basis of the negative experience of others, interventions of a long term and comprehensive nature should take precedence over short-term and superficial interventions,

Project Steering Level

Context appropriate decisions and flexibility

Flexibility and openness to new issues coming up has been a constant feature of the interventions, and this was necessary to achieve project success. More adherence to pre-conceived principles would most likely have done more harm than good. The lesson: Flexibility will be required to be able to act appropriately in the specific context.

Effectivity: Streamlined procedures and short reaction time

There are many reasons why interventions of the nature discussed here take so much time. Most of these factors, however, are outside the sphere of influence of the donor. The only area where the BMfaA can possibly make a difference is by streamlining its administrative procedures as far as possible, and by making sure that personnel on the various levels have the capacity to attend to matters on short notice.

Efficiency versus control

The implementation of engineering projects classically involves supervision and execution tasks assigned to different professionals and institutions. In a large scale project, this involves a number of different specialists, each with a specific task. In small projects such as the Namche SHP, for reasons of cost, different tasks need to be executed by one single entity. The issue is here whether it is permissible to assign different roles to one entity, particularly the supervision and the execution role? Strictly speaking, the answer in no, because it implies that supervision of one's own work cannot be impartial. However, in the implementation of the project, this is what happened. The consulting engineer (supervisor) had to begin organising and subcontracting transportation tasks, thereby moving into the role of the implementer. This was efficient, but control was lacking.

When Eco Himal "took over" the project, it was assigned the role of implementer. It executed all activities on behalf of the BMfaA, and sub-contracted various tasks directly. Again, this was efficient, but the independent supervisory function was lacking.

The lesson learned: Improved implementation efficiency bears the risk of less control. It requires competent and trustworthy partners. Partner selection is therefore of paramount importance. This is in no way meant to indicate that this was not done in the Namche SHP.

Relationship with Austrian suppliers, consultants and others

The award of a supply contract is the basis for the relationship with any supplier. The process consists of the steps *design – equipment specification – tendering – offer evaluation – contract award – delivery check – operational testing and commissioning – various checks within the guarantee period.* Using the "chain analogy": The relationship breaks at the weakest link. Quality and completeness of specifications determine the scope of supply. Offer evaluation and contract award reflect the decision of what was found best, and various checks make sure that the equipment complies to specifications and delivery is complete. It is usually the consulting engineer's task to assist the client in carrying out the process. In the case of the Namche SHP there were some gaps in the process, but it is not clear who's responsibility it was. It is the supplier's and contractor's opinion that specifications were in order. The difficulties encountered had largely to do with stipulations that were inaccurate and too general, which could not have been in the interest of the BmfaA.

The lesson: It must be assured that contracts are very specific and that tasks are assigned in detail. The process described must be followed through from beginning to end. The last step is specially important. Only within the warranty period will claims be honoured by the supplier.