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ECONOMIC AND SOCIAL BENEFITS ANALYSIS OF POWER TRADE IN THE SOUTH ASIA GROWTH QUADRANGLE REGION

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Acronyms

AHREP	Andhikola Hydel and Rural Electrification Project
ASEAN	Association of South East Asian Nations
BoT	Balance of Trade
CBN	Cost of Basic Needs
CIF	Cost Insurance Freight
CNG	compressed natural gas
CMIE	Centre for Monitoring of Indian Economy
CO2	Carbon Dioxide
EPA	Environmental Protection Agency
FDI	Foreign Direct Investment
FY	Financial Year
GDP	Gross Domestic Product
GWh	Gigawatt hour
HMG/N	His Majesty's Government of Nepal
IIP	Independent Power Producer
KV	Kilovolt
KWh	Kilowatt hour
LRMC	Long Run Marginal Cost
MMHP	Mini and Micro Hydel Projects
MW	Megawatt
NEA	Nepal Electricity Authority
NEEPCO	North East Electric Power Corporation
NEI	North East India
OPGW	Optical Ground Wire
PBSs	Palli Bidyut Samitis
PRSP	Poverty Reduction Support Program
PTC	Power Trading Corporation of India
RE	Rural Electrification
REB	Rural Electrification Board
REDP	Rural Energy Development Program
SAARC	South Asian Association for Regional Cooperation
SAGQ	South Asia Growth Quadrangle
SAPTA	South Asia Preferential Trade Association
SITC	Standard Industrial Trade Classification
SMEC	Snowy Mountain Engineering Corporation
Sox	Sulphur Oxides
TFR	Total Fertility Rate
Tk	Taka
US$	United States Dollars
VOC	Volatile Organic Compounds

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INTRODUCTION

The South Asia Growth Quadrangle (SAGQ), a subregion on the eastern fringe of South Asia comprising Nepal, Bhutan, Northeast India (NEI), and Bangladesh, has strategic advantages that favor joint cooperation in regional development. These advantages include economic complementarities, geographical proximity, sociocultural cohesiveness, lifestyle similarities, and lower transaction costs. This subregion is also strategically located for possible trade linkages with the member counties of the Association of South East Asian Nations (ASEAN).

Power trading within SAGQ would create economic and social benefits for all four countries, as discussed in the SARI/Energy prefeasibility study, *Four Borders Project: Reliability Improvement and Power Transfer in South Asia.*

Given the size of its economy, the benefits to India would have a marginal impact on its performance indicators; however, benefits would be more pronounced in those areas of the country where transmission interconnection projects would be built. Accordingly, for the purposes of this report, these benefits have been assessed for Bangladesh, Bhutan, and Nepal in terms of overall economic impact; for India, they have been assessed in terms of their impact on either the eastern and northeastern states or the entire national economy, as appropriate.

ENERGY RESOURCES IN SOUTH ASIA

South Asia possesses vast energy resources, including hydropower, forests, coal, and gas. Despite these resources, per capita energy consumption in the region remains quite low, accounting for 5.9% of world commercial energy consumption. The region's persistent energy shortages have been a major factor in its low rate of growth. A significant portion of the population still does not have access to electricity due to inadequate infrastructure and lack of affordability. Subregional cooperation in the energy sector is seen as a practical solution to many socioeconomic problems.

LIKELY GAINS FROM CROSS-BORDER POWER TRADING

Industrial Production Gains

An October 2003 study by SARI/Energy, *Economic Impact of Poor Power Quality on Industry: Nepal*, found that Nepal's industrial sector loses US$24.7 million annually due to poor power quality. This translates into 4.43% of the industrial sector gross domestic product (GDP) or 0.47% of the national GDP. The study findings indicate that industrial sector losses attributable to unplanned power interruptions averaged US$0.49/kWh, while those from planned outages were US$0.14/kWh. Similarly, power outages in Bangladesh cost about US$1 billion a year and reduce GDP growth by about a 0.5% point.

Financial Gains

Interconnecting the four power grids would reduce the transmission and distribution losses by 90 MW, resulting in a saving of US$79.12 million in investment for new capacity addition. Some of the border areas of these countries could be better served by interconnecting them with the grid substations of the neighboring country, which would further reduce losses. A loss reduction of an additional 50 MW by such interconnections would increase total savings to US$123.08 million.

Revenue Gains

Since India would remain a net importer of energy, only the revenue gains from power trading for Nepal, Bhutan, and Bangladesh have been assessed. In 2002-2003, Bhutan exported 1,472 gigawatt hours (GWh) of surplus energy to India from the 336 MW Chukha project, generating revenue of US$52 million. With the commissioning of the 1,020 MW Tala project, Bhutan's revenue from power exports will reach US$214 million annually. Nepal could earn US$308 million annually from power exports from the West Seti project by the year 2007, which would reach nearly US$1.25 billion by the year 2031. For Bangladesh, the *Feasibility Report on Viability of Power Exports From Bangladesh to India* (SARI/Energy, 2000), projected annual revenue of US$130 million from power exports to India.

GDP Gains

In Bangladesh, the power sector represents 1.3% of GDP and has an annual demand growth rate of more than 7%. If the demand for 1,000 MW of capacity addition is met, the power sector's projected share of GDP will increase to about 2%, and will grow at an annual rate of more than 9%. In Nepal, the *Water Resources Strategy Formulation Report,* prepared by the government of Nepal revealed that, through development of hydropower resources, an annual growth rate of up to 8% is achievable, which would make a major contribution to alleviating poverty and unemployment. It has been estimated that the hydropower sector's impact on GDP would trigger a potential value addition ranging from US$96 million in 2002 to US$1.51 billion in 2027. At the same time, the percentage of value added by hydropower to the total GDP is estimated to steadily increase from the present ratio of 1.5% to 4.21% in 2027. In Bhutan, revenue from the Chukha project represents 11% of current GDP. With the commissioning of the Tala project, revenue from hydropower may grow to 36% of GDP.

Foreign Exchange Gains

Regional power trade can be a significant source of foreign exchange earnings for SAGQ countries. For instance, in Nepal, an estimated 9,000 GWh of energy will be available for export in 2010-2011. With a royalty of 10% on export of energy and a US 5.12 cents/kWh export price, royalty revenues would total US$46 million for the first year of operation. Bhutan's earnings from power exports will reach US$142 million annually on commissioning of the Tala project. Bangladesh would earn US$130 million per year from the export of power from a 375 MW gas-fired plant, per the *Feasibility Report on Viability of Power Exports From Bangladesh to India.* Power trading within SAGQ would help reduce regional foreign exchange outflows, as availability of electricity would help them reduce dependence on petroleum and petroleum products.

Rural Electrification Gains

Accessibility to electricity will boost agricultural productivity, triggering a range of off-farm activities. It would also slow rural to urban migration and reduce associated sociopolitical instability. Economic development and its attendant spinoff benefits, such as food security, better health, and improved literacy rates, would be additional gains. The sociopolitical instability, tension, and insurgencies that have plagued the region can largely be attributed to resource disparity, poverty, and economic inequalities. Regional inequalities and underdevelopment has been a major source of internal conflict. Nepal's insurgency, which caused the country's GDP to shrink by 0.6% in 2002, originated in districts that lacked basic health, educational, and transportation services. Improved electricity access would energize the entire socioeconomic process, mitigating regional disparities, reducing internal stress, and promoting better governance. Rural electrification accelerates economic development and creates markets, enhancing interaction between villagers and urban dwellers. This process also promotes new relationships between various ethnic groups and contributes to better social integration.

Gains from Trade

Export of goods and services is a major driver for regional development. Power trading would encourage trading in other commodities, changing the composition of the export baskets of power exporting countries and helping to address adverse balance of trade and balance of payment issues. The additional income from power exports and enhanced level of economic activity can be invested in social infrastructure. Customs revenue continues to be a significant share of total tax revenue. For Nepal and Bhutan, it is 32% and 26%, respectively. Bangladesh's foreign trade figures underscore the high cost of importing petroleum products and the increasing demand for energy, both of which could benefit from value-additions and natural gas-based power exports.

GENERAL SOCIOECONOMIC BENEFITS OF INDUSTRIAL ELECTRICITY USE

Gains to Farmers

Regional power trading using increased electricity supply will boost agricultural production, trigger a range of off-farm activities, and lead to a number of industrial and entrepreneurial activities. Tertiary sector opportunities would generate more employment and income.

Poverty Alleviation

Providing access to electricity helps alleviate poverty by generating employment, and increasing the incomes of the poor. This results in increased savings, progressive patterns of food-non-food expenditures, higher educational and health expenditures, and increased control over asset building. Electricity access can significantly influence the shift of a household from the poor to the non-poor category. When electrified households are compared with non-electrified households, it is evident that electricity access reduces poverty by enhancing literacy, providing opportunities for better education and health care, and enhancing the empowerment of women.

Rural Asset Building

Land ownership in Bangladesh is less skewed in electrified than in non-electrified villages. The lowest 40% of electrified households owns 3.7 % of total cultivable land, whereas the lowest 40% of the households in non-electrified villages owns only 1.6%. During the past 5 years, increases in land ownership by the lowest 40% of households were more pronounced in electrified communities.. Similar changes were evident in the ownership of other capital assets: dwelling/non-dwelling rooms, agricultural equipment, and household durables.

Impact on Health

Electrification has helped the rural population to have better access to information on health and sanitation. It has also encouraged establishment of private hospitals, clinics, diagnostic centers, and pharmacies in rural areas.

Impact on Education

Electrification has significantly contributed to promoting technical and vocational education. Double shifts and adult literacy courses have been started in some electrified schools. Computer training has been introduced. Science students participate in practical work. Electrified households enjoy higher overall literacy rates and school enrollment ratios than their non-electrified counterparts. Educational expenditures, examination results, attendance rates, and average study times are also higher in electrified households.

Demographic Impact

Population growth rates in electrified households are lower than non-electrified, as is evident from their comparatively low total fertility rates. The total fertility rate of poor electrified households is 26% lower than poor non-electrified households, and the survival rate is higher. The dependency ratio is less pronounced in electrified than in non-electrified households. Migration to electrified villages is more pronounced due to the availability of electricity and associated modern amenities.

Empowerment of Women

Women and girls are spared the drudgery of collecting firewood. The time saved is used for engaging in income-generating activities. Women have become more confident and assertive through leadership training, non-formal education, and income-generation activities. Mobility of women has increased considerably as a result of their involvement in community activities and participation in decision-making.

EMPLOYMENT OPPORTUNITIES

GDP Growth

At an 8% hydropower-led GDP growth rate, Nepal expects that, in the final year of the Tenth Plan (2002-2007), about 352,000 new jobs will be created and the unemployment rate will decline to 3.38%. Similar impacts are expected in the other countries.

Rural Electrification

In Bangladesh about 1.1 million people are directly involved in farmlands using electricity-driven irrigation pump sets. Currently, 63,220 industries using electricity employ 983,829 people. Electrified industries generate 3.3 times more employment on average than do non-electrified industries. Retail and wholesale shops using electricity employ 848,630 people. Palli Bidyut Samities directly employs 16,223 people. In addition, rural electrification has had an enormous spillover effect on employment in various support services

Power Projects

A study estimates that addition of 150 MW power to the system in Nepal could generate considerable additional employment particularly in rural areas. It is estimated that 55,000 people will be involved in farmlands using electrified irrigation equipment. Some 49,191 people would be employed in rural industries and 42,431 people would be employed in shops. During the construction of power projects particularly hydropower plants, sizable job opportunities are created. It is estimated that about 1,200 unskilled jobs are created for each 10 MW hydropower plant for about a three-year construction period. For example, the Teesta Stage V–520 MW project in India provides direct employment to 976 persons.

Tourism Sector

It is a given that electricity is the basic infrastructure requirement for promoting tourism. A 1978-1993 survey of mountaineers in Nepal revealed that each mountaineer provides employment to more than 10 local persons. Over 106,638 tourists visited Nepal in 2000 for mountaineering and trekking purposes, providing direct and indirect employment to 1,066,380 people. In 1978, 42 mountaineering expeditions paid Nepal Rs 0.614 million in royalties. By 1995, 91 expeditions contributed Rs 37.30 million in royalties to the Nepalese exchequer. In addition, the 7,162 tourists who visited Bhutan in 1999 for trekking and mountaineering would have provided employment to over 70,000 local people.

Section 1 Introduction

The South Asia Growth Quadrangle (SAGQ), a subregion on the eastern fringe of South Asia comprising Nepal, Bhutan, Northeast India (NEI), and Bangladesh, has strategic advantages that favor joint cooperation in regional development. These advantages include economic complementarities, geographical proximity, sociocultural cohesiveness, lifestyle similarities, and lower transaction costs. This subregion is also strategically located for possible trade linkages with the member counties of the Association of South East Asian Nations (ASEAN).

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Despite the subregion's much talked about growth potential, it is characterized by low economic growth, poverty, poor physical infrastructure, and an inability to provide basic human necessities. The entire SAGQ region, with a total population of more than 183 million, has been ranked low on human development indices and is considered to be a low-income region. This region also has one of the largest concentrations of people living below the poverty line (Tables 1-1 and 1-2). The widespread economic malaise in this subregion can be tackled effectively by sharing both the experience and benefits of resource development.

Although data relating to economic parameters is periodically updated by the concerned government agencies, data on social indicators may or may not be revised as frequently due to various constraints. Obtaining the latest data from some agencies of the concerned governments is often problematic. Therefore, this report is based on data that is available publicly. Efforts have been made to obtain the latest data to the extent possible; however, in certain instances, especially pertaining to social sector indicators, the data used is the most recent publicly available.

The estimated number of people below the poverty line in Bangladesh was 47.5 % in 1995-1996. For the decade 1986-1996, rural poverty remained stable, but there was a sharp increase in urban poverty, from 13% to 18% of the total poor population. This increase also indicated the spillover of rural poverty to urban areas. It was accompanied by a noticeable increase in inequality as indicated by Gini Coefficient, which rose from 0.36 in 1983-1984 to 0.432 in 1995-1996.[1]

[1] This calculation is based on a daily per capita intake of 2,122 calories for the rural and 2,112 calories for the urban areas. Sobhan, Rehman, *How Bad Governance Impedes Poverty Alleviation in Bangladesh,* Technical Papers No 143, OECD Development Center, 1998, p 15 and Government of Bangladesh, *The Fifth Five Year Plan 1997-2002,* Planning Commission, Dhaka, 1998, pp 147-155.

Table 1-1 South Asia Growth Quadrangle: Macro Data

Area (000 km^2)	143.9	46.5	147.1	7.1	255.1	688.1
Population (million)	120.4	1.7	21.9	0.54	38.49	183.03
Literacy (%)	38	42	39	Table 1.2	Table 1.2	
Per capita GNP (US$)	230	400	200	Table 1.2	Table 1.2	
Population density (No./km^2)	832	34	146	76		
Urban population (%)	14	5	10	9	14	
Human development index (rank)	144	155	154		138 (India)	

Note: Population and literacy figures of the Indian states are of 2001 census. For other countries it is based on 1991 census.
Sources: UNDP, *Human Development Report, 1997*; Ministry of Finance, *Economic Survey,* Government of India; Ministry of Finance, *Economic Survey,* His Majesty's Government of Nepal; *Eighth Five Year Plan (1997-2002)*, Ministry of Planning, Royal Government of Bhutan and *Statistical Yearbook of Bangladesh, 1996,* Bangladesh Bureau of Statistics, Government of Bangladesh

Table 1-2 Per Capita Income and Literacy Rate of the NEI States

Arunachal Pradesh	259	44	13
Assam	158	56	340
Manipur	164	60	107
Meghalaya	201	60	103
Mizoram	228	86	42
Nagaland	232	62	120
Sikkim	225	69	76
Tripura	129	65	304

* Computed from per capita income (Rs) ($1=Rs 42) Ministry of Finance, Economic Survey, 1998-*99*, Government of India.

Although there has been no authentic and independent study done on poverty and income distribution in Bhutan, it is estimated that most of the people live below the poverty line. Bhutan does not have any poverty data based on calorie intake and consumption expenditure. To calculate human development indices, Bhutan takes into consideration per capita wealth rather than per capita income.[2] A poverty assessment survey conducted in 2000 showed that 33% of the households have incomes below the national average. The same document mentions an "average per capita household income of around Nu 1200 per month, about Nu 40 per person per day, is less than a dollar per person per day on average."[3] This information, using World Bank definitions, suggests that a large segment of the population lives below the poverty line.

2 Royal Government of Bhutan, *Bhutan National Human Development Report 2000,* Planning Commission, Thimphu, 2000, pp 16-17.
3 Royal Government of Bhutan, *Poverty Assessment and Analysis Report 2000,* Planning Commission, Thimphu, 2000, pp 20-23.

In Nepal, the size of the population living below the poverty line was 42% in 1996. Of those living below the poverty line, 24.9% are considered to be the poor and 17.1% are estimated to be ultra-poor.[4]

Despite its abundant natural resources, poverty in northeast India remains high. Though the percentage of the population below the poverty line steadily declined in most of the northeast states during the period 1973 to 1994, the number of poor people has sharply increased in absolute terms. For example, between 1973 and 1994, the percentage of people living below the poverty line in the smaller states of Arunachal Pradesh and Meghalaya steadily declined from 51.93% to 39.35 % and from 50.2% to 37.92%, respectively, while the actual number of people living below the poverty line increased from 266,000 to 373,000 and from 552,000 to 773.000, respectively. The total number of people below the poverty line in the northeast states (including Sikkim) increased from 10.9 million in 1973-1974 to 13.49 million in 1993-1994. This means that 4.2 % (3.39 % in 1973-1974) of the people below India's poverty line are concentrated in 7.97 % of the country's land area.[5] The Tenth Five-Year Plan indicates that the northeast states are projected to have a relatively higher percentage of the population living below the poverty line as compared to many of the other states in the country (Table 1-3).

Table 1-3 Northeast States: Poverty Projections for 2006-2007

Arunachal Pradesh	29.33	0.368
Assam	33.33	9.714
Manipur	30.52	0.837
Meghalaya	31.14	0.823
Mizoram	20.76	2.012
Nagaland	31.86	0.822
Sikkim	33.78	0.201
Tripura	31.88	1.098
West Bengal	18.30	15.973
All India	19.33	21.971

More alarmingly, the extreme concentration of the people below the poverty line in the rural areas shows that rural development programs, particularly poverty alleviation measures, have not really benefited the rural poor.

4 In Nepal, the per capita consumption level has been treated as the criterion. The Living Standard Survey launched by the Central Statistical Organization in 1996 determined that 2,124 calories per capita per day were essential. On this basis, the per capita annual expenditure to purchase the calorie-equivalent amount of food worked out to be Rs 2,637. If the expenditure on non-food items is added, per capita annual expenditure is estimated to be Rs 4,404. His Majesty's Government, *The Ninth Plan, 1997-2002,* National Planning Commission, Nepal, 1998, pp 196- 207.

5 Lama, Mahendra P., *Issues and Policy Advocacy on Mountain Commons in North East India,* to be published by ICIMOD, Kathmandu, 2000; and Government of India, Perspective Planning Division, Planning Commission, *Report of the Expert Group on Estimation of Proportion and Number of Poor,* Government Press, Faridabad, 1993.

Section 2 Rationale for Regional Cooperation

Unlike cooperation and economic exchange at the national level, the political risks of cooperation in the SAGQ region are likely to be localized. Failures can also be localized without significantly damaging national interests. At this level of cooperation, a participating country will not need to change its macro policies, ideological profile, or long-term socioeconomic development objectives. Cooperation within SAGQ is seen as a practical solution to the subregion's socioeconomic problems. The expected economic restructuring and greater specialization in production and human resource development will lead to a higher level of economic activity and will allow the subregion to be competitive in the world market.

This region has highly contrasting topographical features ranging from mountainous and hilly regions to hot Terai belts. The region’s agro-climatic variation creates one of the most attractive and richest biodiversity reserves in the world. It is endowed with a rich variety and massive deposits of natural and mineral resources. This region also possesses vast stores of clean and renewable energy, perennial rivers, and high rainfall. Only a very small proportion of this great potential has been exploited so far. On the other hand, the region has a serious energy supply shortfall due to significant increases in demand as well as the high cost of energy from non- hydropower sources.

The SAGQ region offers hitherto unexploited investment opportunities in natural gas, hydropower, port facilities, forests, water, tourism, mineral resources, health, education, and human resource development, as well as traditional commodities and products, such as tea, jute, leather, fisheries, and horticulture. Because of the region’s rich biodiversity, an important area for regional cooperation will be biotechnology and genetic engineering, which will provide wide scope for technology-based joint investments. At the same time, it is clear that all these areas will require adequate provision of electric power.

Ongoing economic reforms could lead to more focused regional integration. In the competition for private investment, the member countries have widely varying foreign direct investment (FDI) policies. These policies have undoubtedly contributed to the presence of a large number of transnational and other foreign companies in the region and the conspicuous absence of any cross-border investments from within the region.[6]

This region is the gateway to the fast-growing and lucrative markets of Southeast Asia, the Far East, and Australia. The large-scale illegal trade in a wide range of products across the borders of all the countries in the SAGQ region (described in the section on “Informal Trade”) demonstrates the availability of markets and the need to bring these markets under proper economic management. To a large extent, this can be achieved by enhancing the pace of development through the provision of electricity. Power trading, therefore, provides ample opportunities for facilitating and encouraging economic development.

[6] Investing in Bangladesh: A Guide to Opportunities, 1999, Board of Investment, Dhaka; Foreign Investment Policy of the Government of India, May 1997, India Investment Center, New Delhi, 1998; HMGN, Procedural Manual for Foreign Investment in Nepal, Ministry of Industry, Kathmandu, Nepal, July 1996.

Section 3 SAGQ Energy Sector Overview

3.1 EXTENSIVE RESOURCES

The SAGQ region possesses vast stores of clean and renewable energy. This region is richly endowed with water resources, forests, coal, and gas—the principal sources of energy. Regional per capita energy consumption remains quite low and persistent energy shortages have been a major factor in the region's slow growth rate. A significant portion of society still does not have access to modern sources of energy due to physical inaccessibility and lack of affordability.[7]

The traditional sources of energy in rural areas of the SAGQ region (i.e., firewood, animal dung, crop residues, etc.) remain the sole—or major—energy sources for the larger populace. Historically, biomass has been a vital part of national energy scenarios. Environmental degradation due to persistent over-dependence on biomass, combined with the use of fossil fuels and their associated carbon dioxide emissions, is increasingly reflected in the strains on the energy cycle (Table 3-1).

Table 3-1 Composition of Energy Supplies (Percentage)

Conventional	55.0	80.0	33.0	87.0
Crop residues*	32.0	17.0	21.8	3.0
Animal dung	13.0	4.0	5.3	6.0
Fuel wood	10.0	59.0	5.9	7.8
Commercial	45.0	20.0	67.0	13.0
Oil and coal	10.0	7.0	39.0	12.0
Natural gas	34.0	0.0	0.7	0.0
Hydropower	1.0	13.0	27.0	1.0
Total	100.0	100.0	100.0	100.0

*Note: crop residues include jute sticks, rice straw, rice hulls, sugarcane refuse, etc. Sources: Government of Bangladesh, *Bangladesh Economic Review, 1996,* Ministry of Finance, Dhaka; Government of India, Economic Survey, 1997-98, Ministry of Finance, New Delhi; Government of Nepal, *Economic Survey, 2000-2001*, Ministry of Finance, 2001, Kathmandu.

Commercial energy consumption has been growing much faster and its share of the total energy requirement is increasing. Although inter-fuel substitution from non-commercial to commercial sources is occurring slowly, it will accelerate in future. Within the commercial energy consumption category, electricity has been the fastest growing segment.

Electricity can substantially transform the quality of life and work. It improves health standards, assists in spreading education, and motivates people to undertake economic activities. In rural areas, it helps to slow the rate of migration to urban areas, enhances income opportunities, and generates employment opportunities.[8] However, the question of

[7] Lama, Mahendra P, Energy Cooperation in South Asia: Issues, Challenges and Potentials, South-South Solidarity, New Delhi, 1999.

[8] Electricity in rural areas helps increase evening working hours, allowing adult literacy and other classes to be conducted. Television and radio sets help disseminate useful information to the rural community. Electric refrigerators can store medicines and vaccines, helping to improve community health. Munasinghe, Mohan PC, "Sustainable Energy Development (SED): Issues and Policy" in Kleindorfor, Paul R., Howard C. Kunreuther & David S. Hong (Eds.), *Energy, Environment and the Economy: Asian Perspectives,* Edward Elgar, Brookfield, U.S., 1996, pp 6-7. Many issues related to energy consumption in both rural and urban South Asia are

accessibility and affordability are very critical in rural areas. Because electricity is one of the prime movers of economic development, the availability, accessibility, and affordability of quality power are primary determinants of the quality of life.

3.2 ECONOMIC AND SOCIAL CHALLENGES

A significant portion of society still does not have access to modern sources of energy due to both inaccessibility and affordability. Only 20% of Bangladesh's total population has access to electricity, and only 30% of Bhutan's population has such access.[9] In Nepal, 14% of the population had access to electricity by the end of Eighth Plan (1992-1997).[10] On the commercial energy front, the SAGQ region's dependence on petroleum imports has been steadily increasing, thereby leading to outflows of precious limited foreign exchange (Table 3-2).[11]

Table 3-2 Petroleum-Related Imports as a Percentage of Total Imports

Bangladesh	2002-2003	6.42	9,658 million
Bhutan*	1998	34.44	121 million
India	2002-2003	27.23	51,413 million
Nepal	1999-2000	8.5	1,469 million

*Note: Since petroleum products are not specifically mentioned, mineral products and mineral oils are taken into consideration. Sources: *Bangladesh Economic Review 2003*, Government of Bangladesh, 2003, p 231; *Selected Economic Indicators, Royal Monetary Authority of Bhutan, September 2000,* pp 37-38 Government of India, *Economic Survey, 2002-2003,* Ministry of Finance, New Delhi, p S-82; Government of Nepal, *Economic Survey, 2000-2001*, Ministry of Finance, 2001, Kathmandu.

Meeting regional energy demand requires large-scale investment in the energy supply chain, including large inputs of scarce physical, human, and financial resources for which there are competing demands from other sectors of economy. Capital is scarce in the SAGQ countries. Therefore private sector participation becomes essential, as there has been intense pressure on public investment, which in turn has become the driving force for regional energy sector reform and restructuring.

dealt with in a comprehensive manner by Gerald Leach, *Household Energy in South Asia,* Elsevier Applied Science, London, 1987. This study is based on field surveys done in Bangladesh, India, Pakistan, and Sri Lanka.

9 Wangchuk, L.K., Bhutan's Minister of Trade and Industry in an interview with *Energy South Asia*, New Delhi, January/February 2002.

10 HMG, *Ninth Plan (1997-2002),* National Planning Commission, Kathmandu, July 1998.

11 Energy has four primary uses: (1) industrial and agricultural consumption; (2) domestic and commercial consumption; (3) transportation; and (4) electricity generation. Lama, Mahendra P., "Economic Reforms and Cross Border Power Trade in South Asia" , *South Asian Survey, New Delhi (January-June 2000).*

Section 4 Likely Gains from Cross-Border Power Trading

4.1 INDUSTRIAL PRODUCTION GAINS

4.1.1 Gains from Improvement in Power Quality

If the supply of electricity is of low quality characterized by frequent outages (planned or unplanned), poor voltage, and frequency instability, the impact on industrial and other outputs, in term of lost output, labor being idle, or the need to install captive generation, can be very negative.

Voltage fluctuations could also potentially cause major problems in certain industrial categories, such as food, beverage, tobacco; textile, and leather manufacturing.

Power shortages and outages have imposed substantial costs on economic growth. The power elasticity of GDP in Bangladesh is estimated at 0.03-0.05, suggesting that a 10% power shortfall could lower GDP growth by 0.3-0.5%[12].

4.1.2 The Role of Generators

In the face of significant power shortages, which are acute during peak hours, the Government of Bangladesh has allowed duty-free import of power generators. The overall cost to the economy due to inadequate power supply and outage is very significant by all indications, although it is difficult to fully quantify this cost. The commissioning of nine power generation plants since September 1997 has eased the power shortage and the problem of load shedding to some extent.

12 World Bank (1999), Macroeconomic Framework for Energy Sector Strategy in Bangladesh.
13 World Bank (2000). Cost of Electricity Outage in Bangladesh, Dhaka.
14 Ibid.

4.2 FINANCIAL GAINS

4.3 REVENUE GAINS

Regional trade based on resource endowment complementarities would promote economic growth within each country. For smaller nations with limited domestic markets, increased regional—or international—trade would enable them to capture the benefits of access to larger export markets. This would enable the power exporting nations to price their power exports competitively as a result of economies of scale in production. This has been a motivating factor in the formation of trading blocs.

4.3.1 India-Nepal Power Exchanges

India and Nepal have been exchanging power for the past three decades. The two governments have an agreement to exchange up to 50 MW of power as required. Interconnections have been built between the Bihar State Electricity Board, Uttar Pradesh Power Corporation (formerly known as Uttar Pradesh State Electricity Board), and now with the newly created State of Uttaranchal. These power exchanges, which currently take place on a goodwill basis, have recently been increased to 150 MW. Despite nominal tariffs, the revenue generated by Nepal through the sale of power to India has increased almost six-fold during the past 8 years (Table 4-1). In the year 2002, 1,113 GWh of hydropower (87.7%), 17 GWh of thermal power (0.8%), and 238 GWh of power imports from India (11.5%) were utilized [15]. Nepal exported 134 GWh of electricity to India but was a net importer of about 104 GWh of electricity in that year. An additional 132 kV interconnection in the far-western region between India and Nepal is intended for Nepalese power imports, as committed under the Mahakali Treaty.

Table 4-1 Power Exchanges Between India and Nepal

Bulk energy sale to India (GWh)	46.1	50.5	39.5	87.0	100.2	67.4	64.2	95.0	126.0
Bulk energy purchase from India (GWh)	82.2	102.8	113.8	73.0	154.0	210.3	232.4	232.2	226.5
Revenue from bulk sale to India (Rs million)	75.5	91.4	97.6	206.7	249.3	199.9	198.1	327.8	441.0

Source: NEA, A Year in Review, 2000/01, Kathmandu, August 2001

15 *Fiscal Year 2002/03- A Year in Review*, Nepal Electricity Authority, Kathmandu, August 2003.

4.3.2 Bhutan—Chukha Project

The transmission link established to evacuate power from the Chukha project is likely to be upgraded to help evacuate 4,500 MW from three large power projects being built in Bhutan.

Table 4-2 Bhutan's Revenue from Sale of Energy from Ongoing and Planned Projects

Annual energy generation in GWh (million units)	1,650	4,000	320	6,900
Unit cost (Nu/unit)	0.37	0.51	0.92	1.36
Revenue from sale of energy (million Nu)	610	2,020	296	9,408

* Year of completion **Ongoing
Note: US$1 = Nu 46 (Ngultrum) (2001). Source: Shangle AK, SP Kakran & Navin Kumar, "Hydropower Development Scenario in SAARC Countries: An Overview of Indo-Bhutan and Indo-Nepal Projects" in RS Goel and RN Srivastava (eds) *Hydropower and River Valley Development: Environmental Management, Case Studies and Policy Issues,* Oxford & IBH Publishing Co., 2000, p 378.

The Chukha power trading model has worked very well, with Bhutan exporting as much as 76% of its generation. The Chukha project (with an annual estimated gross generation capacity of 2,024 million units) is a run-of-river hydroelectric scheme with provision for three-hour peaking on a daily basis. Any regional power trading arrangements should make of note this success story.[17]

Bhutan is keen to expand the market for its power exports. Currently, India is in a monopoly position as the only buyer for Bhutan's power. This trend will likely become more pronounced now that a number of hydro plants are being constructed in India's northeast region, which may reduce the demand for Bhutanese power.

4.3.3 Nepal's West Seti Project—A New Direction

The West Seti power project in western Nepal represents a third type of power exchange likely to occur in the region. A unique feature of this project is the involvement of an independent power producer (IPP). The project's entire power generation output will be

16 *Selected Economic Indicators,* Royal Monetary Authority of Bhutan, September 2000, Thimphu and *Kuensel,* January 2004, Thimphu.

17 Agreement between the Power Trading Corporation of India Ltd and Department of Power of the Royal Government of Bhutan (DOP) on Chukha Power Trading, 2000.

exported to India—a direct outcome of a new hydropower development policy that opened power development to private producers [18].

The 750 MW power project is to be build by Snowy Mountain Engineering Company (SMEC). The Power Trading Corporation of India (PTC) will purchase the entire power output, with the point of delivery to be the India-Nepal border. The amount of electricity to be supplied by SMEC to PTC will be approximately 3,000 GWh per annum. The annual distribution of supplied energy will be approximately 500 GWh per quarter (January-March, April-June, and October-December) except for the wet season (July-September) when it will increase to approximately 1,500 GWh. The type of energy will be primarily peak energy in dry seasons and base energy in the wet season (Tables 4-3 and 4-4). This will be the first dedicated export project having a “no grid synchronization requirement” advantage, as its entire generation will be transmitted to the Indian grid without connection to the Nepal Electricity Authority (NEA) system. As such, the project will function as an integral part of the Indian system.

India is negotiating with the Nepalese government to purchase power from this project for a 25-year period, during which the targeted levelized tariff would be computed at US$0.07 (Table 4-3). A number of crucial assumptions have been made in negotiating the deal—namely, that annual saleable energy from year 2007 to 2031 will be maintained at 3,000 million units, and that rupee devaluation for exchange rate purposes will be computed at 6% per annum. This means that the tariff per unit will increase by about 6.75% per annum. If this agreement as designed is implemented as per the schedules,

However, power trading is currently in its infancy in South Asia. Whatever “trade” currently takes place is basically bilateral exchanges or apportioning of power from surplus areas to temporarily needy regions. A suitable power trade model for this region should take into consideration demand and supply positions on a long-term basis. This also implies establishing proper institutional, legal, and payment mechanisms.

It was also estimated that Nepal’s royalty receipts in the first year (1997) from the export of power from Upper Karnali would be about US$15 million[19]. Further, expansion-planning results show that in the year 2010-2011, about 9,000 GWh of energy may be available for export.

[18] The government earns revenue through royalties and export taxes and gives private developers several incentives and concessions. Once a private developer agrees to the terms and conditions in the regulations, it receives a license to develop the project and subsequently assumes responsibility for marketing the power.

[19] Nepal Proposed Power Sector Development Strategy, World Bank, March 2001.

Table 4-3 West Seti (Western Nepal) Project Offer for Export to India

1 Saleable energy (million units)	3,000	3,000	3,000	3,000	3,000	3,000
2 Exchange rate (Rs/US$)	66.82	89.42	119.66	160.13	214.30	270.54
3 Rate/unit a. US$ b. Equivalent Rs [3a x 2]	0.07 4.68	0.07 6.26	0.07 8.38	0.07 11.21	0.07 15.00	0.07 18.94
4 Total payment (Rs million) [(3b. x 1)/10]	1,4031.9	18,777.9	2,5129.0	33,628.3	45,002.2	56,814.3
Discount factor	1.00	0.567	0.322	0.183	0.104	0.066
5 Present value (Rs) a. Total payment [4 x 5] b. Unit rate [3b x 5]	1,403.19 4.68	1,065.51 3.55	809.09 2.70	614.38 2.05	466.52 1.56	374.30 1.25
6 Levelized tariff for 25 years			7.514			

Source: Power Trading Corporation of India, 2001.

Table 4-4 Analysis of West Seti (Western Nepal) Offer

Project capacity	750 MW
Tariff offer	US7 cents or rupee equivalent (blended rate)
Exchange rate	Rs 46.73 as on 10 November 2000
Rupee devaluation	6%
Exchange rate at COD	66.82

Source: Power Trading Corporation of India, 2001

4.4 GDP GAINS

Increased investment in the power sector will produce a chain reaction, producing major GDP gains, and giving impetus to fresh investment in a range of industrial activities with backward and forward linkages, a services sector, and irrigated agriculture. All of the foregoing will create a basis for expanded employment opportunities, a requirement for implementing initiatives such as the Poverty Reduction Support Program. The major industries that will flourish due to sustained private investment in uninterrupted power supply include iron and steel; pottery and china; textiles and apparel; metal, glass, plastic, leather, and rubber products; electrical machinery; cold storage; chemicals; drugs and pharmaceuticals; and food manufacturing.

There sources for GDP gains include:

- Massive restructuring of rural economies in terms of activities/orientation and the resultant impact on GDP
- Electricity as the GDP originating sector resulting from value-added in this sector

- More reliable electricity resulting in better economic activities that contribute to better sectoral GDP gains
- Government royalties from the export of power being pumped back into the economy
- Promotion of inter-sectoral and subsector linkages resulting in further GDP growth through multiplier effects

Figure 4-1 illustrates these linkages, using Bangladesh as the case example.

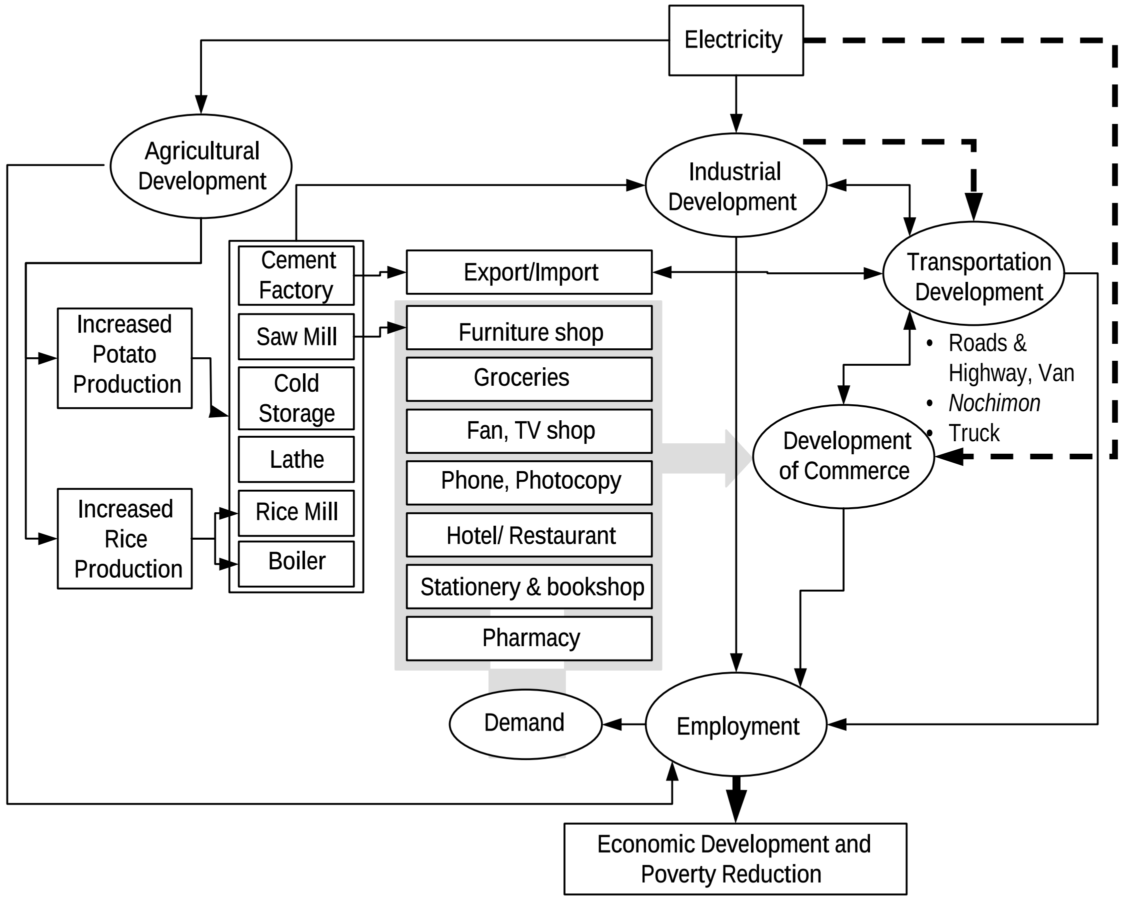
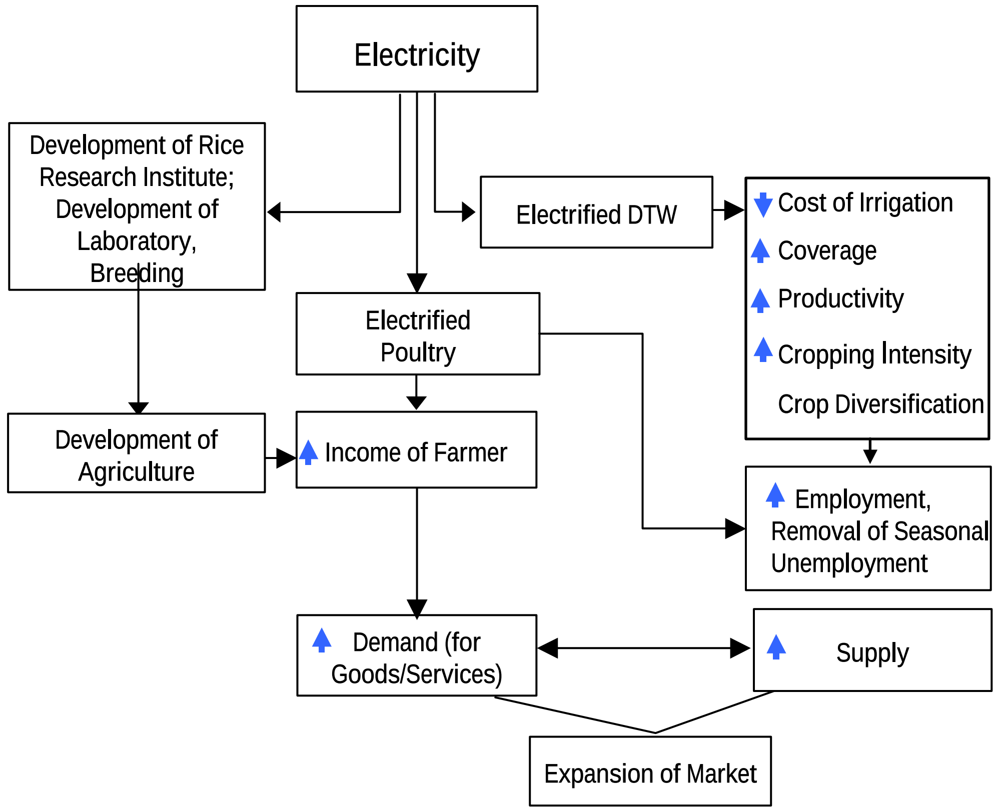


Figure 4-1 Rural Electricity Role in Agriculture-Industry-Commerce Linkages in Bangladesh

4.4.1 Agricultural Sector Gains

In the agriculture sector, the users of electrically operated irrigation pumpsets reported that despite occasional power load-shedding, the introduction of electricity as the energy source for irrigation equipment has helped expand cultivated areas, increase crop yields, and increase incomes at a relatively lower cost for irrigation water[20]. Similarly, poultry firms also grew as a result of the expansion of the rural electrification network. A case example (Bangladesh) of the diverse ways in which electricity and agriculture are related is illustrated in Figure 4-2.

20 Barkat et al., 2003:23.



Source: Barkat et al., 2003.

Figure 4-2 Electricity Promotes Growth in Agriculture in Bangladesh

4.4.2 Economic Impact of Hydropower Resources

In a landlocked country like Nepal, water resources can play a potentially catalytic role in attaining high economic growth. Other than the human resources and natural beauty needed to develop the tourist industry, hydropower is virtually the only other indigenous resource with the potential to contribute to the country's high economic growth.

The *Water Resources Strategy Formulation Report* prepared by the Government of Nepal has attempted to analyze the contribution of water resources to GDP; the investment needed for that contribution; and its impact on macroeconomic variables such as the fiscal, monetary, and external economic sectors. The study revealed that, through development of hydropower resources for domestic consumption as well as export, an annual growth rate of up to 8% is achievable (high-growth, new equilibrium scenario). This economic growth could contribute significantly to Nepal's efforts to address poverty and unemployment. However, major hydropower investments are essential. The study projects the investment demand in the electricity sector for a base, moderate, and high-growth case (Table 4-5).

Table 4-5 Investment Demand in Hydropower Development (Billion NRs, 1997 Prices)

Base case	3.9	10	15.5	8.5	6.6	7.3
Medium growth	3.9	20.3	18.2	34.9	47.9	68.2
High growth	3.9	42	75.4	102.8	123.4	263

Source: Water Resources Strategy Formulation Phase II Study, Macro Economic Framework (Annex 2), WRSF Consortium, October 2000.

Table 4-6 Total Value Added from Hydropower Development (Billion NRs, 1996-1997 Prices)

Base case	6.23	9.26	13.32	18.18	26.30	36.94
Medium growth	7.46	11.83	18.58	28.77	42.61	64.53
High growth	7.46	13.98	22.22	37.61	64.84	110.75

Source: adapted from Water Resources Strategy formulation Phase II Study, Macro Economic Framework, (Annex 2), WRSF Consortium, October, 2000.

4.4.3 Impact of Electrification on National Economies

In Bangladesh, the share of power sector in the GDP is 1.3% and the annual growth rate of the sector is over 7%[21]. The approximate pattern of electricity consumption by economic groups (as a percentage of total sales) is 40% domestic, 42% industrial, 8% commercial, 4% agricultural, and 6% others. Keeping these parameters in mind, if the demand for 1,000 MW capacity additions is met, the power sector's projected share of GDP will increase to about 2%, and the sector will register an annual growth of over 9%.

The government's vision of "electricity for all by 2020" aims at ensuring access to electricity for 100% of its population. An attempt has been made to estimate the income of the rural households assuming that "all rural households have electricity." This has broad policy implications in terms of potential for electricity-mediated economic development in Bangladesh (Table-4-7).

[21] Ministry of Finance (2004). *Economic Review of Bangladesh 2004,* p. 99.

Table 4-7 Bangladesh—Electricity for All by 2020

Installed capacity (MW)	6,716	9,840	17,500
Maximum demand (MW)	5,368	7,887	14,600
Actual production (million kWh)	26,651	39,157	79,250
Transmission line (km)	5,966	9,281	13,921
Grid capacity (MVA)			
230/132 kV	7,270	12,520	21,284
132/33 kV	9,162	12,719	19,078
Distribution line (km)	266,962	346,173	519,259
Consumers (million)	9.0	12.5	24.3
Number of electrified villages	51,900	63,400	84,000
Per capita production (kWh)	190	260	470
Population access to electricity (%)	47	65	100
Investment requirement (US$ billion)	3.6 (2004-07)	4.5 (2008-12)	7.0 (2013-20)

Source: Ministry of Finance (2004), Economic Review of Bangladesh 2004, p 105.

It is estimated that out of the total of 19,092,224[22] rural households in Bangladesh, 3,413,825 households (17.88%) have Rural Electricity Board (REB) electricity connections. Another 6,395,086 households (33.5%) are situated in the electrified villages but do not have electricity in their households. The remaining 9,283,313 households (48.62%) are situated in the non-electrified villages (implying that they do not have electricity). Using values generated in a recent comprehensive impact study[23] on annual income and electricity's share in that income for three sample categories, the nationwide weighted values have been estimated (Table 4-8). These estimates show that the total annual rural household income (at 2002 market prices) is about Tk 1,105 billion, of which Tk 102.73 billion can be attributed to electricity. Thus, 9.3% of the annual income of the country's 19.1 million rural households is electricity-dependent.

Table 4-8 Estimated Annual Income and Income from Electricity: Rural Bangladesh

With electricity	3,413,825	92,962.9	15,229.0	317.36	51.99	16.38
Without electricity in electrified villages	6,395,086	41,109.6	4,946.5	262.90	31.63	12.03
In non-electrified villages	9,283,313	56,523.5	2,058.6	524.73	19.11	3.64
Total	19,092,224	57,873.5	5,382.2	1,104.99	102.73	9.30

Source: Barkat et al., 2003.

22 According to the Bangladesh Population Census-2001 (Preliminary Report published by BBS, August 2001), 76% of the total households (dwellings) 24,924,613 are rural households distributed in 68,000 villages. The rural electrification program covers 34,936 villages, with a total of 3,413,825 domestic connections (REB/MIS, June 2002).

23 Barkat et al., 2002.

It would be appropriate to conclude that ensuring non-electrified household access to electricity will have a substantial impact. Electricity access will not only increase incomes, but will also address various dimensions of human poverty through improved health and education and the enhanced empowerment and status of women.

Considering Bangladesh's 2002 total of 3,413,825 domestic rural electricity connections, the approximate number of total tungsten bulbs in use would be 12.6 million and the number of fluorescent bulbs, 1.54 million. As a result of rural electrification, the total quantity of electrical equipment sold would be 5,735,226 fans, 1,795,672 televisions, 1,570,356 cassette players, 1,010,492 irons, 170,691 refrigerators, 146,794 mobile phones, 81,500 juice machines, and 9,900 toasters. Moreover, the future market (in the next 3 to 5 years) for electrical appliances would be enormous. For example, the market for refrigerators would be six times larger; the market for charger lights would be 4.2 times larger; and the market for television sets will grow by 60%. Increasing the number of domestic connections will further expand the market for electrical appliances and will improve living standards. Procurement sources for electrical appliances already owned by households indicate that markets would develop relatively close to consumers. This would generate employment opportunities in the industrial and commercial establishments involved in manufacturing, selling, and repairing electrical appliances, and serves as an example of the increased intersectoral chain effect from production to consumption.

4.5 FOREIGN EXCHANGE GAINS

Regional power trade can be a significant source of foreign exchange earnings through the sale of power for the exporting country. For instance in case of Nepal, 9,000 GWh of energy will be available for export in 2010-2011 (Table 4-9); for a royalty of 10% on export of energy and US 5.12 cents/kWh export price, the royalty amount would amount to US$46 million for first year of operation alone.

[24] *Statistical Pocketbook Bangladesh 2000*, Bangladesh Bureau of Statistics, 2002.

Table 4-9 Expansion Plan for Moderate Growth Rate with Export

2003-4	947	Middle Marsyangdi (61 MW) Upper Modi (14 MW)	572	1,166	0
2004-5	1,103	Khimti-2 (27 MW)	636	1,071	0
2005-6	1,284	Kulekhani-2 (42 MW) Kabeli-A (30 MW) Chamelia (30 MW) Melamchi (25 MW)	746	1,336	0
2006-7	1,494	West Seti (750MW) Rolwaling (120 MW)	1,616	2,913	2,097
2007-8	1,653	Likhu-4 (44 MW)	1,660	3,263	1,710
2008-9	1,828	Upper Karnali-A (300 MW)	1,960	3,670	3,120
2009-10	2,021	Arun-3 (402 MW)	2,351	4,100	5,348
2010-11	2,235		2,327	4,573	4,463
2011-12	2,472	Upper Arun (335 MW)	2,662	5,098	6,216
2012-13	2,764	Budhi Ganga (20 MW) Bheri Babai (83 MW)	2,765	5,799	5,836
2013-14	3,090	Tamakoshi-3 (330)	3,095	6,579	5,954
2014-15	3,455	Bhuri Gandaki (600 MW)	3,623	7,450	7,047
2015-16	3,862	Lower Arun (308 MW)	3,931	8,611	7,728
2016-17	4,319	Kali Gandaki-2 (660 MW)	4,503	9,925	8,911
2017-18	4,707	Rahughat (27 MW) Andhi Khola (176 MW) Lowe Bhotekoshi-1 (96 MW)	4,715	10,911	8,694
2018-19	5,130	Pancheswar (3240 MW)	7,934	11,988	12,286
2019-20	5,590	-	7,934	13,166	10,379
2020-21	6,093	-	7,934	14,384	8,298
2021-22	6,641	-	7,934	15,715	6,029
2022-23	7,506	-	7,934	18,273	2,452
2023-24	8,483	Naumire (245 MW) Dudh Koshi-1 (300 MW) Upper Trishuli-2 (300 MW)	8,491	21,208	2,794
2024-25	9,586	Chisapani (10800)	18,859	24,576	19,052
2025-26	10,834	-	18,859	28,435	13,886
2026-27	4,308	-	18,859	32,850	8,051

Source: Water Resources Strategy Formulation Phase II Study—Hydropower (Annex 5), WRSF Consortium, October 2000.

4.6 RURAL ELECTRIFICATION GAINS

The entire SAGQ region is predominantly rural. The provision for supply of power could bring about substantive changes in the rural areas particularly in the following areas:

- Boost agricultural productivity and production
- Trigger a range of off-farm activities
- Stimulate a number of industrial and entrepreneurial activities
- Help provide urban facilities in rural areas thereby creating a range of opportunities in the tertiary sector, including in banking

- Generate more employment and income, thereby leading to a quantum jump in gross domestic product
- Slow rural to urban migration and reduce associated sociopolitical instability

The availability of power in rural areas will lead to economic development and its attendant spinoff benefits including food security, better health, and wider literacy, etc. Although India has achieved electrification of about 86% of the country's villages, the use of electricity in villages for productive and subsistence needs is still very limited. The actual benefits of the investments made in the rural electrification program can only be realized if the people are in a position to use electricity for their day-to-day activities as well as for industrial and commercial activities. Therefore, universal rural electrification coupled with widespread use of electricity by rural people would produce a major increased demand for electricity. This is likely to be true throughout the SAGQ region.

In India out of the estimated 80,000 villages yet to be electrified, the Tenth Plan proposes to electrify 62,000 villages via grid supply [25]. Outside of Jharkhand, Madhya Pradesh, Rajasthan, Uttar Pradesh, and Uttaranchal, most of these villages are concentrated either in SAGQ regions like West Bengal, Arunachal Pradesh, and Meghalaya, or regions surrounding it like Bihar, Jharkhand and Orissa. Electricity would bring about significant changes in the poverty and other social profiles of these states.

The sociopolitical instability, tension, and insurgencies that have plagued the region for past several decades, can largely be attributed to resource disparity, poverty, and economic inequalities. Regional inequalities and underdevelopment have been major sources of internal conflict. Nepal's insurgency, which caused the country's GDP to shrink by 0.6% in 2002, originated from the districts lacking basic health, educational, and transport services. Mitigating regional disparities through the introduction and distribution of electricity would reduce internal stresses and energize the entire socioeconomic processes. Rural electrification accelerates economic development, introduces better communications and transportation services, and creates markets, enhancing interaction between villagers and urban dwellers. This process also promotes new relationships between various ethnic groups and contributes to better social integration.

4.7 TRADE GAINS

4.7.1 Formal Trade Gains

Availability of power triggers a large number of industrial activities in the region, thereby producing a diverse number of products both for domestic consumption and export. Power trading may also result in a higher level of trading in other sectors as well. With the additional revenues generated by the electricity exports, the power exporting country could invest more in social or physical infrastructure, triggering higher demand for goods and services in that country. This could further enhance regional trade (Figure 4-3).

[25] Plans call for electrification of the remaining 18,000 remote villages by 2011-2012 through the use of decentralized, non-conventional sources of energy. The current definition of an electrified village states that "a village will be deemed to be electrified if electricity is used in the inhabited locality within the revenue boundary of the village for any purpose whatsoever." The Tenth Plan document summarily mentions that "there is need to change this definition so as to declare a village as electrified only if a minimum number of households in that village are provided with electricity connections." According to the 1991 census, there are 587,000 villages of which 500,000 (86 %) are declared to be electrified on the basis of the existing definition. Available data show that only 31% of rural households are electrified, and out of the total estimated potential of 19.5 million electric irrigation pumpsets, only 12 million have been energized. Government of India, *Tenth Five Year Plan 2002-2007,* Planning Commission, New Delhi, p 914.

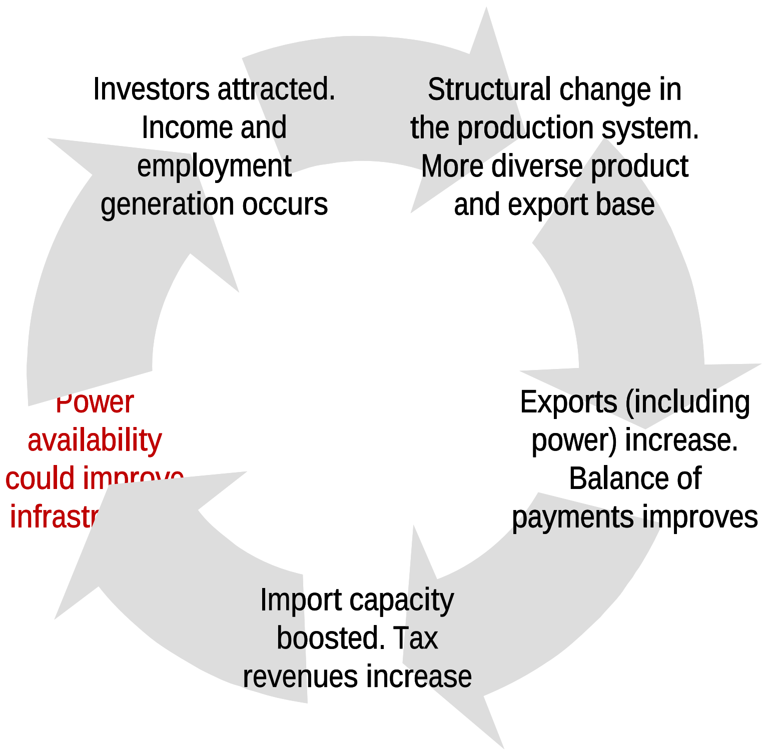


Figure 4-3 Impact of Power Export Revenues on Various Economic Sectors

For countries like Bangladesh, Bhutan, and Nepal, trade has been a major boost to the development process. The share of customs revenue in the total revenue and the total tax revenue continues to be quite significant in all these countries. For instance, in the case of Nepal it is 32 % and 26 %, respectively.

In terms of the significance of diversifying its export basket, Nepal's yearly export earnings barely equal three months of imports. The country's lagging export performance has always put a tremendous strain on its balance of payments. Nepal's exports to India have increased 16.76-fold (growth rate of 175% per annum) during the decade ending in 2001. India's share of Nepal's total exports has increased from 21% to 46 % during this period, while Nepal's imports from India experienced a six-fold jump. India's share of Nepal's total imports has risen steadily, from 31% to 39 % during the same period. India is again emerging as the top destination of Nepalese exports and imports, constituting almost 42% of Nepal's total global trade in 2000-2001. A decade ago, India's share of Nepal's trade was only 29%.

This quantum jump in Nepalese exports to India in the last few years was to a large extent triggered by India's relaxation of key provisions of the 1996 Trade Agreement. Additionally, the trade liberalization process initiated by the South Asian Association for Regional Cooperation's (SAARC's) 1995 South Asia Preferential Trade Association (SAPTA) agreement—coupled with liberalization at the national level under the larger economic reform process—opened the door to greater bilateral trading.

Free entry of Nepalese manufactured goods has also led to structural changes in the pattern of its exports to India. There has been a sharp change in the composition of Nepalese primary and manufactured goods exported to India. For decades, primary products (rice, ghee, animals, foodstuffs, and wood) constituted an overwhelming percentage of Nepal's exports to

India—as much as 93% between 1982 and 1988. Between 1998 and 2001, manufactured goods constituted more than 63% of exports, substantiating the role of unilateral trade concessions in stimulating Nepal's economic shift toward increased manufacturing (Table 4-10). Equally noteworthy, Nepalese imports continue to be overwhelmingly dominated by manufactured products.

Historically, the balance of trade has always been unfavorable to Nepal except for a few years in the early 1950s. The gap is widening at an unprecedented pace. Nepal's trade deficit with India increased almost 34-fold from Rs 563.2 million in 1976-1977 to Rs 19.18 billion in 2000-2001. Transport, banking, and insurance have been some of the obstacles faced by Nepal's in promoting its foreign trade. In recent years, items like vegetable ghee, polyester yarn, and toothpaste have played a larger part in Nepalese exports to India. Such changes in Nepal's export basket would help to reduce its trade deficit with India, and also indicate that tremendous potential for diversifying Nepal's export basket.

Electricity could be an important item in diversifying the export basket. However, one of Nepal's major constraints on developing new industrial ventures has been the lack of electricity.

Therefore, the trade-investment linkage between India and Nepal is critical because of Nepal's weak industrial base, its narrow export base, and other structural weaknesses. Trade and investment need to be consciously linked by designing appropriate provisions into trade treaties and foreign direct investment policies.

Table 4-10 Structure of Nepal's Export to India

Primary products (SITC 0-4)	80.5	92.7	36.42
Manufactured products (SITC 5-9)	19.5	25.2	63.58
All products (SITC 0-9)	100.0	100.0	100.00

Note: Definition of SITC codes: (0) food and live animals; (1) beverages and tobacco; (2) crude materials (inedible) excluding fuels; (3) mineral fuels and lubricants; (4) animal and vegetable oils, fats and waxes; (5) chemicals and related products; (6) manufactured goods classified by materials; (7) machinery and transport equipment; (8) miscellaneous manufactured articles; (9) commodities and transactions not classified elsewhere. Source: Estimated from data presented by Trade Promotion Center and *Quarterly Economic Bulletin,* Nepal Rashtra Bank, Kathmandu.

An analysis of the pattern of Bangladesh's foreign trade (especially with India) shows possible gains from power trading, taking into account the high cost of importing petroleum products; increasing demand for energy to attain the "Electricity for All by 2020"goal;

26 *The Business Environment and Manufacturing Performance in Nepal,* World Bank and FNCCI, December 2001, pp 45-48.

existing natural gas use pattern; and possibilities of higher value-added and gas-based power exports. For fiscal year 2002-2003:

- Balance of trade deficit was US$2,200 million and balance of payment (deficit) was US$2,207 million.
- Highest level of imports was from India (US$1,358 million), with a correspondingly high trade deficit with India, about US$800 million annually.
- Bangladesh's net production of power was 18,422 kWh (89.4% gas-based**,** 4.5% hydro, 5.1% petroleum-based); trend for gas-based production is increasing.
- Bangladesh has rich natural gas reserves and natural gas represents 70% of overall commercial energy. In the 22 gas fields discovered so far, the recoverable reserve as of June 2003 was 15.33 TCF. Natural gas production was 421.2 billion ft^3 and usage by sector was: electricity, 45.4%; fertilizers, 22.8%; industries, 15.1%; households (domestic fuel), 10.6%; commercial, 1.1%; compressed natural gas (CNG), 0.05%; and other purposes, 4.95%.

There is ample scope for harnessing power exchange benefits, not only through one-way export from Nepal-Bhutan to Bangladesh and India but also from Bangladesh to India in the form of gas-based power exports. Power exchange and trading between these countries has significant potential for conserving scarce foreign exchange and reducing costly petroleum product imports—all of which will be instrumental in improving balance of payments and trade balances. Bangladesh is endowed with substantial reserves of natural gas that can provide ensured value addition through electricity production. Moreover, CNG can be used as fuel for transportation, industry, and domestic use. In essence, developing energy resources within the region to meet regional energy demand would be the best choice for SAGQ's socioeconomic development.

4.7.2 Informal Trade Gains

Informal trade within SAGQ has continued to thrive. Informal trade across borders predates formation of present-day national boundaries. For instance, over 98% of the border of India's northeastern states is shared with the neighboring countries of Bangladesh, Bhutan, China, and Myanmar. This long border has been a symbol of the traditional patterns of economic exchange and sociocultural interchange. Most of the people living in the northeast continue to look to these borders as opportunities for trade and related services. Technically speaking, informal trade is comprised of unrecorded trade flows. There are several centers in India that have served as important conduit points for informal trade with Bangladesh, Nepal, and Bhutan.

The main informal trading centers on the Indo-Bangladesh border (i.e., northeast India-Bangladesh) include Fakiragram, Mankachar, and Karimgunj in Assam; Lichubari, and Dawki in Meghalaya; Tlangbung in Mizoram; and Kailashsahar, Agartala, Sonamora, Bilonia, and Sabroom in Tripura. The main centers in West Bengal bordering Bangladesh are Petrapole, Bagdha, Mejdia, Lalgola, Mohidpur, Radhikapur, Kaliaganj, and Hilli. On the Indo-Nepal border, the main centers in India are Naxalbari in West Bengal, Jogbani and Raxaul in Bihar, Barhi and Nautanwa in Uttar Prodesh. On the Indo-Bhutan border, there are two main informal trading points, namely Gelephu and Samdrup Jhonkar.

Several studies have attempted to estimate the value of informal trade in the region. Chaudhary (1995)[27] gives an estimate of Rs 12.196 billion of informal trade between India and Bangladesh. However, this study does not cover many of the trading points between India and Bangladesh. Another estimate of informal trade between India and Bangladesh is provided by Barua[28] (1995), who estimates the total trade between northeast India and Bangladesh to be Rs. 2.768 billion. A recent study (Karmacharya, Taneja, Sarvanathan, 2002) based on an extensive field surveys in major trading centers and entry points—Kankarvitta, Biratnagar, Birgunj, Bhairahawa, and Nepalganj—revealed that the annual volume of informal imports from India to Nepal was on the order of Rs 12 billion (30% of Nepal's official imports). The respondents for their study were informal traders, carriers, government officials, and others.[29] Indo-Bhutan informal trade has been estimated to be Rs. 1.031 billion. However, these are considered to be gross underestimates of the actual informal trade in the region[30] (Table 4-11).

The conventional argument is that informal trade helps to evade tariff and non-tariff barriers. To the extent that informal trade is taking place due to high tariffs and non-tariff barriers in the region, trade liberalization would mean removing these barriers with a consequent shift of trade to legal channels. However, bilateral- and regional-level liberalization has not helped in reducing informal trade volumes.

Table 4-11 India's Informal Trade (Rs Million)

Bangladesh				
Estimate(1)[a]	11,647	549	11,098	12,196
Estimate(2)[b]	2,103	665	1,438	2,768
Nepal[c]	n.a.	n.a.	n.a.	12,000
Bhutan[d]	992	39	953	1,031

Notes: *X* denotes exports and *M* denotes imports; estimates of informal trade refer to the following years:(a) 1992-93, (b) 1995, (c) 2002, and (d) 1995. Sources: Chaudhary (1995) for Bangladesh estimate (1); Barua (2000) for Bangladesh estimate (2); Karmacharya (2002) for Nepal ; Barua (1995) for Bhutan.

However, the major issue often attributed to unrecorded trading is the lack of supporting infrastructure, which substantially increases trading costs. Information, communications, banking, financial exchanges, and other trade facilitation mechanisms are important infrastructure requirements for regularizing trade. If these systems are improved through better power availability, the resulting enhanced service sector activities could drastically reduce overall transaction costs[31]. As a result, a large portion of informal trade will be diverted to formal channels, resulting in a major increase in official revenue generation.

27 Chaudhari, S. K. (1995) "Cross Border Trade between India and Bangladesh", NCAER, *Working Paper 58*, New Delhi.

28 Barua, Poonam (1995), *Towards a Free Trade Arrangement in South Asia*, IIFT, New Delhi.

29 Karamacharya, Binod, Nisha Taneja, and Sarvanathan , *Informal Trade in SAARC Region : India, Nepal and Sri Lanka,* South Asia Network of Economic Research institutes (SANEI), New Delhi 2002.

30 Pohit, S. and Nisha Taneja (2000) "India's Informal Trade with Bangladesh and Nepal: A Qualitative Assessment" Working Paper 58, Indian Council for research on International Economic Relations, New Delhi.

31 Unlike formal trading, informal channel transaction costs would be much higher as they include bribes paid to ensure safe delivery of goods across the border, transportation costs, cost of credit, and cost of currency conversion. For example, one study identifies bribe

This change could also have a series of backward and forward linkages, including income and employment generation, other economic exchange-related gains, and cross-border crime reduction. Even if a tariff rate of 5-20 % were imposed on the trade volumes shown in Table 4-11, the national exchequers in the SAGQ region could gain additional revenue of some Rs 1.261 billion to Rs 5.045 billion per annum (and even this estimate could be grossly underestimated). There would also be major political and commercial gains as informal trading moves to formal channels—allowing governments to more easily regulate, control, and deal with contraband.

4.7.3 Foreign Exchange Savings

Power trading between SAGQ countries would significantly reduce foreign exchange outflows from the region, as availability of electricity would help reduce dependence on petroleum products as a source of energy. This would tangibly impact rural areas, allowing kerosene to be phased out as a major rural household fuel and diesel-powered irrigation equipment to be replaced by electrically operated equipment.

For instance, projections show that by increasing the percentage of electrified rural households from the current level of 22% to 100%, the savings on household expenditure for kerosene would equal 2.15% of the current annual valuation of Bangladesh's imports. In rural areas, the average monthly expenditure on fuel by electrified households is Tk 545; for non-electrified households in electrified villages it is Tk 362, and in non-electrified villages it is Tk 385. Irrespective of household electrification status, most fuel costs are related to traditional biomass sources (i.e., firewood, cow dung, leaves, straw). Biomass fuel costs are 66% of the total fuel expenses incurred by rural electrified households versus 80% in non-electrified households. Electricity's share of fuel costs is 25% (electrified households only). Spending on kerosene is much higher in non-electrified than in electrified households. Kerosene's share is about 20% of the fuel expenses in non-electrified households, but only 5% in electrified households. The monthly expenditure on kerosene for electrified households is only Tk 28.3 versus approximately Tk 65 for non-electrified households.

On average, the volume of kerosene used as fuel is 1.6 liters per month in electrified households; 3.3 liters per month in non-electrified households of electrified villages; and 4.1 liters per month in households in non-electrified villages. This volume has a significant effect on Bangladesh's imports, and puts it at a disadvantage in terms of trade and foreign currency reserves. The proposed 100% electrification of rural households could thus lead to substantial savings on the country's kerosene imports (Table 4-12).

Rural households in Bangladesh consume 775.53 million liters of kerosene a year as domestic fuel. If all rural households were electrified, the annual volume of kerosene consumption will decline to 366.58 million liters, a projected annual savings of about 410 million liters.

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points (police, customs, local administration, and state transport authority). With the payment of Rs 2 million as bribes, the average monthly "rent" paid by a syndicate of traders is the highest in Birgunj. This trading point also has the maximum number (42) of bribe points versus only 2 in Kakarvitta. [Karamacharya, Binod, Nisha Taneja and Sarvanathan , *Informal Trade in SAARC Region: India, Nepal and Sri Lanka,* South Asia Network of Economic Research institutes (SANEI), New Delhi 2002].

Table 4-12 Estimated Annual Cost Savings on Kerosene as Domestic Fuel in Rural Bangladesh After 100% Electrification of Rural Households

1	2	3	4	5	6	7	8	9
Households with electricity	3,413,825	19.2	65.55	65.55	0	1,179.90	1,179.90	0
Households without electricity in electrified villages	6,395,086	39.6	253.24	122.79	130.45	4,558.32	2,210.22	2,348.1
Households without electricity in non-electrified villages	9,283,313	49.2	456.74	178.24	278.50	8,221.32	3,208.32	5,013.0
Total	19,092,224	40.26	775.53	366.58	408.95	13,959.54	6,598.44	7,361.1

Source: Barkat Abul et al., 2002

4.8 GENERAL SOCIOECONOMIC BENEFITS OF INDUSTRIAL ELECTRICITY USE

4.8.1 Benefits to the Telecommunications Sector

As electricity is an essential input to the telecommunications sector, a reliable electricity system is a prerequisite for modern communications infrastructure, such as mobile telephones. For fully competitive wholesale or retail power trading to occur, better communications are essential for system coordination and electricity trading. One potentially feasible option for this is to create a broadband communication network by installing optical ground wire (OPGW) on existing transmission towers. This facility can be utilized for voice and data communications, and is superior to existing microwave or satellite communications systems. It can also be a source of revenue, in addition to facilitating system control and trading activities. An example of how access to mobile telephones can enable rural entrepreneurs to be more competitive by virtue of their having better access to market information was reported recently in a Nepalese local newspaper.[32] Traders or farmers in distant areas are using mobile telephones to assess the market situation in Kathmandu on a real-time basis. They then price their commodities opportunistically and dispatch the produce to wholesale markets to earn higher profits than other farmers and traders.

[32] *Sandhyakalin (a Nepali vernacular)*, June 18, 2004, Vol. 8, No. 178.

4.8.2 Poverty Alleviation

Poverty alleviation through higher economic growth and reduction or elimination of socioeconomic inequalities is also largely related to adequate provision of electricity. In most of these societies, the issue of exclusion has been prominent.[33] With electrification providing improved communications, better access to social amenities, entertainment,[34] and improved transportation systems, people are more likely to work together to bring about substantive sociocultural and economic changes, irrespective of their backgrounds.[35]

Economic poverty reduction due to electricity access is evident in enhanced employment generation, increased incomes, increased savings, a progressive pattern of food and non-food expenditures, increased education and health expenditures, and increased asset building. Household access to electricity significantly influences the shift of a household from poor to non-poor status. The impact of electricity in reducing poverty is evident in the enhanced literacy, improved educational quality, relatively higher empowerment of women, and better health status of the poor in electrified households compared with those in non-electrified households. Exposure to media—chiefly television—affects human capital formation and improves the knowledge base which, in turn, influences educational and health practices. Electricity’s impact on reducing and transforming poverty is synergistic.

Under the Andhikhola Hydel and Rural Electrification Project (AHREP) in Nepal, local consumers participate in a low-cost electricity distribution system. The AHREP experience indicates that electrical services can be provided to remote rural consumers at higher quality and more competitive cost than conventional rural electrification efforts. Affordable electricity helped the project bring drinking water to nearly 8,000 households in the village. In the past, women and young girls typically had to make at least a 45-90 minute daily round trip to collect water from a natural spring.[36]

AHREP’s participatory rural electrification program resulted in increased participation of women in village decision-making related to such issues as female literacy and planting kitchen gardens. Women also play a role in environmental conservation through improved sanitation (e.g., adoption of pit latrines) and increased fodder and fruit tree plantation. Community members prefer electricity, although it is slightly more expensive than kerosene, because it is brighter, cleaner, and provides quality light for children to study; in addition to saving time and effort and enabling enterprise development.[37]

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33 Owing to social tradition and decades of undemocratic political values, a schism has developed in the Nepalese population along caste or ethnic lines. Some believe it is one of the chief reasons for the so-called lower segment’s participation in the Maoist’s movement. Socially excluded groups include women, Dalits, and other ethnic nationalities, as well as the ultra-poor.

34 *Impact and Implications of Rural Electrification Through Micro-Hydro in Nepal With Special Reference to Barpak* (Gorkha district), and *Ghandruk* (Kashki district). ITDG, Kathmandu, 1997, p.26.

35 In Ghandruk (Kashki) district, the major and minor ethnic groups are Gurung and Kami-Damai, respectively. In Barpak (Gorkha) district, the major and minor ethnic groups include Ghale-Gurung and Kami-Damai. Both districts possess socially excluded ethnic groups, but Kami and Dama, who are regarded as Dalits, are still treated as untouchables in some parts. The process of rural electrification has undermined traditional social taboos between so-called “higher” and “lower” caste people in Nepal. Ibid, pp. 9 and 47.

36 The *Andhi Khola Hydel and Rural Electrification Project Report,* prepared for the Office of Agriculture and Rural Development, USAID/Nepal, Private Sector Hydropower Development Project, International Resources Group, Ltd., Washington D. C. 1999, pp. 8-11.

37 Small enterprises/factories established in the AHREP area include: 18 grain processing, 4 carpentry/furniture, 5 welding, 1 fruit juice, 1 ice cream, 1 noodle, 1 garment, 1 poultry hatchery, 2 oil pressing, 2 spice drying, 2 roof tile and concrete block, 1 bakery, and 1 popcorn. These small enterprises also create employment for sizeable numbers in the area. Ibid, pp. 12-17.

In Khaireni, a city located 190 km west of Kathmandu, over 49% of the respondents noted that there was an increase in working hours at its large *dhaka* (cloth) factory where a considerable number of local residents are employed. Nearly 20% of the respondents reported an increase in income[38] as well.

Another study in Nepal found that due to electrification in the villages of Barpak and Ghandruk, power-operated mills have replaced traditional rice-husking technology and small-scale industries have been established.[39] This has diversified the workload and saved time. Electric lighting has facilitated new local raw material-based economic activities. People pay their electricity tariff out of the profits they make.[40] The villages also observed positive impacts on their health habits and overall sanitary situation due to the use of electricity.[41] Children of the area developed better reading habits, and reported fewer respiratory problems[42] and improved quality of life.[43]

Like absolute poverty, hardcore poverty is least pronounced in electrified households (21.8%). The corresponding poverty incidence is 27.1% in non-electrified villages. Using cost-of basic needs (CBN) methodology, the incidence of poverty by household is also much lower for electrified households than non-electrified households. The average annual income (2003) of electrified households (Tk 92,963) is 65% higher than households in non-electrified villages (Tk 56,524). The annual income of the landless poor in electrified households (Tk. 58,864) was around 50% higher than in the non-electrified households (see Figure 4-4).

38 Ibid.

39 Intermediate Technology Development Group (ITDG), Kathmandu. According to the data, this remote village has 1 bakery, 2 rice/flour mills, 1 paper mill, 1 wool-carding factory, and 1 sawmill. These six industrial facilities employ 66 women and 6 men. Ibid, Annex V.

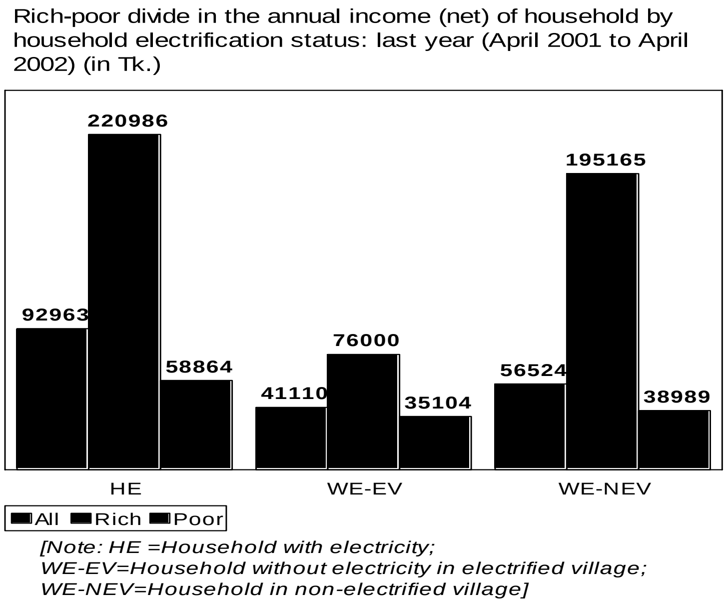
40 *Impact and Implications of Rural Electrification Through Micro-Hydro in Nepal* with special reference to Barpak (Gorkha district), and Ghandruk (Kashki district). ITDG, Kathmandu, 1997, pp.29-30.

41 Ibid, p.44.

42 Ibid. p. 25.

43 *Electrification and Distribution Improvement Project,* Final Draft Report, Worley International in association with Shah Consult International (private) Limited and NEA, 1999, p.31.

44 Economic-poverty has been estimated using head count measurements. The direct calories intake (DCI) and cost-of-basic-needs (CBN) methods were used. To ensure comparability of estimated values, the official methodology used by the Government of Bangladesh in the *Household Income and Expenditure Survey 2000* (published by BBS in 2001) was adopted. Also, to ensure comparability, the relevant correction factors were applied (e.g., 2001 taka values per person per month, for estimates of lower and upper poverty lines using the CBN method).



Source: Barkat et.al

Figure 4-4 Rich-Poor Divide in Net Annual Income of Households by Electrification Status

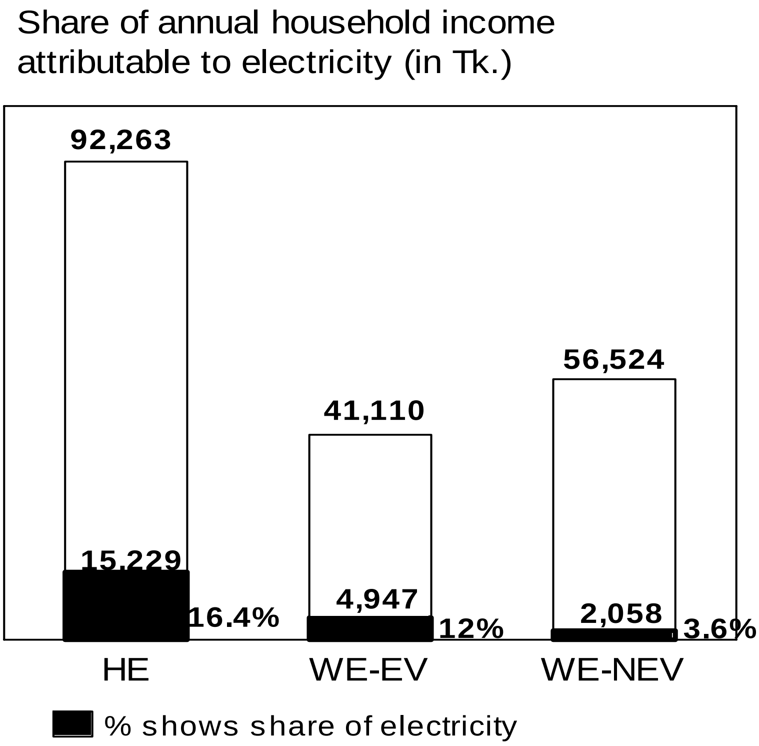
On an average, 16.4% of the income of electrified households can be attributed to electricity (Figure 4-5). The corresponding figure for the non-electrified households in electrified villages was 12%, and for those in the non-electrified villages, only 3.6%.

The income-poverty reduction impact of rural electrification is evident in that, irrespective of household electrification status, the relative share of household income attributable to electricity is consistently higher for the poor than that for the rich (Table 4-13). The impact is further evident in the amount of income attributable to electricity in poor electrified households (Tk 10,124 annually) is even higher in absolute terms than that in the rich households of non-electrified villages (Tk 7,461). Analysis clearly shows that access to electricity positively and significantly influences the shift of a household from the poor to non-poor category. This shift is also influenced by the educational status of the head of the household, which in turn is influenced by electrification status. (The results of the binary probit analysis are not shown here.) Thus, ensuring that poor households have access to electricity should be given high priority in any future poverty reduction strategy for rural Bangladesh (Figure 4-5).

Table 4-13 Rural Electrification and Income-Poverty Reduction

With electricity	15.2	Tk 220,986	17.2	Tk. 54,864
Without electricity in electrified village	8.6	Tk 68,237 **	14.3	Tk. 38,989
Non-electrified village	3.8	Tk 195,165	6.1	Tk.38989

* Poor means those having >50 decimals landownership; rich means those having landownership of 750 decimals and above.
** Since there was only one rich (large) landowner in the sample, the medium landownership (31 in number) is included.
Source: Barkat 2004

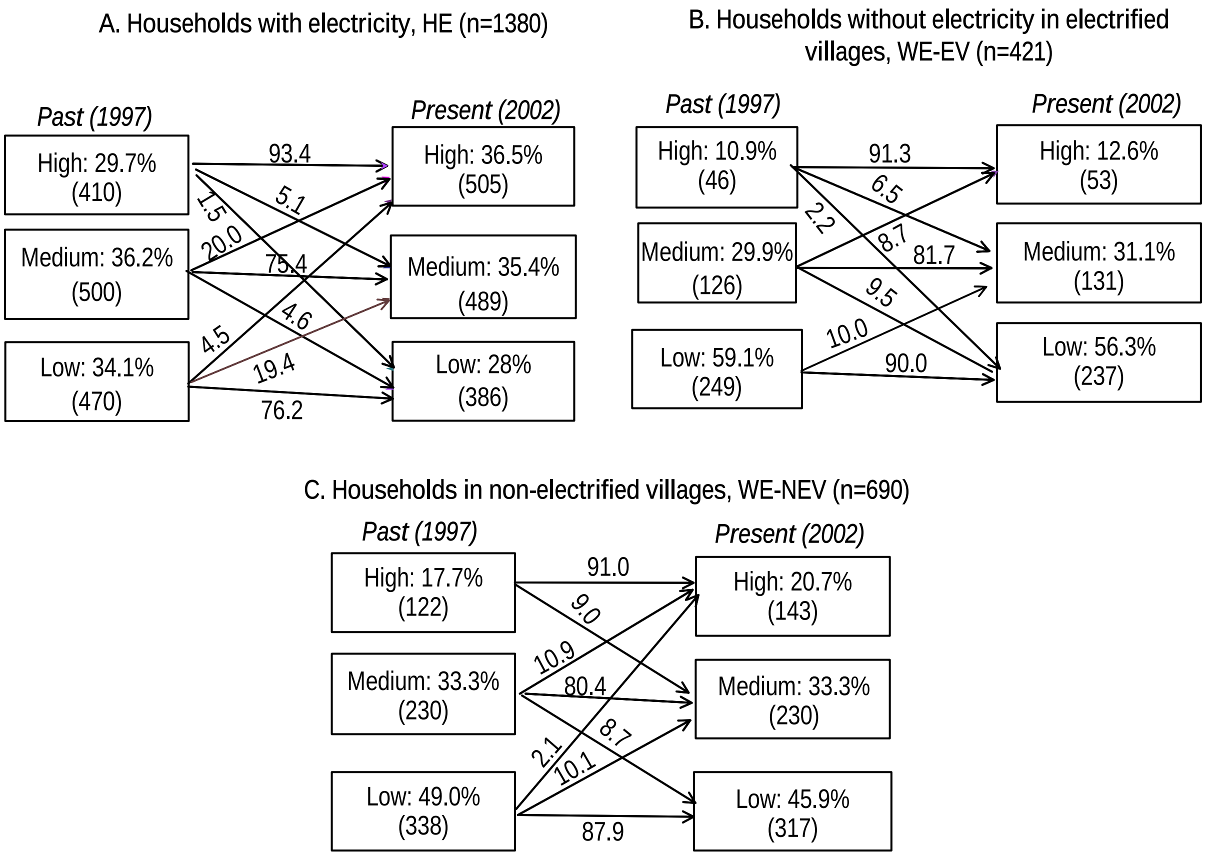


Source Barkat, 2002. Abbreviations: HE – Households with electricity; WE-EV – household without electricity in electrified villages; WE-NEV – households in non-electrified villages.

Figure 4-5 Share of Annual Household Income Attributable to Electricity

4.8.3 Rural Asset Building

Over the past five years, similar changes favoring the poor in electrified households versus the poor in households of non-electrified villages were evident in the ownership of other capital assets—dwelling/non-dwelling rooms, livestock and poultry, agricultural equipment, and durable household goods. During the five-year period 1997-2002, the increase in average assets (measured in monetary terms) was 19.4% in electrified households. The corresponding figure for households in non-electrified villages was 10% and 2.4% for non-electrified households in electrified villages. Electrified households exhibited a more progressive trend, with a relatively lower proportion of households in the low-asset group; a higher rate of upward movement in the original (1997) low- and medium-asset groups; and a relatively less pronounced downward trend of all three asset groups (Figure 4-6).



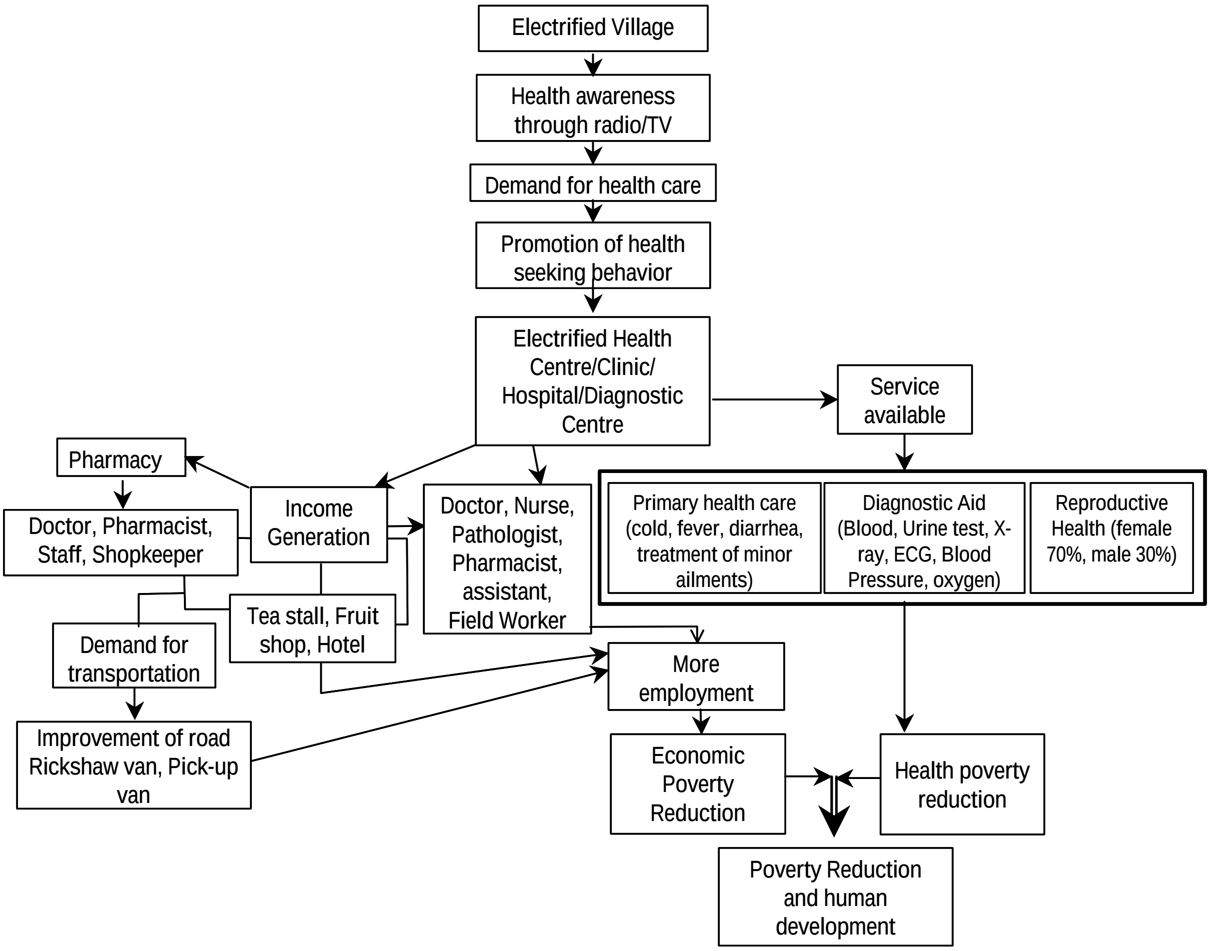
Source: Barkat et al., 2002.

Figure 4-6 Five-Year Asset Changes In Rural Bangladesh—With and Without Electricity

4.8.4 Impacts on Health

Rural electrification has had a remarkable impact on public health. This is seen in enhanced pubic health awareness through health education, including advice and information on healthy behavior on the one hand, and a decrease of risk-taking behavior on the other. Electrification has facilitated transmission of information on health-related matters through television. Villagers with access to electrification have been made aware of ANC, PNC, pregnancy-related complications and their treatment, sanitation, abuse of drugs, breastfeeding, immunization, family planning, balanced diet, iodized salt, food and nutrition, environmental conservation, and the effects of vitamin deficiency. Electrification has also encouraged establishment of rural private hospitals, clinics, diagnostic centers, and pharmacies.

Because of the increased number of customers, the demand for doctors and medicine has increased. Life-saving medicines previously available only from distant urban centers are now available in electrified rural areas, reducing cost, access time, and health hazards for rural people. The growth of clinics, health centers, and pharmacies also contribute to employment creation. With electrification, advanced procedures, such as x-ray, ECG, and ultra-sonogram, are available at a few village clinics. Oxygen is also available and minor operations are done at clinics in some villages. All these contribute to improved health, and development of these facilities has generated income-earning opportunities for many people in the vicinity.



*Source: Barkat et. al, 2003***.**

Figure 4-7 Human Poverty Reduction Mechanism in Health in Typical Bangladeshi Electrified Village

4.8.5 Impact on Education

In the SAGQ region, electricity has made significant contributions to technical and vocational education. Electrified schools are qualitatively better than non-electrified schools:

- Electrical fans in schools help students to be more attentive than before, and the teachers feel more comfortable
- Before electrification, children had to read in the light of *kupi* and *haricane,* which caused eyestrain and produced hazardous smoke

- Student performance has improved with electrification
- In some schools, double shifts have been introduced, with adult literacy in the evenings
- In many electrified village schools, five or six computers are available, and in some schools, computer training has been introduced
- Science students can participate in practical work, and the students organize cultural programs at night
- Vocational centers have been established in many electrified villages offering training in welding, electrical wiring, poultry farming, sewing, lathwork, and repairing. Technical education has helped increase employment

Compared to non-electrified households, electrified households fare better in terms of overall literacy rate and ratio of children enrolled in schools. Educational expenditures, examination performance, attendance rates, dropout rates, and average time spent on study (after sunset) have all improved.

In addition, the average annual household expenditure on education is 87% higher in the electrified (Tk 3,260) compared to non-electrified villages (Tk 1,746). Moreover, in the electrified households, not only is there more time available for study (average 30-45 minutes more after sunset as compared to non-electrified), but the quality of that time due to sufficient lighting and fans for comfort plays a determining role in improving the quality of children's education. Thus, household access to electricity should be seen as one of the major strategies to reduce knowledge poverty.

4.8.6 Demographic Impact

The population growth rate in the electrified household segment is lower than in the non-electrified. This is evident from the relatively low total fertility rate (TFR)[45] measured indirectly (using contraceptive prevalence rate) as compared to the non-electrified segment.

Young age structure and dependency ratios are relatively less pronounced in electrified than in non-electrified households. Inbound-migration is more pronounced in electrified villages due to access to electricity and other associated modern amenities. Population survival rate is higher in electrified than in non-electrified villages: This is evident from the lower infant

45 TFR refers to the average number of children that would be born alive to a woman (or group of woman) during her lifetime if she were to pass through her childbearing years conforming to the age-specific fertility rates of a given year.

mortality rates in electrified villages (42.7/1000 live births versus 57.8/1000 live births) in non-electrified villages.

4.8.7 Empowerment of Women

The Rural Energy Development Program (REDP) conducted a survey on *Women and Environment* after the introduction of a village-based micro-hydro and locally managed energy system at Tanahu district in Nepal. The survey revealed some interesting gender-related aspects of improved conditions:[46]

- Health of women and family members has improved due to elimination of kerosene smoke for light and firewood for cooking
- Women and girls are spared the drudgery of collecting firewood and fodder
- Women are making decisions related to the businesses they have initiated
- Women use time saved to engage in income-generating activities, such as sawmills, poultry and pig raising, sweater knitting, stickmaking, soapmaking, etc.;
- Women and men community members are engaged in off-season vegetable farming
- Women have become relatively more self-confident and assertive than previously due to leadership training, non-formal education, and income-generation activities
- Mobility of women has considerably increased as a result of their involvement in community group activities and development issues

Similarly, another REDP study of five districts—Baglung, Tanahu, Dolakha, Kavre, and Dadeldhura—found that women were participating in 80% of the decision-making process for project sites.[47] Women have been significantly empowered, and at the same time, their workload has been diversified. [48] In the Tarai, women mentioned an increased feeling of security.[49] In Bangladesh, the number of women benefiting from raising poultry and establishing micro-enterprises has increased, which has enhanced their socioeconomic status. For women, rural electrification has improved access to and control over resources.

46 District Development Committee-Rural Energy Development Section (DDC-REDS Tanahu), 1999.

47 Op. cit. *Impact Study Report,* REDP, p.5-5.

48 Apart from household chores, women are found to be more involved in skill training than men (spinning, *Allo*), bakery, paper industry (*Lokta*) wool carding, rice/flourmill, sawmill/furniture, poultry, and adult literacy. See for details, Impact and Implications of Rural Electrification Through Micro-Hydro in Nepal, Report Prepared by Info Assembly Pvt. Ltd. Nepal, for ITDG; 1997. pp. 20-22.

49 Op. cit. *Electrification and Distribution Improvement Project,* 2-32.

4.9 EMPLOYMENT OPPORTUNITIES

4.9.1 GDP Growth

4.9.2 Rural Electrification

Creation of sustained employment opportunities constitutes one of the major economic impacts of expanded access to electricity. In Bangladesh research has shown that, due to expanded electrification, additional employment has been generated in farmlands using electrified irrigation equipment, in industries (small/medium, rural/urban, handicrafts), retail and wholesale shops, support services, social sectors (health facilities, diagnostic centers, educational and training centers), and even among women in home-based micro-finance mediated income generating activities.

Employment impact is both direct and indirect. In agriculture, an estimated 1.1 million persons are directly involved in farmlands using rural electricity-connected irrigation equipment. Currently, 63,220 industries using rural electricity employ 983,829 people; and electrified industries, on average, generate 3.3 times more employment than non-electrified industries. Retail and wholesale shops using rural electricity employ 848,630 people. There has been direct employment of 16,223 persons in the *Palli Bidyut Samities* (PBSs). Moreover, women in electrified households, versus those in non-electrified households, are involved in more income-generating activities and are can better reallocate time for remunerative employment. The unemployment rate is relatively low in electrified households, and the relatively higher share of non-agricultural employment in electrified households demonstrates

[50] *Water Resources Strategy formulation Phase II Study, Macro Economic Framework (Annex),* WRSF Consortium, October 2000, p 57.

[51] The Big Business Houses in Nepal, GEFONT-Nepal, website: ww.gefont.org/research/bigbuss/html/bigbuss.htm.

the modernizing effect of electricity on occupations. In addition, rural electrification has had an enormous spillover effect on employment in various support-services, such as shops, restaurants, banks, fax-email-photocopy facilities, schools and colleges, bus/tempo stoppages, diagnostic, centers and clinics, etc.

Impact on Employment Directly Associated with Rural Electrification (RE)
(2.95 Million People)

4.9.3 Power Projects

The *Feasibility Report on Viability of Power Exports From Bangladesh to India* estimates that 150 MW power (domestically generated or imported through interconnections) could generate considerable additional employment, particularly in rural areas (Table 4-14).

In addition, during the construction of power projects, particularly hydropower plants, sizable job opportunities will be created. It is generally estimated that about 1,200 unskilled job will be created for each 10 MW hydropower plant for about a three- year construction period. Depending on the size and the geographical distribution of hydro plants, there will be a potentially sizable job market for local inhabitants. The *Hydropower-Led Development Strategy Report* finding is that, at sustained level of 8% growth rate driven by hydropower exports, unemployment will vanish after 2012.

Table 4-14 Potential Employment Opportunities Due to 150 MW Power Imports by Bangladesh

Agriculture	55,000	1. More area will be under irrigation than with diesel-operated pumps. 2. Land use and cropping intensity will increase. 3. Average yield per acre will increase. 4. These increases will contribute to food self-sufficiency 5. Improved purchasing capacity will enhance farm living standards. 6. Electricity-driven irrigation systems are more environment-friendly than diesel.
Industry	49,191	1. Electrified industry generates 11 times more employment than non-electrified. 2. Electrified industry generates more employment for women than does non-electrified. 3. Electrified industries are cost-efficient, productive, and environment-friendly; they promote backward-forward linkages and diversification.
Retail and wholesale shops	42,431	1. On average, an electrified shop employs one additional person. 2. Electrified shops are better integrated with the marketplace. 3. Electrification gives rise to constellations of shops. 4. Electrified shops are open about 2 hours longer after sunset (prime business hours). 5. Compared to non-electrified shops, average turnover for electrified shops is two times higher for retail and 11 times higher for wholesale.
Support services and social sectors	Significant employment addition/creation (new employment)	1. Fax-email-telephone facilities, photocopy shops 2. Restaurants 3. Bus/tempo stoppages 4. Medical/diagnostic centers 5. Vocational training centers.

Realization of Bangladesh's vision of "Electricity for All by 2020" will require a huge investment totaling US$15.1 billion between 2004-2020 (i.e., an annual average of about US $1 billion).

The research team preparing this report found that at the ongoing Teesta (Stage V–520 MW) project there is direct employment generated for 976 persons. There is also a large number of indirectly generated employment opportunities, such as those in Sikkim National Transport for transporting goods from Siliguri to the project site in Singtam; as well as in compensatory reforestation, landslide stabilization, muck deposit sites, fruit and fodder plantation, greenbelt development, catchment area treatment, the project hospital, and the women's welfare association. The welfare aspect of the project is also very interesting—from 2001 through July 2004, the project hospital provided 56,171 patient treatments. The project workforce spends about Rs 30 million per month in the local markets, providing many opportunities for the local business community. Employment is likely to go up once the transmission and distribution network is built.[52]

4.9.4 Tourism Sector

In the tourism sector—for which electricity is the backbone, especially in the hill and mountain regions of Nepal—a 1978-1993 survey of mountaineers conducted revealed that

[52] Based on the visit by the Research Team, at the Teesta Hydel project Stage V site at Singtam, Sikkim in August 2004.

each mountaineer gives employment to more than 10 local people.[53] Nepal is an excellent tourist destination for trekking in the Himalayas and for whitewater rafting in the rivers that drain down to the Terai lowlands from the snow-clad mountains. It is estimated that 50% of the tourists are on pleasure trips, 23% are trekking and mountaineering, 6% are on business, 6% are on official trips, and 2% are on pilgrimages. There has been a steady increase of tourists visiting Nepal for trekking and mountaineering purposes, from 13.6% of the total tourist arrivals in 1975 to 23% in 2000.

Table 4-15 Tourist Arrivals

India	117,260	122,512	133,438	143,229	140,661	95,915
Other	246,135	271,101	288,419	320,455	350,843	367,731
Total	363,395	393,613	421,857	463,684	491,504	463,646

Source: Nepal Rashtra Bank, *Economic Report*, Kathmandu, Various Issues and Ministry of Finance, *Economic Survey*, Kathmandu, Various Issues.

Foreign tourists have exhibited an increasing interest in participating in mountaineering expeditions to Nepal. In 1978, 42 mountaineering expeditions paid NRs 0.614 million in royalties; in 1995 91 expedition teams contributed NRs 37.30 million in royalties to the Nepalese exchequer. Additionally, these expeditions aid the economy, as the teams tend to make significant local purchases. In 1990 these teams generated the highest recorded employment (12,179 people) and highest total expenditure (NRs 68.36 million).

4.9.5 Poverty Alleviation

These conclusions were reached by assuming that the existing structural relationships between economic variables would continue. If the structure of the economy changes, stimulating higher industrial and service sector contributions, poverty alleviation may be achieved much earlier. As a result, hydropower-led development strategy is likely to reduce the incidence of poverty in the span of less than one and a half decades.

53 Ramesh Arya, "Small Hydro-Power and Tourism Promotion," in H. B. Jha (ed) *Sustainable Development of Small Hydro-power in Nepal*, CETS and FES, Kathmandu, Nepal, 1995, pp.72-81.

4.10 CONSERVATION AND ENVIRONMENTAL GAINS

Electrification replaces kerosene used for lighting and reduces firewood used for cooking and thereby helps conserve the environment.[54] By reducing the use of fuel-wood for cooking, electrification also reduces associated problems such as landslides and erosion; transport of sediments into the hydroelectric system; decreasing forest product yields (e.g., construction timber, wild fruits and vegetables, resins and saps, nuts, herbs, and medicinal extracts); and the loss of biodiversity.[55] It also provides environmental benefits by offsetting the use of less reliable gas or diesel generators and reducing associated air and noise pollution. The use of electricity will help to slow deforestation, provided the cost is lower than fuel-wood, encouraging the growth of forests that ameliorate global warming. In addition, electricity use would mitigate the accompanying greenhouse gas emissions such as CO_2. It has already been demonstrated that the overall environment of Nepalese households and the surrounding areas has improved due to electrification.[56]

4.10.1 Carbon Dioxide and Other Emission Reductions

Ghandruk, which is a tourist spot situated at the headquarters of the Annapurna Conservation Area in Nepal, has been able to reduce CO_2 emissions by using renewable energy technology, such as micro-hydropower, biomass, and solar. As a result of electricity use and fuel-efficient end-use devices, less firewood has been consumed and energy diversification has enabled tourist lodges to gradually shift to a superior energy ladder. Consequently, CO_2 emission rates in Ghandruk were nearly 67% lower than in nearby Ghorepani village. It should be noted that woodfire emissions are the main source of environmental pollution in these rural areas (Table 4-16)[57].

Table 4-16 Principal Energy Sources in Rural Nepal and CO2 Emission (Tonnes/Year)

Firewood	130.1	452.0
Kerosene	45.4	31.3
LPG	3.5	0.2
Total	179.0	483.5

Providing electricity to villages has contributed tremendously to the agricultural production system in Bangladesh, particularly with respect to irrigated agriculture. Diesel-powered pumpsets are now being replaced by electric pumpsets. About 9% of REB's total electricity

54 Indu Shamsher Thapa, "Development of Small Hydro Electric Power and Its Impact on the Small and Rural Industries," in H. B. Jha (ed.), *Sustainable Development of Small Hydropower in Nepal*, CETS and FES, 1995, pp. 37-49.

55 Inversin, Allen R., *New Designs for Rural Electrification: Private Sector Experience in Nepal*, Washington D. C., National Rural Electric Cooperative Association, 1994, p. ii.

56 Butwal Power Compan*y, Study of Promotion of Electricity Distribution by Cooperative s- Final Report,* (This report is based on the Lamjung Electricity User's Association (LEUA) , Salleri Chialsa Electricity Company (SCECO),Khumbu Bijuli Company (KBC) and Andhi Khola Hydro-Electric and Rural Electrification Center (AHREC), 13 September, 2001, pp.48-49.

57 To reduce firewood energy consumption in the lodges of Ghandruk and Bijuli Dekchi, energy-saving or electric cooking devices and back boiler water heaters (BBWHs) for hot showers have been introduced. The BBWH system alone saves an estimated average 675 kg of wood per month per lodge during the peak tourist season. See details: Banskota, K. and Sharma, B. *Impact of Alternative Energy Technologies in Reducing Pressure on Forest Resources in Ghandruk,* Center for Resource and Environmental Studies (CREST), 1996.

consumption is used for agricultural irrigation. The electrically powered irrigation systems are more environmentally friendly. Gasoline and diesel fuels when burned or evaporated produce numerous harmful chemicals and volatile organic compounds (VOCs), which are toxic to humans and contribute to increased greenhouse gases in the atmosphere.

It is estimated that electricity used by REB irrigation pumps is equivalent to about 31% of total diesel fuel consumption in irrigated agriculture in Bangladesh. Based on U.S. Environmental Protection Agency (EPA) emission factors for uncontrolled fuel oil combustion, an estimate of the positive benefits from reduced pollution due to reduced use of diesel in REB-supported irrigation schemes is presented in Table 4-17.

Table 4-17 Potential Reduction in Pollutant Volumes from Elimination of Diesel Pumpsets

Total organic carbon (TOC)	24,011.15
Carbon monoxide (CO)	115,438.21
Sulfur oxide (SO_x)	3,269,759.77
Nitrogen oxide (NO_x)	1,269,820.30
Methane	6,464.54
Lead	34,862.34

4.10.2 Reduction in Firewood and Kerosene Use

The REDP's experience with micro-hydro demonstration schemes in Nepal suggests that reduced firewood and kerosene use due to rural electrification has not only impacted the environment but also helped improve the health of the rural population,[58] as a result of which medical costs have been considerably reduced.[59]

4.10.3 Tourists and Fuel-Wood

The contribution of the tourism sector to Nepal's national GDP is about 2.1%. It is the third largest source of foreign currency earnings after the garment and carpet industries.[60] In the mountain regions, about 80% of energy is consumed in boiling water for the tourists, and the source is fuel-wood. Although the 1978-1993 survey of mountaineers revealed that each mountaineer gives employment to more than 10 local people, [61] it is that same tourism that ironically helps to exhaust the firewood supply. If electricity replaces the traditional source of energy, it will have an immense ecological impact and help prevent depletion of biodiversity in the mountains and hills of Nepal.

4.10.4 Carbon Trading

Replacing existing polluting sources of power in power-importing countries will produce significant environmental gains from avoided pollution, particularly in the case of large-

58 Firewood saving:63% in Kabhre, 60% in Baglung, 72% in Tanahu, and 64% in Dadeldhura districts.

59 Ibid.

60 *The Gorkhapatra*, May 13, 1995.

61 Ramesh Arya, "Small Hydro-Power and Tourism Promotion," in H. B. Jha (edt) *Sustainable Development of Small Hydro-power in Nepal*, CETS and FES, Kathmandu, Nepal, 1995, pp.72-81.

volume power trading. For example, development of Nepal's hydropower for export to India will replace poor-quality coal-based electricity generation in India.

[62] India: Environmental Issues in the Power Sector, Report No. 205/98, ESMAP, June 1889, p.33.

Section 5 Private Sector Participation in Power Development

There is wide variation in installed power capacities and natural energy resources in SAGQ countries. Hydropower has been the most vital source of total installed capacity in Bhutan (100%) and Nepal (90%), whereas thermal power dominates in Bangladesh (92% [mainly gas based]) and India (73% [mainly steam based]).

To expand installed capacity, the SAGQ countries have introduced massive changes in their policies on private sector participation in the power sector.[63] However, private power developers are not satisfied with the pace of reforms in this sector. Nevertheless, in Bangladesh, a large number of IPPs have shown interest, and likely projects are the 360 MW and 450 MW combined cycle power plants at Haripur and Meghna Ghat, respectively.[64]

The installed generation capacity in the SAGQ countries is shown in Table 5-1.

Table 5-1 Installed Generating Capacities in Power Utilities in SAGQ Countries

Thermal	4,483	–	75,931	51.3
% share	*95.12*	–	*72.3*	*9.06*
Nuclear	–	–	2,700	–
% share	–	–	*2.57*	–
Hydro	239	444	26,329	542.8
% share	*4.88*	*100*	*25.1*	*90.93*
Total	4,713	444	104,960	594.1

Notes: @ 84.6 % is gas based; # In addition to this the installed capacities in the non-utilities is over 16,000 MW * 3 MW is wind based energy. Sources:(i) Government of Bangladesh, *Economic Review, 2000,* Ministry of Finance; (ii) Wangchuk, LK, Bhutan's Minister of Trade and Industry in an interview with *Energy South Asia,* New Delhi, January/February 2002 and also Royal Government of Bhutan, *Seventh Five Year Plan 1992-97,* Planning Commission; (iii) Government of India, *Economic Survey 2002-2003,* Ministry of Finance, and (iv) *Fiscal Year 2002/03- A Year in Review*, Nepal Electricity Authority, Kathmandu, August 2003.

In 1995, 3,544 MW (around 4.4%) of India's installed capacity was in the private sector. By 1997, IPPs had expressed interest in developing more than 124 power projects in India with a total installed capacity of 67,281 MW representing an investment of about Rs 2.46 trillion (US$54.17 billion). The IPPs generally sell power to the state electricity boards (SEBs) which oversee electricity distribution.[65]

Among the "operating ventures" in Nepal, the installed capacity by the private sector increased to 113 MW (501 GWh of energy) in 2002, which was 27% of the total generation that year. The major private players in the power sector are Butwal Power Company, Bhotekoshi Power Company, and Himal Power Limited.

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63 Lama, Mahendra P., "Economic Reforms and Cross Border Power Trade in South Asia", *South Asian Survey,* Delhi, "Economic Reforms and Cross Border Power Trade in South Asia", *South Asian Survey,* New Delhi, January-June 2000.

64 Board of Investment, *Guide to Investment in Bangladesh*, Prime Minister's Office, Dhaka, March 1998, pp. 53-54.

65 Government of India, *Economic Survey 1998-99,* Ministry of Finance, New Delhi.

Appendix A Demand-Supply Gap

REGIONAL OVERVIEW

An analysis of the regional power sector demand-supply gap is crucial in reaching any meaningful conclusion on the possibility and potentiality of cross-border power trade. The SAGQ countries are largely energy importers. Most of these countries have faced increasingly serious power shortfalls because of excess industrial and residential demand that exceeds their power-generating capacities. Their inability to cater to increasing industrial and other commercial needs have adversely affected productive activities, social development, and investment climates, a situation that is further exacerbated by structural, institutional, and financial problems. The supply side has recorded both smaller and erratic growth patterns that have led to frequent power cuts and increased rationing. Additionally, the renewed emphasis on rural electrification will widen the demand-supply gap as countries respond to the overwhelming demand for electricity access from rural populations.

It is estimated that every electricity unit that is cut produces an economic loss of five to ten times the cost of the electrical energy generated, due to wastage in manpower, material, and equipment as well as loss of production hours.[66] The power deficit is likely to deepen because regional economic liberalization has led to increased industrial activity and the rise in income levels has led rural and urban families to switch from biofuels to more efficient and convenient modern fuels.

Most of these countries have load forecasts for the next 15-20 years covering the projected demand for electricity, which helps ascertain their capacity and energy requirements. [67] In most cases, forecasts are based on detailed reviews of previous levels of electricity consumption supplemented by overall development policies.

BANGLADESH

The Fifth Five Year Plan (1997-2002) envisaged that future demand for electricity (high demand scenario) would be 4,051 MW by the year 2002. This would have entailed adding 3,319 MW of total generating capacity and raising the total generating capacity to 6,227 MW. Public sector capacity additions during the plan period were likely to be 1,389 MW, with the gap of 1,930 MW to be bridged by private sector/joint venture investments.[68] The projection made in the National Energy Policy of Bangladesh indicates that the deficit level will increase to 43,698 GWh (low scenario) and 74,102 GWh (reference scenario) by 2020. (Table A-1). Table A-2 reveals the current situation against the backdrop of long-term forecasting.

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66 Perera, KKYW, "Energy Issues and Alternatives", *Economic Review,* People's Bank, Colombo, August 1996, p 7.

67 Load forecasting also helps determine the direction and extent of investments required in the power sector. It is prepared in full consideration of the nation's economic growth rate, per capita GDP, population projections, consumer affordability (income and price elasticities), industrial growth rate, and historical trends. Load forecasting is also essential to formulating financial policies, tariff rates, and future fuel requirements.

68 Government of Bangladesh, *The Fifth Five Year Plan, 1997-2002,* Planning Commission, Ministry of Planning, Dhaka, 1998, pp 348-349. Bangladesh Power Development Board (BPDB) load forecasting is used for determining the sizes and types of generation, transmission, and distribution system expansion as a standard procedure.

Table A-1 Current Demand and Supply Situation of Bangladesh Power Sector

Estimated demand (FY 2003-04) Maximum demand supplied (suppressed) (FY 2002-03) Current supply situation (FY 2003-04) (suppressed due to gas shortage) Current installed capacity (FY 2003-04) Public sector IPP Current electricity generation (FY 2002-03) BPDB (gross)	3,900 MW 3,622 MW 3,000-3,500 MW 4,710 MW 3,420 MW 1,290 MW 19,179 MkWh 12,881 MkWh

Source: System Planning, BPDB, Ministry of Power, Energy and Mineral Resources

On the other hand, the Power System Master Plan (PSMP) study used 1994 (July 1993 to June 1994) as the base year for the forecast, which covers the period 1995-2015. The forecast projects electricity requirements by principal consumption category for established supply areas as well as consumption in the more recently electrified rural areas.[69] The Dhaka, central, and southern regions east of the Jamuna River constitute almost 75% of the entire Bangladesh electricity market. The western and northern regions west of the Jamuna River represent the remaining 25%.

Table A-2 Bangladesh—Demand Forecasts and Primary Energy Mix for Power Generation (GWh)

Low scenario	11,584	18,315	26,063	30,994	61,998
Reference scenario	12,270	18,071	28,060	39,750	92,402
Total generation from idigenous fuel	11,300	17,030	18,000	18,300	18,300
Deficit Generated by Imported Fuels					
Low scenario	284	1,285	8,063	12,694	43,698
Reference scenario	980	1,941	10,060	21,450	74,102

Source: Government of Bangladesh, *National Energy Policy, 1996,* Dhaka

Three levels of forecast are available for Bangladesh: (1) the peak demand forecast, which has both the reference and high-forecast components (Table A-2); (2) maximum demand by consumption zone (Tables A-3 and A-4); and (3) an alternative forecast based on different economic scenarios. The medium-term plan has been considered up to the year 2007.

[69] The PSMP is a 20-year plan, based on which the government prepares its five-year plan and tries to arrange foreign financing for development of the sector to systematically meet growing power demand.

Table A-3 Bangladesh—Peak Demand Forecast (MW)

1999	2721	2881	2937	3109
2000	2974	3149	3256	3447
2001	3206	3394	3529	3736
2002	3457	3659	3827	4051
2003	3728	3947	4150	4393
2004	4023	4259	4502	4766
2005	4342	4597	4885	5172
2006	4692	4967	5293	5603
2007	5071	5368	5735	6071
2008	5480	5802	6215	6579
2009	5923	6271	6735	7130
2010	6403	6779	7300	7728
2011	6906	7311	7894	8356
2012	7450	7887	8537	9037
2013	8037	8508	9233	9775
2014	8672	9180	9988	10537
2015	9357	9906	10805	11439

Source: *PSMP*, 1995

Table A-4 Bangladesh—Reference Forecast (MW)*

2001	3097	303	1329	415	673	378	2305	792
2002	3339	326	1451	443	721	400	2497	842
2003	3602	351	1584	272	773	425	2706	895
2004	3886	377	1730	503	828	450	2934	952
2005	4195	406	1890	536	887	478	3182	1013
2006	4533	437	2047	580	953	517	2437	1096
2007	4898	470	2218	629	1025	559	3712	1187
2008	5294	506	2403	681	1102	604	4009	1285
2009	5722	544	2603	738	1184	654	4331	1391
2010	6186	586	2820	800	1274	708	5678	1507
2011	6672	528	3044	865	1369	767	5041	1631
2012	7197	674	3287	936	1473	830	5432	1765
2013	7764	723	3549	1012	1584	899	5854	1910
2014	8377	775	3831	1095	1703	974	6308	2068
2015	9039	831	4137	1185	1832	1056	6799	2240

Excluding Transmission Losses. Source: BPDB, Dhaka.

Table A-5 Bangladesh—2001-2007 Power Generation Plans (MW)

Existing Public							
East	2616	2756	2626	2596	2470	2444	2324
West	398	392	356	288	270	270	270
Total public	3014	3148	2982	2884	2740	2714	2594
Existing Private							
East	180	180	180	180	180	180	180
West	200	200	200	200	200	200	200
Total private	380	380	380	380	380	380	380
Total existing	3394	3528	3362	3264	3120	3094	2974
New Public							
East	0	0	649	939	1039	1039	1189
West	0	100	120	670	1330	1630	1630
Total public	0	100	769	1609	2369	2669	2819
New Private							
East	70	430	880	880	1180	1330	1330
West	0	170	340	340	340	340	340
Total private	70	600	1220	1220	1520	1670	1670
Total new	70	700	1989	2829	3889	4339	4489
Total East	2866	3366	4335	4595	4869	4993	5023
Total West	598	862	1016	1498	2140	2440	2440
Total system	3464	4228	5351	6093	7009	7433	7463
Peak demand <1	3394	3659	4393	4766	5172	5603	6071
Firm demand <2	2983	3537	4371	5113	6029	6423	6453
Surplus (shortfall)	-411	-122	-22	347	857	820	382
Reserve margin (%)	2	16	22	28	36	33	23

There are also alternative forecasts, which were made to formulate a plan for changing economic development scenarios. The reference forecast is used as the basis of generation, transmission, and distribution planning within the PSMP.[70]

- *Low forecast: Net generation: 42,050 GWh*
  8,000 MW demand by 2015.
  Average annual growth rate 7.5 % from 1994 base
  Represents 85 % of reference forecast values.[71]

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70 The principal assumptions included in the forecast are stable pricing of all sources of energy (continuing both subsidized electricity and natural gas), a moderate increase in industrial development, and no significant effort in demand-side management (DSM). The reference forecast also assumes that the completion of Jamuna Bridge would increase commercial and industrial activity in northern and western zones in the last two forecast periods.

71 The low forecast assumes that tariff levels will increase significantly to reflect the long run marginal cost (LRMC) of production as well as the implementation of an aggressive DSM program. Increasing real tariffs tend to decrease sales as customers reduce

- *High forecast: Net generation 56, 800 GWh*
  10,800 MW by 2015.
  Annual growth rate of 9 % from 1994 base
  Represents 15 % higher than the reference forecast value.[72]

The SARI/Energy *Prefeasibility Study on Power Export From Bangladesh to India* mentions that even if all of the projects that are under way or under negotiation are completed, there will still be a serious capacity deficit in both eastern and western Bangladesh. (Figure A-1). The deficit will be particularly pronounced in the west where the cost of power production is much higher due to reliance on liquid fuels and smaller plant sizes.[73] However, another estimate indicates Bangladesh is likely to have a surplus by 2003-2004.

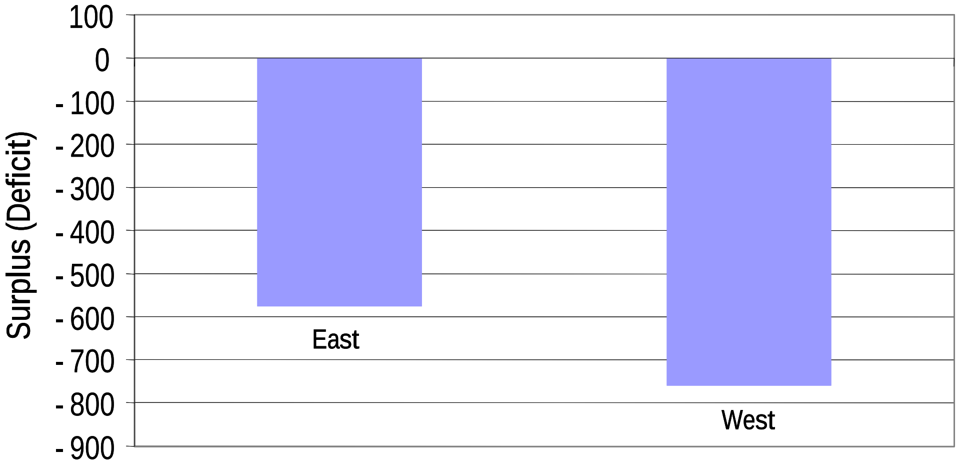

Figure A-1 Projected Deficit in East and West Bangladesh (2007)

BHUTAN

In Bhutan, hydropower potential is being increasingly harnessed. Current total demand is 100 MW and the installed capacity is 444 MW. This has left Bhutan with a substantial disposable surplus, which is sold to India under a bilateral arrangement. The domestic demand for power is growing at the rate of 10% and the supply potential is being enhanced at a much higher scale, creating a huge exportable surplus.

INDIA

In India there are several projections based on different sets of assumptions in each model. The Ministry of Power/Central Electricity Authority in consultation with the Planning Commission has programmed a capacity addition of 41,110 MW (excluding non-conventional energy sources) during the 10th Plan (2002–2007). Out of the feasible 41,110

wasteful consumption. However, it may not be possible to implement a tariff structure based on LRMC in the near future as the current tariff is about 65% of LRMC.

72 The high forecast assumes that there will be increased levels of investment activity in the industrial sector, particularly in the central, southern and western zones. This activity will be in line with the target levels of industrial growth expected after implementation of five-year plan. With this objective in mind, generation expansion planning is being made on the basis of high forecast from FY 2002. BPDB load forecasting is used for determining the sizes and types of generation, transmission, and distribution system expansion as a standard procedure. Load forecasting is also essential in formulating financial policies, tariff rates, and future fuel requirements.

73 The Four Borders Project: Reliability Improvement and Power Transfer in South Asia: A Pre feasibility Study, prepared for USAID-SARI/Energy Program by Nexant in November 2001.

MW, planned capacity additions are 14,393 MW for hydro; 25,417 MW for thermal; and 1,300 MW for nuclear. In addition to various initiatives taken by the North East Electric Power Corporation (NEEPCO) to exploit the power potential of the northeastern states, NHPC has also plans to exploit the large hydropower potential in Arunachal Pradesh, and work has already begun on the first major project with an installed capacity of 2,500 MW.

Given the actual capacity additions during the Ninth Plan, which were 19,015 MW out of a targeted 40,245 MW, Tenth Plan capacity additions are also likely to fall short. This would mean increasing reliance on import of power from the neighboring countries.[74] The demand projections per the government's 16th electric power survey in 2000 are shown in Table A-6.

Table A-6 All India Projected Demand

	2006-07	2011-12	2016-17	2006-07	2011-12	2016-17
Northern Region	220820	308528	429480	35540	49674	69178
Western Region	224927	299075	395859	35223	46825	61966
Southern Region	194102	262718	354599	31017	42061	56883
Eastern Region	69467	90396	117248	11990	15664	20416
Northeastern Region	9501	14061	20756	1875	2789	4134
All India	719097	975222	1318644	115705	157107	212725

Source: Central Electricity Authority, *16th Electric Power Survey,* New Delhi, 2002

The power map of India has five different regions—northern, southern, western, eastern, and northeastern. Throughout the 1990s, the northern and the southern regions faced maximum demand-supply gaps. All the regional grids face perennial energy shortages except the eastern region, which has surplus power varying from 1,000 MW to 3,000 MW throughout the year. In other regions, seasonal surpluses occur mostly during off-peak hours in periods of lean demand caused by weather and agricultural pumping loads.

In India, reliability and accessibility continue to be serious problems. Energy and peak shortages of power have been around 7.5% and 12.1%, respectively, leading to brownouts and blackouts across the country. Scheduled power cuts, unscheduled outages and incorrect voltages are common in most states, leading to enormous disruptions in all aspects of economic life. This has created operational inefficiencies for firms across the country, and a substantial wastage of capital that is tied up in voltage stabilizers, invertors, and generators and in replacing burned-out motors.[75]

Table A-7 shows that India's eastern and the northeastern regions are expected to have surplus electricity by the year 2006-2007. Given that significant inter-regional electricity

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74 This shortfall in capacity additions is attributed to (i) uneconomic tariffs for agriculture, lower domestic consumption, and high T&D losses, which have created roadblocks in attracting much-needed private investment; and (ii) delays in land acquisition and environmental clearances, unresolved issues in fuel linkages, contractual problems, resettlement and rehabilitation problems, and law-and-order problems. Government of India, *Tenth Five Year Plan,* Planning Commission, New Delhi, 2002, p 897.

75 Source: Government of India, *Economic Survey 2002-2003*, Ministry of Finance, New Delhi, 2003, p 181.

transfers already take place in the country, this power is likely to be evacuated to other regions facing deficits, primarily the northern, southern, and western regions.

Table A-7 Projected Power Supply Position in 2006-2007

Northern	35540	29667	-5873	-16.5	220820	181468	-39352	-17.82
Western	36223	30210	-6013	-16.6	224927	191947	-32980	-14.66
Southern	31017	25348	-5669	-18.3	194102	158687	-35415	-18.25
Eastern	11990	14221	2231	18.6	69467	83273	13806	19.87
Northeastern	1876	2035	159	8.5	9501	11057	1556	16.38
A&N	49	40	-9	-18.4	238	183	-55	-23.11
Lakshadweep	11	6	-5	-45.5	44	28	-16	-36.36
All India	116706	101527	-15179	-13.0	719099	626643	-92456	-12.86

The projected surplus power in the east and northeast regions is insufficient to meet the demand gap, importing power from neighboring countries will be the only least-cost viable option available (Table A-8). Regional projections of power demand and supply for the year 2012 indicate a serious shortfall in all the major regional power markets: northern, southern, and western (Table A-9).

Table A-8 India—Growth in Regional Demand-Supply Gaps 1988-2001 (%)

North	8.06	8.22	7.6
West	7.53	7.54	7.49
South	7.14	7.29	6.53
East	7.49	7.67	6.87
Northeast	9.33	9.79	7.9
India	7.62	7.72	7.25

Source: Lama, Mahendra , P, et al 2002

Table A-9 India's Supply/Demand Scenario Through 2012

Northern	21,000	49,000	14,000	(-)14,000
Southern	20,400	42,000	10,000	(-)12,000
Western	24,900	46,000	16,000	(-) 5,100
Eastern Northeastern	8,750	19,000	23,000	(+)12,750
Total	75,050	156,000	63,000	(-) 17,950

Source: *The Four Borders Project: Reliability Improvement and Power Transfer in South Asia: A Prefeasibility Study,* prepared for USAID-SARI/ Energy by Nexant in November 2001, p 2-11.

To meet power and energy demand, the anticipated capacity addition requirements are 10,000 to 15,000 MW every year during the next 10 years. These additions would be possible only if IPPs and mega-power developers participate in power sector development in India and neighboring countries. An optimum utilization of existing generating and transmission capacity is essential through conscious planning and promotion of interstate energy exchanges from surplus to deficit systems.

NEPAL

In the World Bank forecast for Nepal, energy demand increases faster than peak load because a steady increase in load factor has been assumed, from approximately 50% in 1992 to 60% by 2000. Higher load factors become possible when there is peak load. On the other hand, per the NEA forecast, the system load factor increased more slowly, reaching 51% in 2002. This trend is more likely to continue if the load is permitted to grow in a relatively unconstrained manner. NEA's assumption is based on a lesser degree of industrialization and greater rural demand. These factors do not make it possible to improve the load factor significantly.[76]

Table A-9 shows the planned supply and demand scenario from the year 2000-2001 to 2004-2005 and indicates the capacity surplus/deficit. The capacity balance shows that there will be capacity deficit of 67 MW in 2000-2001 to be followed by surpluses until shortages occur to the extent of 1.1 MW in 2003-2004 and 47.1 MW in 2004-2005.77 Domestic demand is indicated in the table under the base case. The capacity-balance (both deficit and surplus) indicates the possibility of power trading between India and Nepal. This also indicates an urgent need to have a project ready by the year 2004-2005 and/or meet this demand by importing power from India. Some of these projections require that the total capacity of the power system should be more than 800 MW to meet the domestic demand because existing capacity is only 425 MW.78

NEA’s capacity demand is increasing at the rate of about 10% annually. To respond to this growth, NEA will have to double capacity every seven years. NEA’s latest corporate plan presented the capacity balance scenario for the period 2003-2004 to 2007-2008[79]. It may be noted that, without import from India, except in 2003-2004, there will be a deficit in the available peak capacity. This projection is based on the existing system, projects under construction. and PPAs concluded with NEA up to this point.

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76 Energy demand, based on a certain projection, increases at a certain rate. If the load factor is constant, peak load also increases at the same rate. However, if the load factor gradually improves, the increase in peak demand is lower because it is inversely proportional to load factor (LF)

$$\text{Peak demand} \propto \frac{1}{Loadfactor}$$

77 To assess the system’s capacity and energy situation, capacity and energy balances up to FY 2004-2005 are calculated. The generation plan shows that the Middle Marsyangdi (70 MW) project should be in the system by that year; financial commitment has already been made for this project and construction began in January 2001.

78 Government of Nepal, *Economic Survey, 2000-2001*, Ministry of Finance, Kathmandu, 2001 and Kapali, Niranjan, *Sunkosi River Basin Study, (East Nepal),* PhD Thesis, University of Agriculture, Vienna, Austria, 1985, p.1. and HMGN, *The Upper Karnali Hydro-electricity Project,* Draft Main Report, Vol. I, June 1988, Nepal Electricity Authority, prepared by Himalayan Power Consultants.

79 *Nepal Electricity Authority Corporate Development Plan FY 2003/04-2007/08*, Kathmandu, February 2004.

Appendix B Scope for Cross-Border Power Trade

There are two primary hypotheses for the possibility of cross-border power trade and its likely impact in the region: [80] (1) cross-border power trade with a comprehensive regional grid network will act as a major confidence building measure in making the process of economic integration in SAGQ countries a reality, and (2) cross-border power trade could ultimately be a panacea for many of the ills resulting from the underdevelopment of this region, particularly for the least developed countries (Nepal, Bhutan, and Bangladesh).

The likely impacts of availability of quality power on economic growth and quality of life in the region would be significant and far-reaching. It would result in revenue generation, foreign exchange savings, and help in changing the composition and the contents in the export baskets of these countries. This in turn would improve the balance of trade deficit. It would also have a direct impact on health, education standards, and opportunities for income and employment generation, as well as cross-border and internal migration including that from rural to urban areas, which has been the greatest challenge facing the developing countries across the globe.

Equally vital is the likely creation of stakeholders due to the forward and backward linkages of power development and cross-border trade. They could become the new and sturdy agents of confidence building process in the region. There will be a variety of stakeholders with significantly varying nature, extent, and depth of interests. They could be in the areas of power generation, distribution, trade, transmission and grid operation, creditors, donors, technology exporters, managers/professionals, and end-users like industries, households, and agriculture. Together, they will have tremendous capacity to absorb and mitigate the impact of any shocks emanating from any major bilateral political apprehensions and dislocations. In fact, the sustainability parameters in power sector cooperation will be so diverse and entrenched that it will be very difficult to ignore and demolish the support base for regional cooperation by mere political actions. [81]

The border regions of Bangladesh, Bhutan, North Eastern India, and Nepal have significant scope for both power generation and trading. The surplus power generated by the hydro plants in Bhutan and Nepal coincides with seasonal peak demands in the power deficit countries – India and Bangladesh. There are pure economic benefits, as the trade in energy sector will not only bring these countries revenue but could change the export composition without disturbing the traditional export baskets and existing arrangement.

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80 Several efforts are under way to examine the issues related to cross-border power trade in the region: (i) the SAARC Secretariat has set up an exclusive Technical Committee on Energy; (ii) two rounds of meetings of stakeholders in South Asian power sector development and trade were held under the aegis of USAID in Kathmandu; (iii) a field-based research project has been launched by the South Asia Network of Economic Research Institutes (SANEI) on the *Economic Reforms in Energy Sector and Cross Border Power Trade in South Asia* covering Bangladesh, Bhutan, India, and Nepal. The study is being conducted by The Institute for Integrated Development Studies (Kathmandu), Bangladesh Unnayan Parishad (Dhaka), and this author from India.

81 Lama, Mahendra P., "Designing Economic Confidence Building Measures : Role of India in South Asia" in *India's Pivotal Role in South Asia, CASAC, N*ew Delhi, September, 2000.

The potential benefits of transmission grid interconnections can be linked to cost savings from reduced operating costs due to overall improvement in system operational efficiencies as a result of (i) lesser spinning reserve requirements for each country's system; (ii) small coincidence peak compared to the average load; (iii) better mix of generation technologies with better load flow capability; and (iv) better mix of generation technologies for the peak, off-peak, and mid-peak requirements resulting in least cost of generation. In other words, cross-border interconnections and power trade can lead to:

- Bridging the seasonality gap
- Reducing cost-per-unit of electricity supplied and system losses
- Accelerating availability of supplies to meet suppressed demand
- Facilitating availability of markets for surplus generating capacity and reserve generating capacity sharing
- Improving system reliability and quality of supply
- Integrating transmission systems to reduce electricity supply costs
- Introducing economies of scale in larger generation units to help member countries meet aggregate peak demand with lower total installed capacity, thereby saving fresh investment
- Reducing air-pollutant emission (based on hydropower)
- Lowering riparian benefits to India and Bangladesh in irrigation and flood control, if power projects are built in Nepal, Bhutan, and northeastern India

There exists a close match between seasonal capacity surpluses in Nepal and shortages in India and Bangladesh. Potential regions for power imports are the north, south and the western parts of India, as the eastern region would not require as much.

POLICY GUIDELINES

Most of the SAGQ countries have clearly expressed their interest in power trading with the neighboring countries in their policy documents. For instance, in the case of Nepal, one of the key objectives of the Hydropower Development Policy-1992 has been to motivate the IPPs to develop hydropower projects and export the surplus power after meeting the national demand. [82]

In India, the recently legislated Electricity Act, 2003 has established fairly advanced and comprehensive policy changes. One of the crucial provisions of the new act is that all distribution companies, traders, and generating companies will have non-discriminatory open access to the inter-state electricity transmission systems in the country on payment of specified transmission charges. This open access is expected to facilitate competition in the industry, thereby creating conditions for the development of the power market. There are adequate provisions for moving away from the cost- plus regulatory regime to a new regime of lighter regulation. This changeover from intrusive regulation involving detailed scrutiny of the actual costs to light-handed regulation based on normative parameters of performance are

[82] HMG, *Nepal Foreign Investment Opportunities,* Ministry of Industry, Kathmandu, October, 1993.

to be followed by all the interstate generating and transmission utilities.[83] In other words, the Electricity Act, 2003 promises to usher in an era of a multi-buyer and multi-seller models.

SEASONALITY IN POWER GENERATION

The seasonality factor in both generation and demand is highly noticeable in South Asian countries. This in turn highlights the urgent need for cross-border power trade in the region. In the case of Bangladesh, there are two distinct trends in power demand patterns. First, during December-February the demand goes down and in March-May load shedding becomes common. Even the system day peak cannot be met in this season. As a result, industrial, commercial, and agricultural activities suffer. During the monsoon period (June-August) agricultural pumping is not necessary. Full capacity hydro generation (230 MW) is available during this period. Seasonality in power generation in Bangladesh is shown in Figure B-1. The demand for electricity increases sharply in the evenings, mainly because shopping is typically done in the evening. This is a critical problem in power system operations in that country.

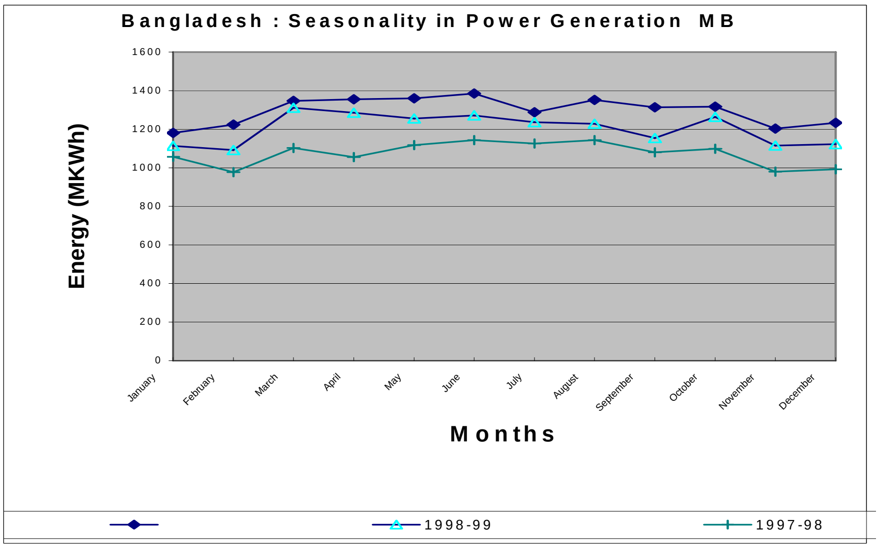


Figure B-1 Seasonality in Power Generation in Bangladesh

The Indian power sector is impacted by seasonality in generation due to hydropower generation. The peak months for hydropower generation are August to September; January to June is the lean period. Thermal generation has been designed to match and balance the trough months created by hydropower plants in winter and the pre-monsoon season. Figure B-2 illustrates the seasonality in hydropower generation in India, and Figure B-3 shows the seasonal trends of thermal power generation.

In Nepal, the peak demand of the integrated power system is usually during December to January. This is the period when generation from the hydropower plants is low. Though, February to April is the driest period, the demand in these months is relatively low. Since it is an integrated system, the regional seasonality characteristic loses its identity as the interconnections transfer power from the surplus region to the deficit region.

83 Interview with A.K. Basu, Chairman, Central Electricity Regulatory Commission, India, *Hindustan Times, 13 January 2004.*

The seasonality in power supply and demand can be clearly observed. Demand for power is at a maximum during the month of December (391 MW) and at a minimum during the month of August (344 MW). The supply capacity in turn is at maximum during the wet months and minimum during the dry months of February to March (322-324 MW).

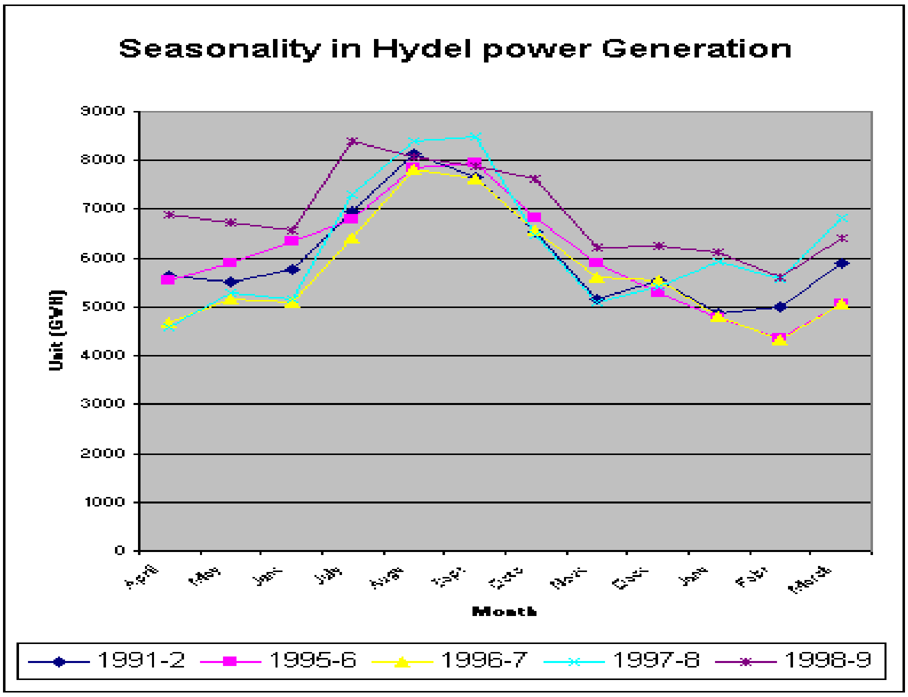
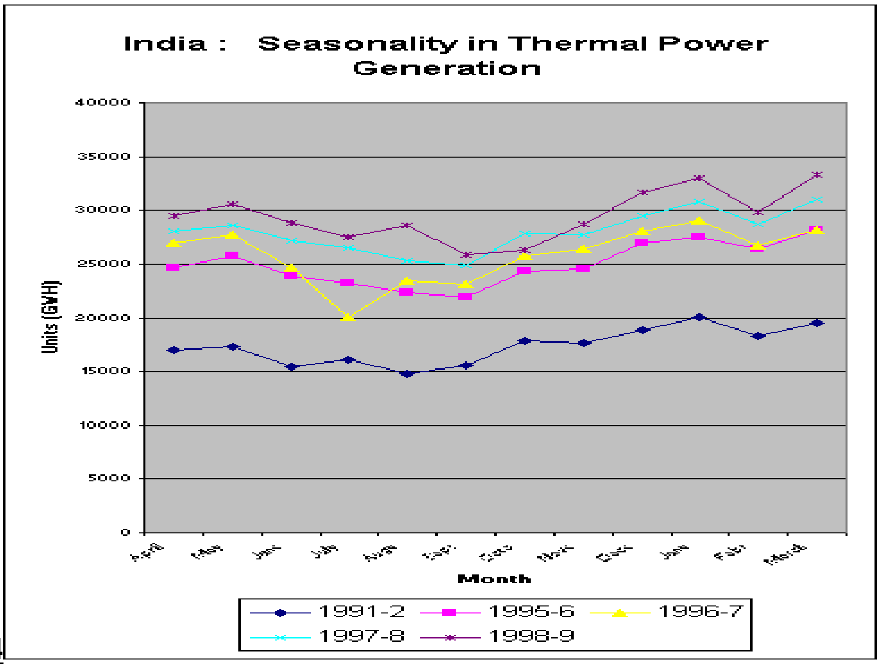


Figure B-2 Seasonality in Hydropower Generation in India



4

Figure B-3 Seasonality of Thermal Power Generation in India

There is capacity surplus during wet months and capacity deficit during dry months (maximum during January, which amounts to 57 MW). The seasonality in energy supply and demand (GWh) indicates that there is surplus energy available throughout the year, except for March and April (Table B-1). During these two months, there is an energy deficit of 20 GWh and 13 GWh, respectively. Energy deficits during the other months are not observed, because power deficits take place for short durations every day during these months and are not reflected in the monthly energy balance. This is where the complementarities in cross-border power trade emerge. It is during this period of hot summer months that the Indian system is starved of energy and capacity.

Table B-1 Seasonality in Power Supply and Demand 2000-2001 (MW)

				2000						2001					
Capacity Balance				Jul	Aug	Sept	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun
Load	Projected for year selected base case	2001	391	350	344	372	365	378	391	389	376	368	383	359	361
Generation	July 2001														
Existing	Existing system (Modi Dec 2000)	MW	252	240	240	240	240	240	232	232	229	230	233	249	252
Contract	Koshi + Tanakpur	MW	26	26	26	26	24	22	22	22	22	22	24	26	26
Committed		MW	0	0	0	0	0	0	0	0	0	0	0	0	0
New Hydro	Khimti-I	MW	60	60	60	60	60	45	34	26	23	23	32	44	47
	Upper Bhotekoshi (Nov. 2000)	MW	36					31	25	20	16	17	24	34	36
Thermal		MW	32	32	32	32	32	32	32	32	32	32	32	32	32
Import		MW	0	0	0	0	0	0	0	0	0	0	0	0	0
Total existing + new plant +ther + impt			393	358	358	358	356	370	345	332	322	324	345	385	393
Months with surplus			32	8	14	0	0	0	0	0	0	0	0	26	32
Months with deficit			57	0	0	14	9	8	46	57	54	44	38	0	0
Net surplus/deficit				8	14	-14	-9	-8	-46	-57	-54	-44	-38	26	32

Source: Nepal Electricity Authority, Kathmandu

Thus, there is scope for selling only the secondary energy during the wet season when demand in Nepal is low. During the lean season when the load demand is high, Nepal can import power from India. Thus, there is a potential for exploiting the inherent diversity in the load patterns between the Nepali and Indian systems through system interconnections. This would contribute to the system reliability and improve the system load factor in both the countries. There are other gains that would accrue from this situation, by way of increased sales resulting from fewer outages and ultimately better consumer satisfaction.

DISPARITY IN REGIONAL DISTRIBUTION

There exists some disparity in power distribution within different regions of India, Nepal, and Bhutan due to various reasons, including the topographical constraints and population distribution. This disparity is most pronounced in Bangladesh. The Dhaka, Central, and Southern regions are East of the Jamuna River. The Dhaka region constitutes 47% of the entire Bangladesh electricity market with the other two regions making up about 28%. The remaining 25% of the market is in the Western and Northern regions, west of the Jamuna River. Economic and gas sector development has been largely confined to the eastern part of Bangladesh, resulting in a widening economic disparity between the eastern and western parts of the country. This disparity can be minimized using mechanisms such as trading surplus hydropower from Bhutan and Nepal. The rationale for this is very strong as the surplus capacity in the wet season of Nepal and Bhutan coincides with the seasonal demand peak in Bangladesh.

Further, the pattern of the historically formed transmission system provides an additional rationale for power trading. The Bangladesh transmission system consists of an integrated network of 132 kV and 230 kV lines covering the main load centers of the country. Existing double circuit 230 kV lines interconnect Bheramara and Ishurdi in the West with Ghorasal (Dhaka area) and Ashuganj at the center of the country. Double circuit 230 kV lines also interconnect Ashuganj and Hathazari and Rauzan (Chittagong area) in Southeast Bangladesh. In addition, a double circuit 230 kV ring circumscribes the capital city of Dhaka. An extensive network of 132 kV lines covers the majority of the country. Thakurgaon substation is the northernmost point, about 90 km from the Siliguri substation in West Bengal, India. For the Siliguri substation as the option for the Four Borders hub, Thakurgaon would be the nearest interconnecting point in Bangladesh.

HYDROPOWER POTENTIAL

The SAGQ region has one of the richest sources of hydropower in the world. Out of the broadly estimated hydropower potentials of 189,245 MW of the region as a whole, of which a very small proportion (hardly **14 %**) has been harnessed so far. (Table 2)

Table B-2 Hydroelectric Potentials in South Asia

Bangladesh*	555	230	41.44
Bhutan**	30,000	444	1.48
India#	84,044	25,407	33.70
Nepal	83,290***	543	0.65
Total	197,885	26,624	14.06

Power System Master Plan (PSMP), 1995.* **Wangchuk, LK, Bhutan's Minister of Trade and Industry in an interview with *Energy South Asia,* New Delhi, January/February 2002, p 14. * 43,000 MW is regarded as economically feasible. # Report of the GOI committee on Raising Resources for Hydropower Projects in 9th & 10th Plan periods.

MINI- AND MICRO-POWER PROJECTS

The other areas where there could be both substantial intra-regional and extra-regional investment are the mini- and micro-hydel projects (MMHP), particularly in the high altitude regions. There has been a long history of MMHP in SAGQ, with the first such plants built in Darjeeling in 1897 and in the Kathmandu valley in 1911. Bhutan has 19 MMHPs with a total capacity of 3.4 MW. Some of these plants have been handed over to the user communities for operation, maintenance, and electricity distribution. The communities also fix tariffs and collect revenues. In India, there are over 160 MMHPs, most of which are in Arunachal Prudish and Uttar Pradesh with a capacity of over 200 MW. Nepal has over 700 MMHPs spread over 59 districts and most of them are owned and managed privately by individual entrepreneurs.[84] MMHPs provide a unique opportunity for the SAGQ countries to electrify the remote areas of the region. Some of the salient features and major benefits that can be harnessed from the development of these projects are:

- Sizeable potential in all the higher ranges of SAGQ region
- MMHPs are comparatively more viable for providing electricity to the remote and inaccessible areas than other commercial fuel systems
- MMHPs are easier to design and implement locally
- MMHPs can be operated without very sophisticated and expensive instrumentation and control systems.
- Operation and maintenance costs of privately owned/operated MMHPs are low
- Indigenous design and manufacturing of such plants contributes to the development of local industrial base including technical expertise.
- Surplus power from these plants can be supplied to the national grid
- Local people can build, operate**,** and own such power plants

SAGQ POWER GRID

USAID-SARI/Energy conducted a prefeasibility study on the possibility of power exchange among the four SAGQ countries (Bangladesh, Bhutan, India, and Nepal), particularly focusing on the northeast region of India in 2001. The study generated considerable interest among the stakeholders in the region.[85] Three technically viable for interconnecting the power grids of these countries were analyzed. The substation for the proposed interconnection could be colocated with either Siliguri (West Bengal) or Purnea (Bihar) substations without using the land in the constrained “chicken-neck” region of northeastern India. The options are:

- **Option A:** Limited power transfer—based on a 132 kV system
- **Option B:** Moderate power transfer with accelerated development—based on developing a 220 kV system in advance of the system developments in Nepal and Bangladesh
- **Option C:** Moderate power transfer with phased development—based on developing a 132 kV system initially, which would be upgraded to a 220 kV system in conjunction with power sector developments in Bangladesh and Nepal

The estimated investment requirements for these options would be minimal, ranging from approximately US$9 million to US$52 million with positive rates of return, which increase significantly with the level of power transfer. The estimated transmission costs for the options range from 2.6 cents per kWh for power transfers of 50 MW to 0.2 cents per kWh for transfers of 500 MW. The interconnection could be build within 2005-2010. The

[84] Junejo, AA, *Mini and Micro-Hydropower Development in the Hindu Kush-Himalayan Region: A Synthesis Report based on the Five Country Reports from Bhutan, China, India, Nepal and Pakistan,* International Center for Integrated Mountain Development, ICIMOD, 1994.

[85] *The Four Border Project: Reliability Improvement and Power Transfer in South Asia,* prepared for USAID-SARI/Energy by Nexant, New Delhi 2001.

environmental impacts of such an interconnection would be minimal, due to the extensive reliance on existing generation facilities. The phased development approach, recommended in Option-C would best serve the purpose of establishing the regional transmission interconnection. It could transfer from 50 MW up to approximately 500 MW. The study concluded that such transfer from Bhutan and Nepal could help reduce power deficits in India and Bangladesh and it would improve system stability and reduce transmission losses in the region by about 90 MW.

INDIAN NATIONAL GRID AND CROSS-BORDER TRANSMISSION INTERCONNECTIONS

Interconnecting the power systems of contiguously located countries and coordinating their operations provide immense technical and economic benefits. Such interconnections would help in reducing fresh investment and also save on operating costs as a result of the improved use of the existing generation facilities. They would also contribute to the quality of electricity supplied to customers as well as reduce environmental damage.
The installed system capacity requirement takes into account transmission and distribution losses, so as to arrive at the net quantity of energy available within the system to meet the actual demand. Reducing transmission and distribution losses would directly help in reducing fresh investment in generation capacity additions as well as reducing the financial losses suffered by power utilities. This would be one of the most efficient and cost-effective means of reducing overall demand; it would directly impact the tariff paid by consumers as well as help the utilities to reduce financial losses. Table B-3 presents the transmission and distribution losses suffered by the power utilities within the region.

Table B-3 South Asia: Transmission and Distribution Losses 86

Countries	T & D Losses (%)
Bangladesh	33.0
India *	25.6
Nepal	24.0

Note: * T & D losses are that of State Electricity Boards in 1998-99
Sources: *Bangladesh: Economic Review, 1996,* Ministry of Finance, Government of Bangladesh; Ministry of Finance, *Economic Survey, 2001-2002,* Government of India, 2002

The SARI/Energy study, *Four Borders Project: Reliability Improvement and Power Transfer in South Asia*, revealed that interconnecting the Indian and Bangladeshi power grids would reduce transmission and distribution losses by about 90 MW. Reduction of losses by 90 MW due to grid interconnection(s) would reduce the need for installing new capacity at an investment cost of Rs. 3,600 million (US$79.12 million at the exchange rate of US$1=Rs.

[86] System losses are both non-technical (pilferage, faulty metering, and billing) and technical like the low plant load factor and other operational and technical inefficiencies. T& D losses could be attributed to substantial energy sold at lower voltage, sparsely distributed loads over large rural areas, inadequate investment in the distribution system, improper billing, and high pilferage.

45.50). Further, there exist ample opportunities of serving the border areas of these countries by interconnecting such areas with the substations of the other country and operating them in a radial mode. Such interconnections have the potential to further reduce losses. If such a mechanism reduced losses by an additional 50 MW, the savings would grow to Rs. 5,600 million (US$123.08 million).

There are many examples where the grids of neighboring countries are interconnected for power exchange purposes. Power Grid Corporation of India has worked out the interconnections required, their feasibility, and the costs and benefits to the participating countries in the SAGQ region. All these interconnections match very well with the Indian effort to have a national grid by the end of Eleventh Plan in 2012.

India's national power grid will be comprised of transmission systems associated with the central generating projects and inter-regional lines. It is expected that the first phase of the national power grid will be completed with a 500 MW high-voltage direct current (HVDC) Transmission system back-to back at Sasaram in Bihar. This will enhance the cumulative power transfer capacity to a level about 4,850 MW.

In the subsequent phase, a strong synchronous national power grid would be established, including schemes to evacuate the power from major generating stations, covering hydro projects in the northeastern region and large sized thermal power plants in Bihar, Orissa, and Madhya Pradesh. The transmission scheme for the ultimate national power grid would involve the development of a high capacity transmission corridor in the "chicken neck" area in the northeast and the establishment of a ring of 765 kV lines interconnecting the eastern, western, and northern regions. With the completion of these links, the cumulative inter-regional power transfer capacity would increase to a level of about 30,000 MW by 2012. [87]

REGIONAL REAFFIRMATION

The idea of having a SAARC power grid has also been approved by leaders at the regional level. The 10th SAARC meeting in Colombo incorporated this item in its resolution related to subregional cooperation.[88] Exchanging power or pooling energy resources should make the entire subregion more prosperous, relatively cleaner, and politically stable, as the countries that enter in to trade agreements are less likely to go to war against each other. This could greatly reduce the crisis of confidence witnessed by these countries.

87 Government of India, *Tenth Five Year Plan 2002-2007,* Planning Commission, New Delhi, p 913.

88 The summit, hinting at the cross-border power trading, declared, "Heads of State or Government encouraged the development of specific projects relevant to the individual needs of three or more Member States." Following this decision, the SAARC Technical Committee on Energy recommended a regional power grid connecting Bangladesh, India, Bhutan, and Nepal at its Dhaka meeting, 19th November 2002.

Appendix C Power Sector Reforms

In the SAGQ countries, power generation and its supply has long been a state monopoly. Respective governments have owned, operated, and regulated the power entities. This resulted in overlapping and to a large extent, undemarcated responsibilities. Lack of accountability, in terms of operational performance, service standards, and codes worsened the situation. Most of the power generating units remained highly dependent on subsidies and other inputs provided by the state and were thus thoroughly unexposed to competitive environments.

The power utilities lacked commercial independence and suffered from unclear definition of corporate structure and responsibilities. On top of the low electricity tariffs in relation to the power utilities' financial requirements, high system loss and low collection efficiency ultimately led to defaults. A high proportion of losses at transmission and distribution levels included non-technical losses such as theft, pilferage, and improper billing. These made the system losses relatively much higher in these countries, and resulted in falling levels of domestic public investment.

Therefore, the inadequate revenue flows could not cover even a reasonable share of investment costs, as they had to meet both debt service and operation and maintenance expenses. All these adversely affected investments for new capacity additions. For instance in the case of India, the financial health of the SEBs, which are the most vital buyers of power in India, has been deteriorating over the years. In 1999-2000 out of the more than 30 SEBs, only seven had a positive rate of return.[89] The financial health of power utilities in Bangladesh, except for some of the Palli Bidyut Samaties is also not encouraging.

During the past four years, Nepal Electricity Authority (NEA), the national power utility has been making small profits ranging from NRs. 106.5 to 698.6 million (US$ 1.46 million to US$ 9.59 million). These amounts are so insignificant that they cannot supplement the government's efforts to provide electricity to larger sections of population. Non-availability of financial resources that could help the government to exploit its hydropower potential to meet the local demand and for export of power to the neighboring countries has forced the government to introduce power sector reforms in Nepal.

The size of the Bhutanese economy is so small that it would take quite some time before it could initiate the process of exploitation of its hydropower resources on its own. However, with the support from the government of India, Bhutan has already established a 336 MW hydropower station and another one with a capacity of 1,020 MW is under construction. Though the revenue from the first project constitutes 11% of its GDP, it is not enough to develop any major projects. With the objective of encouraging private sector investment in the power sector, Bhutan has initiated a reform program.

In addition to a range of interventions at various levels, most of the SAGQ countries have focused on the following strategy in power sector reforms:

- Separating the regulatory functions from the government and vesting them in an independent regulatory commission

[89] Government of India, *Economic Survey 2001-2002,* Ministry of Finance, New Delhi.

- Unbundling the various activities from a vertically integrated utility to distinct and separate units based on functions
- Corporatizing various units—namely, vesting the units in an incorporated company
- Initiating tariff reform
- Encouraging private sector participation, wherever it is considered by the state to be advantageous

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