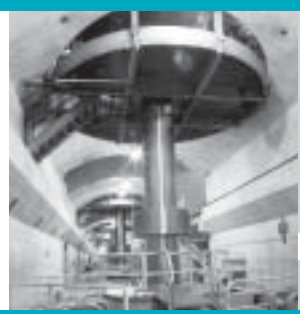
ESMAP Technical Paper 119/07

Bhutan Hydropower Sector Study: Opportunities and Strategic Options



ESMAP

Energy Sector Management Assistance Program

Bhutan Hydropower Sector Study: Opportunities and Strategic Options

Technical Paper 119/07

Energy Sector Management Assistance Program

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Bhutan Hydropower Sector Study: Opportunities and Strategic Options

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Units of Measure

mm^3	million cubic meters
MW	mega watt(s)
MU	million unit(s)
kWh	kilo watt(s) per hour
MT	metric tons
MMBTUs	million British thermal units
GWh	giga watt(s) per hour
km	kilometer
km^2	square kilometer

Acronyms and Abbreviations

ABT	availability-based tariff
ADB	Asian Development Bank
ASEAN	Association of Southeast Asian Nations
BIMSTEC	Bay of Bengal Initiative for Multi-sectoral Technical and Economic Cooperation
BOT	build-own-transfer
BPC	Bhutan Power Corporation
CCGT	combined cycle gas turbine
CDM	clean development mechanism
CEA	Central Electricity Authority
CERC	Central Electricity Regulatory Commission
DPR	detailed project report
ECB	European Central Bank
FDI	foreign direct investment
FY	fiscal year
GDP	gross domestic product
GoI	Government of India
HHs	households
IFIs	international financial institutions
IMF	International Monetary Fund
JV	joint venture
Lao PDR	Lao People's Democratic Republic
LNG	liquefied natural gas

NCR	National Capital Region
NHPC	National Hydro Power Corporation
NJPC	Nathpa Jhakri Power Corporation
NBCA	national biodiversity conservation area
NT2	Nam Theun 2
PGCIL	Power Grid Corporation of India Limited
PPA	power purchase agreement
PPP	public-private partnership
PTC	Power Trading Corporation of India
PwC	PricewaterhouseCoopers
RGoB	Royal Government of Bhutan
RoR	run-of-the-river
SAARC	South Asian Association for Regional Cooperation
SHP	small hydropower
SPV	special purpose vehicle

Currency Conversion

(Exchange rate effective July 2006)

1 Nu = Rs. 1

Rs. 45 = US$1

Foreword

The *Bhutan Hydropower Sector Study: Opportunities and Strategic Options* has been undertaken at the request of the Ministry of Trade and Industry, Royal Government of Bhutan (RGoB). The World Bank Group's support was sought for assessing the long-term strategic options for developing Bhutan's hydropower potential.

The aim of the present study is to provide the RGoB policy guidance on strategic options for hydropower development in the medium- and long-term basis on the specific conditions of the country, the competitiveness of the projects and the chances of attracting private investment.

Acknowledgments

This project was undertaken by the South Asia Sustainable Development (SASSD) unit under the management of Mr. Pedro E. Sanchez, and with the assistance of Mr. Rohit Mittal. Detailed background material was prepared by PricewaterhouseCoopers (PwC) – India. Special thanks to the staff of the ESMAP communications team, Ms. Ananda Swaroop and Ms. Marjorie K. Araya who undertook the final production of the report.

Executive Summary

Responsible exploitation of Bhutan's hydropower potential is critical for the country's growth and macroeconomic stability – power exports can continue to bolster the trade balance and official revenues; improved access to competitively priced and reliable electricity within Bhutan can support diversification of economic activities. Today, power exports constitute 45 percent of the annual official revenues of the Royal Government of Bhutan (RGoB) and 12 percent of Bhutan's gross domestic product (GDP). By 2007, when the 1,020 mega watt(s) (MW) Tala power project achieves its full production potential, the share of RGoB revenues from power exports will increase to more than 60 percent of total revenues.

Bhutan Hydropower

Bhutan is still in the initial stages of developing its hydropower potential. Installed capacity of around 1,490 MW constitutes 6 percent of the total techno-economically exploitable potential of 23,760 MW. Existing hydro projects have been developed with foreign aid, primarily from India.

To date, Bhutan has developed its hydropower in the form of run-of-the-river (RoR)-type projects, rather than utilizing a mix of RoR and water storage approaches. This results in wide seasonal variation in power generation, classifying Bhutan's power export as "nonfirm" and reducing its economic value. As a result of seasonal variations in RoR-based hydropower production, the country actually imports power from India to satisfy demand during the dry season when river flows decline.

Analysis of the commercial viability of large RoR projects in Bhutan reveal that internal rates of return for potential projects are about 10 percent. Consequently, these projects may not be attractive for private sector participation without modification of some key project features: namely, increasing firm capacity through assessing dam-based projects and searching for more profitable demand niches in the market.

Internal Demand

Domestic power consumption in Bhutan is growing rapidly, albeit from a low base, and can affect the country's ability to benefit from exports. Industrial demand is the most critical driver for domestic demand growth (56 percent of sales). The foreign direct investment (FDI) policy announced by RGoB in 2002 is encouraging industrial growth, promoting industrial enclaves by providing concessions and incentives including cheap power. Since Bhutan's ability to provide cheap electricity within the country depends significantly on surpluses from power exports (with which to cross-subsidize domestic consumption), RGoB should carefully study the sustainability of these export surpluses, particularly in light of recent developments in India's power market. RGoB should also carefully study the benefits from current subsidy/pricing policy for internal demand.

Indian Power Market

The Indian power market continues to hold attractive opportunities for Bhutan's hydropower sector. India's high rate of economic growth (7 to 8 percent over the last few years), aggressive growth forecasts, power shortages and increasing costs of imported energy options, will be the basis for the competitiveness of Bhutan's power. A deeper knowledge of this market is essential to access and obtain value from it.

Development Options

In the current context, Bhutan can finance and develop its hydro projects through bilateral agreements along the lines of the umbrella agreement signed with the Government of India (GoI) in 2006. In this regard, a number of potential projects have been assessed, and corresponding detailed project reports (DPRs) have been completed. To avoid limits established in the macroeconomic framework agreed with the International Monetary Fund (IMF), the financing strategy for these projects needs to be reviewed. One option would be that debt would be registered to the power generation enterprises (such as the State-owned Tala Generating Company) instead of to RGoB. While RGoB would continue to bear contingent liabilities associated with State-owned generation companies, these can be mitigated through effective corporate governance structures and commercialization of power sales agreements.

As an alternative to State-owned and -controlled development of hydropower, Bhutan should begin attracting private investment under suitable risk-sharing arrangements (particularly covering construction, operation and market-related risks). This can begin with the development of medium-sized hydro projects (around 300 MW) under different forms of public-private partnership (PPP), ranging from joint ventures (JVs) to build-own-transfer (BOT) schemes. Under the JV model, RGoB or a designated State-owned entity can take an equity position in a project entity – either as a minority or majority partner – with private partner/s making up the balance. This can include multilateral participation, as in the recent experience of the Lao People's Democratic Republic (Lao PDR) under the Nam Theun 2 Project.

A second option involves adopting the BOT model. The benefits of this model are that it offers a form of off-balance sheet financing as project debt will be incurred by a private project company, not RGoB. Risks associated with the construction, finance and operation of the facility would remain with the private sector. In addition to attracting foreign investment and technology and leveraging debt on competitive terms, this model could also help develop Bhutan's human capital.

In order to implement these options, the following initiatives are needed:

- Selection of medium-size projects for pilot PPP schemes and development of DPRs;

- Development of legal and regulatory frameworks for PPP projects, including streamlined and responsible land acquisition and safeguard procedures, and policy which protects investors from expropriation/nationalization and enables the remittance of dividends and repatriation of foreign investment;

- Review of Bhutan's FDI policy with regard to foreign equity participation to include power as an FDI-permitted sector; and

- Establishment of sound institutional arrangements in key areas, such as enforcement of environmental and social safeguards, and the resolution of commercial and other disputes, among others.

1. Background and Context

Bhutan is a landlocked country located between China and India. The terrain is mostly mountainous, with some valleys and plains in the south. It is a predominantly rural economy with more than 76 percent of its population living in rural areas. Agriculture, animal husbandry and forestry employ 94 percent of the workforce and contribute 33 percent of gross domestic product (GDP) (Box 1.1 provides the selected information).

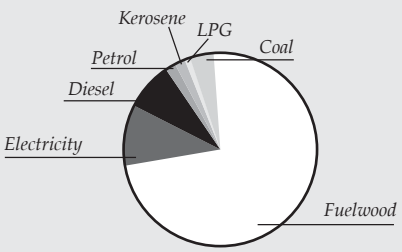
Hydropower is the single largest contributor to Bhutan's economy. Power exports constitute 45 percent of the revenue of the Royal Government of Bhutan (RGoB) and 12 percent of Bhutan's GDP. By 2007, when the Tala power project reaches its full production, the share of RGoB revenues will increase to more than 60 percent. Resources mobilized through exploitation of the Bhutan hydropower potential are critical for future growth and diversification of the economy.

In the composition of trade, hydropower remains the country's dominant export, with sales from the Chukha and Kurichhu projects to India accounting for 32.8 percent of the overall merchandise exports in 2004. The export earnings through the sale of hydropower to India and other markets in the South Asia region have the potential to transform Bhutan's economy and sustain the targeted growth of GDP in the long term.

Box 1.1: Bhutan at a Glance

Land Area	38,394 sq km
Population	920,000
Density	19.6 per sq km
Language	English, Dzongkha (official)
Currency	Ngultrum (Nu 1 = Rs. 1)
GDP	US$482 840 million
GNI per Capita	(2005)
GDP Growth	US$870 (2005)
Rating	5.8% (2005)
	Low-income Country

Bhutan: Energy Mix



Source: The World Bank – Bhutan at a Glance.

Bhutan perceives its hydro potential as similar to oil resources in oil exporting countries. Speedier development of hydro potential is a prerequisite for economic development of the country with the following objectives: (i) meeting its energy needs; (ii) developing manufacturing and other economic development activities using relatively cost-effective sources of energy; (iii) monetization of hydro potential through exports to India and other countries in the region in the medium term; and (iv) realizing the true market value of hydro as an energy source.

2. Objective and Scope of Study

The objective of this study is to analyze the opportunities and strategic options available to the RGoB to implement the hydropower projects included in its power master plan. It accounts for the relevant legal, technical, environmental, social and financial issues, as well as Bhutan's overall macroeconomic framework, and with full recognition that this resource is critical to Bhutan's economy.

The scope of the study is to: (i) review and understand the framework for the existing agreement between India and Bhutan to finance the development of hydropower; (ii) review the power sector master plan to determine the competitiveness of planned projects, and their chances of being developed under a nonsubsidized and/or private finance environment; (iii) review the options open to Bhutan in terms of power markets and trading; and (iv) propose some options for hydropower development in the medium to long term.

Bhutan Hydropower

Bhutan is still in the initial stages of developing its hydropower potential, with around 1,490 mega watt(s) (MW) of installed capacity, constituting 6 percent of the total techno-economically exploitable potential of 23,760 MW. Existing hydro projects have been developed with foreign aid, primarily from India (three projects) and Austria (two projects). The addition of the Tala hydro project (installed capacity of 1,020 MW) in 2006 significantly increases the current energy generation (2,560 MW) by an annual average of 4,865 giga watt(s) per hour (GWh).

Bhutan has been exploiting its hydro potential through run-of-the-river (RoR) schemes, keeping in view the economic viability of these projects and also the limited environmental impact of their development. By using RoR schemes, the projects avoid dams and reservoirs, which typically pose environmentally and socially complex issues. However, the absence of water storage structures affects the production regime of power plants, translating into low firm capacity and low plant load factors, which negatively affect the value of the power produced by Bhutan.

The existing RoR power stations have limited pondage capacity to meet the daily peak requirement of four hours. The absence of differential pricing for peaking power in India

Table 2.1: Hydropower Stations in Bhutan

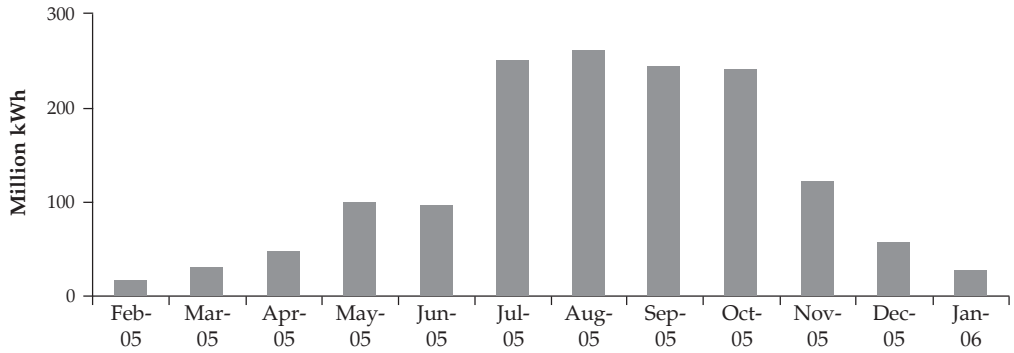
Power Station	*Year of Construction*	*Capacity (MW)*	*Firm Capacity (MW)*	*Energy (GWh)*	*PLF*
Chukha	1986	336	84	1,700	58%
Kurichchu	2001	60	24	400	76%
Basochhu u/s	2002	24	5	105	50%
Basochhu l/s	2004	40	10	186	53%
Tala	2006	1,020	170	4,865	54%
Total		**1,480**	**293**	**7,256**	**56%**

Source: Development of Hydropower in Bhutan – The Way Forward, Department of Energy RGoB – 2004.

does not provide the desired signal for effective use of such capability, which is a constraint for an efficient market development. Power stations are not able to respond/align to seasonal demand in India's power market which they now serve, given the effect of high monsoon flows leading to seasonal energy available during the four months of monsoon rains, and reduced generation during nonmonsoon months, particularly in winter when demand is high and supply constrained. As a result, Bhutan is obliged to reimport power from India[1] during the winter months to meet domestic demand.

As shown in Figure 2.1, Bhutan's hydro generation is significantly seasonal. For example, 68 percent of Chukka's generation is logged during the four monsoon months. India's eastern grid, to which Chukha's power is supplied, is surplus during this period and its plant load factor only 58 percent.

Figure 2.1: Chukha's Production



Source: Department of Energy, RGoB.

[1] *From Power Trading Corporation and from Assam and West Bengal State Electricity Boards.*

Table 2.2: Financial Analysis for Tala

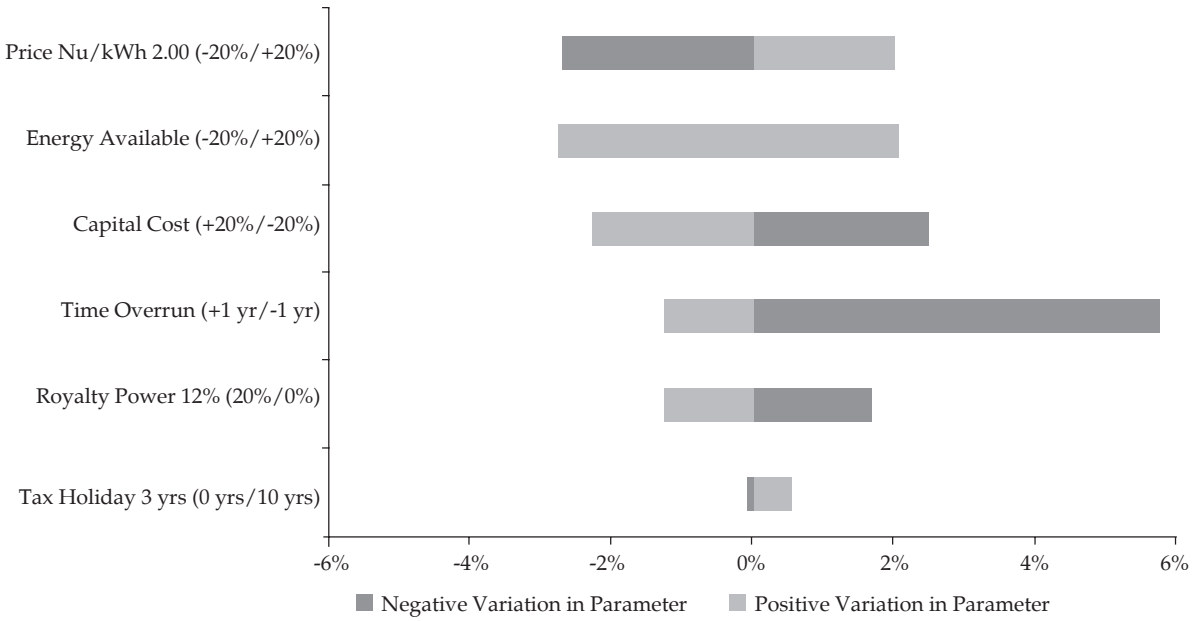
	IRR	*Invest (US$ M)*	*NPV (US$ M)*	*Discount Rate*
Project Cash Flow	7.6%	1,118	-364	12.0%
Equity Cash Flow	12.9%	335	-76	16%

Source: Study estimates.

Large RoR hydropower projects in Bhutan are producing limited financial returns, according to a financial analysis of proposed project development in Bhutan drawn from a private sector perspective. This analysis looked at the Tala project on a commercial basis as the benchmark. The base case scenario is based on a capital cost of US$1,118 million and energy availability of 3,950 million units (MU), and an assumed sale price of Ngultrum (Nu) 2 per unit (the final contract price was Nu 1.8). The project has an internal rate of return of 7.6 percent for the base case, which would not be sufficient to attract private investors.

A sensitivity analysis on various parameters of the project (Figure 2.2) shows that time saving, the sale price and additional energy are the most critical value drivers of the project. In fact, commissioning of the plant one year earlier could improve the rate of return by 6 percent. Conversely, slippage would reduce the internal rate of return by 1.5 percent. An increase in the sale price by Nu 0.50 per unit, or 25 percent additional capacity, can improve the internal rate of return by 2 percent. Policy variables like royalty power, capital subsidy and tax holidays have some impact but are not sufficient by themselves to make the project feasible.

Figure 2.2: Tornado Diagram (Variation from 8.92% Base Case Post-tax Project IRR)



Source: Study estimates.

A similar analysis of the other priority projects, listed in Table 2.3, also shows that the internal rate of return for these projects is less than 10 percent, and hence they might not be attractive to the private sector as currently structured.

The capital cost of a major hydropower project is quite high relative to the overall size of the economy – Bhutan's GDP is Nu 31.2 billion, against the Nu 40 billion cost of Tala. It would not be possible for Bhutan to embark on hydropower development utilizing only internal resources, as the risk of disruption and/or time and cost overruns would adversely impact the overall economy.

There are two possible options to improve the competitiveness of hydro projects in Bhutan: (i) increase plant production; or (ii) negotiate higher selling prices. One possibility for increasing plant production is to consider dam-based projects, which can be developed to address critical environmental and social concerns. Dam-based projects, optimized with a river-basin approach, could provide alternatives to power stations with higher plant load factors and higher internal rate of returns. These options merit review by RGoB.

Higher selling prices can be achieved by targeting premium markets where power commands higher prices. This requires a deeper knowledge of developments and trading trends in India and other markets. As Bhutan's power constitutes a minor portion of India's demand-supply requirements, it is likely that remunerative segments could be found in this market.

Bhutan's Internal Demand

Bhutan's ability to derive benefits from exporting power could be reduced by the rapid growth of domestic power consumption in Bhutan. The Vision 2020 policy document has a target of 100 percent electrification by 2020. Residential sales have been growing at about 12 percent

Table 2.3: Priority Projects up to 2020

Power Station	*Year of Construction*	*Capacity (MW)*	*Firm Capacity (MW)*	*Energy (GWh)*	*Investment US$ Million*	*LRAC*
Punatsangchhu I	2012	1,095	145	5,377	1,109	1.45
Mangedchhu	2014	670	94	2,909	590	1.63
Punatsangchhu II	2017	990	150	4,667	875	1.51
Chamkarchhu I	2020	670	95	3,207	550	1.38
Total		**3,330**	**484**	**15,553**	**2,875**	

Source: Development of Hydropower in Bhutan – The Way Forward, Department of Energy RGoB – 2004.

per annum in recent years. Since the current plan is to have coverage mostly through a distribution network system, sales growth is likely to maintain its current pace for some time. Consequently, additional firm generation capacity will be allocated for domestic consumption.

Industrial demand accounts for 56 percent of current sales and is growing strongly as a result of government incentives, and is the most critical driver for demand growth. The RGoB is encouraging industrial growth, including through setting up industrial enclaves and providing concessions and incentives. The foreign direct investment (FDI) policy announced in 2002 is also aimed at encouraging private sector development and industrialization. In addition, RGoB has been following a policy of encouraging power-intensive industries by keeping industrial tariff rates low. This is intended to attract industrial activity to Bhutan, and thus diversify its economic activities while ensuring reliable demand for its power in the long term. The low electricity cost is aimed at overcoming the labor cost advantage in other countries of the region, and at making it attractive for the import of raw materials and for manufacturing in Bhutan.

According to existing arrangements, Bhutan Power Corporation (BPC), a transmission and distribution company, purchases power from hydropower generation companies at a subsidized price of Nu 0.30, which is passed through to residential domestic consumers. Domestic commercial consumers have a higher tariff. For BPC, long-term power supply agreements with industrial users provide tariff stability and the ability to serve domestic consumers. Consequently, there is a trade-off between "security of market" versus "value realization" which should be addressed.

As per available estimates, the energy requirement will be more than firm availability by 2008-09. This would impact revenues due to reduced exports to India. Since the export rate is higher than the industrial tariff, it would lead to revenue losses. At current tariffs, the opportunity cost would be Nu 0.85 per kilo watt(s) per hour (kWh). Peak demand will exceed firm power, even with Tala's additional capacity, by 2012 as there is no capacity addition planned during this period. This would require imports of power from India to meet the domestic demand.

Table 2.4: Demand-Supply Balance

MW	*FY 07*	*FY 08*	*FY 09*	*FY 10*	*FY 11*	*FY 12*
Peak Demand	190	205	222	240	259	280
Peak Availability	291	291	291	291	291	291

Source: Department of Energy, RGoB.

The impact of demand growth on the revenue is shown in Figure 2.3. The demand growth beyond the firm power would lead to a reduction in available export surplus. In case of the domestic firm power, as sales are more than 90 percent of the total generation, revenues would fall below the operating expense requirement levels.

The perceived "conflict" between internal demand growth and exports should be resolved through a more comprehensive economic policy framework. The opportunity loss in terms of lower exports needs to be compared with the benefits of industrialization and the value added to Bhutan's economy through employment benefits, utilization of natural resources and so on. One possible option would be to charge domestic consumers the export price to keep energy pricing neutral. This would require creating a more focused subsidy scheme for residential consumers.

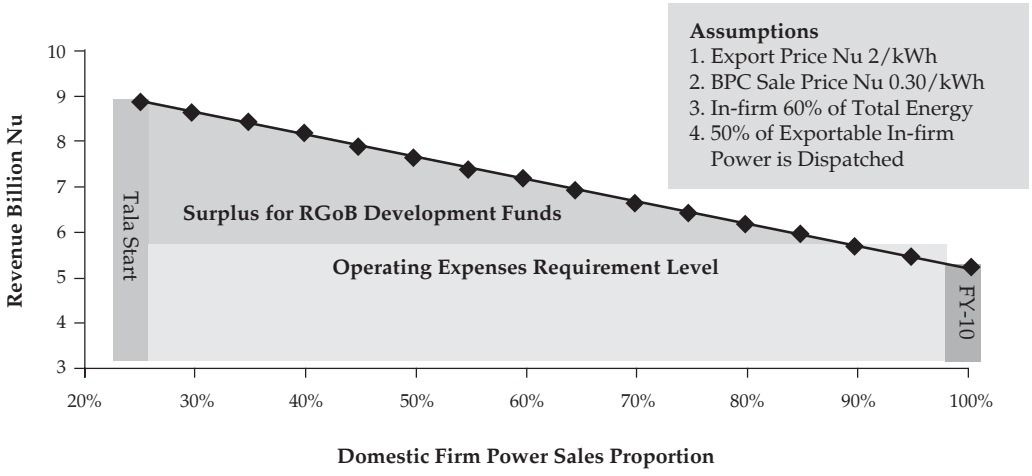
External Markets: India

Up to the commissioning of the transmission system associated with Tala in September 2006, the beneficiaries of Bhutan's power were primarily the constituents of India's Eastern Region, which is also an energy-rich region and has large coal reserves with some subsidy arrangements.

The relevant market for hydropower projects in Bhutan is the Northern Region of India, which is quite different from that of the Eastern Region. A quick analysis of the Northern Region-market's potential in terms of market size, landed cost of power and transmission constraints shows good prospects for Bhutan's power projects.

The Northern Region in India has been experiencing perennial shortages, both in energy and MW terms, throughout the year. During Financial Year (FY) 2006 , the region experienced

Figure 2.3: Revenue Impact – Demand Growth and Firm Power Export Reduction



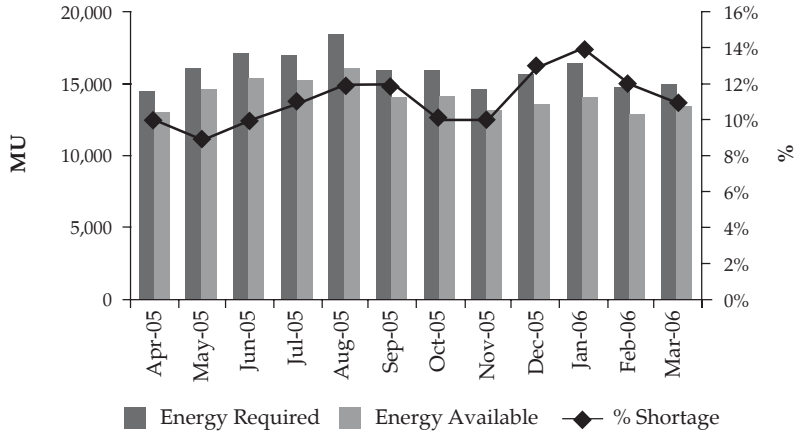
Source: Study estimates.

around 12 percent peak demand shortage during the monsoon period. The energy deficit was more than 1,700 MU per month during the monsoon period from July to October. As shown in Figures 2.4 and 2.5, it is evident that the Tala project's generation can be absorbed in the Northern Region.

The demand-supply gap is increasing in the Northern Region and can provide a market for Bhutan's power. Two crucial factors are the landed price of alternate sources and the availability of hydropower from states in Northern India, such as Himachal Pradesh and Uttarakhand.

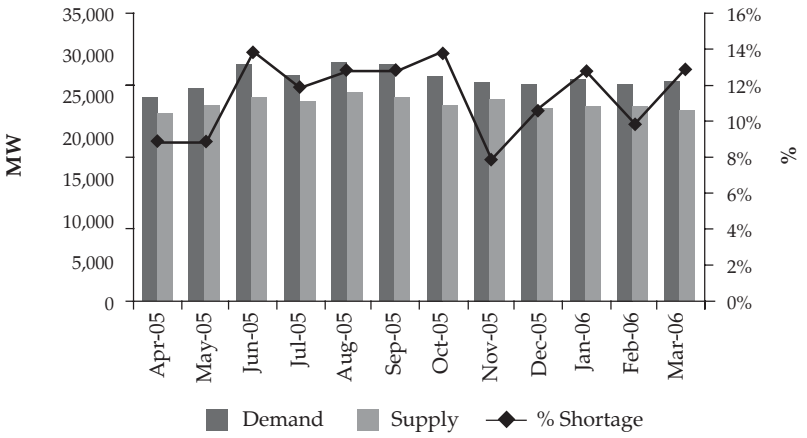
A comparison of landed costs (generation cost and transmission price) in Delhi for alternative fuel-based plants (liquefied natural gas [LNG], pithead domestic coal, imported coal, hydro), across India, shows that Bhutan's power-landed price for the Delhi region is

Figure 2.4: NR Demand vs Supply – Energy (FY 06)



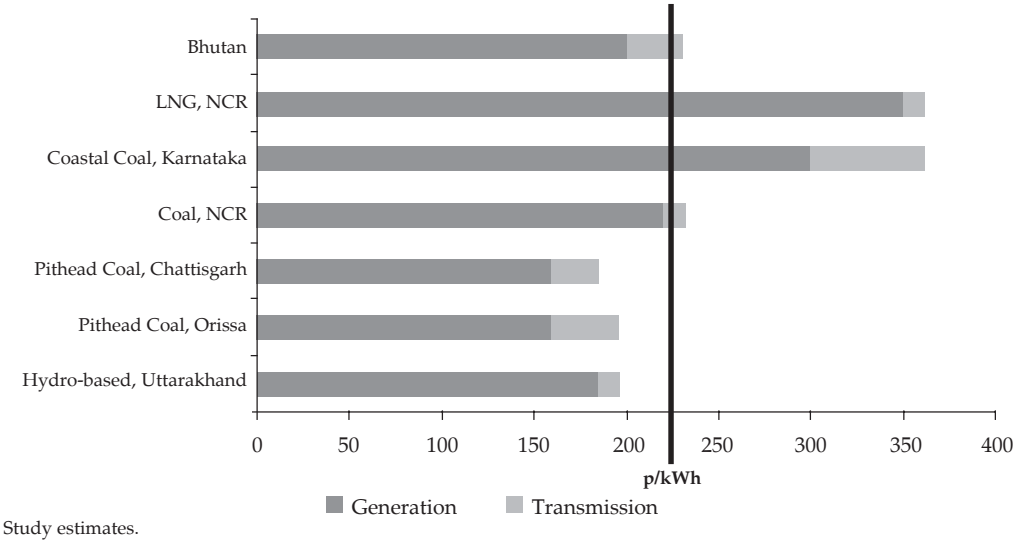
Source: Central Electricity Authority, Ministry of Power, Government of India.

Figure 2.5: NR Demand vs Supply – Peak Demand (FY 06)



Source: Central Electricity Authority, Ministry of Power, Government of India.

Figure 2.6: Landed Cost – Delhi



Source: Study estimates.

comparable to the coal-based station in the National Capital Region (NCR), and works out to be cheaper than an LNG-based plant in Delhi or a coastal coal-based plant in South India. Moreover, taking into account the long-term marginal price for the Northern Region of Rs. 2.9/kWh, Bhutan's power is competitive.

India's aggressive plans for economic growth and increasing costs of imported energy options will be the basis for the competitiveness of Bhutan's power. The demand underlying the capacity-addition program is also ambitious, and current shortfalls are likely to prevail, pushing the plan of electrifying all of India's households (HHs) further into the later part of the decade.

As shown in Annex 1, India's generation capacity addition plans up to 2012 are very ambitious. India has hydropower resources, but relies more on coal and natural gas as potential sources. While natural gas is mostly imported and subject to increasing international prices, coal-based supply will be affected by increasing global concerns about the environment. Hydropower development has often been hindered by time and costs overruns, and social and environmental concerns.

The transmission system constraints in India will increasingly determine energy transactions between surplus and deficit regions. Bhutan should proactively secure its evacuation capacity through its buyers in the upcoming transmission system. This would require, however, entering into long-term contracts with purchasers in different parts of India, or taking the risk of short-term contracts with traders. This is feasible because the level of market-based traded power is rapidly growing, even as associated regulatory and other arrangements are put in place.

The Indian power market continues to hold attractive opportunities for Bhutan's hydropower sector. However, a deeper knowledge of this market is essential to access and

obtain value from it. In this context, Bhutan should study the potential of private sector trading opportunities.

South Asia Regional Market

The energy sector across countries in South Asia is characterized by the poor quality of energy infrastructure, poor financial strength of utilities, a skewed demand-supply situation and varying cost of generation. The demand-supply gap is likely to increase further as a result of increased requirements on account of industrialization and switching over from noncommercial sources like firewood and bio-fuels to power.

Current trading arrangements include bilateral trading between physically-connected neighboring networks (that is, Bhutan-India; Thailand-Lao People's Democratic Republic [PDR] and Myanmar, Vietnam-Lao PDR), which are largely driven by intergovernmental agreements, with institutional support subsumed in existing agencies and minimal systems standardization.

Broad-based trading arrangements with multiple buyers and sellers bring in greater benefits of competition in terms of pricing, but also from enhanced optimal planning, risk allocation and capital investment. Such arrangements require a higher degree of standardization, specialist multiple institutions (market operator, system operator, transmission system operator, regulator and so on), and more sophisticated systems such as real time settlements. They also raise additional policy issues of competition and sector reform in member countries (for example, market power of a vertically integrated utility, rebalancing tariffs, energy security issues and lifeline supplies).

Bhutan is a member of two key regional groupings in South Asia: South Asian Association for Regional Cooperation (SAARC); and Bay of Bengal Initiative for Multi-sectoral Technical and Economic Cooperation (BIMSTEC). These regional groupings have taken key steps in promoting initiatives with regard to energy trade and energy conservation in South Asia.

There are distinct advantages for South Asian countries to cooperate in the energy sector given the following key drivers for evolution of a regional market in the South Asia Region: (i) regional availability of diverse energy sources including water, coal and natural gas; (ii) significant complementarities across nations vis-à-vis demand and supply patterns; (iii) the seasonality factor in hydro generation in the Himalayan region; (iv) improved system reliability and better quality of supply; (v) economies of scale possible in generation; (vi) mutual support during contingencies; and (vii) the potential for reduction of transmission losses.

Market-based regional energy trading would allow the region to grow synergistically. The current lumpiness of supply and asymmetrical distribution of energy resources and needs underpin opportunities for trade in future.

Transmission infrastructure and interconnectivity would need to be developed between Bangladesh, Myanmar and India to achieve a long-term vision of the South Asian regional markets. In the long term, the integration of the South Asian Regional market with the West and Central Asian market is a distinct possibility. The future interregional trade in electricity would be guided by demand growth within each region, seasonality factors in generation, competitiveness of the Central Asian Region's generation in terms of cost and investors' risk perceptions.

Regional political factors significantly impact the development of regional markets. Indo-Bangladesh bilateral arrangements for energy and other trade would need to progress from its current stalemate. If this happens, Bhutan could explore other opportunities since, for example, access through India is necessary for Bhutan-Bangladesh trade to be feasible.

Options for Hydropower Development in Bhutan

This section evaluates strategic options available to Bhutan in the context of the above-mentioned opportunities, requirements and constraints. The SWOT analysis in Table 2.5 summarizes the key factors governing Bhutan's hydropower development.

Table 2.5: SWOT Analysis

Strengths	*Weaknesses*
• Successful execution of mega projects • Skilled manpower for operation • Planned development • Friendly regional relationship • Strong environment agenda and track record	• Limited experience on commercial and capital market-based financing • Reliance on single market for export in the medium term due to poor regional connectivity and arrangements • Monsoon-dependent RoR projects and consequent seasonality of generation • Limited financing capacity • Policy-related: – FDI for power – Current industrial policy – Large subsidy dependent electrification
Opportunities	*Threats*
• Potential access to large, diversified and energy-deficit market • Demand-supply gap in India to continue • South Asian regional energy market to open up opportunities in other countries • Increasing fossil fuel price and consequent high costs of power • Environmental concerns over fossil fuel	• Competition from other hydro-rich countries in the region like Nepal • India's Northeast and Northern hydro-rich states have similar potential to meet domestic demand • India's initiatives on ultra mega projects in terms of price as well as volume supply lumpiness (volume imbalances) • Regional initiatives on gas pipelines

Source: Study analysis.

Large hydro projects have very high capital costs and large investment requirements. Bhutan, on its own, would have a limited scope for undertaking the development of such projects in the short to medium term, particularly given that the outstanding debt for Bhutan in 2005 was 87 percent of the GDP. Consequently, additional measures are required.

Bhutan's hydropower projects have in the past been supported by the Government of India (GoI) with concessional lending and equity grants to Bhutanese institutions on a bilateral

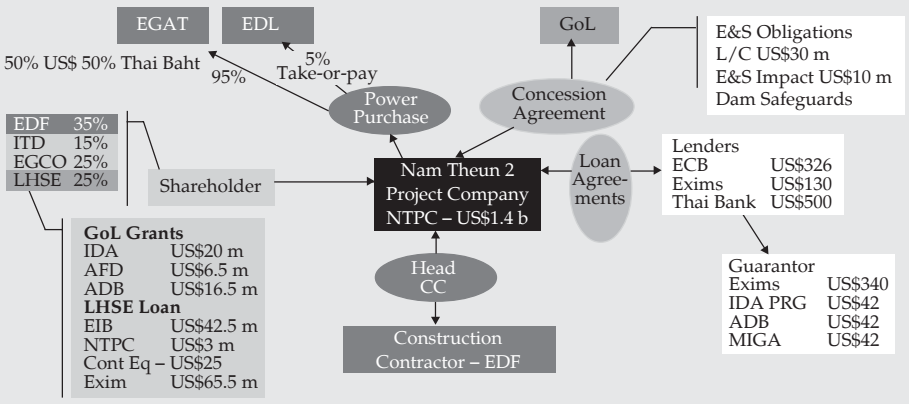
Box 2.1: The NT2 Project

The NT2 development highlights important lessons in the following areas: (i) use of natural resource rents to accelerate development in a small, poor country with weak capacity; (ii) PPP in large regional infrastructure projects; (iii) engagement with stakeholders in large dam projects: ownership, quality, participation and communication; and (iv) environmental and social safeguard management: risks, mitigation, project design, financing, monitoring and evaluation.

NT2 proposes to benefit the host country with an immediate and significant stimulation of economic activity and growth by increasing GDP during the construction period, as well as earning foreign exchange. NT2 is a financially and commercially attractive project with economic rate of return of about 17 percent (high for hydroelectric projects) Government of Lao PDR was able to leverage an equity of US$130 million for US$1.4 billion asset which it would own after 25 years under the BOT model, while contributing significantly to treasury revenue during the concession period.

NT2 would dam the Nam Theun River near Ban Sop Hia, Khammouane Province on the Nakai Plateau, about 150 km east of Vientiane. It would impound 195 km of the river. The reservoir would have a surface area of 450 Square Kilometer (km^2) at full supply level, a capacity of 3,910 million cubic meter (mm^3) and would flood about 40 percent of the Nakai Plateau but less than 100 km^2 when drawn down. Eighty-eight percent of its catchments fall within the Nakai Nam Theun-National Biodiversity Conservation Area (NNBCA). More than 5,000 people would have to be resettled on the Nakai Plateau from inundated areas and there are about 5,000 people resident in the NNBCA.

The lending of the project was shared equally between Thai banks and international commercial banks in line with the project revenue streams of 50:50 Thai and US dollar revenues. Concerted effort of Nan Theun 2 Project, supported by the World Bank and Government of Lao PDR resulted in nine institutions providing funds and guarantees. International Financial Institutions (IFIs) provided US$130 million as loans and US$108 to fund the Government of Lao PDR commitment to the project. US$340 million of European Central Bank (ECB) lending was achieved on the back of the guarantees available till 2009. The World Bank's involvement was relied on by the lending institutions for their due diligence. The World Bank support made it possible for the project to meet international norms for dam-based hydropower development. The enclave guarantee structure made commercial lending for the project possible.



Source: The World Bank.

basis. This cooperation in the power sector is a win-win situation for both countries. Bhutan can rely on the export of power for sustainable development, while India needs unlimited energy to drive its rapidly growing economy. Clearly, this is the best option to develop hydropower for Bhutan and RGoB should continue pursuing it. However, given that this option is subject to intergovernmental agreements with budgetary constraints, RGoB should explore other developmental options in order to accelerate its hydro monetization process.

The options available are: (i) public-private partnerships (PPPs) with private investors; and (ii) seeking private sector participation through build-own-transfer (BOT) schemes. In the first case, RGoB could enter into joint venture (JV) agreements with private investors to develop a project. In order to maximize the benefits of such a project, RGoB would have an equity contribution in the special purpose vehicle (SPV) and the private partner would have the balance. The SPV, managed by a private partner, would provide financing from capital markets or have multilateral partial funding of equity grants and commercial loans for development. Under this option, Bhutan could leverage its cash flows from the existing Chukka and Tala projects. Box 2.1 provides details of the recent experience of Lao PDR with the Nam Theun 2 (NT2) project, which involves the first cross-border hydropower sales scheme in the Mekong Region. The World Bank and the Asian Development Bank (ADB) have been involved in funding Nam Theun 2 Power Company (NTPC), a private sector company in which EdF (a French public sector company), Lao PDR Government and EGCO (Thai Genco) are key investors and the consumer is EGAT, the Thai Government power enterprise.

The second option would be to seek private participation in the development of hydro assets through an internationally competitive bidding process. The BOT model offers the following benefits:

- Offers a form of off-balance sheet financing as the lending in relation to the project will be undertaken by the project company and not by the RGoB. As it does not require direct borrowing to develop the project, this would have a favorable impact in terms of any constraints on public borrowing and would potentially free funds for other priority projects;
- Transfers the risks for construction, finance and operation of the facility to the private sector; and
- Provides a vehicle to attract and utilize foreign investment and technology, which helps boost human capital development.

The private operator would transfer assets to the RGoB after a concession period (usually 25 years); in the interim, it would pay rent for the use of the resource.

There are obvious constraints to the development of mega projects and the pace of development is slow. Bhutan should consider medium-scale hydro development for diversifying its hydropower sector and prospects in the medium term. The risk profile for these projects is comparatively low and they have the potential to attract private sector participation. The Indian experience also indicates that the development of hydropower in the private sector has been primarily focused on medium-sized projects. Either JVs or BOT approaches can be used for this type of project.

Small hydropower (SHP) development seems an obvious choice for Bhutan because of dispersed electrification needs and the concentration of population settlements near rivers. SHP also supports sustainable development (economic, social and environmental) by improving energy use (away from fuelwood/liquid fuels) and providing dispersed employment generation options. It is highly suited for clean development mechanisms (CDMs) eligibility. The high initial capital cost of small hydro projects makes it prohibitive for development through the private sector unless adequately incentivized through government policies and regulatory processes. Small hydro development can be considered through bilateral involvement and multilateral lending agencies. In the long term, the involvement of the private sector can also be explored with market-based incentives for renewable power development, without burdening RGoB's finances.

Conclusions

To date, Bhutan has developed RoR-type projects with highly seasonal power generation capacity, providing nonfirm power with correspondingly limited realization value. In addition, Bhutan is obliged to purchase power from the Indian network to satisfy demand during the dry season.

Analysis of the viability of RoR mega project development in Bhutan from a commercial perspective reveals that the internal rates returns for the proposed projects are about 10 percent and, hence, may not be attractive to the private sector without altering key project features, namely: increasing firm capacity through assessing dam-based projects; and searching for more profitable demand niches.

The perceived "conflict" between internal demand growth and exports should be resolved through a more comprehensive power policy framework. The opportunity loss in terms of lower exports needs to be compared with the benefits of industrialization in terms of the value added to Bhutan's economy through employment benefits and utilization of natural resources, among others. One possible option would be to charge domestic consumers the export price to keep energy pricing neutral. This would require creating a more focused subsidy scheme for residential consumers.

In this context, it is desirable to focus on the Indian market through both public and private development modes. A concurrent strategy to use both modes will help Bhutan learn more about Indian market opportunities, as well as realize better value for its hydropower. Medium-size projects in the private sector will help provide useful commercial benchmarks for pubic sector JV projects.

Bhutan should explore seeking greater market access to the Indian market through discussions with the Indian government. Such a dialog could be based on the energy security requirements of India and long-term secure, green and competitive energy sources in Bhutan. This should result in a more comprehensive cooperation agreement on energy and related

matters than that which exists today. This should facilitate access to all segments of the power market and private participation in the sector.

Bhutan should reassess the option of developing storage-based hydropower projects in addition to RoR type projects. The power system master plan has identified 8,500 MW of generation capacity including the Sankosh multipurpose project (4,000 MW) and Manas reservoir I and II (2,800 MW). These projects could provide the flexibility of flood-control and irrigation facilities, in addition to optimizing generation and reducing the seasonality effect of the generation curve and reducing the effects of sediments.

Under the current arrangements, loans to finance hydropower projects are accounted to the RGoB and subject to limits established in the macroeconomic framework agreed with the International Monetary Fund (IMF). This debt ceiling limits the country's ability to scale-up investment in hydropower projects. To avoid these constraints, it is necessary to review the financing strategy and develop a policy framework and implementation mechanisms to channel the benefits of hydropower development for improving the lives and prospects of local communities and people.

In parallel, Bhutan should pursue the development of medium-sized hydro projects (around 300 MW). Viable options include: (i) PPP schemes with private investors; and (ii) seeking private sector participation through BOT schemes. In the first case, the RGoB could enter into JV agreements with private investors to develop a project. In order to maximize the benefits of the project, the RGoB would have an equity contribution in SPV, with a private partner having the balance. This could include some multilateral participation, as in the recent experience of Lao PDR with the NT2 Project.

The second option would involve adopting a BOT model. The benefits of this model are that it offers a form of off-balance sheet financing, as lending will be undertaken by the project company and not the RGoB. It transfers the risks for construction, finance and operation of the facility to the private sector, and provides a means of attracting and utilizing foreign investment and technology, thus boosting human capital development.

To implement these options, the following initiatives would be required:

- Selection of medium-size projects for pilot PPP schemes and the development of detailed project reports (DPRs);
- Development of legal and regulatory frameworks for PPP projects, including policies protecting investors from expropriation/nationalization and allowing the remittance of dividends and the repatriation of foreign investment;
- Review of Bhutan's FDI policy to permit foreign equity participation including power as an FDI permitted sector; and
- Review of institutional arrangements for environmental and social assurance and commercial disputes resolution and capacity enhancement of these institutions.

Annex 1

Hydropower Development: The Role of India

The Government of India (GoI) has financed the construction of three hydro projects in Bhutan, which are designed to exploit Bhutan's rich natural resources for mutual benefit. The output of these mega projects is primarily designed for export to India, earning revenue for Bhutan in return. The development of Chukha (360 MW), Kurichhu (60 MW) and Tala (1,020 MW) projects has been financed through a 60 percent grant extended by the GoI to the Royal Government of Bhutan (RGoB). The remaining 40 percent has been financed through a loan.

India is still the largest single donor and trading partner with Bhutan. It has been a key contributor to the development of the power sector in Bhutan and exclusively benefits from Bhutan's surplus power. The following extract from the Vision 2020 document summarizes the evolving relationship between the two countries:

"The Kingdom's relationships with India will remain of primary importance. The contribution made by India to the Kingdom's development can be expected to lessen in the years ahead, with the Indo-Bhutan relationship maturing into one that gives increasing importance to trade and economic transactions within the framework of new bilateral and subregional agreements." (Vision 2020).

The development of hydro projects in Bhutan is based on bilateral agreements between the two countries, with projects developed with the grant and technical support of the GoI. The agreement for Chukha was signed between the GoI and the RGoB in 1974 for a 99-year period; the agreement for Kurichhu was signed in February 1994 and for Tala in March 1996. The bilateral agreements are within the framework of the Indo-Bhutan Friendship Agreement of 1949.

The projects are executed through a project authority with representation by both countries, and transferred to an operating entity on completion. The transmission for evacuation of Tala power on the Indian side has been developed as a JV between Power Grid Corporation of India Limited (PGCIL) and Tala Power on Bhutan's side; the transmission system will be under the Tala project authority for the first two years and subsequently transferred to BPC.

Power Trading Corporation of India (PTC), a GoI-owned power trader, took over trading of Chukha and Kurichhu power from PGCIL on October 1, 2002, and signed Power Purchase Agreements (PPAs) for 15 years and 25 years, respectively. The Tala power will also be traded through PTC.

The key features of these agreements are: (i) surplus power, i.e., all power other than that required for domestic use in Bhutan is exported to India; (ii) the rate for purchase of power is fixed for a defined period (four years for Chukha though actual increase was different); and (iii) there is provision for Bhutan to import the power that it needs to meet domestic demand in its lean season.

The agreements for hydropower projects development have to be viewed in the overall context of friendly relations between the two countries. The existing model of hydropower

development has been beneficial for both governments. It has helped Bhutan to monetize its hydro resources through the Indian grant, which would otherwise not have been possible due to scarcity of funds for such large cross-border hydro projects, and has assured Bhutan a stream of revenues for future years. The Indian government has been assured of availability of hydropower at competitive rates, when its own hydro capacity additions have been delayed due to various reasons. At this time, there is recognition of the need to place a commercial mechanism for the PPAs between the two countries. A free access to the Indian market, and investments based on such access, are essential prerequisites for a mutually beneficial commercial mechanism.

Enhancing the commercial framework for bilateral project development would facilitate speedier development of hydro projects in Bhutan, as well as a better realization value for the power. For example, such a framework could address the allocation of firm capacities from Bhutan's stations to India and also address Bhutan's concern for value realization by appropriately benchmarking the price with the Indian market.

India and Bhutan signed an umbrella agreement in July 2006 to facilitate, encourage and promote development and construction of hydropower projects and associated transmission systems as well as trade in electricity, through both public and private sector engagements. Under this agreement, India has agreed to minimum imports of 5,000 MW of hydropower capacity by 2020. The agreement will be valid for a period of 60 years and can be extended with mutual consent.

Under the current arrangements, both electricity export prices and Bhutan's hydropower-related debt are established in rupees. This mechanism provides a natural hedge against foreign exchange risk under the current Bhutan-India specific exchange regime. Bhutan currently has limited capacity to earn convertible currency as most of the exports from Bhutan, including electricity, are destined for markets in India.

Annex 2

The Power Market in India

Current Scenario

India is experiencing significant peak and energy shortages. The total peak deficit in 2005-06 was 11.6 percent. It is likely to increase to 12 percent in 2006-07. In energy terms, the total deficit is likely to be 54,000 MU or 7.6 percent. The Northern, Western and Southern Regions are expected to face the maximum shortages in energy, while the Eastern Region is expected to remain surplus and export power to other regions. In the medium term, significant growth in demand is expected as shown in Figure A2.1.

On the supply-side, there are several constraints. The coal sector is not keeping pace with the requirements of the power sector and coal unavailability in the medium term is seen as a critical limiting factor for meeting the gap. Hydro capacity additions have been delayed due to time overruns for several projects, low flexibility and technology adaptation.

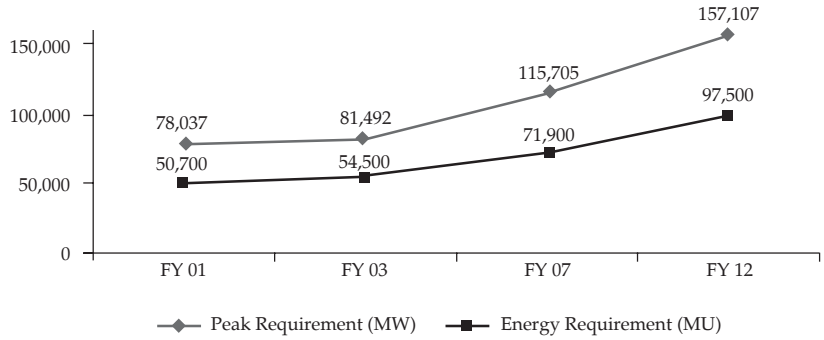
During the 11th Five-Year Plan, around 65 percent of capacity addition is proposed for coal-based stations and 27 percent for hydropower stations, others less than 8 percent combined. This is a considerable shift from earlier projections, basically the gas- and LNG-fired capacity has been significantly scaled down due to the high prices currently prevailing.

The government has taken the following initiatives for proposed capacity additions: (i) sweeping provisions pertaining to disintermediation and promotion of captive power; (ii) fiscal benefits provision via the mega power policy; (iii) promotion of "ultra-mega" projects in the private sector; and (iv) captive mining and import of coal to meet the shortfall in coal availability.

Demand-Supply Scenario

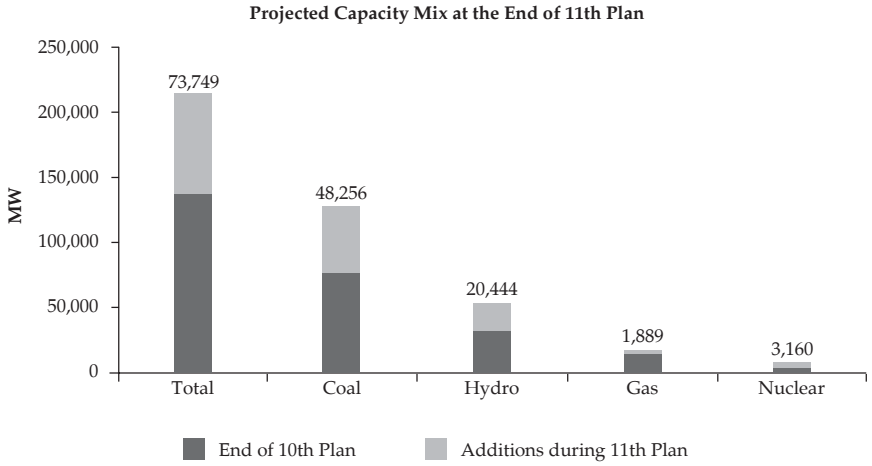
As per the draft National Electricity Plan published by the Central Electricity Authority (CEA), India is likely to experience peak demand deficits during the winter months. However, the actual situation has been quite different from CEA's projections in the past, most likely due to: (i) lower performance of generating stations than projected; and (ii) delays in generation capacity additions.

Figure A2.1: Energy and Power Requirement



Source: Central Electricity Authority, Ministry of Power, Government of India.

Figure A2.2: Generation Capacity Profile for India 2007 and 2007-12 Additions

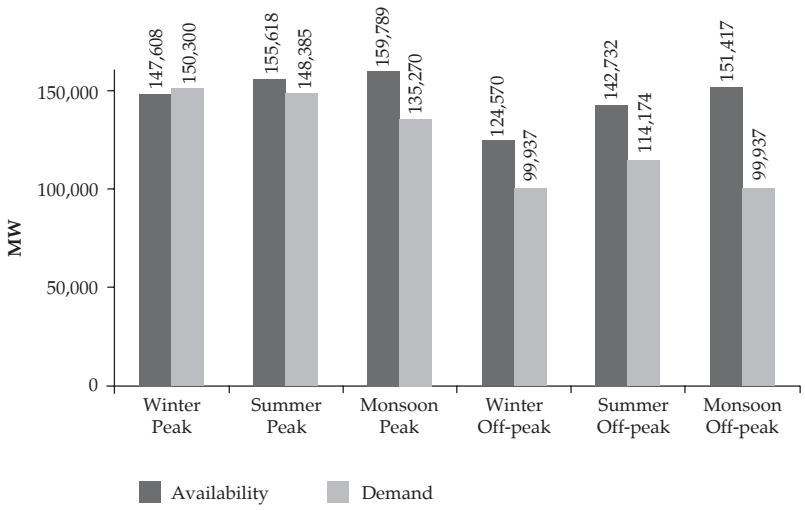


Source: Central Electricity Authority, Ministry of Power, Government of India.

Figure A2.3 shows the demand-supply gap projected for 2011-12 for various seasons (National Electricity Plan draft prepared by CEA). The region-wise analysis of peak demand-supply deficits/surpluses shows that Northern, Western and Southern Regions would continue to be in deficit during the winter and summer peak periods. Eastern and Northeastern Regions will continue to have surplus on account of capacity additions in coal and hydro, respectively. This has been further encouraged by the trading potential and significant trading earning of the participants.

PricewaterhouseCoopers (PwC) analysis show that there would be significant constraints in adding 48,400 MW due to the lack of an adequate quantity of coal. The capacity, which is likely to come on line considering available coal and proposed development, is likely to be in the region of 20,000-25,000 MW.

Figure A2.3: Demand-Supply Gap Projected for 2011-12 for Various Seasons



Source: Draft National Electricity Plan, 2005.

Transmission Development Strategy

The future development of the Indian transmission system is being planned with the following key objectives: (i) to utilize the hydro-thermal mix of generation resources taking into account the concentration of coal in the Eastern part of the country and hydropower sources in the Northeastern and Northern parts of the country; (ii) to develop an integrated national grid; (iii) to implement the open access provisions of the Electricity Act of 2003; and (iv) to develop the power market in the country.

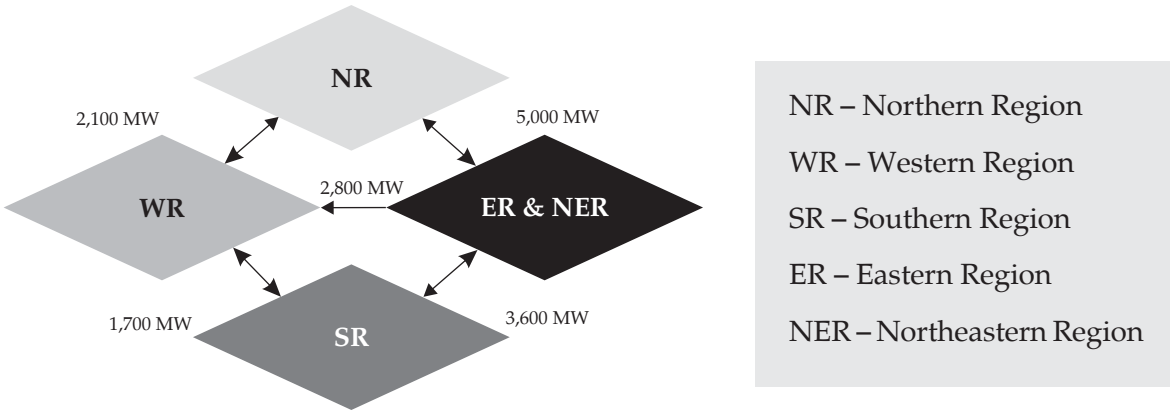
The energy-surplus Eastern Region has about 4,000 MW interconnectivity with other regions in India today. By the end of 2007, this will be increased to 11,600 MW as shown in Figure A2.4.

The transmission charges for the trading of energy through the Eastern Region is high, and this is likely to affect the competitiveness of landed cost of Bhutan's generation in the Southern, Western and Northern Regions.

CEA proposes to enhance the interregional transmission capacities from the Eastern Region to 20,000 MW by 2012. The transmission capacities from the Eastern Region to energy-deficit regions are being developed keeping in view the proposed generation plans. It is proposed in the draft National Electricity Plan that interregional transmission capacities from the Eastern Region be enhanced to 20,000 MW by 2012.

The proposed generating stations as per Bhutan's power system master plan have not been considered in the preparation of India's National Electricity Plan. Delays and time overruns in the Eastern Region generation expansion plan could provide capacity for new Bhutan projects. However, Bhutan should ensure that long-term contracting for corridors is done in advance so as to avoid any transmission constraints later.

Figure A2.4: Interregional Transmission Capacity by 2006-07



Source: Central Electricity Authority, Ministry of Power, Government of India.

Competitiveness for New Capacity

The pricing of fuel to the power sector in India continues to be largely administered. The fuel supply is primarily from public sector companies with private producers (especially in the gas sector) seeking market-determined prices. Coal companies have the flexibility to make formula-based revisions to the coal prices, which they have been exercised regularly. Indian coal reserves are quite high but significantly underexplored. Also, the coal mining sector has significant inefficiencies which systematic reform and opening up of the sector could resolve. The discussion below examines the competitiveness of Bhutan power vis-à-vis other sources in the short to medium term.

The new capacity-addition costs on indigenous coal are expected to be around Rs 2 per kWh. Private sector gas supply contracts are also showing increased pricing of US$3-4.5/million British thermal units (MMBTUs). The variable fuel cost from indigenous coal and equivalent gas price is shown in Figures A2.5 and A2.6.

India is expected to add 48,000 MW of coal-fired stations. The projected requirement of coal works out to be 620 Metric Tons (MT) in 2012 which is about 90 MT higher than the expected availability of coal for the power sector. A similar trend is also visible in the gas sector. The gas supply is expected to fall significantly short of the requirements as shown in Figures A2.7 and 2.8.

The constrained fuel availability could also limit the Eastern Region's ability to export power, thus providing Bhutan with a medium-term opportunity. Under the coal constraint scenario, the total export is expected to be 11,000 MW as compared to 20,000 MW in a normal scenario as shown in Figures A2.9 and A2.10.

In the medium term, imported fuel forms an essential part of India's capacity addition strategy. The key constraint requiring this is not an overall shortage of coal, but the ability of

Figure A2.5: Variable Fuel Cost Using Washed Coal

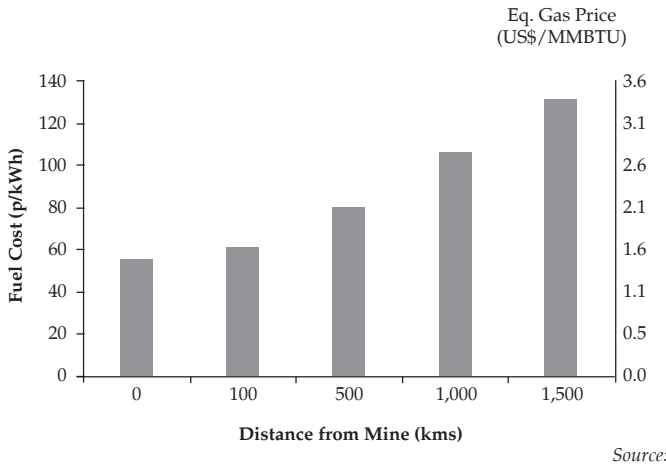
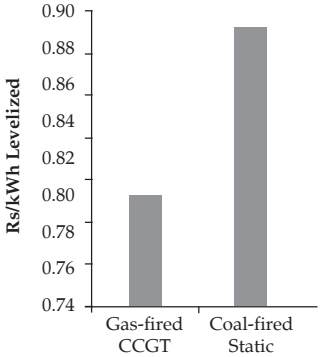


Figure A2.6: Fixed Cost



Source: Study estimates.

Figure A2.7: Coal Availability for Power Sector

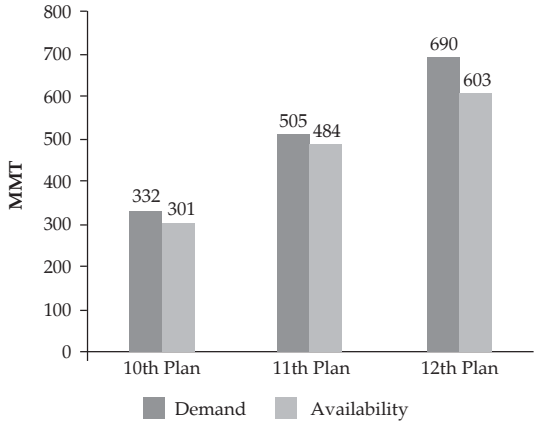
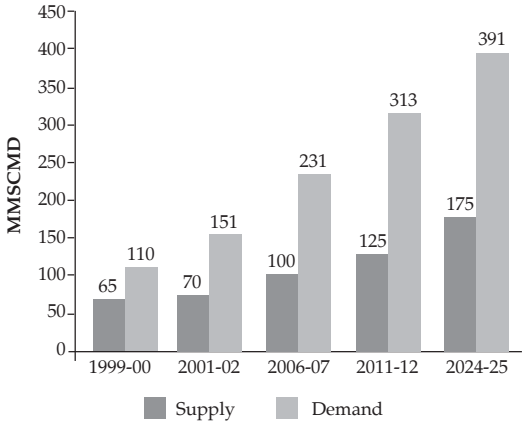


Figure A2.8: Gas Availability for Power Sector



Source: India Hydrocarbon Vision 2025.

Figure A2.9: Interregional Power Flows (MW): 2011-12 Desirable Scenario

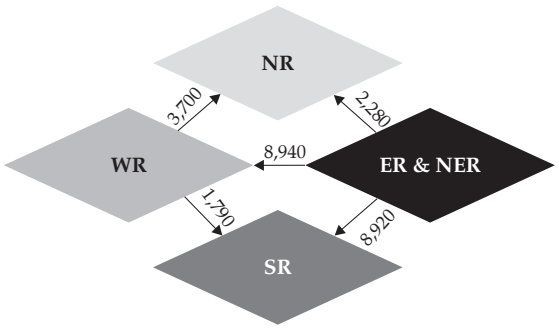
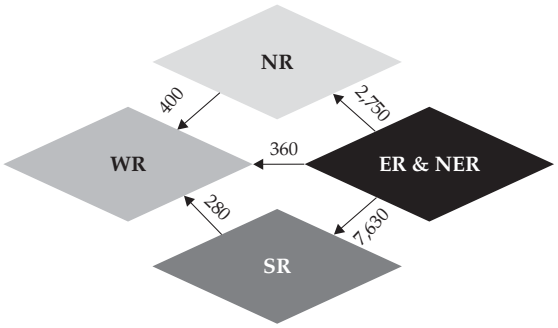


Figure A2.10: Interregional Power Flows (MW): 2011-12 Limited Coal Scenario



Source: India Hydrocarbon Vision 2025.

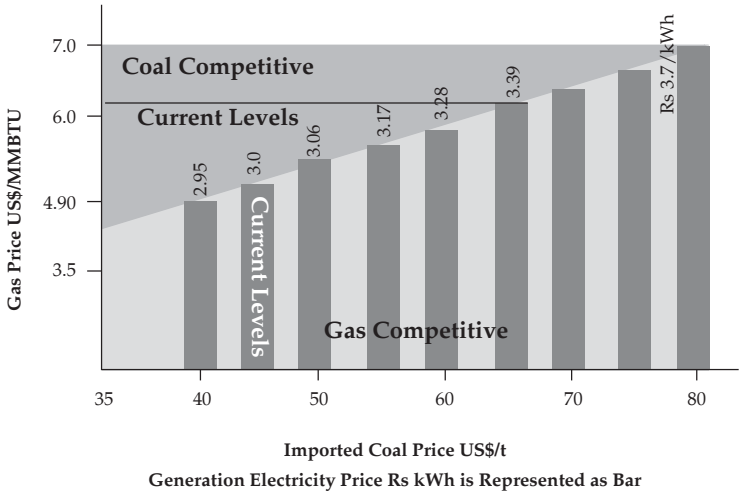
the public sector coal companies to improve productivity and scale up investment. For this reason, the Ministry of Coal is pursuing a strategy of allowing captive mining to steel and power companies.

Generation Based on Imported Fuel

Imported fuel poses significant cost implication for power generation. Figure A2.11 shows the imported coal and gas comparison. The light area shows the price at which gas is competitive vis-à-vis coal, while the dark area represents the competitive advantage of coal.

Spot prices and freight rates indicate US$45 per ton of delivered cost of coal and gas prices is considered at US$6.2 MMBTU. The bus-bar cost of generation at these levels is Rs 3 per kWh and Rs. 3.39 per kWh, respectively. The current levels are, however, at historical highs, and recent long-term deals are showing signs of softening prices.

Figure A2.11: Comparative Cost of Generation



Source: Study estimates.

The high price of power generation based on the imported fuel and the uncertainty in future prices can allow Bhutan to obtain leverage compared with India.

India's Energy Security Requirements

India's energy security, at its broadest level, has to do with the continuous availability of primary commercial energy at an affordable price. Reducing the energy requirement and increasing energy use efficiency are the most important measures to increase energy security. However, it is still necessary to recognize India's growing dependence on energy imports. The threat to energy security arises not just from the uncertainty of availability and price of imported energy, but also from possible disruptions or shortfalls in domestic production. Coal accounts for over 50 percent of India's commercial energy consumption and some 78 percent of domestic coal production is dedicated to power generation. Though current shortages are a concern, coal is likely to remain India's primary source of energy till 2031-32. The pricing of domestic coal could also be an issue in the long run with the likely reduction in subsidy over time and also the stringent environmental norms could make the coal cost more expensive. The import of coal is a feasible option.

Energy security can be increased not only by diversifying sources of import of a particular fuel but also diversifying the energy mix by using different types of fuels. India is seeking development of hydro potential in Nepal and Bhutan, among other initiatives to reduce energy security risk. The draft report of the expert committee on Integrated Energy Policy 2005 states the following: (i) there is significant scope to import hydropower from Nepal and Bhutan; (ii) it will enhance energy security as hydropower can replace natural gas-based generators which are also used for peaking purposes; (iii) the problem of arriving at an agreement on the price of power needs to be resolved; and (iv) the development of a market for power trading in the country provides a benchmark

that should make this task simpler. Nepal and Bhutan may give the right to sell power to anyone in the market.

Nature of Power Market in India

The evolution of the power market within the country has been hastened due to the following key changes brought about in the recent past:

- *Introduction of availability-based tariff (ABT)*. The introduction of ABT at the regional level all across the country has provided the platform for a real-time settlement mechanism. The frequency-linked UI mechanism is used for settlement at the regional level for real-time energy transactions;

- *Enactment of the Electricity Act of 2003*. The Electricity Act, 2003, which came into being on June 10, 2003, envisages an enabling framework conducive to development of the power sector in an open, nondiscriminatory, competitive, market-driven environment, keeping in view the interest of the consumers as well as of the suppliers of power. Generation has been delicensed and trading has been recognized as a distinct activity from transmission. The Electricity Act also provides for specific dispensation for power development in rural areas. Open access in transmission from the outset and in distribution in a phased manner has been stipulated; and

- These substantive changes in the the power sector are expected to lead to the formation of a competitive power market over the next five years. Power markets in India are evolving into three broad categories based on the tenure of commercial arrangements, namely, balancing/spot market, short-term contract market and long-term contract market. In the near future, with the phasing of open access, there would be ample opportunities for power generators to enter into contracts with large industrial consumers.

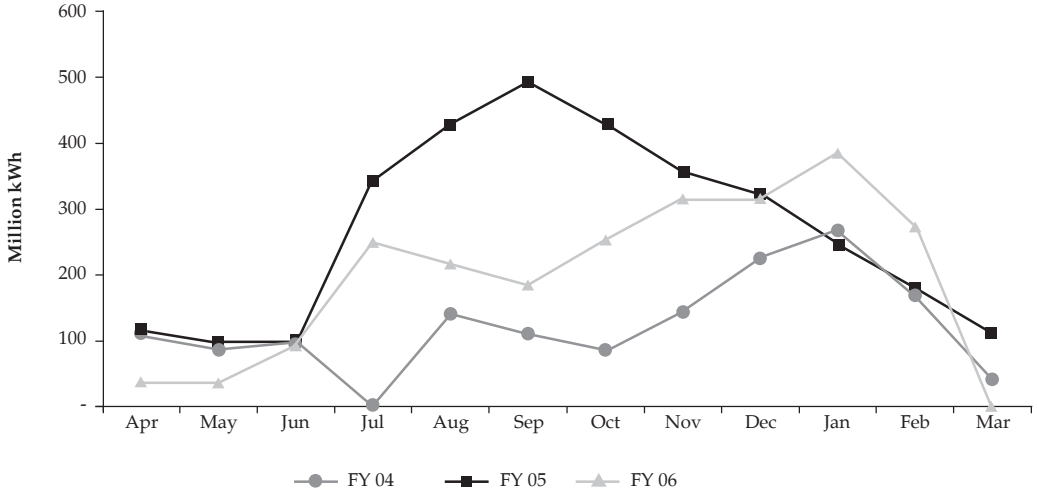
Table A2.1: Comparison of Present and Future Enablers

	Balancing/Spot Market	*Short-term Contract Market*	*Long-term Contract Market*
Present	UI Rates for imbalance in central pool	Short-term contracts (1-6 months) have emerged. UI Rate acts as a price signal	Regulated price (Sec. 86)
Future	State Pools will emerge (Sec 66) (Raj, UP, AP are opting for multibuyer models)	Competition "in the market" could grow Open Access sale to direct consumers (Sec. 42)	Competition "for the market" to emerge (Sec. 63)

Source: Study analysis.

Interregional trading in India has gained importance in the last few years and has provided new markets for the energy surplus Eastern Region. Interregional trade is active in all seasons, in part due to agriculture and other demand, and in part to compensate for the loss of generation of some of the older plants which need regular maintenance shut downs. The average cost of short-term power ranges from Rs 2.50/kWh (off-peak period) to about Rs 3.25 per unit (peak period).

Figure A2.12: ER-NR Energy Exchange



Source: Central Electricity Authority, Ministry of Power, Government of India.

List of Technical Reports

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	SUB-SAHARAN AFRICA (AFR)		
Regional	Power Trade in Nile Basin Initiative Phase II (CD Only): Part I: Minutes of the High-level Power Experts Meeting; and Part II: Minutes of the First Meeting of the Nile Basin Ministers Responsible for Electricity	04/05	067/05
	Introducing Low-cost Methods in Electricity Distribution Networks	10/06	104/06
	Second Steering Committee: The Road Ahead. Clean Air Initiative In Sub-Saharan African Cities. Paris, March 13-14, 2003	12/03	045/03
	Lead Elimination from Gasoline in Sub-Saharan Africa. Sub-regional Conference of the West-Africa group. Dakar, Senegal March 26-27, 2002 (Deuxième comité directeur : La route à suivre - L'initiative sur l'assainissement de l'air. Paris, le 13-14 mars 2003)	12/03	046/03
	1998-2002 Progress Report. The World Bank Clean Air Initiative in Sub-Saharan African Cities. Working Paper #10 (Clean Air Initiative/ESMAP)	02/02	048/04
	Landfill Gas Capture Opportunity in Sub Saharan Africa	06/05	074/05
	The Evolution of Enterprise Reform in Africa: From State-owned Enterprises to Private Participation in Infrastructure-and Back?	11/05	084/05
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Chad	Revenue Management Seminar. Oslo, June 25-26, 2003. (CD Only)	06/05	075/05
Côte d'Ivoire	Workshop on Rural Energy and Sustainable Development, January 30-31, 2002. *(Atelier sur l'Energie en régions rurales et le Développement durable 30-31, janvier 2002)*	04/05	068/05
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	Sub-Saharan Petroleum Products Transportation Corridor: Analysis and Case Studies	03/03	033/03
	Phase-Out of Leaded Gasoline in Sub-Saharan Africa	04/02	028/02
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Mauritania	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Mauritania - Action Plan *(Elimination progressive de l'essence au plomb dans les pays importateurs de pétrole en Afrique subsaharienne Le cas de la Mauritanie – Plan d'action.)*	12/03	040/03
Nigeria	Phase-Out of Leaded Gasoline in Nigeria	11/02	029/02
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	Taxation and State Participation in Nigeria's Oil and Gas Sector	08/04	057/04
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Tanzania	Mini Hydropower Development Case Studies on the Malagarasi, Muhuwesi, and Kikuletwa Rivers Volumes I, II, and III	12/01	019/01
	Phase-Out of Leaded Gasoline in Oil Importing Countries of Sub-Saharan Africa: The Case of Tanzania - Action Plan	04/02	024/02
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