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INFRASTRUCTURE DEVELOPMENT IN INDIA

An Assessment of Status and Strategies

Study Sponsored by

Holcim Ltd.

National Council of Applied Economic Research
11 I.P. Estate, New Delhi-110 002 (INDIA)

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Foreword

The importance of infrastructure for sustained economic development is well recognised. High costs of production, processing and distribution arising from inadequate and inefficient infrastructure can prevent the economy from realising its full growth potential regardless of the progress on other fronts. Lack of access to basic transportation, energy and communication services will not only make living conditions difficult but also make participation in any modern economy impossible. While India has made considerable progress in its quest for development, its infrastructure remains weak and badly in need of additional investment.

Against this backdrop, this study is an attempt to summarise the status of development in each of the core sub-sectors of physical infrastructure in India, the inter-linkages of infrastructure with the rest of the economy and provide an assessment of the constraints and opportunities for growth. The sectors covered by the study include power, telecommunications, roads, railways, airports, ports and irrigation.

The study is presented in two volumes. In the main report we provide an overall analysis of developments in the infrastructure sector and provide an assessment of the progress, constraints and recommendations based on a synthesis of overall and sector-level analysis. The companion volume, "Sectoral Perspectives on India's Infrastructure Development", presents a detailed description of the status and progress of the selected infrastructure sectors.

Over the last two decades, fiscal constraints on the one hand and the potential for efficiency gains from competitive markets on the other have led to a sharp change in India's strategies for infrastructure development. The role for private sector in infrastructure building has increased substantially in areas which were earlier managed solely by the public sector. The transition has required numerous changes in the institutional framework, in policy and in monitoring of progress. There has been progress in attracting private investment into the infrastructure sectors; first in telecommunications, then in ports and roads, and in individual projects in the other sectors.

The Eleventh Five Year Plan (2007-11) projected investments in infrastructure development to the tune of $500 billion over a five year period. The current economic slowdown has cast some doubts on the scale of investments that may be possible in a short period of time, but there is a wide recognition that infrastructure development would be essential for sustained high rate of economic growth over a medium-term which is required to bring about the core objective of 'inclusive growth'.

The study concludes that the Eleventh Plan targets for infrastructure development will be difficult to achieve. The study points to areas which require attention to improve performance

in infrastructure development. The report is a comprehensive documentation of the existing policies and trends of various infrastructure sectors in India. It is hoped that the report will act as a useful source of reference to policy makers, academics, corporate sector and the public-at large on infrastructure development in India.

This study has been commissioned by Holcim Ltd. We would like to place on record our sincere thanks to Paul Hugentobler, Holcim Ltd. and his colleagues Torsten Kleiss and Tobias Schwarz for their support to the NCAER research team during the course of this study. Their suggestions have been very valuable inputs to the study.

The study has provided an opportunity to NCAER to continue its engagement in the debate on infrastructure development policies and programmes in India. Our previous work in the areas of power, telecom, roads, rural infrastructure and regulatory issues in general has been intended to contribute to policy debate in this area.

Suman Bery
Director-General, NCAER

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This study has been commissioned by Holcim Ltd, Switzerland. The study team would like to place on record its sincere thanks to Paul Hugentobler, Holcim Ltd. and his colleagues Dr. Torsten Kleiss and Mr. Tobias Schwarz for their active involvement in the study and inputs to the NCAER research team during the course of this study. Their suggestions have been very valuable.

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The study has also used data and analysis from a number of published sources. The sources have been acknowledged as far as possible.

The study team would also like to acknowledge the contribution of editors in making this report more readable. We also wish to thank Mrs. Sudesh Bala, Mr. J.S. Punia and Mr. Praveen Sachdeva for their support in the production of this report. The team, however, remains responsible for any errors.

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List of Acronyms

3G	Third Generation of Mobile Telephony
AAI	Airport Authority of India
AC	Air Conditioned
AERA	Airports Economic Regulatory Authority
AIBP	Accelerated Irrigated Benefit Progamme
AT&C	Aggregate Technical and Commercial
BHEL	Bharat Heavy Electricals Limited
BOOT	Build Own Operate and Transfer
BOT	Build-Operate-Transfer
BPL	Below Poverty Line
BRGF	Backward Regions Grant Fund
BRIC	Brazil, Russia, India, China
BRO	Border Roads Organisation
BSNL	Bharat Sanchar Nigam Limited
CADP	Command Area Development Programme
CAGR	Compound Annual Growth Rate
CEA	Central Electricity Authority
CERC	Central Electricity Regulation Commission
CGE	Computable General Equilibrium
CRIS	Centre for Railway Information Systems
CWC	Central Water Commission
DoT	Department of Telecommunications
EBITDA	Earnings Before Interest, Taxes and Depreciation Allowance
EFYP	Eleventh Five-Year Plan
EGW	Electricity, Gas and Water Supply
EP&C	Engineering, Procurement & Construction
ERM	Extension, Renovation and Modernisation
FDI	Foreign Direct Investment
GCF	Gross Capital Formation
GCFI	Gross Capital Formation in Infrastructure
GDP	Gross Domestic Product
GIA	Gross Irrigated Area
GQ	Golden Quadrilateral
GST	Goods and Services Tax
GWh	Giga Watt hours
IATA	International Air Transport Association
IEBR	Internal and Extra Budgetary Resources
IIFCL	India Infrastructure Finance Company Limited
IMD	Institute of Management Development

INR	Indian Rupee
IT	Information Technology
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
JNPT	Jawaharlal Nehru Port Trust
JV	Joint Venture
Km	Kilometer
KWh	Kilo Watt hour
LCC	Low-cost Carriers
MDR	Major District Roads
Mha	Million hectares
MoCIT	Ministry of Communications and Information Technology
MoSPI	Ministry of Statistics and Programme Implementation
MPRAA	Major Ports Regulatory Authority Act
MT	Million Tonnes
MTNL	Mahanagar Telephone Nigam Limited
MTPA	Million Tonnes Per Annum
MW	Mega Watt
NABARD	National Bank for Agriculture & Rural Development
NAS	National Account Statistics
NDPL	North Delhi Power Limited
NH	National Highways
NHAI	National Highways Authority of India
NHDP	National Highways Development Programme
NIA	Net Irrigated area
NMDP	National Maritime Development Programme
NREG	National Rural Employment Guarantee
NS-EW	North-South and East-West
NSICT	Nhava Sheva International Container Terminal
NTKM	Net Tonne Kilometres
NTP	National Telecom Policy
NTPC	National Thermal Power Corporation
PIM	Participatory Irrigation Management
PLF	Plant Load Factor
PMGSY	Pradhan Mantri Gram Sadak Yojana
POL	Petroleum, Oil, Lubricants
PPP	Public-Private Partnerships
RDSO	Research, Designs and Standards Organisation
RIDF	Rural Infrastructure Development Fund
RVNL	Rail Vikas Nigam Limited
SEB	State Electricity Boards

SERC	State Electricity Regulation Commission
SH	State Highways
SPV	Special Purpose Vehicle
TAMP	Tariff Authority for Major Ports
TDSAT	Telecom Disputes Settlement Appellate Tribunal
TFYP	Tenth Five-Year Plan
TRAI	Telecom Regulatory Authority of India
UIP	Ultimate Irrigation Potential
UMPP	Ultra Mega Power Projects
USO	Universal Service Obligation
UT	Union Territory
VSNL	Videsh Sanchar Nigam Limited
WiFi	Wireless Fidelity
WiMAX	Worldwide Interoperability for Microwave Access

Executive Summary

The Backdrop, objectives and approach to the study

The importance of infrastructure for national overall economic development and enhancement of trade needs no reiteration. The state of infrastructure is reflection of many dimensions of economic capacity. Good infrastructure means better civic amenities. It is a decisive factor for credibility in the business sphere and a country's overarching market competitiveness. India's economic performance in the recent two decades has again emphasised the urgency of accelerating its infrastructure development. The role of physical infrastructure for supporting economic growth and poverty reduction has been well recognised.

India's ongoing Eleventh Five Year Plan (EFYP), which spans the period 2007-08 to 2011-12, has laid great stress on both infrastructure development and inclusive growth. The EFYP aims to more than double investments in the core infrastructure sectors covering power, telecommunication, transportation and irrigation to an estimated US$ 469 billion as compared to the actual investment of US$ 198 billion in the previous five years. The strategy for achieving 'inclusive growth' has focused on making infrastructure widely available in both rural and urban areas and investing in human resources through creating infrastructure for health, education and habitation.

What gives the Eleventh Plan an extra dimension is its proposal to substantially involve private sector investment in infrastructure development. The share of private sector investments in the seven core infrastructure sub-sectors, viz. roads, railways, electricity, telecommunications, irrigation, port and airports, has been projected at 30 per cent as compared to 20 per cent in the Tenth Five Year Plan (TFYP). The sharp increase in the share of private sector reflects the urgency that the planners have attached to infrastructure development. The growing international experience in public private partnership (PPP) in the supply of infrastructure services has also influenced the strategic shift to a greater role for the private sector in infrastructure.

The Five Year Plans have been instruments for the government to articulate its development strategies and goals. The EFYP has outlined a medium-term strategy to meet its goals. In the three years into the plan, there has been some progress and also evidence of short-comings in the strategies. Overall investment levels have fallen short of targets because of the severely adverse external economic environment in 2008 and 2009. There have also been delays in the implementation of the projects.

Against this backdrop, the present study aims to assess the prospects for sustained infrastructure development which is so essential for accelerated economic growth. We examine metrics for the state of development of the sub-sectors both in terms of quantum and quality, and go on to highlight the strengths and weaknesses of alternative strategies.

The study has reviewed the existing literature on the indicators for assessing the state of infrastructure. We provide an assessment at the sectoral level, besides giving an overview for infrastructure taken as a whole. At an aggregate level, the strategies for infrastructure development have been analysed in terms of (1) status of development, (2) level of investments, (3) financing of investments, (4) role for the private sector, (5) regulation, pricing and access to services, and (6) sustainability of development in terms of attention to maintenance of the stock of infrastructure and also in terms of the implications of fiscal imbalances to investments in infrastructure. Additionally, the study looks to draw useful lessons for India through international benchmarking, with particular reference to China's infrastructure development.

The study is based on information available from a variety of sources. We provide an overall analysis of developments in the infrastructure sector and their interlinkages with the other sectors of the economy. There is also an overview of development efforts covering the perspectives of the seven sub-sectors of infrastructure. It is presented in two volumes. The first volume presents an overall assessment and the second gives the 'sectoral perspectives'.

The Strategies

An important feature of infrastructure development is the predominant role that governments have come to acquire in their planning, execution and maintenance. In the Indian context, the economic reforms of the early 1990s led to liberalisation of controls on private sector investments in a wide range of activities. A number of infrastructure sub-sectors fell into its ambit. The need for sustained high rates of economic growth became an overriding concern as it provided the means for overall economic development. Completing the virtuous circle of infrastructure development and growth is necessary to sustain the other circle of economic growth and economic development. In order to sustain these positive relationships, it is important to keep infrastructure services 'affordable' so that the services are used widely and productively.

India's position in the global setting has begun to change perceptibly as it demonstrated its sustained average growth rates of above five per cent per year throughout the 1980s, 1990s and then in the first nine years of the current decade, actually accelerating to nine per cent in the three year period of 2005-06 to 2007-08. The average growth rates were maintained despite the shocks of the monsoon, political uncertainty and the recent global economic turmoil. India now accounts for five per cent of world's GDP on purchasing power parity basis. It has begun to attract reasonably large amounts of global capital flows while maintaining overall economic

stability. However, the inadequacy of infrastructure has remained a key constraint through this sustained modest growth record. Comparison of India's infrastructure development with China shows that there are large gaps by which India lags behind her northern neighbour.

The prominent role for the public sector was a key strategy for infrastructure development in India well into the end of 1980s. The change in policy regime that occurred in the early 1990s, essentially moving to more market oriented solutions and to a more open trade regime, led to a change in the strategies for infrastructure development also. Private sector participation in infrastructure development was actively pursued first in electricity and telecommunication sectors. New institutions were created to regulate the industry to ensure competition and at the same time ensure commercial sustainability of the operations. Entry of private sector operators in ports, civil aviation and telecom has led to very rapid growth of these sectors. In the case of electricity, the non-conventional and renewable energy sources such as wind energy and small hydro projects have been largely in the private sector. There has been limited success in attracting private operators in thermal electricity generation although the stage seems to have been set for progress here as well. Private sector has begun operations under 'build, operate and transfer' contract or its variants in the development of roads, airports and ports. Major and medium irrigation projects remain in the public sector. Nevertheless, public private partnerships (PPP) and the increasing role for the private sector are becoming established as a critical element of the strategy for infrastructure development.

Highlights of the Study

The study suggests that India's impressive economic growth could be marshalled as the new engine for infrastructure development. The international experience could be replicated; both as a source of financial resource and also as a paradigm of operational efficiency. Private sector participation, if combined with independent regulation, could provide the framework for supplementing the public sector's resources in developing infrastructure.

Infrastructure development is also benefiting from progress in other sectors of the economy. Technological advances have increased the speed with which infrastructure is created and cost of services reduced. Financial sector reforms have increased access to resources both within and outside the economy.

Infrastructure development has a strong, synergetic relationship with input and downstream industries. It's forward and backward linkages with the other sectors are among the largest across different sectors of the economy. Economic reforms have made rapid expansion of the supply of input industries possible, enabling infrastructure construction. However, the growth of downstream industries is affected by infrastructure constraints as they are non-tradable. More efficient infrastructure would have positive impact on the growth of the manufacturing sector and in turn would positively impact net exports.

The policy framework which is currently evolving reflects the new strategic choices and compulsions of building efficient infrastructure to meet the needs of a fast growing economy. Enabling legislations have been put in place and institutions of regulation established. The evolution of mechanisms for coordination of policies across finance and environment domains is an ongoing process. Coordination of policies at the central and state levels is another challenge to be overcome for speedy implementation of projects. The need for policy coordination between infrastructure and other sectors is also highlighted by the sudden rise in demand for skilled and semi-skilled manpower in project execution as well as management of contracts, monitoring and evaluation of capacity and the suitable policy response to it in the education sector.

A number of other studies have pointed to a range of issues that need to be addressed to make speedy infrastructure development possible. Based on a review of the status and progress of infrastructure development in the country, the present study has highlighted the following challenges:

Infrastructure gaps: At the outset, the Eleventh Plan provided an assessment of the prevailing gaps in quantity and quality and proposed a comprehensive plan to bridge these over a five-year lag. The measures included stepping up investments to increase supply of electricity; build roads; modernise ports and airports; achieve extensive telecommunication facilities and improve the services of Indian Railways. The Plan placed emphasis on improving the quality and levels of infrastructure for attaining high economic growth. However, the progress of the Eleventh Plan in bridging the infrastructure gap in most sectors has been slower than foreseen. The gaps have become more acute as the rising average income level has put even greater pressure on available infrastructure. The supply-demand gaps, would, therefore, remain significant and urgent steps are necessary to increase the pace of implementation.

Slack capacity: Ironically, while overall infrastructure remains inadequate, there is also slack capacity to deal with. In the case of power, the causes are both internal and external. Internally, there is abundant scope for improving the Plant Load Factor in generating units and for reducing line losses. Both problems need targeted outlays on equipment modernisation and adoption of efficient management practices. In the case of line losses, governance issues are primal. The external factors include fuel shortages that have caused under-utilisation of capacity in coal-based as well as gas-based plants. In addition to the problems associated with the coal sector, logistic constraints attributable to the railways also contribute to this problem.

Delay in project implementation: All the infrastructure sub-sectors are affected by delays in implementing identified projects cleared by the appropriate authorities. Delays invariably cause cost overruns, often leading to a cascading effect on funding. Time is lost before the actual physical commencement of work on a project, as well as during the course of execution.

Land acquisition for large projects (e.g. thermal power projects require extensive land area) is becoming a contentious issue. Land acquisition for highways, power projects, pipelines and such large projects has been an elaborate process requiring long periods of time to accomplish. There is a need to reduce the time needed for land acquisition while recognising the competing demands on scarce resource.

Uneven private participation: The record so far of the infrastructure sectors in regard to private participation and even within segments of the same sector itself is very uneven. Only the telecom sector has crossed the hurdles of privatisation though the allotment of spectrum for 3G services and infrastructure sharing in rural areas are yet to be resolved. The Ports sector has functioning examples of fully privately owned ports. However, further scope exists for private participation in select areas of port operation. In the case of Airports, Green field airports have come up in the private sector. There are also successful cases of upgradation of metro airports under the PPP mode. To garner investments for upgrading the second tier of airports there is urgency to develop suitable PPP models. The Power sector – where the need for private investment is the greatest – provides an example of uneven progress within the sector itself. The progress is most inadequate in the distribution sector- despite some successes – and the need to overcome this drawback is of the highest priority because efficient distribution holds the key to efficient pricing as well as overall efficiency of the sector itself. The roads sector has developed a conceptually viable model for private entry on the basis of BOT and its variants but faced problems of implementation. In the Railways PPP schemes like 'own your wagon' contrast with models to award concessions for passenger and freight terminals still remain to be developed.

Overall, though there is an increasing number of cases of successful PPPs initiated in recent years in India, the PPP route has not been able to meet the supply-demand gap in infrastructure facilities. The uneven success of PPPs shows that difficult issues face the PPP route for infrastructure development requiring establishment of clear-cut and stable legal framework, adequate information for the private sector participants, competent institutional mechanisms to prioritise investment projects, efficient mechanisms for dispute resolution and effective financial markets.

Governance related constraints: Infrastructure projects are affected by governance-related constraints in several ways. Project award process has to be transparent. The experience of contract award process in telecom should help improve the process in the other sectors. Given the wide 'rural-urban divide' in the infrastructure services, the general budgetary support in the form of measures such as tax incentives, viability gap funding or direct allocations to make infrastructure services more widely available may be necessary over the long-term.

Efficient pricing of infrastructure: There is unequivocal linkage between problems of attracting private investment in infrastructure and price fixation of infrastructure services. This represents a major challenge for the policy strategy during the Eleventh Plan.

The broad policy approach relies on independent regulation. This is the case with the four sectors dealt with in this study: telecom, power, airports and ports. Roads where pricing is of limited application and railways where all services are priced but prices continue to be set by the operator are the exceptions. Irrigation remains complex sector where power and water pricing for agriculture are yet to achieve resources even for maintenance of services.

The regulator in Telecom is fully empowered, but as forces of competition have taken over much of the sector, the prices ruling are well below the ceilings set. The regulator for airport services has just come into position, which is a positive development. Pricing issues will come to the fore in the sector when more players enter the field through green field projects or JVs with AAI. Potential for large gains from pricing efficiencies are expected in power and railways, because the pricing regime continues to be highly inefficient in both. A comparison of pricing of retail power supply in China and in India shows that the price ratio ranges between consumer groups within 1.8 in China while in India it is as high as 7.8. The National Tariff Policy stipulates that the tariff differentials should be brought down to a range of 2 in phases, but the progress has been slow.

Measuring infrastructure development: An appraisal of infrastructure status at different levels is important for determining progress and gaps in supply and demand. The measure would have to incorporate quantity and quality dimensions as well as equity of access or affordability.

Infrastructure development may be measured in two obvious ways. First, there is the physical measure which is relatively easy. For example in roads, the length is weighted by quality-related measures like class (expressway, highway, others) quality (type of surfacing, number of lanes) and usage (number of vehicles); in electricity, consumption per capita and percentage of population with access; in airports, handling capacity in terms of number of flights that can be serviced and number of passengers and cargo volumes to be handled with the available infrastructure; in ports, berthing capacity, number of vessels and cargo volumes that can be disposed off with the available infrastructure, and finally, with railways, the length of the track with percentage of multiple line sections and electrification.

The second measure, which is specific to the Indian context, may be termed as 'institutional' and would include aspects like existence of enabling laws, adequacy of regulatory institutions, clear path for entry of service providers, etc.

In addition, there is a third measure. It sizes up infrastructure in terms of improvement in pricing, capacity utilisation, service quality, etc. In some cases, this would involve estimating the latent unused capacity that could make a significant difference to the supply of infrastructure services.

The present study has not developed these measures but points to the necessity of having such metrics to enable assessment of the status and progress in infrastructure development.

Sustainability of infrastructure development: There are several dimensions to sustainability of infrastructure development. We have focused here on the financial aspects and the maintenance of assets created. When the Eleventh Plan was launched, there was concern that the stepping up of investment-spend may lead to breaching the upper limits dictated by the Fiscal Responsibility and Budgetary Management (FRBM) Act for at least a few years until the dividends from better infrastructure were realised. As it has turned out, the fiscal norms were breached for entirely different reasons: the global economic crisis. To put it in brief, a stable and favourable macroeconomic environment would be necessary to facilitate long-term investments and harvest the benefits of these investments.

The poor state of available infrastructure is also reflection of poor maintenance. Resource allocation for repair and maintenance would have to keep up with not just rising wages and prices of inputs, but also the increased utilisation levels. There has been significant growth in the utilisation or build up of 'moving infrastructure' relative to 'fixed infrastructure' in the case of railways, road transport and civil aviation. A related issue is the quality of the assets created. In an era witnessing rapid expansion of assets it is important to build assets that could stand the test of time and require less maintenance. In this context, an appropriate metric of status of infrastructure is necessary to monitor the progress made in infrastructure development. It is not merely that we have the longest network of railways and roads that will matter but also the quality of the roads and railway network.

Concluding Remarks

The experience of infrastructure development both within the country and outside has now led to a change in strategies that take note of the need for accelerating infrastructure development and the synergetic role that can be played by the public and private sectors together.

The strong linkages of the various sectors in the economy to infrastructure show that infrastructure development has large multiplier effects and in turn imply inadequate infrastructure will retard growth. Moreover, weak infrastructure will also imply that more infrastructure intensive sectors such as manufacturing will be more adversely affected leading to loss of gains that manufacturing offers in employment. The review of various aspects of strategies for development has also identified a number of bottlenecks to the process. Steps are needed to address these concerns to build infrastructure necessary for India's economic development. The main areas highlighted by the present study are:

Utilising slack capacity: the inefficiency in the utilisation of existing infrastructure assets requires to be addressed. The slack capacity in infrastructure has multiplier effects on

downstream and upstream industries. Allocation of adequate resources to improve efficiency in the operation of services will be necessary to improve utilisation of the available capacity.

Project implementation: a number of factors have been identified as responsible for delays in project implementation. Designing good contracts and contracting procedures, streamlining approval and clearance processes and developing skilled human resources are essential elements of a strategy for improving project implementation. We have also emphasised the need for optimal choice of investments taking into account financial capacity for investments.

Privatisation and PPPs: Though a number of successful examples of privatisation and partnership between public sector and private sector are available, there is uneven progress on PPPs across sectors. Electricity distribution is an area where private sector participation could yield significant benefits.

Governance issues: a wide range of concerns are addressed by better governance. Stable policies and fair implementation of policies are prerequisites for deriving benefits from investments made by the public or private sector enterprises.

Fiscal and commercial sustainability of investments: though the role of the private sector in infrastructure development is projected to increase significantly, the public sector would continue as a dominant service provider. Therefore, ensuring adequate returns on investment even at an aggregate level would be necessary to maintain the fiscal sustainability of investments, which is essential to draw private investment.

Efficient pricing of services: independent regulation and competition have led to sharp reduction in the pricing of telecom services. Affordability of services is determined not only by the price but also the quality of services. The role of independent regulation and market competition cannot be overstated in the context of making infrastructure services more affordable. Cross-subsidisation has not succeeded in providing the resources needed for ensuring universal access to services.

Maintaining high quality of services: inadequate recovery of costs has led to lack of maintenance of assets in sectors such as roads, electricity and irrigation. Poor maintenance leads to poor quality of service. Poor maintenance may also be a result of taking resources away from this task to creating new assets. We have also noted that life of assets will also be influenced by choice of technology in construction, and consumer education in proper use of assets. We are unable to indicate what level of resources is to be allocated to maintain the asset quality. Monitoring quality of service should provide indication of resources needed for maintaining quality of service.

Measuring infrastructure development: there is need to benchmark capacity utilisation of infrastructure services. The available information may be useful in developing an indicator of the status and therefore measure changes over time. However, we need another set of measures to monitor the institutional and policy frameworks for development of the sectors. Such measures may be very valuable in assessing infrastructure development in the future.

Policy Coordination and implementation: infrastructure projects require approvals and policy support from several quarters in the government at different levels. Past experience in the process particularly in the more liberal economic policy regime of the past two decades has led to some streamlining of the procedures, especially at the level of the central government. Coordination of policies relating to fiscal incentives, financial sector measures, foreign investment and environmental concerns should be clear and not be at cross purposes. There are broader policy concerns relating to education and training. Creating human resources adequately trained for sectors where employment is also created would have to be a broader policy goal. At the level of state and lower levels of government there will be a need for continuous monitoring and building capacity – human resources and systems – to implement policies efficiently. Design of model procedures and contracts with wider applicability would help in streamlining implementation.

The infrastructure development in India will continue to be mainly demand led and therefore efficient use of existing infrastructure and efficient construction of new assets will be critical in the pursuit of higher economic growth. Fiscal support will continue to be dominant for infrastructure development but equally important would be the enabling policies that could lead to streamlining of procedures and protecting interests of both investors and consumers. ●

I. An Overview of India's Infrastructure Development Strategies

I.1 Background, Objectives and Approach of the Study

The importance of infrastructure for overall economic development and enhancement of trade and business activities in a country needs no emphasis. Infrastructure reflects civic amenities, economic credibility, efficient economic activity and the market competitiveness of a region. The adverse impact of deficiencies in the provision of basic economic services such as electricity, transportation and communication to the population are well known. In addition, India's economic performance in the recent two decades has further emphasised the urgency of accelerating its infrastructure development.

There is also a global dimension to India's infrastructure development. The performance of the Indian economy will have a significant impact on the global economy in the years to come. India, along with China, has become one of the fastest growing large economies of the world in the past two and a half decades. India's overall GDP doubled between 1998-99 and 2008-09. Its share in world GDP, measured in purchasing power parity (PPP), increased from about 3 per cent in 1990 to 3.5 per cent in 2000 and grew rapidly to an estimated 5 per cent in 2009. India's share in the world population is currently about 18 per cent, which is way above its income share, pointing to the need for accelerating the pace of income generation. However, it is important to note that the high growth rates seen in India and China also mean that the two countries together contributed as much as 10 and 30 per cent respectively, of world GDP growth in 2008.

The accelerated economic growth in recent years indicates that infrastructure development will also need to pick up to sustain this growth rate into the future.

The positive impact of physical infrastructure for economic growth and poverty reduction has been well documented in literature. Efforts at economic development in any country have started with investments in the transportation and power sectors. Investments in these key physical infrastructure sectors lead to opportunities for income generation and improvement in the income of the poor when economic growth that follows is inclusive. India's current Eleventh Five-Year Plan (EFYP), covering the period 2007-08 to 2011-12, has laid great stress on both infrastructure development and inclusive growth. The EFYP aims to raise investments in core infrastructure sectors covering power, telecommunications, transportation and irrigation to an estimated US$ 469 billion compared to the actual investment of US$ 198 billion in the previous five years. The strategy for achieving 'inclusive growth' is focused on

making infrastructure widely available in both rural and urban areas, and investing in human resources through creating infrastructure for health, education and habitation.

Besides the significant scaling up of investments, what is distinctive about the EFYP strategy for infrastructure development is the substantially increased share of investments assigned to the private sector. The private sector's share in investments in the seven core infrastructure sub-sectors of electricity, telecom, roads, railways, airports, ports and irrigation has been projected at 30 per cent compared to 20 per cent in the Tenth Five Year Plan (TFYP). This sharp increase in the share of the private sector points to both the perceived urgency of infrastructure development and also growing international experience in public-private partnerships (PPP) in the supply of infrastructure services.

Infrastructure development requires resources. Access to such resources is possible because of bi-directional linkages between infrastructure development and economic growth. This reflects a virtuous cycle of the creation of an enabling infrastructure which can be financed by the subsequent economic growth. Infrastructure is necessary to enable economic activity and, hence, growth. Economic growth is needed to generate the resources needed to make infrastructure development strategies sustainable. International experience suggests that as per capita income levels increase, the demand for infrastructure services also increases. In this sense, when each household is able to generate effective demand for a minimum level of electricity, transportation and communication facilities, the overall demand for these services from a large economy like India can be enormous. Hence, the strategy for infrastructure development will have to take into account the potential demand for services as the economy develops.

The scale of efforts required in infrastructure development in the next 5-10 years is illustrated by the electricity sector, which is also the largest of the infrastructure sectors in terms of investment requirements. The per capita electricity consumption in India is less than half that in China. At current rates of growth, in another 10 years India's per capita GDP would reach China's current per capita GDP, implying that demand for infrastructure services would at least double in the next 10 years. The EFYP has projected the creation of an additional power generation capacity of 92,577 MW (inclusive of about 14,000 MW from non-conventional and renewable energy sources) compared to the additional capacity of 21,080 MW created in the previous five years. At the present rate of growth, the per capita consumption of electricity is projected to increase to 628 kWh by 2011-12 compared to China's consumption of 2,480 kWh in 2007.

Objectives and approach of the study

The Five-Year Plans have been instruments for the government to articulate its development strategies and goals. The EFYP outlined a medium-term strategy and also the goals that need to be achieved. In the three years into the Plan, there has been some progress and also some evidence of the short-comings of the strategies planned. This study attempts to summarise the

status of development in each of the core sub-sectors of physical infrastructure in India and the inter-linkages of infrastructure with the rest of the economy. It also provides an assessment of the constraints and opportunities for growth.

More specifically, the study has the following objectives:

- Reviewing the status of selected infrastructure sectors with respect to capacity, access or reach and adequacy;
- Reviewing the strategies for development of the sectors including policies, institutional arrangements and investment plans;
- Assessing the constraints and opportunities for the development of the sectors; and
- Based on the above analysis, providing recommendations for the sustained development of infrastructure in India.

This study is based on information available from a variety of sources such as Five-Year Plan documents, other official statistics and also a review of the other analyses that are available. The study also provides a comparison with an international setting, particularly with respect to China, wherever possible.

The study's Report has an executive summary and two chapters. Chapter 1 provides a macro view of developments and Chapter 2 contains a synthesis of sectoral analyses and an overall analysis of the study. The companion volume, 'Sectoral perspectives on India's Infrastructure Development', provides an analysis of the seven sub-sectors selected in the study: Power, telecom, roads, railways, airports, ports and irrigation.

I.2 Drivers of Infrastructure Development

The pressures that deficiency in infrastructure creates on the supply system of an economy have a multiplying effect. As infrastructure services fall short of demand, the cost of producing goods and services using the infrastructure would rise. Surveys on the investment climate have repeatedly shown that limited and poor quality of infrastructure facilities act as a major impediment to business growth in India. The poor quality of power supply with frequent outages continues to be a feature in many parts of the country. Congestion on the roads, with consequent delays in transportation, has also been well recognised. The bottlenecks in rail, ports and airports have meant that the cost of transportation in terms of time and value is greater here than elsewhere. Infrastructure deficiency is also arguably a factor that constrains the growth of manufacturing relative to services, as manufacturing is more intensive in the use of infrastructure services.

The EFYP provides an indication of the extent of the deficit in the infrastructure sector at the beginning of the Plan period:

- Power: More than 10 per cent peak load shortage, 40 per cent loss of energy generated due to transmission and distribution losses, and absence of competition leading to both efficiency losses and poor customer service.
- Roads: The national highways (NHs) comprise only 2 per cent of the road network, but carry 40 per cent of the traffic; only 12 per cent highways are 4-laned, 50 per cent are 2-laned, and 38 per cent are single-laned. The state of the other roads is even less satisfactory. The EFYP has targeted the improvement of the quality of NHs significantly. The EFYP also seeks to improve connectivity of rural habitations to all-weather roads.
- Railways: Slow speed, low pay-load ratios, old technology and saturated routes have characterised rail transport. The EFYP aims to expand track length, convert narrow tracks to broad gauge and modernise facilities at railway stations. Dedicated freight corridors are planned to achieve more efficient freight transportation.
- Airports: Inadequate runways, aircraft-handling capacities, parking spaces and terminal buildings. The EFYP proposed the modernisation of the four metro airports and 35 non-metro airports, and building 10 Greenfield airports.
- Ports: Inadequate berths and rail/road connectivity. The EFYP proposed to improve capacity in both major and minor ports.
- Telecommunications: The emergence of mobile telephone technology and the entry of private operators in the telecom sector led to a huge expansion of the telephone network. At the beginning of the EFYP period, there were 18 telephone connections per 1,000 people. By the end of 2009, there are more than 54 telephone connections per 100 people. The EFYP had targeted a teledensity of 38 per 100 people, which has already been reached. The real challenges now are penetrating rural areas and moving the value services higher up through telecommunication channels.
- Irrigation: Irrigation remains the key to achieving sustained growth in agriculture, but its coverage has remained at about 43 per cent of the net sown area. Hence, further expansion of irrigation facilities will be necessary. The EFYP proposed to create an additional 16 million hectares of irrigation potential, taking the total irrigated potential created to 118.77 million hectares by the end of the EFYP period.

The acceleration in economic growth during the 1990s and in the first decade of the 21st century has pointed to the need for rapid improvement in infrastructure. The benefits from global markets are likely to be significant only if there is an enabling infrastructure. Ships, aircraft and communication facilities are necessary to move goods, people and information. Rising income levels also mean that there are now possibilities for the commercial development of the infrastructure sector on a much larger scale without the need for large subsidies. Accelerated economic growth seems to be just within reach and weak infrastructure appears to be a major bottleneck in achieving the higher growth rates necessary for overall development.

There have also been technological developments that have made infrastructure development faster and more cost-effective. Mobile telephony is one example. Further, improvements in construction technologies, the rise of gas-based power generation, and the emergence of technologies for mega power generation plants have also meant that the execution of infrastructure development can be much faster than it has ever been before.

The drivers of the new emphasis on infrastructure development in the EFYP have thus included the realisation that the current status is a major bottleneck in achieving sustained levels of high rates of economic growth over a fairly long time period. Further, the drivers also realise that there are new opportunities in terms of technological improvements available that would make faster infrastructure development feasible at a lower cost.

I.3 Strategies for Infrastructure Development

The strategies for infrastructure development need to consider a wide range of options and trade-offs. The goals of ensuring an affordable, high quality and adequate quantum of services to consumers will have to consider the large scale of resources that will have to be mobilised in a short span of time. There are also issues relating to availability of suitable materials and skills for the execution of projects. There is a need for a coordinated and comprehensive strategy for the development of infrastructure. We now note some of the considerations that have an impact on India's infrastructure development strategies.

Public sector, markets and financing

As noted earlier, the development of basic infrastructure has been a primary policy goal in India, as in other developing countries, in its quest for economic development. However, for a variety of reasons the infrastructure sector in India had become public sector dominated. The reasons for this include the public goods nature of infrastructure services which implies non-excludability, elements of natural monopoly in the sectors and the need for long-term investments before commercially viable returns could accrue to the highly capital-intensive nature of the sector.

The share of the public sector in Gross Capital Formation (GCF) in electricity, gas and water supply (EGW) was as high as 95 per cent by the end of the 1980s. In the case of railways and communications (including telecom), the share of the public sector in GCF by the end of the 1980s was nearly 100 per cent. In the case of transportation, other than railways, the share was relatively lower at 47 per cent thanks to the presence of a large segment of motorised transportation in the private sector. The prominent role of the public sector was a key strategy for infrastructure development in India well into the end of the 1980s.

The change in policy regime that occurred in the early 1990s, essentially moving to more market-oriented solutions and to a more open international-trade policy regime, also led to a change in the strategies for infrastructure development. Private sector participation in

infrastructure development was actively pursued first in the electricity and telecommunications sectors. New institutions were created to regulate the industry to ensure competition and, at the same time, ensure the commercial sustainability of operations.

The entry of private sector operators in ports, civil aviation and telecom has led to a very rapid growth of these sectors. In the case of electricity, non-conventional and renewable energy sources such as wind energy and small hydro projects have been largely in the private sector. However, there has been limited success in attracting private operators in the generation of thermal electricity, although the stage seems to have been set for progress here as well.

The private sector has begun operations under 'build, operate and transfer' contracts or its variants in the development of roads, airports and ports. Though major and medium irrigation projects remain in the public sector, public-private partnerships are becoming established as a key strategy for infrastructure development.

By 2005-06, the share of the public sector in GCF had declined to 77 per cent in EGW and 41 per cent in transportation other than railways in which it remained 100 per cent. The share of public sector in GCF in the case of communications declined sharply to 38 per cent. The share of the public sector in GCF for all the three main groups of infrastructure sectors – EGW, railways, other transport and communications – combined, dropped from 44 per cent in 1990-91 to 23 per cent in 2005-06.

A number of steps have been taken for the financing of infrastructure. These include the setting up of specialised financial institutions, liberalisation of access to international financial markets, simplification of foreign direct investment rules and extending fiscal support to PPP projects to improve their commercial viability for private investments. The strategy has been to increase access to financial markets and provide fiscal incentives to make private investments attractive in the margin.

Equity in access

Another major strategic policy concern when it comes to infrastructure has been equity in access to services. Equity in access implies both a regional balance in access to services and also access to populations across income categories. Commercial sustainability requires pricing which covers costs and provides a reasonable return to the producer. Governments have, so far, subsidised infrastructure development in order to improve access to the economically weaker sections of society. The imbalances remain a challenge. The significant rural-urban divide in access to many infrastructure services will require policies that help bridge the gap.

There are also large variations across regions with respect to availability of infrastructure services. Development of industries and urbanisation are possible only if core infrastructure services are available to all.

While fiscal support in terms of tax incentives and subsidies is important in addressing the disadvantages faced by less developed regions, market competition and new technologies now appear to be equally effective in expanding access across regions and reducing tariffs.

Balanced development of sectors

The inter-linked nature of infrastructure services makes it necessary that the sectors provide the benefits of these synergies. Links between alternative modes of transport, links between energy and telecommunications, electricity supply and irrigation or linking ports through roads and rail with the hinterland and so on are essential for deriving the full benefits of infrastructure development.

The Plans accord high priority to electricity and roads as they remain the basic services for modern life. However, inadequate development of the other sectors can mean that the benefits realised from these two basic sectors are less than their potential. Identification of the bottlenecks and the missing linkages has also led to investments to bridge these gaps.

Supply led vs. demand led development

Creation of infrastructure ahead of demand for services is an option provided there is access to high levels of savings. Creating an infrastructure supply may reduce the costs of these services to the users and in turn expand their markets. In the Indian context, resource constraints have meant that infrastructure development in general has lagged behind growth in demand with the inadequacy of infrastructure being evident. The proposed doubling of investments in the infrastructure sector in the EFYP is still a plan that aims to maintain the high growth rates experienced in recent years. The investments are, therefore, meant to meet the existing demand rather than building excess capacity.

Technology choices and inputs in infrastructure building

The relatively long life of infrastructure assets means that the choice of technology plays an important role in keeping the cost of services over the life time of the assets low; it also enables exploiting the maximum possible benefits from investments. Technology choices also influence the efficiency of the application of infrastructure relative to producers in other competing regions or countries. In the Indian context, these trade-offs must be considered in creating an efficient infrastructure that maintains the competitiveness of Indian producers in global markets.

Developing appropriate input supply chains including necessary human resources is a pre-requisite for the efficient planning and execution of infrastructure projects. India has developed production capacities in some of the key input industries including engineering. It also has a large educational infrastructure but the need for a skilled labour force both in the planning and execution of projects has increased manifold. Training the available manpower in the best practices of the sectors has to be part of the strategy for accelerating the pace of

infrastructure development. It is, however, also necessary to point out that access to competitive international markets has been recognised in some cases where import of critical machinery has been allowed at low rates of tariff.

Governance and infrastructure

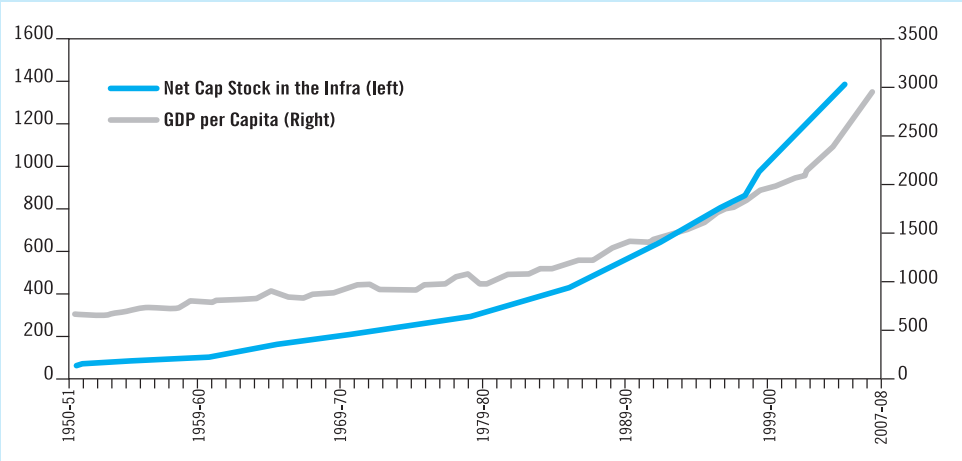
Given the considerations of universal access, the impact of development and resource constraints, infrastructure development requires transparent and effective mechanisms of governance. Regulatory institutions, dispute resolution, approval processes and political support for the processes are needed to sustain infrastructure development. India has created new institutions to meet the requirements of accelerating the pace of infrastructure development. Given the federal structure of governance in the country, greater coordination in policies is needed to facilitate both investments and execution of projects.

I.3.1 Development of infrastructure in India

The rising level of infrastructure investment over the years is illustrated by the trend in net capital stock in **Figure I.1**. The net capital stock in infrastructure comprising: 1) electricity, gas and water supply, 2) transport, and 3) communications increased at a higher pace in the mid-1980s, when per capita GDP growth also accelerated.[1]

Figure I.1

Trends in Per Capita GDP (Rs.) and Net Capital Stock in Infrastructure (Thousand crore Rs.) (1993-94 prices)



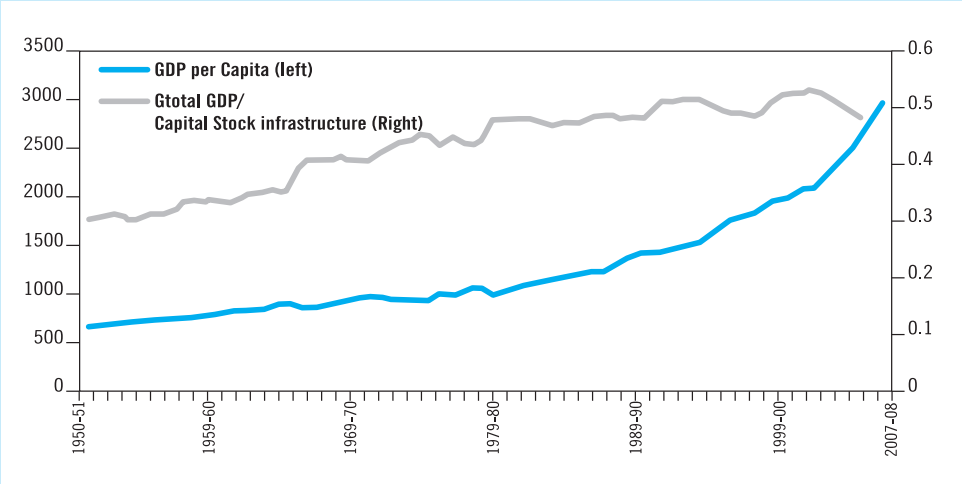
Source: National Accounts Statistics Central Statistics Organisation, 2009 and various previous issues.
Notes: Figures are in Rupees. Infrastructure comprises: 1) electricity, gas and water supply, 2) transportation, and 3) communications.

1. The measure of capital stock here includes both 'fixed infrastructure', such as roads, railway tracks and airports and 'moving or loose infrastructure' such as commercial vehicles, rolling stock of railways, aircraft and ships. We consider the changes in the two components separately in the case of railways and roads at a later stage in this analysis, but, because of data limitations, a similar exercise is not carried out for the other sectors.

The pace of increase in capital formation in infrastructure – comprising both fixed and 'moving' or 'loose' infrastructure – was faster than the increase in GDP during 1950-51 to 1982-83. The period after this witnessed a faster increase in both capital stock and GDP. The ratio of capital stock of infrastructure to GDP increased at a much slower pace from 1982-83 onwards **(Figure I.2)**. The difference in the growth rates of capital stock of infrastructure and GDP narrowed.

Figure I.2

Trends in Infrastructure Development (stock of infrastructure capital) and Output (GDP at 1999-00 prices, Rs.)



Source and notes: Same as that for Figure I.1.

The early period of development, until the mid-1980s, was one of establishing very basic infrastructure. This period also reflected the modernisation of the production, distribution and consumption processes in the economy. More electricity, transport and communications became necessary to accelerate output growth. However, in the second phase of infrastructure development, there was a sharp improvement in the utilisation of resources as GDP growth also accelerated.

These trends also suggest that the economy was not getting adequate returns to investment in infrastructure in the early period of 1950-51 to 1982-83 as the GDP growth rate was modest relative to the subsequent period. The problem may not have been with infrastructure development but with other policies which led to less efficient processes. Just as the higher growth rate of per capita GDP has illustrated rising productivity since the early 1980s, productive use of infrastructure may also have improved in the second sub-period.

The growth of the overall economy as a driver of infrastructure development is captured by the strong links between the two variables. As shown in Annexure AI.1, investments in the

infrastructure sector are strongly influenced by economic growth. Infrastructure development appears to have taken place primarily within the bounds dictated by overall economic growth, and the fiscal and foreign exchange constraints appear to be captured by the overall influence of economic growth itself on infrastructure investments. As we show later, the strong links between infrastructure development and the other sectors of the economy reflect the contours of a virtuous circle of high growth and infrastructure development.

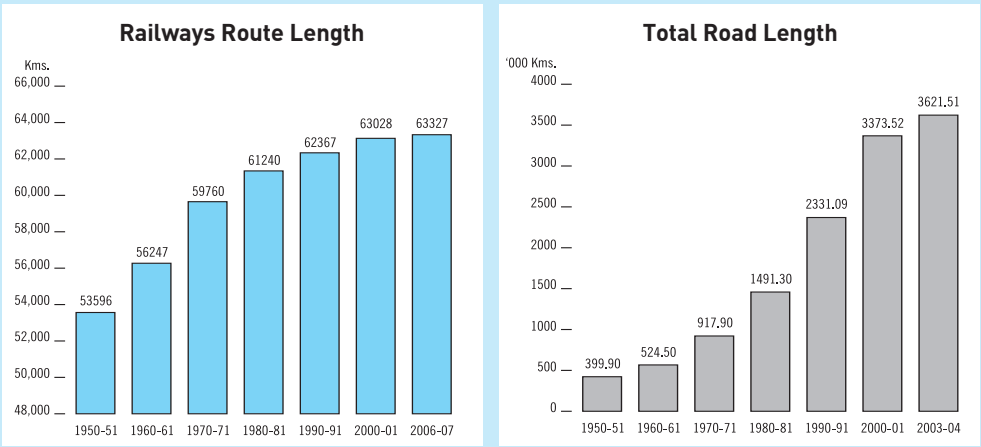
Development across sectors

There has been an uneven pattern of development across infrastructure sectors over time, which may reflect the influence of a number of factors. India's infrastructure utilisation indicators like port and airport traffic, teledensity and motor vehicles grew considerably, while 'fixed' components like roads and railways witnessed relatively slower expansion over the same period.

There have also been differences in the pattern of growth of the infrastructure sectors over time. For example, expansion of the railway network was rapid in the 1950s and 1960s in terms of route length **(Figure I.3)**. In the case of roads, however, an expansion in road length came in the 1980s and 1990s. Most of the other sectors like ports, telecommunications and motor vehicles basically gained growth momentum post-liberalisation in 1991 **(Figure I.4)**. In the case of telecom and electricity, the 1990s experienced the fastest increase in capacity **(Figure I.5)**.

Figure I.3

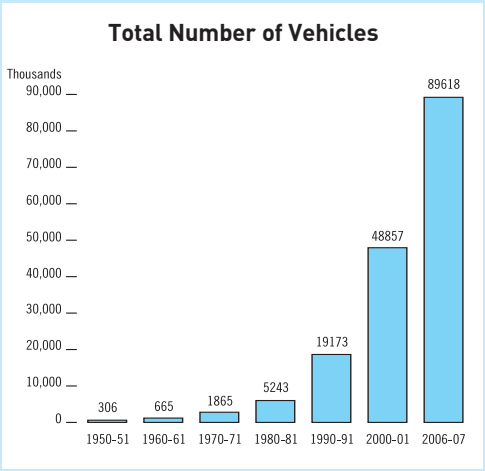
Developing Surface Transport Network



A well-functioning infrastructure which caters to the transportation, communications and energy requirements is essential for a modern economy. The selection, design, funding, implementation process and operation of infrastructural services have macroeconomic implications for the growth of a country. High transaction costs arising from inadequate and

Figure I.4

Indicators of Infrastructure Output: Motor Vehicles and Shipping



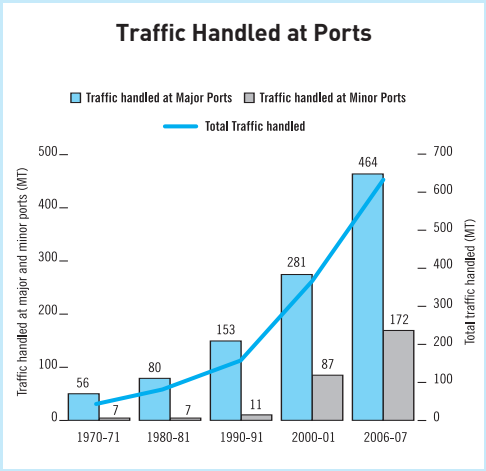
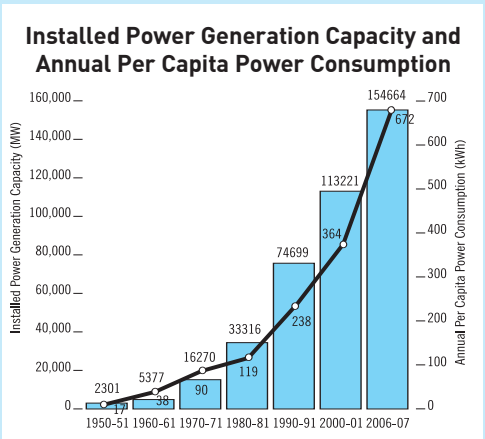
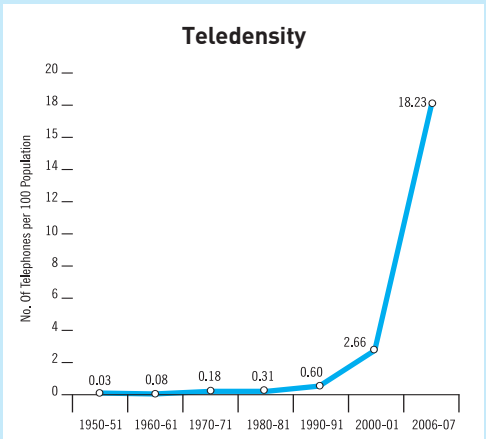


Figure I.5

Indicators of Infrastructure Output: Electricity and Telecom





Sources of data for Figures I.3-I.5 are official statistics including Statistical Abstract of India (2008).

inefficient infrastructure can prevent the economy from realising its full growth potential, regardless of the progress on other fronts. At the same time, past experience suggests that achieving accelerated economic growth is necessary to stimulate investments in infrastructure spending. While supply-led infrastructure development may not be possible for a resource constrained economy, infrastructure should not be a bottleneck for growth.

Roads

India now has one of the largest road networks in the world, aggregating at around 3.7 million kilometres and consisting of national highways, state highways and other roads comprising major district roads, other district roads and village roads. The national highways (NHs), with

a total length of around 67,000 km, serve as the arterial network of the country. State highways (around 1,37,000 km) are the main roads in the states; they connect the capitals and major cities in the states. Other district roads have a total length of around 3.5 million km.

Table I.1 shows the trends in the development of roads and also the utilisation pressure on roads in terms of the vehicles plying on them. Whereas the road length increased 8-fold over four and a half decades, the number of vehicles increased 200-fold. The total number of motor vehicles had increased from just 306,000 in 1950-51 to 89,618,000 by 2006-07. Even if we consider only 'goods vehicles', the increase is 50-fold.

Table I.1

Development of Roads and Road Transport

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Total length	000 kms	400	525	918	1,491	2,331	3,374	3,709
National Highways	000 kms	20	24	29	32	34	58	67
State Highways	000 kms	43	62	89	94	127	132	137
Other Roads	000 kms	338	439	800	1,365	2,170	3,184	3,506
Road Transport								
Total	000 Nos	306	665	1,865	5,243	19,173	48,857	89,618
Goods vehicles	000 Nos	82	168	343	590	1,289	2,715	4,436
Buses	000 Nos	34	57	94	154	312	562	992
Cars, Jeeps, Taxis	000 Nos	159	310	682	1,122	2,733	6,143	11,526
Two-wheelers	000 Nos	27	88	576	2,530	12,525	34,118	64,743
Other vehicles	000 Nos	4	42	170	847	2,314	5,319	7,921

Source: Plan Documents, Basic Road Statistics, Motor Transport Statistics.

Railways

The Indian Railways enterprise was nationalised in 1953. It is now one of the world's largest rail networks under one management. It plays an important role in not only meeting the infrastructure needs of the country, but also in bringing together dispersed areas and promoting national integration. From a very modest beginning in 1853, when the first train steamed off from Bombay to Thane (a distance of 34 km), Indian Railways has grown into a vast network of 6,909 stations spread over a route length of 63,327 km **(Table I.2)**.

The two segments of traffic for Indian Railways are freight and passengers, of which freight traffic accounts for about 66 per cent of its revenues.[2] Within freight, 'bulk' freight accounts for nearly 89.8 per cent of revenue-earning freight traffic (in physical terms), of which about 42 per cent is coal.[3] Not only did the railways transport more than 18 million passengers and 2.18 million tonnes of freight daily in 2007-08 (in urban and suburban railway networks), but it is also the single largest employer in the country, with over 1.4 million people on its payrolls.[4] India's rail infrastructure is among the largest in the world.

2. Outcome and Performance Budget of the Railways for 2009-10 (July 2009), Ministry of Railways publication.
3. Ibid.
4. Indian Railways Yearbook 2007-08 (2008), Ministry of Railways publication.

Table I.2

Development of Railways

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07	2007-08
Route length	Km	53596	56247	59760	61240	62367	63,028	63,327	63,273
Electrified route length	Km	388	748	3706	5345	10083	14,856	17,786	18,274
Locomotives	Number (in thousands)	8209	10624	11158	10908	8417	7566	8153	8330
Number of wagons	Number	100	152	226	269	278	246	243	247
Wagon capacity	Million tonnes	4.14	6.3	9.35	11.14	11.5	10.9	10.06	10.24
Originating friegth traffic	Million tonnes	93	156.2	196.5	220	341.4	473.5	727.75	793.89
Net tonnes km	Billion tonnes km	44.12	87.68	127.36	158.47	242.2	312.4	481	521.4
Passengers originating	Millions	1284	1594	2431	3613	3880	4,833	6,219	6524
Passenger km	Million km	66,517	77,665	118,120	208,558	295,644	457,022	694,764	769,956

Source: Plan Documents, Railways Yearbook 2007-08.

As in the case of roads, the growth of 'moving infrastructure' has outpaced the growth of 'fixed infrastructure' in the case of railways. While the railway route length increased by 18 per cent between 1950-51 and 2006-07, freight and passenger traffic increased by 900 per cent.

Power

Installed power generation capacity in the country has increased significantly over the years from about 2,301 MW in 1950-51 to 1,54,664 MW by 2006-07. Correspondingly, the overall generation increased from 2,519 GWh during 1950-51 to 7,25,454 GWh during 2006-07. Consequently, the annual per capita power generation increased from 17.28 kWh in 1950-51 to 671.89 kWh in 2006-07 **(Table I.3)**.

Ports and Shipping

India is the 20th largest maritime country in the world. Its long coastline that flanks important global shipping routes makes it a major maritime nation. The maritime sector in India comprises ports, shipping, shipbuilding and ship repair, as well as inland water transport systems. Ports have played an important role in facilitating India's international trade and also in generating economic activity in their surroundings.

The 12 major and 200 minor ports scattered across its 7,517 km coastline handle both domestic and international trade **(Table I.4)**. In the initial years, the traffic was handled mostly at major ports. However, over the years, non-major ports have also witnessed a growth in traffic, rising to 171.92 million tonnes by 2006-07. The major ports still hold a share of 70-75 per cent of the

Table I.3

Development of the Power Sector

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Power generation capacity	MW	2,301	5,377	16,270	33,316	74,699	113,221	154,664
- hydro	MW	560	1,917	6,382	11,794	18,757	23,904	34,714
- thermal	MW	1,741	3,460	9,468	20,662	54,346	85,422	108,112
- nuclear	MW	0	0	420	860	1,565	2,680	3,900
- renewable	MW	0	0	0	0	30	1,215	7,938
Gross electricity generation	6574	20,123	61,212	119,260	289,439	536,452	752,454	
- hydro	GWh	2,519	7,837	25,248	46,557	71,656	80,854	113,719
- thermal	GWh	4,055	12,287	33,546	69,702	211,610	440,840	609,856
- nuclear	GWh	0	0	2,417	3,001	6,141	13,249	18,802
- renewable	GWh	0	0	0	0	32	1,509	10,076
Annual per capita consumption of power	kWh	17.28	38.12	89.76	119.36	237.95	364.45	467.68

Source: Plan Documents, CEA Electricity Reviews.

Table I.4

Development of Ports

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Total traffic handled	M.Tonnes			62.46	87.14	163.82	368	635.76
major ports	M.Tonnes	19.2	39.9	55.7	80.41	152.55	281.1	463.84
minor ports	M.Tonnes	NA	NA	6.76	6.73	11.27	86.9	171.92
No. of major ports	Numbers	5	9	10	10	11	12	12

Source: Plan Documents.

tonnage handled. Of the 200 non-major ports in the country, about 60 handle traffic, while the remaining cater to local cargo requirements, ferrying passengers and fishing operations.

Telecommunications

In the initial Plans, telephones were not considered a necessity or for mass use. As a result, telephone penetration levels were very low and the quality of service was poor. However, long waiting lists, technological advancements and pressure from various domestic and international stakeholders pushed the government to initiate reforms in this sector in the mid-1980s. Further, after liberalisation the results in this sector have been impressive. Teledensity increased from less than 1 per cent in 1991 to around 18.23 per cent by 2006-07 and the number of phone lines from 5.07 million to 205.89 million over the same period. Wireless has been the principal engine for telecom growth in the country. The wireless subscriber base grew from less than 1 million in 1997-98 to 165 million in 2006-07; this figure had leaped to 543 million by November 2009 **(Table I.5)**.

Development of the telecom industry in India illustrates the huge potential benefits from the growth of infrastructure sectors. India's telecommunication network is now the third largest in

Table I.5

Development of Telecommunications

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Number of telephones per 100 population		0.03	0.08	0.18	0.31	0.60	2.86	18.23
Total no. of telephones	Millions	0.10	0.33	0.98	2.15	5.07	30.36	205.86
Fixed lines (DELs)	Millions	0.10	0.33	0.98	2.15	5.07	26.51	40.75
Cellular mobile telephones	Millions	0	0	0	0	0	3.85	165.11
Number of telephones per 100 rural population	Number	NA	NA	NA	0.03	0.08	0.90	5.8

Source: Plan Documents, Annual Reports of TRAI, Indian Telecommunication Statistics 2002.

the world and the second largest among the emerging economies of Asia. India is also among the fastest growing telecom markets in the world. The Indian telecom industry manufactures a complete range of telecom equipment using state-of-the-art technologies designed specifically to match the diverse terrain and climatic conditions in the country.

Irrigation

The net irrigated area (NIA) in the country had increased from 20.85 Mha in 1950-51 to 60.20 Mha by 2005-06 and the gross irrigated area (GIA) had increased from 22.56 Mha to 82.63 Mha during the same period. The country accounts for 31.4 per cent of Asia's total irrigated land and 17.9 per cent of the world's total irrigated land. The country's total agricultural land is 16.8 per cent of Asia's total agricultural land and 11.9 per cent of the world's total agricultural land. India now has the largest irrigated area in the world **(Table I.6)**.

There has been a striking change in the sources of irrigation over the Plan periods. The importance of groundwater has increased considerably. In 1951, tube wells were little known and the entire area under groundwater irrigation was served mainly by shallow dug wells. Tube well irrigation initially started under state patronage in the 1950s. However, its coverage was insignificant till the early 1960s. Thereafter, the growth of tube wells picked up significantly

Table I.6

Development of Irrigation

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Gross Irrigated Area	Mn.ha.	22.56	27.98	38.20	49.78	63.20	76.57	83.56
Net Irrigated Area (NIA)	Mn.ha.	20.85	24.04	31.10	38.72	48.02	51.63	60.64
Net irrigated area by type								
Canals	000 ha.	8,295	10,370	12,838	15,292	17,453	14,578	14,156
Tanks	000 ha.	3,613	4,631	4,112	3,182	2,944	2,258	2,083
Tube wells	000 ha.	0	0	4,461	9,531	14,257	20,711	28,031
Wells	000 ha.	5,978	7,083	7,426	8,164	10,437	9,231	9,277
Other	000 ha.	2,967	2,209	2,266	2,551	2,932	4,849	7,094

Source: Plan Documents, Agricultural Statistics at a Glance, All-India Agricultural Statistics.

due to government support. Further, the private profitability of tube wells increased with the introduction of new technologies and subsidies in electricity as a result of which the number of tube wells had increased from barely 200,000 in 1961 to 5 million[5] in the late 1990s and then to 8.8 million[6] by 2000-01. Tube wells are now a major source of irrigation. Correspondingly, the share of canals in the NIA has decreased.

Civil Aviation

With air travel becoming popular and cheaper, the civil aviation sector is experiencing high growth in domestic passenger carriage, cargo movement and international air traffic. The airlines' passenger kilometers flown on international and domestic routes recorded more than 20 per cent growth per year between 2005-06 and 2007-08; India jumped to the 9th position in the world aviation market in 2007 from the 12th place that it occupied in 2006. Though the rate of growth dropped in 2008-09 due to the global economic crisis, India's new status as an international IT and manufacturing hub has led to a growth in international air traffic. Considering the increase in air traffic and the entry of new airlines, the government has taken steps to re-structure and modernise existing airports and to set up new Greenfield airports.

I.3.2 Differences in infrastructure building between India and China

Infrastructure spending accelerated in China in the mid-1990s

India spends 5 per cent of its GDP on infrastructure development compared to China's 9 per cent. China, with its high economic growth rates and higher savings rates, was able to allocate much larger resources for investments in general. The higher savings rate provided greater scope for investments from domestic sources. In 1980, China saved 35 per cent of its GDP, whereas India's savings rate was less than half at 15.5 per cent **(Figure I.6)**. According to the 'World Development Report on Infrastructure', developing countries, on average, invested 4 per cent of GDP on infrastructure (World Bank, 1994). The gap between infrastructure investments in China and India is widening not only as a share of GDP, but also in absolute levels, given that India's GDP is only one-third that of China's.

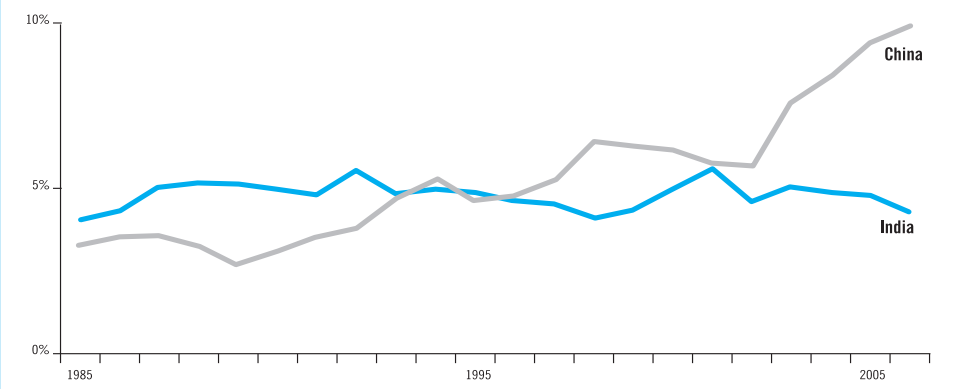
The widening disparity in infrastructure development is highlighted in the case of electricity and ports. For example, China's electricity output at 7.3 billion kWh in 1952 was only slightly ahead of India's power output of 6.3 billion kWh. The volume of freight handled at China's ports now is nearly four times the volume handled at India's ports.

Further, the Indian road network in the 1950s was extensive at 400,000 km compared to about one-third that in China. In both the countries, about 40 per cent of the roads were paved.

5. Vaidyanathan, A. (2006). *India's Water Resources; Contemporary Issues on Irrigation*.
6. 3rd Census of Minor Irrigation Schemes, 2000-01, MoWR. Includes shallow tube wells (8.3 million) and deep tube wells (0.5 million). Deep tube wells extend up to a depth of 200 meters or more and discharge 100-200 cubic meters per hour.

Figure I.6

Infrastructure Investments (as a percentage of GDP)



Source: 'Developing Physical Infrastructure: A Comparative Perspective on the Experience of China and India', Asian Development Bank.

However, today China is ahead of India. India's railway network at 62,000 km in 1985 was longer than China's. However, by 2005, China had invested enough in this sector to overtake India's position **(Table I.7)**.

Table I.7

Development of Infrastructure Capacity – China and India

Item		1985	1995	2005
Power installed capacity (GW)	China	100	217	508
	India	43	81	118
Road network ('000 km)	China	943	1157	3345
	India	1852	2538	3300
Coastal ports – volume of freight handled (metric tonnes)	China	310	800	1930
	India	129	223	513
Railways ('000 km)	China	55	60	75
	India	62	63	64
National electrified railway ('000 km)	China	4	10	19
	India	6	12	18

Source: Data for China based on China Statistical Yearbook, various issues, China Highway and Water Transport Statistics Yearbook, 2006. Data for India are compiled from a number of official publications.

The substantial difference in the pace of building infrastructure between India and China may have several explanations. The difference in the method of financing provides an interesting comparison. First, effective user charges for infrastructure services are much lower in India than they are in China. Hence, the subsidy to users of infrastructure services in India is significantly higher than in China. The power sector is the most pertinent example in this regard.

Further, India is significantly more dependent now on foreign debt financing for its infrastructure sector development. The Chinese have had greater success in tapping foreign direct investment (FDI) and also equity markets for infrastructure financing[7] **(Table I.8)**.

7. *Developing Physical Infrastructure: A Comparative Perspective on the Experience of China and India'*, Asian Development Bank.

Table I.8

Sources of Investment Financing in China and India (as a per cent of total)

	China		India
Item	**1995**	**2006**	**EFYP Targets (2007-08 to 2011-12)**
State budget allocations	3	4	31
Domestic loans	20	20	27
Self-raised funds & Other	66	72	42
Foreign funds	11	4	-
Total	100	100	100

Source: Data from China Statistical Yearbook 2007 and State Statistical Bureau 1996 for China; Planning Commission 2008 for India.
Note: For India, the borrowings of the state and Central governments for infrastructure are grouped under 'domestic loans'. The internal and extra budgetary resources (IEBR) of the central and state enterprises are included along with the private sector's total resources under 'Self-raised funds & Other' category in the table. The share of foreign funds is not directly available from India's EFYP.

At 43 per cent, the share of budgetary contributions and, hence, of the grant component in the infrastructure finance chain is more than 2.5 times higher in India than in China.[8] This is a corollary to the fact that the subsidy enjoyed by the Indian end-user of infrastructure services is much higher than that given to her Chinese counterpart. Also, there is no equivalent in India of the funding source such as extra-budgetary revenues at the level of local governments as in China. In India, funding at the level of sub-national governments is mainly from the state and central governments. The weak budgetary resources of municipalities, for example, have led to the near-collapse of urban infrastructure.

The burden of the subsidy provided for end-users in China is widely distributed across a significant universe of state-owned enterprises and local government agencies in the form of sub-market returns to their equity contributions. In India, the burden of the subsidy, which is a large claim on funds in the country, falls on the exchequer. We illustrate the point taking the case of electricity. In China, the average tariff rate in 2004 ranged from US 5 cents/kWh to US 9 cents/ kWh compared to the range of US 1.5 cents/ kWh to US 11.7 cents/ kWh in India **(Table I.9)**. In China, the subsidy implicit in the infrastructure financing chain is intended not so much to protect the end-user but to incentivise the creation of new capacity. In India, the subsidy is intended primarily to make infrastructure services affordable to a wider class of consumers. As a consequence, subsidies also cover up for the inefficiencies and operating losses of state-owned service providers and safeguard the superior returns to the equity of private investors in India.

Though most Indian Plan documents continued to emphasise the importance of infrastructure, it was only with the acceleration in the pace of economic growth that the urgency of stepping up infrastructure development efforts became a central policy concern. The experience of China, therefore, is of significance to India's own strategies.

8. Planning Commission 2006.

Table I.9

Effective Electricity Tariff in China and India - 2004

Item	China				India			
	Average Tariff	Consum-ption	Weighted Average Tariff	Effective Tariff	Average Tariff	Consum ption	Weighted Average Tariff	Effective Tariff
	US cents/ kWh	(% share)			US cents/ kWh	(% share)		
Domestic	5.7	10	0.6		6.2	25	1.6	
Commercial	9.0	15	1.4		11.7	8	0.9	
Agriculture/ Irrigation	5.0	4	0.2		1.5	24	0.4	
Industrial	5.9	71	4.2		9.0	35	3.2	
Other			0.0		7.8	8	0.6	
		100	6.3	5.9			6.6	4.0

Source: 'Developing Physical Infrastructure: A Comparative Perspective on the Experience of China and India', Asian Development Bank.

I.3.3 Private participation in infrastructure development

Today, the private sector is the engine of growth for many countries and the expansion of the private sector has become a central theme in the development agenda of many of these countries. Sustained economic growth is critical for job creation and poverty reduction. In addition, a thriving, private sector-led economy is probably the best defense against corruption, as economies with broad private sector participation, active competition and clear rules have less scope for corruption. The private sector also has much to contribute to other government goals by way of tax revenues, reaching out to local communities, setting international standards and working with governments to extend access to infrastructure.

The experience with private sector participation at the regional level, of which India is a major component, indicates slow progress in this direction. South Asia has relatively low levels of private participation in infrastructure. From 1990 to 2008, the region attracted only 452 projects, which is far short of the commitments made in leading regions of East Asia **(Table I.10)**. The sector that attracted the largest share of investments was telecommunications (48 per cent); Greenfield projects have constituted the most common form of PPPs, not only in terms of investment but also by type of projects. Projects cancelled comprised 3 per cent of the total investment in the region.

In most countries of South Asia, the largest investment by the private sector has been in the telecommunications sector – nearly US$ 29,926.2 million during 2000–05 – followed by energy, transport, and water and sanitation. India has received the maximum investment in the region, followed by Bangladesh and Pakistan **(Table I.11)**.

According to the Private Participation in Infrastructure Project Database private activity in infrastructure showed mixed results in 2008. Although investment commitments to infrastructure projects with private participation were down, they remained strong – at the

Table I.10

Public Private Partnerships in Infrastructure in South Asia

Featured Indicator, 1990-2008	Value
Infrastructure sectors reported	Energy, Telecom, Transport, Water and Sewerage
Number of countries with private participation	8
Projects reaching financial closure	452
Sector with largest investment share	Telecom (48%)
Type of PPI with largest share in investment	Greenfield project (79%)
Type of PPI with largest share in projects	Greenfield project (66%)
Projects cancelled or under distress	8 representing 3% of total investment

Source: Public-Private Infrastructure Advisory Facility (PPIAF), PPI database, World Bank.

Table I.11

Investment in Infrastructure Projects with Private Participation: South Asia (in US$ million)

Country/Region	Telecommunications		Energy		Transport		Water and Sanitation	
	1995-99	2000-05	1995-99	2000-05	1995-99	2000-05	1995-99	2000-05
Bangladesh	438	1294	555	502	-	-	-	-
India	7457	20642	7166	8286	1273	4281	-	113
Nepal	-	109	98	39	-	-	-	-
Pakistan	76	6595	4298	525	421	71	-	-
Sri Lanka	602	766	176	271	240	-	-	-
South Asia	8605	29926	12293	9623	1934	4352	-	113
East Asia and Pacific	29305	29854	43590	30742	24636	20562	8988	10486
China	5970	8548	16916	10493	10803	13797	720	3477

Source: Public-Private Infrastructure Advisory Facility (PPIAF), PPI database, World Bank.

second highest level observed during 1995–2005. Activity in the first half of 2008 kept investments at a high level for the year. Investments slowed down in the second half with the full onset of the financial crisis. The slowdown in the second half also led to a decline in the number of projects for the entire year. In 2008, 216 infrastructure projects with private participation reached financial or contractual closure in 48 low- and middle-income countries. These involved investment commitments (hereafter, investment) of US$ 66.5 billion. Infrastructure projects implemented in previous years had additional commitments of US$ 87.9 billion, bringing the total investment in 2008 to US$ 154.4 billion. This represents a drop of 4 per cent from the level reported in 2007. Investments in new projects accounted for the decline, falling by 12 per cent from the level in 2007. By contrast, investment in projects implemented in previous years was up 3 per cent from 2007. When investment is classified by type, it is payments to governments (such as concession or lease fees and divestiture revenues) that explain the drop in total investment. Such payments totaled US$ 19.1 billion, 42 per cent lower than in 2007 and the lowest since 2004. By contrast, investment in physical assets grew by 6 per cent from 2007 to reach US$ 135.3 billion, the highest level since1990–2008.

I.4 Policy Response and Prospects

I.4.1 Infrastructure investment in India

The EFYP projected an investment of US$ 469 billion in the core infrastructure sectors, which would increase the share of infrastructure investment to 9 per cent of GDP from 5 per cent in 2006-07. In an important contribution to the thinking on infrastructure, Goldman Sachs (2009) estimates that in the decade to 2020, India will need to more than double its electricity capacity, increase its length of paved roads by half, and add substantially to its railways, irrigation, ports and airports to keep pace with economic growth and urbanisation. The strong population growth and its booming economy are generating enormous pressures on the need to modernise and expand India's infrastructure. The creation of world-class infrastructure would require large investments in addressing the deficit both in quality and quantity. Nearly $ 515 bn worth of investment is to flow into India's infrastructure by 2012.

In the five years of the EFYP, the planned infrastructure investment in India in some key sectors (at current prices) is: modernisation of roads—US$ 79 billion, development of civil aviation—US$ 8 billion, development of irrigation systems—US$ 64 billion, development of ports—US$ 22 billion, development of railways—US$ 66 billon, development of telecom—US$ 65 billion and development of power—US$ 167 billion. In addition to these, investments to the tune of US$ 46 billion have been planned in other infrastructure sectors like tourism, water infrastructure, urban infrastructure, rural infrastructure, sanitation infrastructure and SEZs, taking the total infrastructure investment in the Eleventh Plan period of 2007-08 to 2011-2012 to US$ 515 billion. Domestic and global infrastructure funds too have exposure to Indian infrastructure sectors (Planning Commission, 2008).

The estimated infrastructure investments in the EFYP will create demand for power equipment, construction equipment, material handling equipment, electronic and IT systems, environment technologies, transport equipment, infrastructure companies in India, financial services, real estate, education and training, design and planning services, infrastructure consultants, and advisory and professional services. It will also provide opportunities for investors, contractors, developers of infrastructure projects and foreign players.

The impact of investments in infrastructure is thus widely spread across different sectors of the economy. One way to assess the links between these sectors is through the input-output links among the sectors. The 'forward' and 'backward' linkage coefficients of the input-output analysis provide one methodology to quantify these linkages. The analysis presented in Annexure AI.2 reinforces the expectation of relatively high linkage coefficients for electricity and land transport other than railways and communications. The coefficient for air transport is low relative to the other sectors.

I.4.2 Infrastructure development- EFYP perspective

The EFYP recognises that GDP growth averaging 9 per cent per year can be achieved only if the infrastructure deficit can be overcome and adequate investments take place to support higher growth and improved quality of life for both rural and urban communities. Therefore, the Plan has provided renewed emphasis on the development of infrastructure as a key to achieving and sustaining high rates of economic growth. The EFYP has provided a roadmap for the development of infrastructure sectors in the medium term. It has also provided estimates of financial outlays and goals in terms of physical progress in the different sectors. Its strategy includes an increased role for the private sector, including foreign investment.

The aggregate capital formation in infrastructure required to achieve India's targeted annual average GDP growth of 9 per cent over the Eleventh Plan period will have to increase from Rs. 259,839 crore in 2007-08 to Rs. 574,096 crore in 2011-12 at 2006-07 constant prices. Over the Eleventh Plan period as a whole, the estimates aggregate to Rs. 2,011,521 crore or US$ 502.88 billion (at an exchange rate of Rs. 40/$). In terms of ratio to GDP, investment spending is expected to increase from about 5 per cent in 2006-07, the first year of the Plan, to 9 per cent in 2011-12, the terminal year of the Plan. This shift indicates that the Plan, if realised, would lay the foundation for sustaining growth in GDP in the years to come.

Physical targets for the development of infrastructure in the Eleventh Plan vis-a-vis infrastructural deficits are presented in **Table I.12**.

I.4.3 Prioritisation of infrastructure sectors for development

Uninterrupted power supply at affordable rates is vital for rapid economic growth. Against this backdrop, the TFYP set a target of 41,110 MW additional power generating capacity. However, the performance of the TFYP in this regard has been disappointing. Only 21,080 MW of power generation capacity was commissioned in the TFYP, out of which only 18,000 MW were actually made fully operational. Therefore, development of power is a priority sector in the EFYP. Additions to power generation capacity in the EFYP are expected to be nearly four and a half times that of the TFYP. However, despite environmental concerns and the prospects of a strong nuclear energy programme in the future, most of the capacity additions during the EFYP period will be accounted for by thermal sources of power generation (63 per cent). The share of hydro and nuclear power in the additional installed capacity in the EFYP is expected to be half of that in the TFYP, primarily due to the significant shortfall in meeting the targets for thermal capacity creation in the TFYP **(Table I.13)**.

The EFYP envisages a major programme of road development covering national highways, based on a combination of public investment and PPP and the completion of rural road connectivity through the Pradhan Mantri Gram Sadak Yojana (PMGSY).

Table I.12

Infrastructure Deficit and Plans for Development

Sector	Deficit XI	Plan Targets
Roads/ Highways	65,569 km of NH comprises only 2% of network carrying 40% of traffic; 12% 4-laned; 50% 2-laned; and 38% single-laned	6-lane 6,500 km in the Golden Quadrilateral (GQ); 4-lane 6,736 km North-South and East-West (NS-EW) corridors; 4-lane 12,109 km; 2-lane 20,000 km; 1,000 km expressway
Ports mn.	Inadequate berths and rail/ road connectivity	New capacity: 512 mn. MT in major ports; 347 MT in minor ports
Airports	Inadequate runways, aircraft handling capacity, parking spaces and terminal buildings	Modernise 4 metro and 35 non-metro airports; 3 Greenfield in NE; 7 other Greenfield airports
Railways	Old technology; saturated routes: slow speeds (freight: 22 kmph; passengers: 50 kmph); low payload-to-tare ratio (2.5)	10,300 km new rail; 10,000 km gauge conversion; modernise 21 stations; Dedicated Freight Corridors
Power	11% peaking deficit; 7% energy shortage; 40% transmission and distribution losses; absence of competition	Add 92,577 MW (including 14,000 MW from conventional sources); Access to all rural households The national transmission expansion plan is estimated to cost Rs. 75,000 crore (approximately US$16.5 billion)
Irrigation	Only 43% of net sown area irrigated	Develop 16 mha major and minor works; 10.25 mha CAD; 2.18 mha flood control

Source: Planning Commission 2008; Eleventh Five-Year Plan, Volume I.

The EFYP envisages continued progress towards developing a world-class telecommunications infrastructure. The Plan targets to reach a telecom subscriber base of 600 million. Given that urban teledensity has reached a high level of around 85 per cent at present, expanding rural teledensity is a priority area of the EFYP. Rural teledensity is targeted to reach 25 per cent by the end of the EFYP period.

Indian ports suffer from inefficiency and congestion. Therefore, the EFYP envisages a major programme of expansion in port capacity based on PPP. The capacity of both major and minor ports will be almost doubled.

Air traffic increased at an average of 30 per cent per year between 2003-04 and 2006-07. However, the development of airports and related facilities has not kept pace with the increasing traffic. Therefore, the EFYP plans to augment airport infrastructure. This will include development of three Greenfield airports and expansion/modification of six existing airports in the North Eastern Region and the modernisation of Jammu, Dehradun, Agatti and Port Blair airports under the scheme for the modernisation of 35 non-metro airports (Planning Commission, 2008).

The EFYP has placed significant importance on the development of irrigation. It has envisaged a target of developing 16 Mha of major and minor irrigation projects.

Table I.13

Sector-wise Achievements in the Development of Infrastructure in the IX and X FYP and Targets for the XI Plan

	IX Plan	X Plan	XI Plan	% Change IX to X Plan	% Change X to XI Plan
	Actual	Anticipated	Targets		
Power					
Plan-wise Additional Installed Capacity (MW)	19015	21080	92577	111%	439%
Hydro	4538	7886	16553	174%	210%
Thermal	13597	12114	58644	89%	484%
Nuclear	880	1080	3380	123%	313%
Renewables		6253	14000		224%
Ports and Shipping					
Total Capacity (Million Metric Tonnes)	462	733	1592	159%	217%
Major Ports	344	505	1017	147%	201%
Non-Major Ports	118	228	575	193%	252%
Civil Aviation					
Passenger Traffic (Lakhs)	1425	1699	2030	119%	119%
International	420	476	540	113%	114%
Domestic	1005	1223	1490	122%	122%
Freight Traffic (Thousand Metric Tonnes)	1030	2387	2683	232%	112%
International	658	1714	1823	261%	106%
Domestic	372	673	861	181%	128%
Railways					
Originating Freight (Million Tonnes)	492.5	728.4	1100	148%	151%
Freight Tonne km	332.2	475	702	143%	148%
Originating Passengers (Millions)	5169.3	6352.1	8400	123%	132%
Passenger km (Billions)	494.2	691.8	942	140%	136%
Telecommunications					
Teledensity (%)	4.40	18.31%	36.98%	4%	202%
Rural	1.14%	2.83%	25%	248%	883%
Urban	10.16%	55.94%	108%	551%	
Roads					
Total Road Network (km)	2852167	3314000	3597285	116%	109%
National Highways (Total Length km)	58112	66590	84690	115%	127%
State Highways (Total Length km)	124300	137000	3256000	110%	104%
Major District Roads (Total Length km)	2028042	3000000		148%	
Rural Roads (Total Length km)	641713	110410	256595	17%	232%
Irrigation					
Cumulative Potential Created (Mha)	94	103	119	109%	116%
Major & Medium	37	42	52	114%	124%
Minor	57	60	66	106%	110%
Surface Water	14	14	16	105%	110%
Groundwater	43	46	51	106%	110%

Source: X and XI Plan, www.indiastat.com; airport statistics, http://www.dot.gov.in/plans.

The rapid increase in international trade and domestic cargo has put a great strain on the Delhi-Mumbai and Delhi-Kolkata rail tracks. The government has, therefore, decided to build dedicated freight corridors in the western and eastern high-density routes involving the construction of 7,201 km of new rail tracks (Planning Commission, 2008). Institutional and financial mechanisms have been put in place, but the execution is yet to begin.

The proposed development plans for different sectors have addressed the need for creating adequate capacity to meet emerging demand for services as the economy is expected to reach a period of high growth over the medium term. The priorities for the power and road sectors in terms of allocation of resources are justified because of the basic nature of these services for any economic activity and also because of the fact that these services are some of the minimum services required for livelihood. As the income levels increase, demand for other services will also increase and priorities for services such as airports may begin to assume greater importance over time **(Table I.14)**.

Table I.14

Investment in Infrastructure Sectors (US$ billion)

Sector	X Plan			XI Plan		
	Centre + States	Private	Total	Centre + States	Private	Total
Electricity	50.0	23.0	73.0	120.3	46.4	166.6
Roads	34.5	1.8	36.2	51.8	26.7	78.5
Railways	29.8	0.1	29.9	52.9	12.6	65.5
Telecom	12.3	13.6	25.8	20.2	44.4	64.6
Irrigation	27.9	0.0	27.9	64.3	0.0	64.3
Ports	0.9	2.6	3.5	8.4	13.6	22.0
Airports	1.0	0.7	1.7	2.3	5.4	7.7
Sub-total	156.3	41.7	198.0	320.2	149.1	469.3
Total	174.8	43.0	217.9	360.2	154.9	515.0

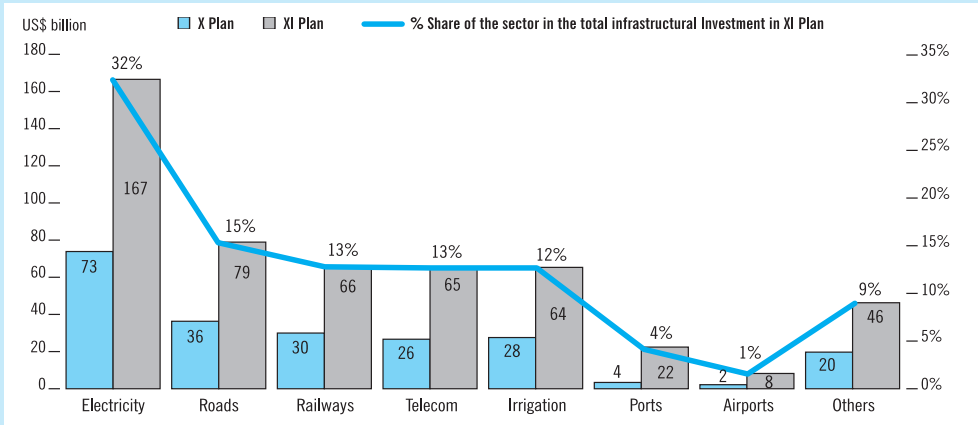
Source: Based on Eleventh Five-Year Plan, Volume I.
Note: The calculations are based on an exchange rate of $1= Rs 40.

Around 32 per cent of the total infrastructural investment in the EFYP will be allocated to the power sector, followed by roads (15 per cent), railways (13 per cent), telecom (13 per cent) and irrigation (12 per cent). Ports and airports will account for 5 per cent of the allocated infrastructural investment in the EFYP. The other sectors will account for the remaining 9 per cent of the total investment allocated for the development of infrastructure in the EFYP. In the EFYP, investments in ports and airports will be 4-5 times that in the TFYP, whereas for most other sectors the investment will be almost twice that in the TFYP **(Figure I.7).**

If India were to grow at the current rate, improvements in infrastructure would become an important component of the Twelfth Plan. Assuming that infrastructure investment (GCFI) as a percentage of GDP increases from 9 per cent in 2011-12 to 10.25 per cent in 2016-17

Figure I.7

Sector-wise Investment in Infrastructure in Tenth and Eleventh FYPs



Source: Planning Commission 2008; XI Five-Year Plan, Volume I.

and that GDP continues to grow at 9 per cent a year, infrastructure sectors (excluding the real estate sector) during the Twelfth Plan would be around US$ 989 billion (IIFCL, 2008).

I.4.4 Investment in rural infrastructure

The government started a special programme, Bharat Nirman, for the improvement of India's rural infrastructure over 2005-09. The key areas covered under the project are: village telephone connectivity, rural electrification, rural road upgrades and providing drinking water and irrigation facilities. The first four years' performance of the project has been poor, except for telephone connectivity, drinking water supply, rural housing and rural roads which was helped by the presence of the private sector. The progress of electrification of below poverty line (BPL) households has been very poor. Of the total projected investment of US$ 469.3 billion to be incurred by the centre and the states in the EFYP, US$ 85.53 billion will be spent entirely towards the improvement of rural infrastructure.

With a view to promoting rural infrastructure beyond core areas such as roads, bridges and irrigation, the National Bank for Agriculture & Rural Development (NABARD) has taken initiatives to channel more funds into building a marketing infrastructure in the rural belts and for removing bottlenecks in allied agriculture activities such as fishery, poultry and dairy.

It is estimated that of the total projected investment of Rs. 14,36,559 crore to be incurred by the centre and the states in the EFYP period, Rs. 4,35,349 crore (30.3 per cent) would be spent exclusively on improving rural infrastructure. The distribution across sectors is indicated in **Table I.15**.

I.4.5 Private sector in infrastructure development

Traditionally, until the 1980s in the Indian context, power, railways, roads, ports, airports and telecom were the government's exclusive domain. However, given the pressures of increasing

Table I.15

Projected Investment in Rural Infrastructure in the EFYP (2007-08 to 2011-12) (Rs. crore at 2006-07 prices)

Sector	Projected Investment
Electricity	34,000
Rural roads	41,347
Telecommunications	16,000
Irrigation (including watershed)	2,53,301
Water supply and sanitation	90,701
Total	4,35,349

Source: Planning Commission 2008; XI Five-Year Plan, Volume I.

gaps between infrastructure demand and supply and the deteriorating quality of the assets managed by the government the policy has changed gradually over the past two decades. The government has made efforts to facilitate the entry of private enterprises in infrastructure development through changes in the legal framework and through unbundling of different segments of infrastructure so that the public and the private sectors can take up the components most suited to their capacities.

The key difference in the EFYP and the TFYP is the existence of numerous success stories of private participation in infrastructure development in roads, ports, airports, power and railways in the EFYP. The TFYP period started in the shadow of the Dabhol power plant fiasco, leading to skepticism and the unwillingness of the private sector to participate in India's infrastructure sectors.

The first year of the EFYP, on the other hand, began with the award of the three largest ever infrastructure projects in the country (Mundra, Sasan and Krishnapatnam UMPPs), commissioning of Greenfield private airports in Hyderabad and Bangalore, opening up coal mining to the private sector and the award of some mega road projects to the private sector under the new Model Concession Agreement.

The biggest increase in private participation is expected in roads (from 5 per cent of total investments in the TFYP to 36 per cent in the EFYP), ports (47 per cent to 74 per cent), railways (less than 1 per cent to 20 per cent), gas (from nil to 32 per cent) and telecom (36 per cent 67 per cent). In the power sector, the share of private investments is likely to actually decline from 32 per cent in the TFYP to 26 per cent in the EFYP. But NTPC and state utilities have the lion's share in orders for new generation projects placed so far. However, during the Twelfth Plan (2012-17), a sharp increase is expected in the share of the private sector in power capacity.

Increasing share of private investment in infrastructure

There is an increase of around 171 US$ billion (2.4 times) over the TFYP in investment allocations for infrastructure development in the EFYP. Such a high requirement of capital

calls for a need for increased private participation. Moreover, opening up some of the former fully government-owned infrastructure sectors such as telecommunications and domestic civil aviation has produced exemplary results. In both these sectors, new private entrants have gained significant shares. In both the sectors, choice has expanded and prices have fallen. Since the easing of regulatory constraints in 2004, India's telecommunications network has become the third largest in the world. Even so, more needs to be done to promote competition in the fixed-line market, given the possibilities offered by broadband technology.

The Government of India has encouraged private sector investment, both domestic and foreign, in almost all infrastructure units through the PPP mode as the infrastructure sectors have been progressively opened up for private investments, both domestic and foreign. Today the debate is no longer focused on the conflict between the public and private sectors, but rather on the most efficient way of sharing risks, joint financing and achieving balanced partnerships between private sector developers/operators and public authorities – the Public-Private Partnership. The governments is also increasingly exploring the possibilities of private participation in infrastructure services, with the aim of improving the service levels offered to citizens. This framework of increased private participation provided by the government provides numerous opportunities for investment in the various infrastructural sectors of the country which have immense untapped potential for further growth and expansion.

However, when it comes to providing infrastructure in remote areas, backward areas and to the population which may not be served by the markets, it is public sector investment that will have to play a significant role. Even otherwise, the predominance of the public sector will continue in the medium term.

The resources to be mobilised by the public sector are projected to double, while the resources from the private sector are expected to triple relative to the outlay in the TFYP.

The share of private investment as a percentage of total infrastructural investment will increase from 19.8 per cent in the TFYP to 30.1 per cent in the EFYP (**Table I.16**).

A relatively high share of investment needs in airports, telecom and ports will be met by the private sector in the EFYP. However, a comparison of the share of investment needs met by the private sector during the TFYP and envisaged in the EFYP reveals that roads and railways have been opened up significantly for the private sector, and there will also be a considerable increase in private sector activity in airports. The telecommunications sector has been further opened up for the private sector.

Table I.16

Share of Investment by Private Sector in Total Investment in the Sector during the Two Five-Year Plans (per cent)

Sector	X FYP	XI FYP
Electricity	31.5	27.8
Roads	4.8	34.0
Railways	0.3	19.2
Telecom	52.6	68.8
Irrigation	0.0	0.0
Ports	73.6	61.9
Airports	43.4	69.8
Sub-total of above	21.1	31.8
Total	19.8	30.1

Source: Planning Commission 2008; XI Five-Year Plan, Volume I.

I.4.6 Institutional mechanisms for infrastructure development

Infrastructure projects are large and the development that is planned has been fast-paced. The Plans have also provided a significant role to the private sector with the consequent need for institutional mechanisms to achieve co-ordination in programmes and also for monitoring the pace of development.

The primary responsibility for financing infrastructure development lies with the Government of India, mainly with the Ministry of Finance. However, state governments also contribute to infrastructure development by allocating funds in their annual budgets. Though there is no consolidated ministry of infrastructure in India, there are ministries for each sector of infrastructure like the Ministry of Power and the Ministry of Railways.

Power

The Ministry of Power is concerned with perspective planning, policy formulation, processing projects for investment decisions, monitoring the implementation of power projects, training and manpower development and the administration and enactment of legislation with regard to thermal and hydro power generation, transmission and distribution. In all technical and economic matters, the Ministry of Power is assisted by the Central Electricity Authority (CEA) and the Central Electricity Regulation Commission (CERC). The main functions of the CERC are to regulate the tariffs of generating companies owned or controlled by the Central Government, to regulate the tariff of generating companies other than those owned or controlled by the Central Government, to regulate the inter-state transmission of energy including tariffs of transmission utilities, grant licences for inter-state transmission and trading and to advise the Central Government on the formulation of the National Electricity and Tariff Policies.

There is also an Appellate Tribunal for Electricity, a statutory body constituted for the purpose of hearing cases against the orders of the Regulatory Commissions and the Adjudicating Officers.

Further, states having State Electricity Boards (SEBs) and others with unbundled and corporatised units have the responsibility of power generation, transmission and distribution. The main functions of the State Electricity Regulation Commission (SERC) are to determine tariffs for generation, supply, transmission and wheeling of electricity, and wholesale, bulk or retail sale within the state; to issue licences for intra-state transmission, distribution and trading; and to promote co-generation and generation of electricity from renewal sources of energy.

Railways

Indian Railways is owned by the centre, and operated by the Ministry of Railways. The Ministry is responsible for formulating policy, managing and regulating the railways. The railways include production units and central organisations related to the railways, some central training institutes and the Railway Board of India. The railways finances are separate from the government's general budget, and its annual requirements for funds are voted through a separate budget presented to Parliament every year.

The policy of the railways is formulated and managed by the Rail Board. The Board has wide powers to supervise the running of zonal railways, metro networks, production units, construction organisations and other rail establishments. Eleven subsidiary organisations under the Ministry of Railways have specialised responsibilities for Indian Railways' operations, finance, engineering and other activities. Some of these are:

- The Dedicated Freight Corridor Corporation of India is a recently created organisation set up to deal with the dedicated freight corridors for railways incorporated in October 2006 under the Indian Companies Act, 1956.
- In 2003, the Indian Railways incorporated Rail Vikas Nigam Limited (RVNL) as a special purpose vehicle to implement physical improvements envisaged in the Indian Railways' National Railway Development Programme (National Rail Vikas Yojana).
- The Centre for Railway Information Systems (CRIS) is mainly a project-oriented organisation engaged in developing major computer systems for the railways.
- In addition to these, the Research, Designs and Standards Organisation (RDSO) is the research and development wing of the railways which is consultant and technical advisor to the Ministry of Railways, the production units and the zonal railways.

Roads

The Ministry of Road Transport and Highways is responsible for roads and highways. It is an apex organisation under the Central Government, entrusted with the task of formulating and administering, in consultation with other central ministries/departments, state governments/UT administrations, organisations and individuals, policies for road transport, national highways and transport research with a view to increasing the mobility and efficiency of the road transport system in the country. It has two wings – roads and transport. The roads

wing mainly deals with the development and maintenance of national highways in the country. The transport wing deals with matter relating to road transport.

The development and maintenance of national highways is divided between the states and Union Territory governments, the National Highways Authority of India (NHAI) and the Border Roads Organisation (BRO). State roads including state highways and major district roads are managed by state governments. They get money from the Central Road Fund. Some Indian state governments such as Assam, Kerala, Maharashtra and Uttar Pradesh, have also developed their own dedicated state road funds for the development and maintenance of their own state road networks. Urban roads are managed by the municipalities. Rural roads are managed by the Ministry of Rural Development which also manages programmes such as the Pradhan Mantri Gram Sadak Yojana (PMGSY) and Bharat Nirman, which are responsible for the rapid increase in the number of rural roads.

Telecommunications

The Ministry of Communications and Information Technology (MoCIT) has two departments—the Department of Telecommunications and the Department of Telecommunication Services, later corporatised in October 2000 into a new entity, Bharat Sanchar Nigam Limited (BSNL). While the former functions as the licensor and policy maker, the latter was entrusted with the responsibility of operations. BSNL provides services in the entire country except in Delhi and Mumbai where the government-controlled corporate entity, Mahanagar Telephone Nigam Limited (MTNL), continues to be the service provider.

The Telecom Regulatory Authority of India (TRAI) ensures that the interests of consumers are protected and, at the same time, nurtures conditions for the growth of telecommunications, broadcasting and cable services in a manner and at a pace which will enable India to play a leading role in the emerging global information society. The appellate authority, the Telecom Disputes Settlement Appellate Tribunal (TDSAT), provides further mechanisms for resolving disputes in the sector.

Irrigation

The Ministry of Water Resources is responsible for laying down policy guidelines and programmes for the development and regulation of the country's water resources. The Central Water Commission (CWC) is a premier technical organisation in the field of water resources which currently functions as an attached office of the Ministry of Water Resources, Government of India. The CWC is entrusted with the general responsibilities of initiating, co-ordinating and furthering, in consultation with the concerned state governments, schemes for the control, conservation and utilization of water resources throughout the country for the purpose of flood control, irrigation, navigation, drinking water supply and water power development. It also undertakes investigations, construction and execution of any such

schemes as required. The Ground Water Board carries out regional hydro-geological studies which provide information on groundwater occurrence in different terrains and are essential for future planning of groundwater development and management. The development of irrigation comes under the purview of the state. There are irrigation departments at the state level for this. A schematic description of the institutions involved in infrastructure development is given in **Figure I.8**.

Over the years, since the push for accelerated investment plans in the EFYP, the Central Government has taken up a number of initiatives some of which are:

Streamlining of procedures

- A cabinet committee on infrastructure, headed by the Prime Minister, to keep track of large infrastructure projects of 'national importance'.
- Plan to complete environmental clearance procedures within a specified time (proposed as 60 days).

Financial incentives

- Tax benefits on all infrastructure projects. For developers: a 10-year tax holiday; for financiers: 40 per cent of profit on infra-lending is exempt.
- Viability gap funding for infrastructure projects increased up to a maximum of 40 per cent.
- A large increase in funding provided through the India Infrastructure Financing Company Ltd. (IIFCL), with refinancing and take-out financing facilities introduced. IIFCL is a special purpose vehicle (SPV) created to render long-term financial assistance to infrastructure projects through direct lending to eligible projects, refinance to banks and financial institutions and any other method approved by the Government of India.
- Reduced/zero import duties for heavy equipment for road construction and power.
- Apart from these, various sector-specific reforms have also been introduced. Initiatives such as the National Highways Development Programme (NHDP), the Airport Financing Plan, the National Maritime Development Programme and the Jawaharlal Nehru National Urban Renewal Mission (JNNURM) are efforts in the same direction.

Measures on the anvil

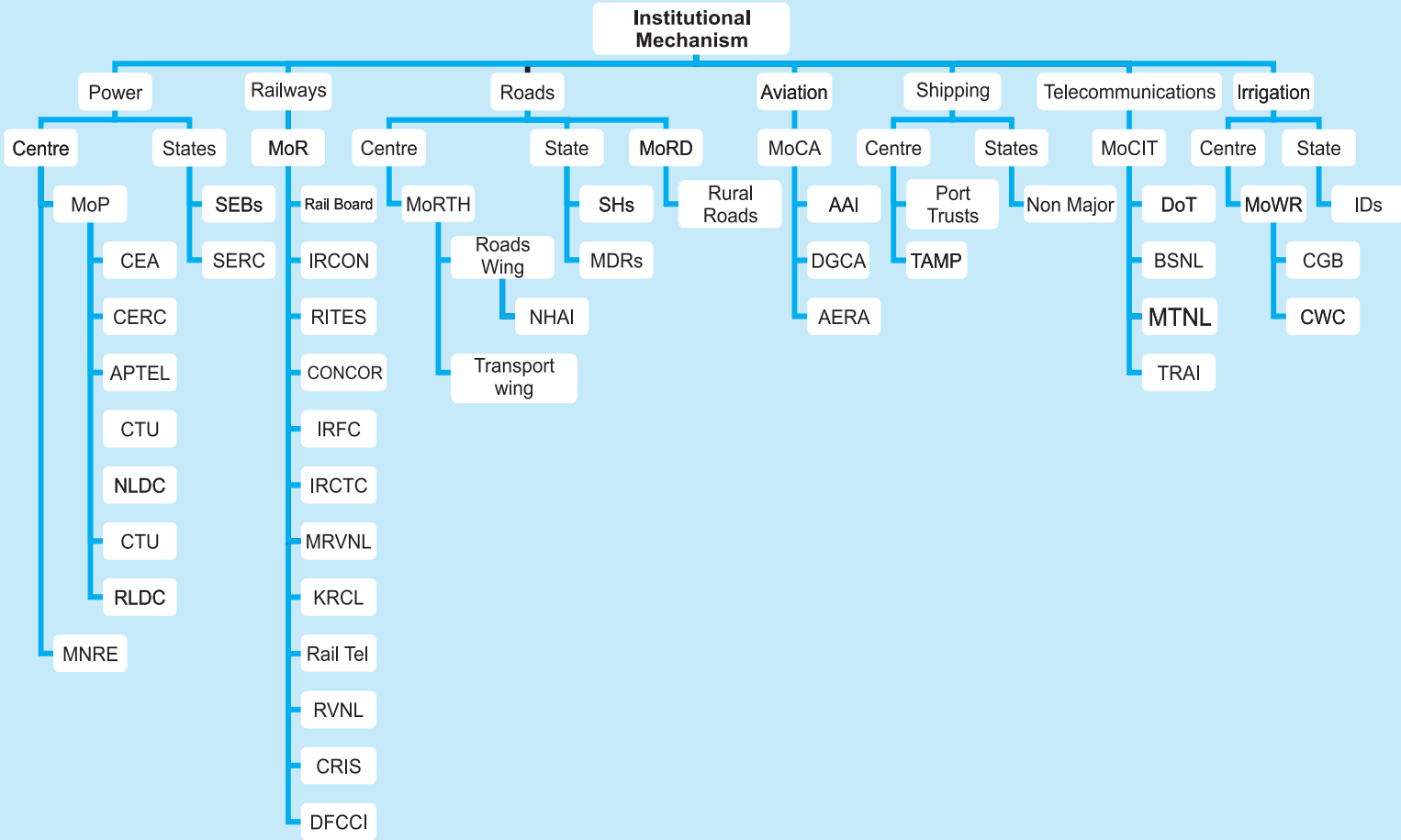
- A Land Acquisition Bill to streamline land transactions likely to be introduced in Parliament.
- Fast-track courts for infrastructure project disputes.

I.4.7 Quality and quantity of infrastructure

India has an impressive scale of infrastructure in terms of a rail network, a road network, a telecom sector and irrigated area, but it is important to bear in mind that technological developments and wear-and-tear require continuous upgrading and rebuilding to enable

Figure I.8

Institutional Mechanism for Infrastructure in India



Source: Based on various documents.

optimal utilisation of infrastructure assets. The quality of infrastructure is as important as the quantum of infrastructure in determining efficiency in economic activities based on infrastructure.

Frequent disruptions in the supply of electricity, the slow speed of rail and road transportation, the high incidence of accidents in transportation and poor runway visibility in winter reduce the efficiency of services based on such infrastructure. The metric for assessing quality would be a relative one. It should reflect the efficiency with which services are provided when compared to alternatives. In this context, international benchmarking of service efficiency has led to the seeking of 'world class infrastructure', at least where international comparisons are relevant.

Indicators to measure the quality of infrastructure are not easily obtained from secondary or published data. Their development may require specialised surveys of customers of services. In this section, we point to some indicators that reflect high rates of utilisation of infrastructure which may imply the need to expand 'fixed infrastructure' because of inefficiencies resulting from 'congestion' or 'over-use'.

In a few cases, improvements in the quality of infrastructure can be inferred. In the case of roads, it is not only the total road length but also road length by type of road: whether it is 'surfaced' or not, the type of surface and whether the roads are single lane or multi-lane. These variations have implications for the cost of road construction and for the durability of the roads that are built. Similarly, in the case of the railways, the tracks may be 'broad gauge' or 'narrow', and routes may be 'electrified' or not which may determine the speed of trains run on such routes.

We first examine the measures of aggregate infrastructure in the sectors and its output based on national income data as they are fairly comprehensive in coverage. The trends over time are illustrated in **Table I.17a** in the case of capital stock and GDP for the selected sectors. The capital stock includes all types of capital ('fixed' and 'loose') and the GDP is also an aggregate measure. In the case of electricity, gas and water supply (EGW) and 'transport other than rail', capital stock increased 5-8 times during 1976-77 to 2006-07. However, in the case of rail transport, the increase in capital stock was only one-fold. It has actually increased by only 80 per cent. In the case of communications, the increase in capital stock during the 30-year period was phenomenally large at more than 10 times.

We should note that the measure of capital stock used here includes both 'fixed' and 'moving' infrastructure and, therefore, does not reflect the status of 'fixed infrastructure' which has generally been the concern of public policy on infrastructure. Even with this level of aggregation, the pressure on 'fixed infrastructure' can be inferred from the growth of output in various sectors. In all the cases, GDP growth has been faster than the growth of capital stock if we consider the entire 30-year period. However, there have been sub-periods where the

Table I.17a

Indices of Infrastructure Capital and Output of Infrastructure Sectors

Year	Electricity/Gas & Water supply		Railways		Other Transport		Civil Aviation	Shipping	Communications	
	Capital stock	GDP	Capital stock	GDP	Capital stock	GDP	Output	Output	Capital stock	GDP
1976-77	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0
1985-86	201.7	186.5	88.0	137.2	160.2	175.9	268.3	188.1	186.6	169.9
1990-91	291.9	284.7	84.7	167.3	223.0	242.1	340.8	226.7	295.4	232.1
1995-96	387.6	419.4	87.2	190.0	303.1	353.6	293.6	343.3	566.5	441.5
2000-01	474.3	549.1	149.2	232.4	436.6	495.2	408.1	435.0	903.1	1093.5
2005-06	571.7	695.0	165.1	324.7	708.4	772.1	614.4	701.6	1253.2	3343.9
2007-08	634.4	770.1	180.6	390.3	803.1	904.7	1013.8	802.3	1373.3	5361.5

Source: National Accounts Statistics (Central Statistical Organization, 2009 and previous issues) for data on capital stock and GDP, both of which are in constant prices; in the case of civil aviation, output index is based on data on passenger km flown and freight tonne km flown; in the case of shipping output, the index is based on the freight tonnage handled in the major ports.

growth of capital stock was faster. In the case of the railways, civil aviation and communication sectors the growth of output was significantly faster than the growth of capital stock. While the fast growth of output in the case of communications may not reflect the pressures on 'fixed infrastructure', in the case of the other sectors it may indeed be the case. The distinction between 'fixed' and 'loose' infrastructure may be important from another perspective. 'Loose' infrastructure is more amenable to private sector operations than 'fixed' infrastructure and, accordingly, we see much faster growth in 'loose' infrastructure than in 'fixed' infrastructure.

Table I.17b provides indices of 'quality-adjusted' infrastructure indices in the case of the railways and roads. The 'adjustments' are not fully satisfactory but an attempt to highlight the issue. The indices of infrastructure after adjusting for quality show only some improvement in

Table I.17b

Quality-Adjusted Indices of Infrastructure in Roads and Railways

Year	Roads Infrastructure			Railways Infrastructure		
	Fixed (road length index)	Fixed Quality Adjusted track length weighted (road length weighted by % of roads surfaced by CC & BT top)	Output (index of motor vehicles road/length)	Fixed (track length index)	Fixed Quality Adjusted (track length weighted by % ofelectrified length)	Output (average of index of passenger km and index of freight tonne km)
1976-77	100.0	100.0	100.0	100.0	100.0	100.0
1985-86	129.8	126.4	245.8	105.9	119.1	143.7
1990-91	147.3	138.5	440.6	113.9	143.6	172.1
1995-96	174.8	156.2	649.4	116.8	158.0	193.3
2000-01	184.1	183.2	914.2	121.8	153.4	249.9
2005-06	234.8	238.3	1268.4	127.7	150.2	355.9
2007-08	257.5	238.3	1398.4	130.4	154.3	423.4

Source: Basic data on infrastructure and output are from the Centre for Monitoring Indian Economy (CMIE, 2009).
Note: For 2005-06 and 2007-08, data are projections are based on past trends.

status over time as compared to the indices 'without adjustment'. The pressure of utilisation on available infrastructure has increased very sharply over the years in the case of both roads and railways.

In the case of roads, there has been an attempt to broaden the highways by double-laning and multi-laning them, which would increase the capacity of the same road length to move vehicles at the same time. Quality adjustments would also need to take into account these changes.

The new airports that have been built are said to be 'world class'. Their improved efficiency should be reflected in greater output for the same level of capital stock, including greater convenience to travellers. The quality adjustment would have to take into account both 'subjective' and 'objective' indicators of the quality of infrastructure. As summary measures of quality of infrastructure one may also consider key inputs that go into the building of infrastructure such as steel and cement. Although these materials are used in a very wide range of applications, they are used extensively in construction, which is a major component of infrastructure development. In both cases, India's per capita consumption levels are about one-fourth of the levels in China.

I.4.8. Assessing the impact of more efficient infrastructure

A representation of the linkage between infrastructure and the economy in the form of a virtuous cycle implies that better and more infrastructure is essential for the expansion of the economy and higher productivity than in the other sectors of the economy. Better infrastructure would imply faster transportation, adequate power supply and a more efficient telecommunications system. More efficient infrastructure would benefit all the sectors of the economy but more so those sectors where the infrastructure requirements are greater. We have attempted to examine the impact of a more efficient infrastructure using a Computable General Equilibrium (CGE) modelling framework which allows us to understand the implications of more efficient infrastructure on the economy in an empirical setting. The model is described in other documents (Chadha et al., 1999, 2009). Here we draw attention to two simulations carried out in the present analysis.

The question we ask here is: what if infrastructure becomes more efficient in the sense that the cost of using infrastructure decreases? This may happen with improvements in the technology used in infrastructure or simply because there is expansion of infrastructure (broader roads allow faster movement of goods; or new roads connecting a port and hinterland reduce the cost of transportation as compared to a previous bad road). Conceptually, there are two alternative ways in realising the benefits of better infrastructure: the efficiency of infrastructure sectors would improve so that their services become less expensive and the sectors using infrastructure also improve their respective efficiencies and produce benefits for the consumer. We capture

these effects through two scenarios: Scenario 1 where infrastructure services become more efficient and Scenario 2 when infrastructure-consuming sectors become more efficient. Improvement in the efficiency of infrastructure and the other sectors is captured by reduction in the domestic prices of the respective sectors.

The actual simulation under Scenario 1 is carried out by reducing the prices of inputs consumed in the production of infrastructure services. The extent of such reduction is based on the shares of inputs used in the production of infrastructure services. The results show that even when the overall stock of resources is held constant there is gain in overall GDP and returns to land, labour and capital in the economy due to improved efficiency of the infrastructure services. The results are summarised in **Table I.18**.

Table I.18

Impact of Increased Efficiency in Infrastructure Services: per cent change over the base scenario

S. No.	Item/ Sector	Scenario 1	Scenario 2
1	GDP	0.12	0.12
2	Exports	4.12	4.89
3	Imports	2.86	3.37
4	Net Exports	1.25	1.53
5	Gross Output	0.14	0.31
6	Real Returns to Land	0.21	0.09
7	Real Returns to Labour	0.41	0.42
8	Real Returns to Capital	0.21	0.37

Source: Based on the results of a CGE model analysis for the Indian economy.

In Scenario 2, we decrease the prices of all the other sectors in proportion to the shares of infrastructure in the cost structure of the respective sectors. As the price of a sector decreases, its usage in the production of other goods and services also decreases and stimulates its use. If a sector is a more intensive user of infrastructure, it may be expected to benefit more than the others. The results are similar to those of Scenario 1 **(Table I.18)**. In both the scenarios, the overall price index across all sectors decreases by about 0.15 per cent, which leads to the various changes captured in **Table I.18**.

The results also show that it is the manufacturing sector which benefits relatively more from improved efficiency in the infrastructure sectors. As explained in **Annexure AI.3**, each of the three sectors, viz. agriculture, manufacturing and infrastructure is intensive user of its own respective output. Thus, there is a circular relationship: efficient/low-cost manufactured inputs lead to more efficient infrastructure, which, in turn raises efficiency of the goods produced in the manufacturing sectors. These two linkages make efficient infrastructure critical for the growth of manufacturing. Poor infrastructure as a bottleneck for the expansion of manufacturing is illustrated by these results.

The results show that infrastructure development has a significant positive impact on the economy because of better allocation of resources. The results also show that the economy achieves greater competitiveness in trade as a result of improved efficiency in infrastructure. Net exports improve as other sectors become more efficient in global markets.

I.5 An Assessment of Performance

The review of aggregate trends, progress of development in specific infrastructure sectors and comparisons of development, especially with China, highlight the current critical context for India's renewed focus on infrastructure development. In this section we capture the key points that emerge from the analysis.

I.5.1 General concerns

Adequacy of infrastructure

Despite significant infrastructure development over the Plan periods, the present level of infrastructure still falls short of requirements. The visible signs of shortfalls in capacity and inefficiencies include increasingly congested roads and power failures. The issue is not merely one of the physical dimension of infrastructure; it is also the efficient management of available infrastructure. Monitoring the use of infrastructure with respect to licensing (in the case of motor vehicles), conservation (in the case of power) or mere improvement in efficiency illustrates the widening gap between the demand and supply of infrastructure and also raises questions concerning the sustainability of economic growth in the future.

India is often seen as a developing country with poor infrastructure. The 'IMD World Competitiveness Yearbook 2009' gives an overall ranking on four components—economic performance, governance efficiency, business efficiency and infrastructure. India's ranking on infrastructure is deteriorating over the years. Of the 57 countries under study in 2009, India's infrastructure got the lowest ranking. The country's economic performance and business efficiency are improving in rank over time but government efficiency and infrastructure need to be dealt with **(Table I.19).**

Despite the importance of roads for the national economy, the development of this sector has been grossly inadequate in various respects. Thirty-five per cent of rural habitations are still without road connectivity. Road infrastructure is unable to handle high traffic density and high speeds in many places; it is also of poor quality in many places. National highways comprise only 2 per cent of the road network, whereas they carry 40 per cent of the traffic. Only 12 per cent of the national highways are 4-laned; 50 per cent are 2-laned and 38 per cent are single-laned. Moreover, the development of roads is somehow offset by the rapid increase in the number of vehicles. The number of vehicles per km of road had increased from 0.77 in 1950-51 to 3.52 by 1980-81 and further to 24.16 by 2006-07.

Table I.19

India's Ranking in Components of Global Competitiveness Index

Components	2005	2006	2007	2008	2009
Overall Competitiveness	33	27	27	29	30
Economic Performance	12	7	10	18	12
Government Efficiency	32	30	33	23	35
Business Efficiency	20	18	19	20	11
Infrastructure	46	47	50	49	57
Total No. of Countries	51	53	55	55	57

Source: IMD, World Competitiveness Yearbook, 2009
(http://www.imd.ch/research/publications/wcy/upload/Overall_ranking_5_years.pdf)

The railways continue to depend on ageing technology in a significant manner with saturated routes coupled with slow speeds (freight: 22 kmph; passengers: 50 kmph) and a low payload-to-tare ratio (2.5).

Ports are characterised by inadequate berths and rail/road connectivity and airports with inadequate runways, aircraft-handling capacities, parking spaces and terminal buildings.

The country has 11 per cent peak power deficit, 7 per cent energy shortage, 29 per cent transmission and distribution losses and lack of competition in the power sector. Around 19 per cent of the villages in the country are still not electrified. Fifty-seven per cent of the net sown area in the country is still not irrigated.

In the case of telecom, the challenge of rural telephony in terms of access remains. Moreover, progress with the spread of broadband and next generation services remains tardy **(Table I.20)**.

Sustainability of development: new investments and maintenance of assets

An essential aspect of the sustained development of infrastructure is financing arrangements for development. As noted earlier, the EFYP aimed to raise investments in infrastructure, including urban infrastructure, from 5 per cent of GDP at the beginning of the Plan to 9 per cent of GDP during the period 2011-12. As much as 30 per cent of the new investments were to be from the private sector. The remaining 70 per cent of the investments would have to come from public sector resources. Budgetary support for infrastructure investments in the EFYP is estimated at 31 per cent. Given the lack of any 'fiscal space' in the event that either private sector investments do not materialise or there are shocks to revenue realisations, as happened in the current episode of the global economic crisis, the realisation of the Plan targets remains uncertain.

In order to make private investments in infrastructure more attractive – given the large and long-term nature of investments of the sector and the associated risks – governments at the centre and state levels have designed incentives in the form of tax holidays, tax rebates and

Table I.20

Accessibility of Infrastructure

Sector	Units	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2006-07
Rural habitations without road connectivity	%	–	–	–	–	–	40%	35%
No. of vehicles per km of road	No.	0.77	1.27	2.03	3.52	8.22	14.48	24.16
Un-electrified villages	%	–	–	–	53%	17%	13%	19%*
NCA un-irrigated	%	82%	81%	78%	72%	66%	61%	57%
Number of telephones per 100 population	–	0.03	0.08	0.18	0.31	0.60	2.86	18.23
Number of telephones per 100 rural population	–	–	–	–	0.03	0.08	0.90	2.0

Source: Plan Documents; Agricultural Statistics at a Glance; Annual Reports-TRAI; Indian Telecommunication Statistics 2002; CEA General Review.
Note: * There has been an upward revision because cumulative achievement of electrification has been recast using a more appropriate definition.

access to resources such as land and water. There is also the 'viability gap funding' support offered by the Central Government to make infrastructure investments commercially viable in the margin.

While private sector investors would look for the commercial viability of investments, public investments would have to look for the overall economic growth outcome of the investments to make new investments sustainable. The point here is that achieving a sustained economic growth rate of 8-9 per cent per year would be necessary to maintain the current momentum of infrastructure development. Conserving fiscal resources for infrastructure development is essential for maintaining the momentum of infrastructure development.

Maintaining a sustainable strategy for infrastructure development would also be influenced by the rising average income level of the population, which will make commercial pricing of services possible and also raise tax resources for the government. A metric for sustained development of infrastructure would, therefore, include the overall growth rate of the economy, average level of income of the population and the ability of the government to maintain its expenditure on infrastructure investments which may be governed by the prevailing fiscal deficit levels.

The second concern relating to the sustained development of infrastructure is the maintenance of infrastructure assets. Inadequate maintenance is well known in all the infrastructure sectors. The two dimensions of sustainability, noted with reference to new investments – fiscal capacity and commercial viability – are also critical in ensuring an effective maintenance of assets. Fiscal capacity in terms of providing necessary resources to maintain assets has to be protected. Commercial viability has also become dependent on fiscal support, particularly in the case of irrigation, electricity and roads. Subsidies are provided by the centre and also the states to meet the operational costs of infrastructure assets as the prices do not meet all the costs of operation and maintenance of assets. The metric for sustained development of infrastructure would again

rest on the fiscal capacity of the governments and on pricing policies that provide resources for the maintenance of assets. If pricing relates to the quality of service from infrastructure assets, then commercial strategies would lead to effective maintenance of assets.

I.5.2 Specific bottlenecks in executing infrastructure development

The infrastructure sector in India is faced with many bottlenecks at all stages of development, from project approval to construction to contract implementation to management. These problems appear to stem from poor governance. There are significant hurdles in achieving the targets set by the government.

- **Inadequate regulatory framework leading to time and cost overruns of projects**

Most of the infrastructure projects in India suffer from delays in completion. This is mainly due to an inadequate regulatory framework and inefficiency in the approval process. Infrastructure projects require multiple sequential clearances at various levels of government. As an illustration, more than two years were needed for the Gujarat Pipavav port project to receive the necessary clearances after achieving financial closure. Moreover, most of the large projects involve dealings with various ministries. Often, the perspectives of the different ministries/departments vary and co-ordination remains inefficient (World Bank, 2006).

Based on data from the recent status report on the central sector projects monitored by the Ministry of Statistics and Programme Implementation (MOSPI), as of July 2009 out of the 602 projects in the central sector each costing Rs. 100 crore and above, 13 projects were ahead of schedule, 145 projects were on schedule and 329 projects were delayed. Of the remainder, 74 projects do not have a fixed date of commissioning, while 41 projects were sanctioned without any commissioning date but subsequently dates of completion were finalised **(Table I.21)**. The total cost of implementing these 602 projects when sanctioned was Rs. 544,657 crore, but this was subsequently revised to Rs. 600,414 crore, implying a cost overrun of 10.24 per cent. As per the report, a single infrastructure project under the Ministry of Health and Family Welfare reported the maximum cost escalation of over 500 per cent. A similar situation has been reported in projects under the Ministries of Water Resources and Railways where the cost of projects has escalated by 219 per cent and 169 per cent respectively.

- **Inadequate dispute resolution mechanisms**

Lack of proper dispute resolution mechanisms is another bottleneck in the development of infrastructure sectors. Disputes often lead to lengthy litigation and substantial project delays. An important factor affecting the efficient implementation of investment plans is the land acquisition process. Infrastructure projects require an efficient process of land acquisition to be in place with adequate checks and balances for considerations of equity and justice.

Table I.21

Sector-wise Analysis of Central Sector Projects each Costing Rs. 100 crore or above (July 2009)

Sector	Number of Projects	Cost (Rs. Crore)		
		Original Approved	Latest Approved	Anticipated
Atomic Energy	5	22054	25054	24123
Civil Aviation	9	4832	4821	4832
Coal	40	25688	25795	27178
Mines	1	4092	4092	4092
Steel	29	45597	45597	49056
Petroleum	62	135864	135864	144474
Power	84	154056	155870	159808
Health & Family Welfare	1	71	423	443
Railways	152	50199	56037	94938
Road Transport & Highways	166	49441	49441	49646
Shipping & Ports	19	13612	13691	13625
Telecommunications	30	12347	12347	11806
Urban Development	30	14597	15084	15206
Water Resources	1	543	543	1187
Total	602	535992	544657	600414

Source: MoSPI, July 2009, http://www.mospi.gov.in/mospi_pi_flash_report.htm.

- **Capacity to monitor and evaluate**

The pace of infrastructure development has accelerated and the projects are relatively large. As many of the infrastructure projects are expected to be outsourced and monitored by government agencies, it is necessary that there is adequate capacity to manage these projects. There is a need to strengthen capacity, especially at the state and lower levels given that rural infrastructure development form a large component of the projects.

- **Shortage of skilled and semi-skilled manpower**

The shortage in trained manpower in vocational skills has been highlighted in more than one context. The situation is true even in the case of infrastructure projects. The process of enlarging the facilities for vocational training across the country has to become more effective to meet the manpower needs of the growing economy. The requirement is not merely for large numbers but for large numbers who are imparted with quality skills.

I.6 Concluding Remarks

This chapter provided an overview of the experience and strategies of infrastructure development adopted in India over the years up till the EFYP. The experience over the years and lessons from both within the country and outside have now led to a change in strategies. These strategies take note of the need for accelerating infrastructure development and the synergetic role that can be played by the public and private sectors together.

Fiscal constraints and the need for large investments have complemented the potential for

extracting efficiency gains from the participation of the private sector in infrastructure development. This has required designing of coordinated and comprehensive policies and institutions to attract investments, ensure quality of services and affordability and efficient execution of projects.

The key elements of the strategy for accelerating the pace of development have been to plan to nearly double the level of investments in the infrastructure sector during 2007-08 to 2011-12, (the EFYP period), as compared to the actual spending in the previous five years. The strategy has also envisaged a sharply enhanced role for private sector investments in infrastructure development during the EFYP period. The overall strategy still aims to meet the requirements of the growth path that has been set for the Indian economy in the medium-term, rather than to catalyse growth. In this sense achieving accelerated investments in and the development of infrastructure are essential for achieving a sustained level of high economic growth.

The strong linkages that the various sectors of the economy have with infrastructure show that infrastructure development has large multiplier effects; inadequate infrastructure will retard growth. Moreover, weak infrastructure will also imply that sectors such as manufacturing will be more adversely affected leading to loss of gains that manufacturing may offer in terms of employment.

A review of the various aspects of the strategies for development also identified a number of bottlenecks in the process. Steps are needed to address these to build the infrastructure necessary for India's economic development. In the next chapter, based on a review of the progress in each of the core sectors of infrastructure, we discuss the steps needed to achieve infrastructure development goals. ●

II. A Synthesis of Sectoral Perspectives and Recommendations

II.1 Introduction

The macro view provided in the previous chapter focuses on the key features of the strategies of infrastructure development, particularly the ones introduced in recent years. A comparative study of the Chinese and Indian strategies brings out the differences in the two countries' policies. In this study, we have reviewed the status of developments, plans and investments in seven core infrastructure sectors, viz. power, telecom, roads, railways, ports, airports and irrigation.

This chapter brings together the assessments of the developments in each of the seven sectors, and combines it with the macro-level assessment given in the previous chapter to evolve an overall assessment of infrastructure development strategies.

Governments everywhere have come to play a key role in planning, executing and maintaining infrastructure in the economy. Changes in technology, developments in the financial sector, increases in global capital flows to developing countries, institutional innovations in regulation and contracting and management of service delivery have created potential to forge effective PPPs for infrastructure development. In the Indian context, the economic reforms of the early 1990s led to the liberalisation of controls over investments by the private sector in a wide range of activities, including infrastructure. The need for sustained high rates of inclusive economic growth became an overriding concern. Completing the virtuous circle of infrastructure development and growth is necessary to sustain the other circle of economic growth and economic development. In order to sustain these positive relationships, keeping infrastructure services 'affordable' remains an important prerequisite.

The efforts of the past decades have shown that reliance on public sector resources alone would not be adequate to step up investments in the sector. Inefficiencies in the public sector also required correction which could be realised through greater market competition. Finally, technological breakthroughs have shown that there were no 'natural monopolies' in the sector.

Against this background, India began to focus on a number of strategies which included: (1) stepping up targets for investments in infrastructure to enable economic enterprises to become more competitive and thus resulting in improvements in the quality of living conditions, (2) forging partnerships with the private sector wherever possible to benefit from efficiency gains which are expected to follow and channelising additional financial resources into the sectors,

(3) designing regulatory institutions to ensure protection for both service providers and consumers, and (4) making necessary changes in policy to achieve faster development of infrastructure within a short period of time.

At a conceptual level, the compulsions of policies and mechanisms needed to achieve the targets of infrastructure development were easier to articulate. Public-private participation, market competition and economic incentives did hold promise. However, it is the process of actual implementation of the plans that has helped in shedding light on the strengths as well as the weaknesses in the approach. For example, the success in the telecom sector and the slow progress in electricity indicate the need for continued attention to the constraints hampering implementation of the plans.

II.2 Infrastructure Gaps and Progress in Bridging Them

II.2.1 Backdrop

Physical infrastructure has a direct impact on growth and overall development of an economy. As the Indian economy recorded a significant growth of 6.7 per cent despite the global financial and economic crisis in 2008-09, the need for efficient and well developed infrastructure was reiterated to sustain the growth momentum. The faster growth of the economy in recent years has placed increasing stress on the available supplies of physical infrastructure, such as electricity, railways, roads, ports, airports, irrigation, and urban and rural water supply and sanitation, all of which already are known to suffer from a substantial deficit in terms of capacities as well as efficiencies in the delivery of services. In view of the setback to growth in 2008-09 and perhaps in the current financial year too, attaining the average growth of 9 per cent during the Eleventh Five-Year Plan (EFYP) period will be unlikely. However, efforts to bridge the infrastructure deficit cannot lag behind high growth. They need to anticipate high growth.

While investments in infrastructure sectors have increased over time, the Eleventh Plan proposed to consolidate and accelerate growth by making a quantum jump in overall investment on infrastructure development. It should however be pointed out that there has also been acceleration of growth in other sectors. The investment rate in the economy as a whole increased to 39.3 per cent of GDP in 2007-08.

The allocation of resources between current and capital expenditures and between infrastructure and the other sectors is influenced by a number of factors. The central government's gross capital formation from budgetary resources was estimated at 3 per cent of GDP in 2007-08 (revised estimates) compared to 2.1 per cent in the previous year. However, the budget estimates for 2008-09 showed a decline to 2.5 per cent, indicating fiscal pressures and higher demand for current expenditures. If infrastructure investments do not pick up, maintaining the high growth rate of the economy of 9 per cent per year would also become elusive.

China has achieved an average growth rate of 10 per cent for more than a decade based on a strategy in which building strong infrastructure has been an integral part. The quality of physical infrastructure in India has been acknowledged to be weak in comparison to China particularly in roads, ports, electricity and telephones. Only in the case of the rail network and civil aviation did India rank better than China in a survey of over 160 countries.

The Eleventh Plan provided an assessment of the gaps between the desired level of infrastructure services and proposed plans to bridge these gaps. The measures included stepping up investments to increase supply of electricity, build roads, modernise ports and airports, achieve extensive communication facilities through telecom and improve the services of the railways. In the following section we review the plans and status in respect of each of the sectors.

II.2.2 Sectoral perspectives

Power

The installed generating capacity increased at a combined annual growth rate (CAGR) of 7.1 per cent between 1980-81 and 2008-09. The overall Plant Load Factor (PLF) for thermal plants, the major source of power in the country, increased to 77.2 per cent in 2008-09 from 44.2 per cent in 1980-81. Demand has continued to outstrip supply, despite sizeable growth in the power sector. This is in spite of the fact that average electricity consumption in India is quite low even by developing country standards. Energy shortages have become somewhat more acute over the past five years. In 2008-09, the energy shortage was estimated at 11.1 per cent and shortage with respect to peak demand was 12 per cent.

The Electricity Act, 2003 was enacted with a view to completely revamp out-dated laws governing the sector and bring about several far-reaching changes. It mandated the restructuring of the state electricity boards (SEBs), sought to facilitate private investment in all segments and introduced new concepts like electricity trading and competition through 'open access'. It also incorporates provisions relating to autonomous regulation, seeks to rationalise tariffs and stipulates transparency in policies regarding subsidies.

Most states have restructured their SEBs by unbundling generation, transmission and distribution. Electricity trading has come into play and has improved overall capacity utilisation. Trading volumes are still small, because of continuing shortage of generating capacity. Regulators of several states have cleared the way for 'open access'– the principal instrument to promote competition – but its actual implementation is yet to take off. To meet the increasing demand, the government has proposed massive expansion of power projects to augment capacity by doubling investments in the Plan period.

The total installed electricity generating capacity of the utilities[9] in the country as on March 31, 2009 was 1,47,965 MW, to which the private sector contributed 22,879 MW – only 15 per cent of the total capacity. The share of the private sector is increasing. Energy generation till March 31, 2009 was 723.6 billion units, to which the private sector contributed 68.9 billion – only 9.5 per cent. The transmission sector continues to be mainly under the public sector, though there have been joint ventures between public and private sector enterprises (for example, the Tala Hydro Electric Project which is a joint venture between Tata and Powergrid). As noted earlier even as late as 2008-09 there was significant shortage of electricity supply relative to demand. Though 82.4 per cent of the 593,732 villages were electrified as on March 31, 2009, the percentage of households with electricity connections was much lower.

The private sector is expected to contribute 20 per cent of the capacity addition during the EFYP period. So far, private investment in both transmission and distribution is minimal. The road to greater private sector participation in the distribution sector, where gains in efficiency may be relatively the highest, requires political commitment to back the state-level electricity regulatory measures. The Eleventh Plan has stressed the importance of the Public-Private Partnership (PPP) model for resource mobilisation and efficiency gains.

The projected investment requirement for financing generation, transmission, sub-transmission, distribution and rural electrification projects in order to achieve the objective of "power for all" by 2012 is a whopping Rs. 900,000 crore. The private sector is estimated to contribute 15,043 MW, excluding the renewables which are expected to contribute another 14,000 MW, taking the total capacity addition to 92,700 MW[10].

However, till March 2009 only 12,717 MW, i.e. just 53 per cent of the Plan target (for the first two years of the EFYP) of 23,865 MW, was met. The private sector contributed 1,633 MW, which is just 13 per cent of capacity addition. The creation of a National Power Grid by the end of the Plan period is expected to augment inter-regional transfer capacity to 38,650 MW from 20,750 MW, the cumulative capacity as on March 2009. Some of the key constraints and challenges affecting this sector include demand constantly exceeding supply and high transmission and distribution (T&D) losses. What is worrisome is that power sector reforms have slackened at the state level. The sector is also confronted with inadequate fuel supply, problems relating to open access in the distribution sector, poor T&D infrastructure, problems in tariff fixation by state electricity regulatory commissions and inadequate metering.

9. Utility means the electric lines or electrical plants, and includes all lands, buildings, works and materials attached thereto belonging to any person acting as a generating company or licensee under the provisions of the Electricity Act, 2003 (CEA, 2009).
10. National Electricity Plan, 2007; Annual Report 2008-09, Ministry of Power.

There are also some positive developments. Capacity-related problems are likely to ease in the final year of the Plan, with several power generating projects coming on-stream. The flow of gas from fields in the south-eastern coastal area would also ease the fuel shortage currently affecting gas power plants. Ultra Mega Power Plants (UMPP) are taking off. The UMPP in Mundra is being developed by Tata Power Limited and is likely to be commissioned before the end of the Plan period. Reliance Power is developing the Sasan and Krishnapatnam UMPP projects; the company is also going to develop the Tiliaya UMPP in Jharkhand. The experience of Delhi in privatisation of distribution has been fairly encouraging because Aggregate Technical and Commercial (AT&C) losses have come down from 52.36 per cent in 2002-03 to less than 20 per cent in 2008-09. There has been some improvement in energy supply as well, as load shedding has reduced from 3 per cent in 2001 to 0.58 per cent in 2008-09 as percentage of total energy supply. The discoms have also undertaken measures to augment the distribution infrastructure. There has been some improvement in meter reading and billing accuracy. The discoms have also undertaken measures to bring down power theft. Renewable energy, particularly solar power, along with nuclear power is expected add to the capacity, thereby brightening prospects for the long term.

However, if these gains are to translate into overall improved sector efficiencies and quality of supply, ways would have to be found to draft private investment into distribution, which is the weakest link at present and the main cause for continuing financial weaknesses of the utilities.

Telecommunications

The telecommunications sector in India underwent massive structural changes in the 1990s. Its growth is the result of the success of liberal policies. Liberal pro-competition policies and regulation have increased affordability for a large section of the population. Now the government needs to think beyond teledensity targets and ensure that access to high-speed data networks and broadband is available to every citizen.

The first step in the reform process was the restructuring of the incumbent in 1999 into the Department of Telecommunications (DoT) and the Department of Telecommunication Services was transformed into a commercial entity, Bharat Sanchar Nigam Ltd. (BSNL), which was put in charge of operations in the entire country, except at Delhi and Mumbai where MTNL is the service provider. The government also allowed the entry of private players from the mid-1990s. The overseas carrier, Videsh Sanchar Nigam (VSNL), was privatised in April 2002. The Telecom Regulatory Authority of India (TRAI) was set up as the regulator prior to the New Telecom Policy, 1999. The initial years saw emergence of conflicts among investors, incumbent and the regulator. As a result, the regulator was challenged in the courts, exposing inadequate clarity on the roles of the government and the regulator. Some clarity was established with the TRAI Act of 1997 (implemented in 2000), whereby the government retained the powers of the old DoT to award licenses, but had to seek TRAI's approval with

regard to the introduction of service providers, technological improvements, quality standards as well as fixing the terms and conditions of licences and management of spectrum.

TRAI fixes interconnection rates between service providers. Its recommendations are not mandatory, and the government can send them back for review and modification. In July 2003, the unified license regime was introduced, keeping in view the technological developments in this sector. The unified license regime allowed the operator to provide fixed as well as mobile services using any technology. Other important policy measures included lowering the access deficit charge, slashing duties on telecom equipment and eventual exemption since 2005, and reducing the roaming and port charges.

As a result of the reform measures, the wireless subscriber base has grown from 0.88 million in 1999 to 543.2 million in November 2009. Teledensity increased from 2 per cent in 1999 to 46.32 per cent by November 2009, with 8-10 million mobile subscribers being added every month.

Urban teledensity was 68.66 per cent and rural teledensity 14.8 per cent in March 2009. In 2008-09, capital investment reached Rs 2.35 trillion ($ 58.67 billion). The total revenue from the telecom sector was Rs 2.97 trillion ($ 65 billion), which amounted to 6 per cent of the GDP at current prices. The private companies contributed 71.6 per cent to the revenue. The earnings before interest, tax, depreciation and amortisation (EBITDA) at the end of 2006-07 was Rs 391.67 billion ($ 9.79 billion).

Telecom growth in India is largely driven by domestic investment with the contribution of FDI being only $ 4 billion, i.e. about 5 per cent of the total investment in telecom. The main reason for the entry of private players was the realisation that the incumbent had scarce funds and the rising unmet demand could only be met by new entrants.

Competition has resulted in tariff declines, which has resulted in the boom of wireless telephony. The mobile sector has grown faster than landline and led to fixed lines being substituted for the mobile variety. Indian telecom operators operate at very low average revenue per user but continue to make profits. Further, low-income consumers in India were able to own telephones because of zero rental for service (in the form of lifetime validity offers), micro prepaid schemes (where talk-time could be bought for very low denominations), micro recharge facilities in rural areas, and lifetime validity plans.

Estimates indicate that operators are working at full capacity and at minimum efficient scale of investment. India's business model is based on low cost-high volumes of traffic and innovative packaging of services. Operators have used the demographic advantage to exploit economies of scale by increasing volumes, reducing costs and having one of the highest earning margins. The sector, however, is burdened with the highest number of levies and duties.

Low prices lead to increased usage by attracting new customers. It implies higher utilisation of the network and soon the operator covers his operational as well as capital expenses, generates profits. This facilitates network growth and high degree of network utilisation. Incidentally, 86 per cent of mobile phone subscribers take the pre-paid scheme.

The experience of the sector shows that pro-competitive policies and regulations are sufficient to achieve market-driven solutions in order to achieve the objective of universal services obligation (USO). A telecom subscriber base of 600 million was envisaged by the end of the Plan period. However this target has been nearly achieved by the end of the current financial year, a good two years ahead of target. A rural teledensity of 15 per cent with spread of telecom connectivity to the rural areas is, however, still unrealised.

The spread of the next level of services is not yet satisfactory. Broadband penetration is one of the lowest in India. Technological options like the combination of WiFi as well as WiMax or 3G would be needed in this regard.

All the aforementioned factors pose challenges to the regulators who must keep pace with technological changes as well as find ways to remain competitive. As mobile phones become increasingly pervasive and powerful, unanticipated uses are likely to emerge, posing additional challenges to the regulator. **Box II.1** summarises the key constraints and challenges of the sector.

Box II.1

Constraints and Challenges of the Telecom Sector

- Massive infrastructure is required to extend the telecom network to geographically challenging rural areas. TRAI has advocated the concept of infrastructure sharing which would help telecom companies reduce their cost of entry in rural areas. Financial incentives need to be given to service providers who are not beneficiaries of the USO fund.
- The country has almost Rs 100 billion ($ 2 billion) unused money from its USO fund collections. The government is unwilling to reduce the impact of market distortions caused by universal service, which compromises the ability of the market and competitive forces to expand the network in rural areas.
- There are a large number of license fees and taxes which act as barriers to entry. The high taxation on mobile telephony is regressive.
- The administrative approach to spectrum allocation has resulted in hoarding of spectrum. The 3G auctions have been delayed several times and the high reservation price set for the auction may deter fresh entrants.
- The content of mobile phones is low quality and concentrates on entertainment. The revenue-sharing arrangement between the mobile operators and players is skewed in favour of the former lower down the chain leading to this outcome.
- The rural population is inadequately covered by the existing e-Governance projects. Internet penetration in rural areas is only 0.6%.

Roads

The 2008-2009 Annual Report of the Ministry of Road Transport and Highways indicates that 60 per cent of freight and 86.7 per cent of passenger traffic is carried by roadways. Further,

National Account Statistics (NAS) suggests that in 2007-2008 the road transport sector comprised 68.43 per cent of the total transportation sector GDP and 4.4 per cent of total GDP. This empirical importance of roads is understandable from a theoretical perspective too, as roads offer a flexible mode of transport that caters to a range between very long and short distance travel.

In the 1970s, roads comprised more than 50 per cent of the GDP from transportation sector. In the history of Indian planning, roads and road transportation did not receive consistently high priority till the Ninth FYP. Since the Ninth FYP, outlays on roads and road transport sector have more than doubled in each five year period. The emphasis on inclusive growth has also led to a focus on rural roads. Indian roads are the second longest network in the world, with 3.31 million Km.[11] However, less than 48.62 per cent (2004-2005) of Indian roads were surfaced compared to 81 per cent of China in 2005.[12]

The roads sector in India may be studied under two separate sub-sectors: Roads and Road transport sectors (corresponding to the 'fixed' and 'moving' infrastructure discussed in the previous chapter). At present, the national highways (NH) consist of 70,548 Km, state highways (SH) 1,28,000 Km, major and other district roads (MDR) 4,70,000 Km and rural roads (RR) 26,50,000 Km.[13,14]

The NH network forms about 2 per cent of total roads in India and carries 40 per cent of the total traffic.[15] Its development and maintenance is shared by the state governments/union territories, the National Highways Authority of India (NHAI) and the Border Roads Organisation (BRO). NHAI is responsible for the National Highways Development Programme, which proposes to connect all parts of India in seven phases. About 99.8 per cent of national highways are surfaced.

The secondary road system of India, which forms 23.28 per cent of India's roads includes SH and MDR, and carries 40 per cent of the total traffic.[16] State governments are responsible for the secondary road system. The SH show very little growth.[17] The growth rate of MDR is slightly higher, but less than 60 per cent of these roads are surfaced.

The tertiary road system comprising rural roads also falls within the jurisdiction of the state

11. Ministry of Road Transport and Highways, Government of India (2009).
12. Basic Road Statistics and World Development Indicators CD-ROM.
13. Ministry of Road Transport and Highways, Government of India (2009).
14. Rural Roads includes roads built under the Jawahar Rozgar Yojana Scheme (JRY), Pradhan Mantri Gram Sadak Yojana (PMGSY)/Bharat Nirman, Village Panchayat Roads and CD/Panchayat Roads.
15. Ministry of Road Transport and Highways, Government of India (2009).
16. Ministry of Shipping, Road Transport and Highways, Department of Road Transport and Highways, Government of India (2007).
17. NCAER's own calculations from various issues of Basic Road Statistics.

governments. At the end of year 2000 only 40 per cent of habitations in the country were connected. The RRs' inadequacy was sought to be addressed by a new central government programme called the Pradhan Mantri Gram Sadak Yojana (PMGSY). Subsequently, the programme became part of a massive five-year rural development programme under the banner of 'Bharat Nirman' which was launched in 2005-06. The Bharat Nirman programme has aimed at improving rural infrastructure in a time-bound manner. These programmes have resulted in growth of rural roads and greater connectivity of villages with markets and amenities.

In the EFYP, the investment needs of the roads sector was estimated at Rs. 2, 94,735 crore at constant 1999-2000 prices. Most of the money is expected to come from the private sector. For example, the Report of the Working Group on Roads for the EFYP envisaged a need for Rs. 1,73,501 crore for the roads sector (only primary and secondary), of which Rs. 87,735 crore is to be provided by the private sector[18]. PPPs (PPP) and FDI in the roads sector have been encouraged. The PPP models in India have taken the form of Build-Operate-Transfer (BOT), Toll and Annuity, and Special Purpose Vehicles (SPV) models. The cess imposed on petrol and high-speed diesel oil has been used to finance rural roads and national highways.

Progress in the Eleventh Five-Year Plan has been slow. The building of expressways and upgrading of national highways to 4-6 lanes has proceeded at slow pace even though the NHAI has almost completed building the Golden Quadrilateral, East-West and North-South Corridors. Attention to the secondary roads system appears is low. The website of PMGSY gives monthly updates on connectivity achieved. The target was to build 24,000 Km of roads in 2009-2010; about 10,262 Km have been built till November 2009. There is better progress on upgrading rural roads where the target was 16,000 Km and approximately 26,167 Km has been upgraded by November 2009. The number of habitations to be connected in 2009-10 was 13,000, whereas only 1,189 habitations got connected by September 2009.

The World Bank (2008) and Gupta *et al.* (2009) have analysed the constraints in building roads in India. The former included delays in pre-construction activities, actual forms of contracts used, unrealistic completion schedules, existing institutional structures, direct and indirect taxes and entry barriers as impediments to investment. India lacks a unified construction law, unlike China and Singapore. Supply-side constraints include very few numbers of eligible contracts and contractors, and inadequate skilled human resources, key construction equipment and materials. Land acquisition is becoming a major constraint in building new roads in India.

India regularly experienced double-digit annual growth rates between 1956-57 and 2005-2006 in the number of motor vehicles, especially two-wheelers. With the average growth rate of

18. Ministry of Shipping, Road Transport and Highways, Department of Road Transport and Highways, Government of India (2007).

roads at 4.62 per cent (1950-2004), and the growth rate of vehicles at 10.94 per cent (1950-2006), the pressures on roads is evident from the number of accidents, which is among the highest in the world. Delays in movement of goods and passengers cost us heavy in terms of economic growth.

The prospects for the road sector are bright. The government has recognised the need for private sector funds, both internal and external. The national highways are attracting private sector funds especially in the later phases. However, the problem is with implementation. There is also a need for change in the legal and institutional structures on road transport to increase efficiency and safety in the use of roads.

Railways

For Indian Railways, the period from 2003-04 to 2008-09 was marked by high growth in passenger and freight traffic. The freight output in net tonne Km increased at a CAGR of 7.14 per cent and passenger Km increased by 9.14 per cent.

The main growth in freight was in commodities like coal, iron ore and cement. However, competition from road transportation forced a decline in fertilisers, iron ore and petroleum, oil and lubricants (POL). There may also have been some substitution among commodities transported. However, the railways need to focus on cement, petroleum products and iron and steel as they are the chief sources of freight revenue. Productivity and efficiency showed improvement during the Tenth Plan period as there was improvement in payload per train and in terminals to facilitate engines on load handling and round-the-clock operations. The growth in freight traffic during the period was the result of a market-based strategy which aimed at increasing the volume of traffic as well as efficiency in the utilisation of wagons and tracks. But traffic volumes did not increase to their full potential. Freight earnings decelerated from 2005-06 onwards. But demand for passenger traffic outstripped available capacity.

Freight traffic at the end of the Eleventh Plan period is expected to be 1,110 million tonnes and revenue freight 706.78 billion in net tonne Km (NTKM). A freight-loading target of 1.1 billion tonnes for 2012 would stretch the carrying capacity of Indian Railways. There were 6.35 billion originating passengers towards the end of the Tenth Plan in 2006-07, which is expected to go up to 8.4 billion by the end of the Eleventh. The passenger-Km traffic was 691.8 billion at the end of the Tenth Plan, which is expected to grow to 942 billion at the end of the Eleventh. Annual passenger traffic is expected to grow at about 5.5 per cent to about 8.4 billion passengers and 942 billion passenger-Km by 2012.

The main initiatives in the Tenth FYP were: (1) to increase the carrying capacity of wagons by increasing their load on selected routes to 15 per cent, (2) to realign tariffs to competitive market conditions, and (3) to incentivise loading. These measures led to a fall in unit costs in

spite of rising input costs. During the Eleventh Plan, the main objective would be capacity enhancement in the short run as well as maximum utilisation of the existing capacity, achieving higher maintenance standards, technology upgrading, safety, and passenger amenities. Container movement has been opened up to the private sector (Ministry of Railways, 2009).

Earnings from freight during 2008-09 were Rs 53,433 crore, registering a growth of 12.65 per cent over the previous year. Earnings from freight tariff were Rs 99.28 per net tonne Km, a growth of 9.12 per cent from the previous year. Passenger earnings in 2008-09 were Rs 1,931 crore, a growth of 10.52 per cent from the previous year and earnings from passenger tariff were Rs 26.13 per passenger Km, a growth of 1.52 per cent over the previous year.

Some of the constraints and challenges of this sector (Ministry of Railways, 2009) are summarised in **Box II.2**.

Box II.2

Constraints and Challenges in the Railways

- Freight business is suffering from stretched capacity and inadequate technology, and low market share of some goods. While competition from roads is significant it is also necessary to examine if traffic volumes now are close to their full potential.
- Addition of new lines has been below the planned target; the common corridor for freight and passenger traffic makes it extremely difficult to run passenger services. The metre and narrow gauge networks account for 19.2 per cent of the total route Km, but contribute only 2 per cent and 0.2 per cent of the total passenger and freight traffic output, respectively.
- There has been slow progress in network augmentation, including doubling of congested routes. There is also inadequate infrastructure capacity creation which has not kept pace with the transport output.
- There are a large number of economically unviable and socially desirable projects both in operation and under implementation.

Railways is emphasising removing the above bottlenecks and creating additional capacity. The construction of dedicated freight corridors and increasing speed on the passenger corridors have received attention. However, the PPP mode is seen to play a role only for efficient execution of projects such as stations, urban metros, multimodal logistics parks and connectivity to ports/industrial clusters (Ministry of Railways, 2009).

Airports

The quality of airport infrastructure is a vital component of the overall transportation network, contributing directly to a country's international competitiveness. There are 85 operational airports in India. The Indian aviation sector is experiencing rapid growth as the entry of low-cost carriers (LCC) has made air travel an increasingly affordable option. LCCs have been charging almost the same fare as AC First Class on the railways, with the benefit of saving of travel time over longer distances.

The annual growth in passenger movement has steadily increased over time. However, traffic is highly concentrated in the top six cities and accounts for 75 per cent of India's air traffic, leading to congestion at the airports of these cities. To mitigate this bottleneck, projects were planned and executed to modernise and redevelop four metro and 35 non-metro airports and construct seven greenfield airports during the Eleventh Plan period. The Airport Authority of India (AAI) plans to identify non-operational airports which could be put to use for better connectivity.

Air cargo in India accounts for less than 1 per cent of the total cargo exported; however it comprises 35 per cent of the total value. During 2007-08, domestic cargo grew by 11 per cent, while international cargo grew by 15 per cent. The infrastructure related to air cargo handling is not keeping pace with the growth in traffic. The Ministry of Civil Aviation has identified Nagpur as India's national cargo hub and is developing it as India's first cargo hub. The Ministry's proposal to set up dedicated cargo airports within a radius of 150 Km of existing airports is another major step.

The success story of the Indian aviation sector has its shortcomings. Airport charges in India are significantly higher than at other international airports. The International Air Transport Association (IATA) reports these charges to be 78 per cent higher than those applicable in other countries. Delhi, Mumbai and Bengaluru feature in a Forbes study (2009) titled "The world's most delayed airports", as among the worst five in terms of arrival. Another area that needs attention is tapping the non-aeronautical revenue stream. Globally, these revenues contribute 50-70 per cent to the total airport revenue, whereas in India this share is a meager 20 per cent. Also, AAI has low commercial revenue per passenger as well as low revenue per employee.

To facilitate the growth of the sector and to meet the rising demand the government has put in place the Indian Civil Aviation Policy whose objective is to maintain a competitive environment and ensure safety and security in accordance with international standards. The Aircraft Act, 1937 provides the basic legislative framework for the sector. The repeal of the Air Corporations Act in 1994, through the Air Corporations (transfer of under takings and repeal) Act. 1994, enabled a number of private airlines to start domestic services. The entry of private operators offering scheduled services resulted in a multi-fold increase in the choice of flights available to passengers and increased competition, leading to lower tariffs. The Airports Economic Regulatory Authority (AERA) works towards creating a level playing field and fosters healthy competition among airports. Government policies include many steps to improve the civil aviation infrastructure through the PPP route. There is now a model concession agreement to attract the private sector to the infrastructure sector

In order to attract private investment to fund the huge financial needs entailed in modernising and upgrading airport infrastructure, the government has allowed 100 per cent FDI under the

automatic route in greenfield airports. In Bengaluru and Hyderabad, greenfield airports have been built (Phase 1) through the BOOT route. FDI to the extent of 100 per cent is allowed with prior government approval. Also, there is 100 per cent tax exemption for airport projects for a period of 10 years.

Financing airport infrastructure has inherent problems, largely similar to the other infrastructure sectors because of their public good nature. As public funds for the development of airports are getting scarce the private sector involvement needs to grow. The task force for the financing plan for airports (Planning Commission, 2006) projected the investment for the period 2006-07 to 2013-14 to be about Rs. 400 billion at 2006-07 prices. Total public spending over the EFYP period amounts to Rs 159 billion with private investment projected to add another Rs 249 billion. The Delhi and Mumbai airport development projects are being undertaken through PPP ventures.

Tourism and trade are sectors closely linked to civil aviation. It is important that airport infrastructure and air services are planned keeping in view the requirement and promotion of these sectors. Air cargo remains a vital mode of transport for India's international trade, especially for products with high value or value addition. The five major airports (Mumbai, Delhi, Kolkata, Chennai and Bengaluru) account for about 88 per cent of the total air cargo handled in India, showing the potential unutilised scope for cargo movement through non-metro airports. At present, India contributes just about 1 per cent to world air cargo traffic. A total of 27.17 million passengers were carried by the scheduled international carriers (both Indian and foreign) during 2007-08. About 97 per cent of the country's foreign tourists arrive by air and international tourism is the nation's second largest foreign exchange earner.

Ports

India has 12 major and 200 minor ports scattered across its 7,517 Km coastline. It is through these ports that India carries out its domestic and international maritime trade. Sea-borne trade comprises 95 per cent by volume and 70 per cent by value of international merchandise trade, with major ports having a huge chunk of the market share – close to 72 per cent. Over the years, non-major ports have witnessed significant growth in traffic and it is expected that by the end of 2011-12 their share will increase from the present 28 per cent to about 30 per cent. Port capacity is expected to increase by 100 per cent in the Eleventh Plan period over the Tenth FYP. The aggregate capacity at major ports as on March 31, 2007 was 504.75 million tonnes per annum. Non-major ports are likely to drive port capacity expansion to over 1 billion tonnes by 2013-14.

The efforts to overhaul capacity may not reap benefits if the deficiencies plaguing the ports sector persist. The average turnaround time has declined over the years, but is still high by international standards. Port charges at Indian ports are 50-70 per cent higher than abroad.

The pre-berthing waiting time has increased over the years, the only exception being Ennore port (the only corporate port), which has consistently improved performance.

The inefficiencies are not restricted to port performance indicators. Indian ports are afflicted with various other shortcomings like lack of or limited competition with other ports. Overstaffing and multiple and conflicting regimes of administration and regulation lead to inefficiencies. Major and minor ports operate under different laws and regulations, leading to inefficiency apart from disadvantages in operation for some ports as compared to the others. The management and development of the major ports in the country is controlled by the central government through port trusts, whereas the minor ports are under the control of the respective state governments. While the major port tariffs are regulated by the Tariff Authority for Major Ports (TAMP), it is not applicable to minor ports.

Even though capacity expansion at major ports has grown in line with increased traffic throughput, Indian ports still operate at 90 per cent capacity utilisation, a sign of less than full capacity utilisation. Another stumbling block for the port sector is inadequate rail-road connectivity, which has now come under attention of the development plans.

The government has now put in place an enabling policy framework for improving the functioning of ports. The Shipping Trade Practices Bill (2008) aims to bring transparency and fairness in shipping trade practices. The government has permitted FDI up to 100 per cent for the construction and maintenance of ports and harbours. A new set of PPP guidelines and a new Model Concession Agreement have also been put in place to facilitate private sector investment in the sector. PPP investment has also been enhanced by the landlord port model, leading to transfer of operational activities of the ports to the private sector.

The government had set up the Tariff Authority for Major Ports (TAMP) in 1997 for regulation of tariffs by major port trusts and private terminals. However, the draft for a Major Ports Regulatory Authority Act (MPRAA), 2009 has been finalised and this Act would be a successor to the provisions currently enshrined in the Major Port Trusts Act, 1963 as far as the working of the TAMP is concerned. In determining rates and governing conditionalities and performance norms, the authority would be guided not only by the interests of the shippers and consignees but would also take into account factors that encourage competition, economical use of resources, efficiency in performance and optimum investment.

Several development projects are already underway to bring about the desired transformation in the ports sector. One such initiative is the Department of Shipping's National Maritime Development Programme (NMDP). The NMDP comprises 387 projects to be implemented in phases up to 2011-12. These projects cover the entire gamut of activities in ports, merchant shipping and inland water transportation to take India's maritime infrastructure to global levels.

The private sector plays diverse roles such as developing and operating terminals at major ports under BOT, promote and construct greenfield ports. Private investment in major ports is assumed to grow at 30 per cent and in minor ports by 15 per cent per annum during the EFYP period. The ratio of public to private spending on investment in the sector is 26:74.

Irrigation

The net irrigated area (NIA) in the country increased from 20.85 million hectares (Mha) in 1950-51 to 60.20 Mha by the year 2005-06 and the gross irrigated area (GIA) went from 22.56 Mha to 82.63 Mha during the same period. India now has the largest irrigated area in the world. However, despite the growth, only 42 per cent of the country's NCA is irrigated, while the remaining 58 per cent is rain-fed. India has an ultimate irrigation potential of 139.89 Mha, of which a cumulative of 73 per cent (102 Mha) has been created and 87 Mha actually utilised by the end of the Tenth Plan. The rate of utilisation (defined as irrigation potential utilised as a percentage of irrigation potential created) is 85 per cent.

Fourteen states, namely Uttar Pradesh, Rajasthan, Andhra Pradesh, Madhya Pradesh, Punjab, Gujarat, Maharashtra, Bihar, West Bengal, Haryana, Karnataka, Tamil Nadu, Orissa and Chhattisgarh account for 87 per cent of the country's total net irrigated area. However, there are huge variations in terms of the development of irrigated area in these states. States like Punjab and Haryana have almost the entire net cropped area under irrigation and states like Andhra Pradesh, Bihar, West Bengal and Tamil Nadu have covered nearly half of the net cropped area. In contrast, states like Maharashtra, Kerala, Chhattisgarh, Orissa, Madhya Pradesh and Gujarat have the majority of their net cropped area dependent on rain water, since some of them are also heavy rainfall areas.

There has been a striking change in the sources of irrigation over the plan periods. The importance of groundwater has increased considerably. In 1951, tube wells were almost unknown and the entire area under ground water was served mainly by shallow dug wells operated manually or by animal-drawn lifts. The number of tube wells increased from barely 200,000 in 1961 to 5 million[19] in the late 1990s and then to 8.8 million[20] by 2000-01. If we consider all types of tube wells (including dug wells and surface lifts), their number in 2001 was 19.1 million. The number of irrigation pump sets energised, another indicator of water use for irrigation, increased from 13.1 million in 2001 to 15.8 million in 2008. Tube wells have now become the major source of irrigation, catering to about 41 per cent of the NIA in the country.

India's irrigation sector is plagued with a number of constraints and bottlenecks. The most important one is the gap between the irrigation potential created and what is utilised. The rate

19. Source: Vaidyanathan (2006).
20. Includes shallow tube wells (8.3 million) and deep tube wells (0.5 million). Deep tube wells extend up to a depth of 200 meters or more and discharge 100-200 cubic meters per hour (Ministry of Water Resources, 2005).

of utilisation is 85 per cent. This is greater in the case of major and medium irrigation and minor surface irrigation projects, signaling problems in the use of surface water. There is huge variation across states. While Punjab and Tamil Nadu utilise their available irrigation potential in full, states like Uttar Pradesh, Bihar, West Bengal and Jharkhand under-utilise them.

There is substantial delay in the completion of medium and large irrigation projects, thus affecting the pace of development of irrigation potential. The number of spillover projects has increased from 380 in the Tenth Plan period to 477 [166 major, 222 medium and 89 Extension, Renovation and Modernisation (ERM) in the Eleventh]. These unexpected delays in the completion of irrigation projects result in cost escalation and lead to further draining of scarce financial resources.

Irrigation systems are often designed on the basis of available information on water supply, yield responses, irrigation efficiency, etc. which may not be easy to quantify. Sensitivity analysis may not be adequate in project planning. Cost-benefit ratios are calculated at the end of project preparation rather than as a decision-making aid during project identification or while evaluating alternative project designs. The entire project evaluation process is strictly internal to government agencies. Due to this lack of transparency, project assessment may entail underestimation of costs and exaggeration of benefits (Thakur, 1999).

There is inefficiency inherent in the current pricing mechanism of water and power for irrigation, and the measuring system of power for irrigation. Water chares for irrigation and electricity tariffs for agriculture are very low in India. Compared to other developing countries, India stands out for having the lowest average agricultural power tariff rate. The ratio of agriculture to domestic tariff rates is approximately 0.22 in India, compared to 0.85 in Bangladesh, 1.77 in Pakistan and 1.32 in Vietnam (World Bank, 2004). Subsidies on power have pushed the SEBs into heavy losses and this, in turn, leaves them with hardly any resources to modernise and upgrade their systems. Power subsidies to farmers account for about 10 per cent of the total cost of supply, or about Rs 240 billion a year. This is equivalent to 25 per cent of India's fiscal deficit and two-and-a-half times the annual expenditure on canal irrigation (Briscoe and Malik, 2006).

The maintenance of completed projects is a weak link, which has led to the rapid deterioration of major and medium irrigation projects. Problems like low capacity utilisation, rising incidence of water logging and salinity, and low water use efficiency follow. India's irrigation sector is characterised by low efficiency levels mainly due to the silting of canals, breakage of regulatory structures leading to overuse of water, uneconomic water rates and power subsidies leading to misuse of water. As per Eleventh Plan documents, gross water use (including annual rainfall of 1.17 m) in the country is about 1.45m (4.8 feet) per hectare of gross irrigated area. This is very high compared to water use in irrigation systems in, say, the US where water allocation is about

3 feet. This overuse in India reflects irrigation efficiency of only about 23-35 per cent in most irrigation systems, with efficiency of 40-50 per cent in a few exceptional cases.

Ground water is over-exploited in certain areas, thus leading to a lowering water head. The ground water level has already reached below 50 metres in around 55,000 villages.

The exhaustion of the best sites for dam construction and, therefore, the exploration of more expensive and socio-economically and ecologically less favourable sites, the cost of rehabilitation and resettlement, environmental aspects, inclusion of the cost of catchment area treatment and inclusion of the drainage system in the command of irrigation projects have been responsible for the increase in the cost of creating irrigation potential. The per hectare development cost of major and medium projects is high.

The government has been trying to address the various constraints through policy support. After the second Irrigation Commission (1972) reported a wide gap between the creation and utilisation of irrigation potential, the Command Area Development Programme (CADP) was launched in the Fifth Plan. This programme envisaged integrated development of irrigated areas along with on-farm development. Under the CAD programme, 311 projects with total cultivable command area of 25.58 Mha have been included. Till the end of March 2006, the construction of field channels was completed in an area of 17.43 Mha. The programme is currently being implemented in 136 projects with a total cultivable command area of 17.06 Mha (Planning Commission, 2008). During 1996-97, the Accelerated Irrigated Benefit Progamme (AIBP) was launched to give loan assistance to the states to complete Major and Medium Irrigation (MMI) projects that were in advanced stages of completion. Thereafter, the Tenth FYP highlighted that substantial delay in irrigation projects, especially medium and major projects, was the cause of low additions in the area under irrigation. Therefore, the Tenth FYP and the subsequent EFYP have made investment allocations in the irrigation sector mainly to complete ongoing projects and for extension, renovation and modernisation (ERM) of the existing projects. Under the Rural Infrastructure Development Fund (RIDF), the National Bank for Agriculture and Rural Development has been extending loans to state governments for major and medium projects. Institutional finance is made available for minor irrigation projects, essentially to individual farmers in large irrigation projects. However, these policies have had limited implications.

The EFYP has made further provisions for the irrigation sector. The Plan has set a target of creating an additional 16 Mha of total irrigation potential comprising 9 Mha from MMI, 6 Mha from minor irrigation (1.5 Mha from minor surface and 4.5 from minor groundwater projects) and 1 Mha from restoration of water bodies. Given the large number of spillover projects, the Eleventh Plan has focused on speedy completion of ongoing projects, especially old ones, and proper maintenance and modernisation of the existing projects. The Plan

envisages greater emphasis on physical rehabilitation and modernising the systems required to improve the efficiency of water use. The Plan further emphasises exploring ways to empower and entrust village communities with the right and responsibility to collect electricity charges and, in dark[21] areas, to regulate access through, for example, obligation on groundwater users to undertake rainwater harvesting and groundwater recharge. As per the Plan, more emphasis is to be laid on Participatory Irrigation Management (PIM), including collection and retention of water rates by water use associations to reduce the gap between potential created and the actual utilised. It also envisages that the subsidy on micro-irrigation equipment must be restructured to promote community sprinkler systems by water user associations. National Rural Employment Guarantee (NREG)/ BRGF funds must be used to supplement Command Area Development.

The plan highlights the need to check further exploitation of ground water. It envisages that regular and accurate assessment of actual groundwater use should be made in both rural and urban areas to correlate this with recharge and extraction. It also envisages that further development of groundwater should be strictly monitored, especially in regions where aquifer levels have dropped, causing concerns about future sustainability. The Plan advocates that priority should be given to exploitation of groundwater in areas like Assam, Bihar, Chhattisgarh, and Orissa and parts of Jharkhand, Uttar Pradesh and West Bengal where it is abundantly available.

To check power theft, the Plan makes the provision for the separation of feeders for domestic and agricultural power, and its timely but controlled supply for irrigation can help regulate water use.

India's per capita food grain availability in 2025 is not expected to match the present levels in China even if the entire Ultimate Irrigation Potential (UIP) of 139.89 Mha is created and utilised by 2025. This is based on the assumption that the percentage GIA under foodgrains and water efficiency in irrigation remains the same at 65 per cent (Ministry of Agriculture, 2008) and 30-40 per cent, respectively (Planning Commission, 2002). Food grain production may fall short of supply even if the food grain yield increases substantially in the additional area bought under irrigation, mainly in the north-eastern states. This highlights the importance of raising the productivity of rain-fed agriculture.

The cost of creating the remaining ultimate irrigation potential of 37 Mha (the difference between 139.89 Mha of UIP and 102 Mha of potential created) is significant. This 37 Mha of irrigation potential consists of 16 Mha from Major and Medium schemes (MMI) and 21 Mha from Minor Irrigation (MI) schemes. The cost of creating additional MMI is Rs 362,475 crore. The total cost of creating the ultimate irrigation potential is Rs 439,085 crore (at 2009-10 prices), which turns out to be about 8 per cent of the GDP in 2008-09.

21. Defined as areas where groundwater exploitation is greater than 85% but less than 100%.

In addition to the need for additional irrigation infrastructure, there is dire need for proper management and maintenance of the existing infrastructure, both of which require financial resources. Increased funds would require greater allocation of budgetary resources and also appropriate user charges, coupled with efficient use of available resources. While large projects such as the 'inter-linking of rivers' may create additional irrigation facilities, attention to proper utilisation of existing capacity is equally important.

Institutional reforms are required in the irrigation sector to ensure increased efficiency and better management. There is also the need to improve water use efficiency in most of the existing irrigation projects through modernisation, renovation and upgrading to realise optimum benefits and to mitigate the consequent side-effects like water-logging.

A Recap

Against this backdrop, the medium term strategy of the government articulated in the EFYP placed considerable importance on improving the quality and levels of infrastructure to attain high economic growth. However, the progress in bridging the infrastructure gap in most sectors has been insufficient. **Box II.3** provides an overview of the Eleventh Plan targets and the current status of the sectors covered in the study.

Some key points that emerge from the preceding description are:

- As against the EFYP target of adding 92,577 MW (including 14,000 MW from renewable sources) of power generation capacity, till November 2009 only 23,530 MW had been actually added during the Plan period. Against the target of adding 14,507 MW in 2009, the actual addition was only 6,017 till November 2009. The Plan also aims at providing access to electricity to all rural households. However, as on November 2009, 16.2 per cent of the total villages have not been electrified.
- In the roads sector, except in building the Golden Quadilateral and East-West corridors, the progress has been rather tardy especially in upgrading roads to 4-6 lanes and expressways.
- The EFYP also has a target of extending the length of rural roads from 1,10,410 Km to 2,56,595 Km by 2011-12. However, against the target to build 24,000 Km of road for 2009-10, only about 7,000 Km of roads have been built as of September 2009. There is better progress on the upgrading front in the case of rural roads where the target was 16,000 Km and about 17,000 Km has been upgraded. Similarly, the number of habitations to be connected in 2009-10 was 13,000, whereas only 1,189 habitations had been connected by September 2009 (PMGSY website).
- In the case of ports, the EFYP has a target of increasing the traffic-handling capacity of major ports from 505 MT in the beginning of the Plan to 1,017 MT by the end of the Plan. This translates into additions of 512 MT of traffic-handling capacity of major ports. However, the progress in the ports sector also seems to be slow. As of March 2008, the

Box II.3

Infrastructure Plans and Current Status

Sector	EFYP Plan	Targets Status (As per latest data)
Roads/ Highways	6-lane 6,500 Km in the Golden Quadrilateral (GQ); 4-lane 6,736 Km North-South and East West (NS-EW) corridors; 4-lane 12,109 Km; 2-lane 20,000 Km; 1,000 Km Expressway	March 31, 2009 6-lane 7,188 Km in the Golden Quadrilateral (GQ); 4-lane 2,828 Km North-South and East-West (NS-EW) corridors; 4-lane 787 Km; 2-lane NIL, Expressway
Ports	New capacity: 512 mn. MT in major ports; 347 mn. MT in minor ports major ports in 2007-08	March 31, 2008 27 MT of cargo-handling capacity added in
Railways	10,300 Km new rail; 10,000 Km gauge conversion; modernise 21 stations; Dedicated Freight Corridors	March 31, 2008 No addition in railway length. 1,549 Km gauge conversion.
Power	Add 92,577 MW (including 14,000 MW from renewable sources); access to all rural households. The national transmission expansion plan is estimated to cost Rs 75,000 crore (approximately $16.5 billion)	Till Nov 30, 2009 Added 23, 530 MW (7,465 MW from renewable sources); 16.2% (96,357) villages are not electrified
Telecommunications	600 million subscribers. Rural teledensity of 25% and total teledensity around 50%	Nov 30, 2009 Total telephone subscriber base reached 543.20 million and teledensity reached 46.32%
Irrigation	Creating 16 Mha of additional irrigation potential, comprising; 9 Mha from MMI, 6 Mha from minor irrigation (1.5 Mha from minor surface and 4.5 from major ground water projects) and 1 Mha from restoration of water bodies.	Recent data are not available

Source: Planning Commission (2008); Eleventh Five-Year Plan, Volume I; CEA (2009); Ministry of Road Transport and Highways (2009); TRAI (2009); Ministry of Shipping (2009); Ministry of Railways (2009).

capacity of major ports was 532 MT. This means only 27 MT of traffic handling was increased in the case of major ports in the year 2007-08 (Ministry of Shipping, 2009).

- No additions were made in the railway route length in 2007-08. The EFYP expects passenger traffic in the railways to increase from 6,352 million by the end of the Tenth Plan period to 8,400 million by the end of the Eleventh. In 2007-08, passengers origination in the railways was 6,524 million and 770 billion Passenger Km as against the Plan target of 942 billion Km (Ministry of Railways, 2009).
- Telecommunications continues to perform well. The EFYP has a target of extending the subscriber base to 600 million and rural teledensity to 25 per cent. As of November 2009, the total telephone subscriber base reached 543.20 million (TRAI, 2009).

Next, we focus on the challenges confronting infrastructure development in the country.

II.3 Challenges Confronting Infrastructure

II.3.1 Slack capacity

Two sectors – power and railways – illustrate the slack capacity yet to be utilised. In the case of power, the causes are both internal and external. Internally, there is abundant scope to improve the PLF/ Plant Availability and to reduce line losses. In both cases, targeted outlays on refurbishing equipment and efficient management practices are necessary. In the case of line losses, governance issues come into play.

Plants under private ownership notch up better PLF on the average, but relatively efficient performing units in the public sector prove that improved PLF is not necessarily ownership-dependent. This is not the case with effecting reduction in line losses. Private power distribution companies operating in Mumbai, Kolkata and Ahmedabad have consistently maintained low distribution losses for decades and have been insulated from the deterioration seen in the rest of the country's electricity network over the past two decades. More interestingly, the distribution companies of Delhi that were privatised in June 2002 (majority ownership and management) have succeeded in bringing down Aggregate Technical and Commercial (AT&C) losses from 52.36 per cent in 2002-03 to 19.81 per cent in 2008-09. This they have done through a combination of targeted investments in system improvements and more effective management practices. The fact that these practices included sustained campaigns to educate consumer groups needs special mention, in order to underline the fact that the private sector can bring about results in crucial areas where the public sector is hampered by bureaucratic constraints.

We noted that external factors also contribute to slack capacity in the power sector. The most telling instance is of fuel shortages that have caused under-utilisation of capacity in coal-based as well as gas-based plants.

Chapter 1 notes that the degree of 'forward linkages' of the infrastructure and power sectors tops the list in terms of impact on downstream industry and hence on the output of the economy. The slack capacity in the crucial power sector may also mean underutilisation of capacity in the downstream as well as upstream industries.

The railways have a unique position in respect of slack capacity because it is coupled with acute congestion on key railway routes, several of which operate at more than 100 per cent utilisation of the capacity available (Ministry of Railways, 2009)[22]. The following tabulation of key statistics relating to the rail systems of China, Russia and India helps in explaining this paradox **Table II.1.**

22. Ministry of Railways (Railway Board), December 2009, "White Paper on Indian Railways." Government of India. www. Indian railways. gov.in

Table II.1

Illustrating Slack Capacity

Rail System	Network length (Kms)	Passengers (million Kms)	Freight (million Kms)	No. of Locos	No. of Coaches	No. of Wagons
China	63,637	689,618	2,211,246	17,222	42,471	571,078
Russia	84,158	173,411	2,090,337	12,063	43,124	566,802
India	63,327	694,764	480,993	8,110	33,955	207,719

Source: Ministry of Railways, White paper (2009).

China and India have more or less equal track length and carry about the same number of passengers. Russia's railways carry considerably fewer passengers. But it is in the area of freight that the differences are striking. With roughly half as many more locomotives and nearly three times the number of wagons, the Russian railways move over four times the volume of freight traffic compared to the Indian railways. As for China, owning a little over twice the number of locomotives and about three times the number of wagons, the volume of freight carried is 4.5 times that of India.

The key lies in the low average speeds of freight trains in India, which have hardly improved in the past 30 years. Indian Railways attribute the low speeds to the sharing of track by both passenger and good services, but there is certainly more to it. Technology and management practices must be equally critical.

It may be noted that the issue of ownership is not involved here as all three systems are fully owned by the public sector.

II.3.2 Project implementation

All the sectors of infrastructure are afflicted by delays in implementing identified projects that have already been cleared by the appropriate authorities. Delays invariably cause cost overruns, leading to further delays for arranging the additional funds or for obtaining revised approvals.

Time is lost both before the actual physical commencement of the project work and in the course of execution. In terms of cost to the economy, delays in implementing power projects are arguably the most serious. At this point, it is certain that the Eleventh Plan would succeed in adding more generating capacity than the two preceding Plans combined, but it would fail to achieve the target capacity addition of 92,577 MW. The uncertainty is only with respect to the extent of the shortfall. The problems with power projects may be discussed in some detail because they typically involve all areas to which project delays could be related: land acquisition, rehabilitation/resettlement, environmental, legal, financing, contractual, technical, design-related, and equipment supply and installation.

Taking possession of land for large projects (and thermal power projects in particular require

extensive land area) is both contentious and time consuming issue. There were weaknesses in the laws governing land acquisition and, right now, a process of securing political consensus on the amendment to existing legislation is in progress. Land and environment-related issues often lead to delays caused by legal procedures initiated by various stakeholders. Some of these issues have been recognised in policy pronouncements, but their impact on actual cases needs to be assessed.

Legal tangles could be caused by other factors as well. For example, the award of the Sasan UMPP has been delayed due to legal issues raised in the bidding process, delaying the start of work on this 4,000 MW project. The telecommunications sector has figured repeatedly in disputes and legal proceedings involving disqualification of bidders for large service as well as equipment supply contracts; in the most recent instance, the dispute delayed BSNL's plans to provide wireless internet connections.

In the power sector again, a factor that contributed to several instances of delay in the Tenth Plan related to delay in equipment supply. The country had, till recently, a manufacturing constraint as the sole manufacturer of large power plant equipment, BHEL, was overloaded with orders. The adoption of supercritical technology for new plants also contributed to delays in manufacturing the equipment. Plans were announced last year by a few private manufacturers to set up facilities in association with foreign collaborators to manufacture turbines and generators in the country. This problem may be overcome when the new facilities go on-stream. In the meantime, power equipment manufactured in China has entered the market on the strength of price advantage as well as timely delivery, but in some instances, delays have occurred all the same at the stage of installation and trial runs.

These issues have no easy solutions. Transparency in procedures like contract award and setting of time limits for completing legal processes are among the obvious remedies. Imparting improved project management skills and techniques within the implementing agencies is another area that can fetch results in the short term. Removal of weaknesses in the long-standing law and setting up additional manufacturing capacity will require more time. However, introducing greater competition, including imports, requires as much attention.

Among the Infrastructure sectors noted with respect to central sector projects in Chapter 1 of this report, railway projects account for among the highest cost overruns (169 per cent escalation) caused by dragged-out projects. Much of this occurs because of a factor that we have not discussed above: the deliberate commencement of work on a far greater number of projects than the organisation's financial capacity for execution. According to the Railway Ministry's recent White Paper (December 2009), 286 projects for new railway lines, conversion of narrow gauge lines to broad gauge and adding a second line in sections to increase capacity are on hand. At approved costs, they involve a total fund requirement of

Rs. 79,462 crore and, according to the White Paper; it will take about nine years to complete these projects.

The solution here is more obvious. The Railways have proven capability to implement the projects physically and no technology-related complication is involved. It should do a one-time exercise of arranging the projects in each category according to priority and then go about implementing them in a time-bound manner. There is difficulty with regard to new lines (109 on-going projects, total cost Rs. 50,405 crore) where political pressures are often difficult to surmount. Here a political consensus to prioritise the sequence according to the date of original approval by Parliament to each project should be hammered out.

These measures could fetch badly-needed capacity gains to the railways in the short term and, in the longer term, socio-economic gains to the hinterland areas where the new lines are to be laid. The present policy denies the country and the economy of both.

Land acquisition for highways, power projects, pipelines and so on has always been a time consuming and elaborate process. The National Policy on Resettlement and Rehabilitation is being piloted by the Ministry of Rural Development under Article 73 of the Constitution, which would give it the status of an Act till the whole policy is enacted. While the provisions are being widely debated, it is important to have clarity in the process so that plans for development can be implemented efficiently[23].

II.3.3 Private participation

The record so far of the infrastructure sectors in regard to private participation and even within segments of the same sector is very uneven. The telecom sector has crossed many of the hurdles even though some issues in allotment of spectrum for 3G services and sharing of infrastructure for rural services remain unresolved.

The ports sector has functioning examples of fully private-owned ports (Mundra on the west coast in Gujarat), ports operated as private-public JVs (the Dhamra port project is a joint venture between L&T and Tata Steel in PPP with the Government of Orissa) and ports where select terminals are owned and operated by private owners (Nhava Sheva International Container Terminal is the first private terminal in the country at Jawaharlal Nehru Port Trust in Navi Mumbai). However, further scope exists for private participation in select areas of port operation.

In the case of airports, greenfield airports can come up in the private sector. To garner investments for upgrading the second tier of airports (where greenfield ventures may not be justified), there is urgency to develop a PPP model, either by identifying city-side developments as the share of the

23. *Business Standard*, 14th September 2007.

private party or by forming JVs with private majority ownership and management.

The power sector – where the need for private investment is the greatest – provides an example of uneven progress within the sector. With the persistence of financial weakness of public distribution utilities, IPPs are proving to be a viable model for the private sector, largely because of the opportunities opening up for 'merchant power' and the existence of a regulatory and dispute resolution mechanism. The model developed for the UMPPs – shell companies for each plant under the umbrella of the PFC which processes the necessary preliminary steps and clearances and then selects the private party on tariff-based bids – can be replicated. However, because of the long gestation period involved, tangible results from this model would flow only from the 12th Plan onwards.

In the transmission segment of the power sector, there is one functioning PPP model, through JV (Tala Hydro Electric Project with Powergrid) and more are in the pipeline. The JV model is also being mooted for several of the new nuclear power plants at greenfield locations, but the details remain to be worked out.

It is in the distribution segment that the progress is most inadequate – despite some successes– and the need to overcome this drawback is of the highest priority because efficient distribution holds the key to efficient pricing as well as overall efficiency of the sector itself. The fact is that effective means of smoothly inducting private players into the distribution segment is yet to be developed. Privatisation of electricity distribution in Delhi was carried out virtually under duress because of the degree to which the quality of the public distribution had deteriorated. The model adopted had several drawbacks but now, after six years of private management, it has stabilised; the efficiency gains in terms of quality of service and reduction in losses are tangible.

There appears to be considerable reluctance on the part of power utilities elsewhere to induct private players in urban areas where scope for private entry exists. The causes lie in the areas of governance and efficient pricing, but also in the overall capacity shortage of the sector which is a disincentive for private players interested in improving the services.

The experience of Delhi gives a clue as to how this problem can be overcome. New Delhi Power Ltd. (owned by the Tata group) has been able to ensure smooth supply mainly because of advance planning and tying up of bulk supply sources, some of them from units owned or part-owned by the same group. The time is ripe for inducting private distributors in large urban areas; a viable model would be to encourage agencies with presence in both generation and distribution and they should be encouraged with guaranteed fiscal incentives in urban areas. It would be unwise to wait for overall shortages to be overcome, as this would only perpetuate the vicious cycle of poor service quality and the reluctance of private players to come in. The initiative rests with state governments.

In the meantime, new experiments for inducting private 'franchisees' into urban distribution areas are taking place. One such franchise in Bhiwandi (Maharashtra) that has been operating for about two years is a qualified success (Prayas, 2009)[24]. The risk in this experimental approach is that given the political sensitivity on this issue, even a single failure could set back the process of inducting private players elsewhere.

The roads sector has developed a viable model for private entry on the basis of BOT and its variants, but faced problems of implementation. There are now indications that changes in the contracting process may accelerate private investments in the sector, but the proposition would be tested in the last two years of the Eleventh Plan.

Indian Railways bring up the tail-end of the discussion on private participation. There was initial success with PPP schemes like 'own your wagon', but the momentum could not be maintained by later models. With regard to basic track infrastructure, the limited models available are of three-way JVs for lines connecting Greenfield ports (with the Indian Railways, state government and private port developer as the partners). The urban metro rail projects may offer opportunities for PPPs in some cases.

The railways' investment needs are huge. There is also a large, latent slack capacity in its system as the discussion in the earlier section showed. As with power distribution, developing viable models for private participation is a matter of utmost priority.

Overall, while there are increasing cases of PPP (PPPs) initiated in recent years in India, the PPP route has not been able to meet the supply-demand gap in infrastructure facilities. There are some difficult issues, particularly in the lack of clear-cut and stable legal frameworks, information dissemination and guidance material, competent institutional mechanisms to prioritise investment projects, efficient mechanisms for dispute resolution and effective financial markets. These complementary factors would have to improve to make PPPs effective.

II.3.4 Governance-related constraints

Infrastructure projects are affected by governance-related constraints in several ways. The project award process has to be transparent. The experience of the contract award process in telecom should help improve the process in other sectors. At another level, dozens of Memoranda of Understanding signed by state governments with foreign promoters of IPPs failed to take off because the risk mitigation requirements were not fully grasped and the necessary supporting institutions were not put in place. But even after these limitations have been overcome, progress continues to be severely hampered by governance-related factors.

24. Prayas Energy Group (2009). Review of the Distribution Franchisee model implemented by MSEDCL in the Bhiwandi circle, June, Pune.

The power sector has made considerable headway in setting up autonomous, empowered regulatory institutions and also carried out the restructuring of vertically integrated utilities in most states. Financial incentives to promoters of both public and private sectors (rate of return, tax and duty exemptions, etc.) are generous by international standards, so financing is not a serious bottleneck, though pending financial sector reforms could ease the situation further. The lack of significant improvement in the financial state of sector utilities and accumulated public sector losses point to problems related to efficient pricing and reduction of excessive line losses, both of which have their roots in governance issues.

It has been established beyond doubt that closely regulated private investment brings in investments and management skills that reduce line losses and improve the quality of supply. Regulated private distribution would also help in the efficient pricing of retail power by limiting the impact of politically-set subsidies. But private entry in this cutting interface with the public is yet to be welcomed at the state and local levels because of concerns over increased tariffs. But tariffs could fall in real terms and over a short enough period because of reduction in losses and efficiencies in manpower utilisation.

Tariff increases unaccompanied by improvement in quality cause public resentment. Improving income levels provides a congenial climate for temporary tariff increases (through reduction of cross-subsidies) and would be acceptable provided there is tangible improvement in the quality of supply. We made a case earlier for the induction of resourceful private agencies in bulk supply contracts for retail distribution in urban areas so that there is early prospect of improved supply quality. The climate for that is ripe because enough private players are available. If institutional checks to tone governance standards are matched at the delivery end, the reluctance to privatise electricity distribution could be overcome. A few success stories could create a demonstration effect, leading to more initiatives which eventually would make the idea acceptable.

An added reason for slowing down privatisation of retail power supply is the apprehended impact on the large organised work-force, and the adverse political fallout. There are two pointers as to how this fear can be overcome. The large work-force of the erstwhile Delhi public electricity utility could be persuaded, through safeguards in regard to emoluments and pension and through public pressure to go under private ownership. The case is similar in the telecom industry when the sector saw corporatisation of a government-run enterprise. In this case, it is the tangible results of private entry (which helped liquidate decade-old waiting lists and improved access) that proved decisive. The Delhi electricity privatisation experience shows that seemingly intractable problems can be overcome without causing hardships to the public.

The railway projects reveal another governance-related handicap. In this instance, continuation of the pre-Independence practice of a separate railway budget and, consequently,

the routine announcement of populist policies in announcing new railway projects make a commercial approach to operations even more difficult. The Railway Ministry's White Paper mentions corporatisation of the Indian Railways (it is now a department of the government as telecom was till recently) "to create an arm's-length relationship with the government" as an option that has been debated. Such a measure, accompanied by setting up of autonomous expert regulation of rail tariffs, would help the railways extricate itself from the current unviable situation with regard to projects.

To summarise, institutional safeguards, rearranging outdated structural models and eliminating the climate of shortages (to start with in small pockets) before the stage of total adequacy is reached are the three specific measures that we advocate to overcome governance-related constraints in infrastructure.

II.3.5 Efficient pricing of infrastructure

The problems of attracting investments and efficient pricing of infrastructure are intertwined. In view of the upscaling of investments in the EFYP in all infrastructure segments amenable to commercialisation, the issue is now of critical importance.

The broad policy approach relies on independent regulation. This is the case with the four sectors dealt with in this study: telecom, power, airports and ports. Roads, where pricing is of limited application, and railways, where all services are priced but prices continue to be set by the operator, are the exceptions. Irrigation remains a complex sector where power and water pricing for agriculture are yet to raise resources even for maintenance of services.

The regulator in telecom is fully empowered, but, as the forces of competition have taken over much of the services, the ruling prices are well below the ceilings set.

The regulator for airport services has just come into position, which is a positive development. Pricing issues would come to the fore in the sector when more players enter the field through greenfield projects or JVs with AAI.

With the entry of fully private-owned ports/ dedicated terminals in both the eastern and western seaboards, scope has emerged for pricing efficiencies through inter-port competition. As of now, greenfield ports are designed to handle dedicated new traffic streams and it is only through expansion of their capacity in future that the stage would be set for competition. Till that comes about, and even afterwards, there would be a key role for the regulator in this sector. TAMP had a limited mandate in the setting of tariffs.

There is potential for large gains from pricing efficiencies in power and the railways as the pricing regime continues to be highly inefficient in both. Chapter 1 has presented a

comparison between retail power pricing in China and in India. Notably, the price ratio range between consumer groups is within 1.8 in China, while in India it is as high as 7.8 The NTP stipulates that tariff differentials, reflected in this ratio, should be brought down in a phased way within a range of 2, but progress has been slow. As noted earlier this is one component of the vicious cycle in which private entry into electricity distribution is caught. Increasing per capita income levels provides one plank for price increases for domestic and agricultural users, provided the quality of supply is improved, which is the other plank.

Various studies on pricing of railway services in India have revealed unjustifiably high levels of freight tariffs and the recently released official White Paper reiterates the same. At the same time, the paper is silent on entrusting railway tariff-setting to an independent agency and, until this is done, transparency would not come about. As induction of competition in railway services is yet to get adequate support, assigning tariff function to an empowered outside agency is an important reform that should be pursued.

The final point that we make is with respect to pricing and affordability of services. Cross-subsidisation models have become counter-productive as they reduce the incentives to achieve greater efficiency in operation. The models also require limiting competition, causing greater inefficiency. The experience of the telecom sector where tariffs were reduced in the face of market competition strikes a contrast to the 'cost plus pricing' approaches of the other sectors. The models of 'Universal Obligation Fund' are attractive but may again restrict competitive solutions. Given the wide 'rural-urban divide' in infrastructure services, the general budget support in the form of measures such as tax incentives, viability gap funding or direct allocations to make infrastructure services more widely available may be necessary over the long term.

To conclude, the central message that emerges from the telecom experience is that competition leads to improved efficiencies. Most infrastructure sectors are much less amenable to free competition than telecom, but in each of the sectors studied, there is ample room for competitive forces to be brought into play.

II.3.6 Measuring infrastructure development

The country has moved far to integrate with the global economy and has also identified areas of the economy that need attention in order to progress further. Upgrading India's infrastructure to the best global standards is a key strategic requirement in this context. Recent developments in the global economy suggest that accelerated growth of the Indian economy would benefit not only our own economy but also complement global growth. The issue thus has a wider dimension.

Infrastructure development may be measured in two obvious ways. First, there is the physical

measure which is relatively easy, as for example:

- Road length weighted by quality-related measures like class (expressway, highway, others) quality (type of surfacing, number of lanes) and usage (number of vehicles).
- Electricity consumption per capita and percentage of population with access.
- Airport handling-capacity in terms of number of flights, length of airport runways and number of aircraft using them, number of passengers and cargo volumes.
- Berthing capacity of ports, number of vessels handled and cargo volumes.
- Length of railway track with percentage of multiple line sections and electrified routes.

The second measure, specific to the Indian context, may be termed as 'institutional' and would take in aspects like the existence of enabling legislation, adequacy of regulatory institutions, and clear entry paths for service providers.

In addition, there is a third measure that would evaluate infrastructure in terms of improvement in pricing, capacity utilisation, service quality, etc. In some cases, this would involve estimating the latent unused capacity that could make a significant difference to the supply of infrastructure services. The barriers to full capacity utilisation are obvious in some instances (equipment in need of renovation to raise PLF of power plants, removal of logistical constraints in fuel supply, etc.), but in others the under-utilisation of capacity could remain hidden for years. To illustrate, it is widely acknowledged that the Indian railway system is over-stretched and several of its sections are operating at more than 100 per cent of the authorised capacity, causing excessive wear and tear and increased accident risk. Yet four years ago, Indian Railways raised its loading of coal and iron ore (two of its most profitable revenue streams) by several million tonnes by the simple measure of raising the permissible tonnage limit per wagon on select routes. What had gone unnoticed for years was that both the wagon design and the track standards were capable of handling the increased load.

Not only railways but ports (excessive ship turnaround time, excessive manpower) and airports (under-utilised facilities in several towns and cities) also suffer this problem. To develop efficient measures in this area, international bench-marking is one approach. We noted earlier that by that yardstick, the capacity of Indian Railways is under-utilised, a conclusion that flies in the face of apparent physical conditions. This study has attempted to make such comparisons in a limited way, but it would be worth doing so in greater detail as a base-line exercise needing periodic review and updating.

II.3.7 Sustainability of infrastructure development

Fiscal issues

The predominant position of the government and the public sector in the infrastructure domain meant that investments were determined by the various constraints on government spending including tradeoffs in spending in one sector as compared to another. The tradeoffs were not based on either commercial viability or the impact on economic growth alone. Accelerated government spending during the 1980s did lead to higher economic growth, but the imbalances between revenues and expenditures also led to rising debt and debt-servicing costs for the government. The pricing of infrastructure services was marked by heavy cross-subsidisation within the sectors and across sectors. It was also marked by overall subsidisation through the government budget. New investments in the sectors, therefore, were affected significantly by the general fiscal position of the government.

The policy reforms leading to injection of competition and independent regulation have resulted in augmentation of resources for the sector. The government and public sector agencies continue as the major providers of infrastructure services. In the EFYP, the central and state governments were slated to provide 58 per cent of the investment financial requirements through budgetary resources and borrowing. The public sector enterprises were also expected to supplement these resources through their internal surpluses to a further extent of 12 per cent. It is a major challenge for the government to ensure that necessary resources are mobilised. Infrastructure[25] spending in terms of capital expenditure accounted for 40 per cent of total capital expenditure of the central and state governments together in 2007-08. Increased spending on infrastructure would, therefore, imply relatively less expenditure on the other sectors. With the fiscal deficit of the government now returning to the high levels – at nearly 10 per cent of GDP for the centre and state governments together, taking into account some of the off-budget items such as petroleum sector oil bonds – an increase in investment spending by the government could come only at the cost of an even higher deficit or lower allocations to other sectors –or both.

When the EFYP was launched, there was a concern that the stepping up of investment spending necessary to sustain accelerated economic growth could imply breaching the upper limits dictated by the Fiscal Responsibility and Budgetary Management Act at least until the dividends from better infrastructure was realised. The current global economic crisis has affected the growth trajectory of the economy for at least 2-3 years during the EFYP period, implying that revenues from taxes would not reach the levels anticipated in the Plan. While these constraints may be temporary and global private capital inflows may indeed exceed expectations, a healthy fiscal position is critical for stability in the macroeconomic environment. A stable and favourable macroeconomic environment is necessary to facilitate long-term investment, as in the case of the

25. Covering energy, roads and bridges, railways, civil aviation, ports and shipping and irrigation.

infrastructure sector, and to harvest the benefits of these investments.

Fiscal reforms, which led to reduction in tax rates and rationalisation of tax rates, helped increase spending on infrastructure and the social sectors while also reduce fiscal deficit as a ratio to GDP between 1991 and 2006-07. This trend is expected to continue in the form of further reforms in indirect taxation. The Goods and Services Tax (GST) is expected to be launched, helping streamline assessment and collection of this important source of revenue. Maintaining fiscal balance at sustainable levels would be a key to maintaining the flow of resources. The binding fiscal constraints also make a compelling case for providing a congenial environment for private sector investments in order to achieve the goals of infrastructure necessary for sustained high economic growth. The telecom sector experience has shown that competition and adequate regulations could lead to market solutions that provide services to far more than what the monopoly public sector organisations could do.

The fundamental need for infrastructure development in India is to boost investment, by almost doubling the infrastructure investment from the present level[26]. Infrastructure projects need high initial capital cost and financing them involves a complex and varied mixture of financial and contractual arrangements. Some of the major constraints for financing infrastructure are: (i) limited exit options for investors and weaknesses in corporate governance, (ii) non-availability of numerous well-planned and designed infrastructure projects to choose from, (iii) interest cap and lack of a deep forward foreign exchange market, (iv) lack of depth in the government bond market, (v) regulatory uncertainty which increases the risk-profile of infrastructure projects, and (vi) weak fiscal positions of the governments, making less bankable business partners for infrastructure projects. These constraints are likely to be overcome only over the medium term, but measures to accelerate the pace may also help in accelerating infrastructure development.

New capacity versus maintenance of assets

The poor state of available infrastructure reflects their poor maintenance. The allocation of resources towards repair and maintenance would have to keep up with not only rising prices of wages and inputs, but also with increased utilisation levels of infrastructure. As pointed out in the previous chapter, there has been significantly faster growth in the utilisation or build-up of 'moving infrastructure' relative to 'fixed infrastructure' particularly in the case of road transportation and civil aviation and also in the case of railways. Even in the case of telecom, the investments in 'fixed infrastructure' may have slowed because of lower revenues per customer. In the case of irrigation, the problems of under-utilisation of capacity of dams and the losses from poorly maintained irrigation canals have been well recognised. The privatisation of distribution of electricity in Delhi demonstrated that improvement in repairs and maintenance improved the

26. India currently invests little less than 5% of GDP on infrastructure. This needs to doubled (to around 9 to 10 per cent like China) to meet infrastructure demand.

utilisation of available supplies of electricity. There is no uniform rule that would indicate the level of resources that may have to be provided for repairs and maintenance of the assets. However, ensuring sustained quality output from each sector over the life period of asserts would require adequate attention to the maintenance of the assets.

A related issue is the quality of the assets. Assets may be built with technologies that require less maintenance and repairs than other technologies and materials. In a period where expansion of assets takes place rapidly, it is important to build assets that are long-life and require fewer resources for maintenance. In this context, an appropriate metric of the status of infrastructure is important. It is not enough that we have the longest network of railways and roads; what matters is the quality of those networks.

II.4 Concluding Remarks and Recommendations

The present study has provided an analysis of the status of India's infrastructure, strategies to achieve infrastructure development commensurate with the aspirations of high rates of economic growth which in turn are needed to bring about broad based economic development. Using the EFYP goals and strategies as the bench mark, the analysis has highlighted the challenges in meeting the mid-term goals. The first chapter of this study report examined the overall infrastructure development whereas the second chapter provided a synthesis emerging from an assessment of the specific sectors.

Infrastructure development, even when limited to the physical infrastructure, calls for allocation of a major component of financial resources of an economy. Traditionally the balance or prioritisation of investments across various sectors of the economy and within infrastructure sub-sectors, given the overall resource constraints, has been determined by the structure of the economy and pace of economic growth. In the Indian context, the need for accelerated economic growth also requires increased allocation of resources to infrastructure development. Reliance on fiscal resources alone would not be sufficient to achieve the higher investment levels. Moreover, the likely gains from efficiency resulting from competitive markets may also be significant. Keeping this in view, greater role to private sector was envisaged in the EFYP.

Bringing in the private sector in infrastructure projects has also led to putting together a range of institutional mechanisms not only for the regulation of competition but also for providing necessary fiscal incentives to make infrastructure projects commercially viable. A coordinated approach to policy as well as addressing implementation issues has become necessary to achieve infrastructure development at a pace that has not been done before.

The discussion in the two chapters of the report has identified a number of areas where steps are needed to accelerate the pace of development. We note these areas below.

Utilising slack capacity: the inefficiency in the utilisation of existing infrastructure assets requires to be addressed. The slack capacity in infrastructure has multiplier effects on downstream and upstream industries. Allocation of adequate resources to improve efficiency in the operation of services will be necessary to improve utilization of the available capacity.

Project implementation: a number of factors have been identified as being responsible for the delays in project implementation, both in the present study and also in several other previous studies. Design of good contracts and contracting procedures, streamlining approval and clearance processes, building necessary human resources are required components of a strategy for improving project implementation. We have also emphasised the need for optimal choice of investments taking into account financial capacity for investments.

Privatisation and PPPs: A number of successful examples of privatisation and partnership between public sector and private sector have now emerged. However, there is now uneven progress on PPPs across sectors. There is a need for faster progress given the need for more effective role to be played by the private sector. Electricity distribution is an area where private sector participation can yield significant benefits to the economy.

Governance issues: A wide range of concerns are addressed by better governance. Stable policies and fair implementation of policies are pre-requisites for deriving benefits from investments made by the public or private sector enterprises.

Fiscal and commercial sustainability of investments: Although the role of private sector in infrastructure development is slated to increase significantly, public sector will continue to be a dominant service provider in several sectors. Therefore, ensuring adequate returns on investment even at an aggregate level- such as overall economic growth- would be necessary to maintain fiscal sustainability of investments. Maintaining fiscal sustainability is also needed to attract private investments.

Efficient pricing of services: Independent regulation and competition have led to sharp reduction in the pricing of telecom services. Affordability of services is determined not only by the price but also quality of services. The role of independent regulation and promotion of competition cannot be overstated in the context of making infrastructure services more affordable. Cross-subsidisation has not succeeded in providing resources needed for ensuring universal access to services.

Maintaining high quality of services: Inadequate recovery of costs has led to lack of maintenance of assets in sectors such as roads, electricity and irrigation. Poor maintenance leads to poor quality of service. Poor maintenance may also be a result of taking resources away from this task to creating new assets. We have also noted that life of assets will also be

influenced by choice of technology in construction, and consumer education and proper use of assets. We are unable to indicate what level of resources is to be allocated to maintain the asset quality. Monitoring quality of service should provide indication of resources needed for maintaining quality of service.

Measuring infrastructure development: There is a need to benchmark capacity and utilisation of infrastructure services both in terms of physical quantity and quality. The available information may be useful in developing an indicator of the status and therefore measure changes over time. However, we need another set of measures to monitor the institutional and policy framework for development of the sectors. Finally, the third dimension of change is the pricing and access. The present study has not been able to develop such indicators as the process may require collection of information from the consumers and service providers directly. Such measures may be very valuable in assessing infrastructure development in the future.

Policy Coordination and implementation: Infrastructure projects require approvals and policy support from several quarters in the government at different levels. Past experience in the process particularly in the more liberal economic policy regime of the past two decades has led to some streamlining of the procedures, especially at the level of the central government. Coordination of policies relating to fiscal incentives, financial sector measures, foreign investment and environmental concerns should be clear and not be at cross purposes. There are broader policy concerns relating to education and training. Creating human resources adequately trained for sectors where employment is also created would have to be a broader policy goal. At the level of state and lower levels of government there will be a need for continuous monitoring and building capacity to implement policies efficiently. Design of model procedures and contracts with wider applicability would help in streamlining implementation. ●

Annexures

Annexure AI.1

Infrastructure Development and Economic Growth

Trends in investment in the infrastructure sectors point to a relatively faster growth of infrastructure spending in the 1950s and 1960s and then relatively slow growth in the 1970s. However, in the period since the early 1980s, both GDP growth and infrastructure investment have kept pace with each other. Growth of GDP reflects both rising demand for infrastructure services as well as the availability of more resources for investment.

The strong relationship between infrastructure investment and economic growth is captured in the elasticity of infrastructure investment with respect to GDP. The estimated elasticity for selected sectors is summarized in **Table AI.1.1.**

Table AI.1.1
Elasticity of Investment in Infrastructure Sectors (Gross capital formation in constant prices)

Elasticity with respect to	Elasticity of investment in				
	Electricity, Gas & Water Supply	Transport, storage & communication	Transport	Communication	Total Infrastructure
Total GDP	0.673***	1.251***	1.334***	1.449***	0.995***
Forex reserves at beginning of year/ Annual Imports	0.148**	-0.008	0.088	-0.255**	0.040
Revenue deficit (centre+state)/ GDP	-0.050	0.058	0.038	0.087	0.003

Note:
1. *** = Statistically significant at 1% level.
2. ** = Statistically significant at 5% level.
3. Elasticity is estimated at (Forex/ Import) = 0.5 and (Revenue deficit/GDP) =2%
4. The estimated equation is of the form:
Log (GCF_Infrai) = a0 + a1 Log(GDP) + a2 (Forex reserves/Import value) + a3 (Revenue deficit of centre + states/ GDP) + AR and MA terms
where Infrai = Gross capital formation in real terms in the ith sector; EGW = Electricity, Gas and Water Supply; Infrastructure= EGW + Transport + Communication.

The coefficients in the regression model used for estimating the elasticity were estimated using the ordinary least squares approach after including AR and MA terms to make the error term stationary. The estimated elasticity suggests a close relationship between infrastructure investment and GDP. If economic growth does not retain its pace, infrastructure development cannot sustain its pace.

Thus, while further economic growth or sustaining economic growth may not be possible without infrastructure development, past experience suggests that achieving accelerated economic growth is necessary to stimulate investments in infrastructure spending. This may also be the factor which is driving greater focus on infrastructure spending in the EFYP, on the back of acceleration in economic growth for about decade and a half.

Annexure AI.2

The Inter-linkages of Infrastructure with the Economy

The concepts of backward and forward linkages are useful in assessing the impact of changes in the demand or output levels of a particular sector on the other sectors of the economy. The input-output analysis provides a method to quantify these linkages. Backward linkages refer to the impact of increase in the output of a downstream industry on its demand for inputs from upstream industries. For example, increased production of electricity would increase demand for a variety of other inputs in the generation of electricity. Forward linkages refer to increased production of an upstream industry on requirements of downstream industries. Thus, increased production of electricity would make its availability easy for downstream industries that use electricity as an input. The impact of backward and forward linkages is not uniform across industries. An industry may be strong in its backward linkage effects, forward linkage effects, both of these or none of these.

Here we provide estimates of such linkage coefficients for selected infrastructure industries. We follow the computations of backward and forward linkages based on the standard input-output model of an economy:

$AX + F = X$
and
$X = (I - A)^{-1} F$ or $X = BF$

where X is the n x 1 vector of total output requirement of the economy with n sectors of production; A is the n x n matrix of input coefficients; F is the n x 1 vector of final demand; and B is the n x n matrix of $(I - A)^{-1}$. aij are n x n elements of input coefficients of A-matrix of the input-output balances and bij are n x n elements of $(I - A)^{-1}$ matrix.

The backward linkage index, BL j is computed as:

$$BL_j = \frac{1}{n}\sum_{i=1}^{n} b_{ij} \Big/ \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}$$

The backward linkage for sector j reflects the effects of one unit increase in final demand in this sector on overall economic activity.

The forward linkage effect, FLi , is computed as:

$$FL_i = \frac{1}{n}\sum_{j=1}^{n} b_{ij} \Big/ \frac{1}{n^2}\sum_{i=1}^{n}\sum_{j=1}^{n} b_{ij}$$

The forward linkage for sector i reflects the effects of one unit increase in production of sector i on overall economic activity.

The estimated linkage coefficients are summarised in **Table AI.2.1.**

Table AI.2.1
Estimated Linkages between Infrastructure and the Rest of the Economy Using an Input-Output Structure

S. No.	Commodity/ Sectors	Backward Linkages	Forward Linkages	(FW + BW)
1	Electricity	1.0757	4.2787	5.3544
2	Land transport including via pipeline	1.0584	4.0225	5.0809
3	Construction	1.0872	2.0263	3.1135
4	Railway transport services	1.0449	1.6429	2.6878
5	Storage and warehousing	1.2173	0.5191	1.7364
6	Air transport	1.0267	0.5930	1.6197
7	Communications	0.7298	1.7647	2.4945

Source: Estimates based on the India CGE Model structure developed at NCAER.
Note: We have included 'construction' and 'storage and warehousing' sectors in the analysis because of the strong linkages between the core infrastructure sectors covered in the present study.

These estimates provide indications of very strong linkages between infrastructure sectors and the rest of the economy. A Re. 1 increase in the production of electricity will require an increase in the output of its input-supplying industries by Rs.1.07 and it will enable an increase in the output of the other electricity-using industries by Rs. 4.28. Generally, forward linkages are stronger than backward linkages for the infrastructure sectors, indicating their critical role in the economy.

Annexure AI.3

Impact of Improvement in the Efficiency of Infrastructure Sectors

The inter-linkages between various sectors of the economy through inter-industry investment and consumption flows are captured by economy-wide models such as the Computable General Equilibrium (CGE) Model. In the present study we applied the CGE Model of the Indian economy developed at NCAER (NCAER, 2009) to estimate the impact of improvements in the efficiency in infrastructure on the economy.

The shocks to the 'base run' scenario are through a reduction in import taxes across the sectors of the economy. The reduction implies that there are efficiency gains in the sectors because of the improvements in infrastructure with the reduction in taxes being: (1) proportional to the share of sectors as inputs to infrastructure services (Scenario 1) and (2) proportional to the share of infrastructure in the cost structure of the respective sectors. In this sense the two simulations reflect two alternative ways to look at the transmission of the impact of infrastructure improvement on the economy. In the first Scenario, the infrastructure efficiency improves as simulated by reduction of costs of inputs required for production of infrastructure services. In the second Scenario, the efficiency of all the sectors improves through the availability of more efficient infrastructure services. This has positive impact on the economy.

The model is based on the assumption of full employment and fixed levels of capital stock and labour. In this sense, the model simulations capture the effects of re-allocation of resources and gains in efficiency due to expansion of the scale of firms. The model incorporates increasing returns to scale and imperfect competition in the manufacturing sector, and perfect competition and constant returns to scale in agriculture and services.

The macro or aggregate level impact of the two simulations of the model has been provided in the main text. However, the results of the model also indicate the sectoral impact of infrastructure development. The sector-wise results show that the manufacturing sector gains the most from infrastructure development **(Table AI.3.1)** relative to the other sectors. With fixed levels of capital and labour, a re-allocation of resources leads to expansion of the manufacturing sector relative to the other sectors. Poor infrastructure as a bottleneck to the manufacturing sector's expansion is illustrated by these results. An explanation for the greater impact of infrastructure development on manufacturing is the high use of manufacturing products as inputs to manufacturing itself **(Table AI.3.2)**. Increasing returns to scale enhance the competitiveness of manufacturing and this advantage is further enhanced by the fact that the manufacturing sector also provides inputs to the other manufacturing sectors.

Table AI.3.1

Impact of the Improvement in the Efficiency of Infrastructure on the Gross Output of the Sectors: per cent change in Gross Output as Compared to the Reference Scenario

Sector	Scenario 1	Scenario 2
Agriculture & allied	-0.06	-0.08
Manufacturing	0.45	0.92
Infrastructure	0.13	0.14
Services	-0.06	-0.06
Overall	0.14	0.31

Source: Based on the results of a CGE model analysis for the Indian economy.
Notes:
(1) In Scenario 1, the efficiency of the infrastructure sectors improves due to a reduction in the cost of producing infrastructure services. In Scenario 2, the efficiency of all the sectors improves due to the greater efficiency of infrastructure sectors.
(2) Infrastructure sectors covered here are electricity, transportation and telecom. Irrigation is not considered in the analysis.

Table AI.3.2

Share of Inputs, Taxes and Contribution of Primary Factors of Production (GVA) to the Output of a Sector (per cent)

Item	Agriculture & allied	Manufacturing	Infrastructure	Services
Agriculture & allied	19	7	1	2
Manufacturing	7	42	29	12
Infrastructure	3	9	14	5
Services	5	12	13	11
Net indirect taxes	-6	6	2	2
Gross value added	70	24	41	68
Total Output	100	100	100	100

Source: Derived from Input-Output Transactions Matrix (CSO 2008).

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