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Risk management in a large rural electrification programme

Abstract

Although rural electrification projects and programs have been implemented in many countries, they suffered from design, planning, implementation and operational flaws. This paper presents a risk management framework in order to manage large scale development projects effectively. The proposed framework first identifies, with the involvement of the stakeholders, the risk factors of a rural electrification programme at three different levels. Subsequently it develops a qualitative risk prioritizing scheme through probability and severity mapping and provides mitigating measures for most vulnerable risks. The study concludes that the hierarchical risk management approach provides an effective framework for managing large-scale rural electrification program.

Key words: Rural electrification, risk identification, risk mapping, risk mitigation.

1. Introduction

Indian policymakers realised the importance of electricity supply to rural areas quite early, and even the first five year Plan (1951-56) considered rural empowerment through productive use of energy and electricity. Since then rural electrification efforts continued for over five decades, but the progress in rural electrification in India remains poor.

The literature on rural electrification has focused mainly on policy issues [e.g. Chaurey et al. (2004), Biswas et al (2004), Foley (1992), Ranganathan (1993), and Schramm (1993)]. Some case studies of country experiences (e.g. ESMAF (2005) and Yang (2003) among others] and project appraisal studies of projects financed by international funding agencies are also found. But the published literature has paid less attention to risk management aspects in rural electrification.

Large-scale development projects / programs are characterized by their complexities in terms of involvement of various stakeholders, high dependence on socio-economic and environmental factors, bureaucratic red tape, financial constraints, and non-transparent regulatory and legal frameworks. Management of those projects / programs requires considering these factors within the project / program planning framework in order to achieve successful implementation. Project risk management provides an analytical framework to deal with project complexities.

Risk management got prominence within the project management literature since mid-1990s. Risk management framework has been used to resolve various issues of project management (Chapman and Cooper, 1983; Cooper et al. 1985; Perry and Hayes, 1985; Kangari and Riggs, 1989; Yeo, 1990, Williams, 1995 and Dey and Ogunlana, 2001) and there are evidences of successful applications of risk management framework in industry (Dey et al. 1994; Halman and Keizer, 1998; Tumala and Leung, 1999; and Dey, 2002, and Dey and Ogunlana, 2004). Although, various tools and techniques are routinely deployed by the researchers and practitioners, every method has its own advantages and disadvantages when applied to specific cases. As large-scale projects / programs are executed in various levels namely national, state and project site, the risks involved in each level vary considerably. Hence, the risks are required to be identified in each level in order to analyze their effect on project outcome and subsequently suggest their mitigation measures.

The objective of this paper is to analyse the risks involved in a large rural electrification programme being implemented in India. The paper identifies the risks at different levels of the programme and prioritises them using risk mapping. Some mitigation options are also discussed.

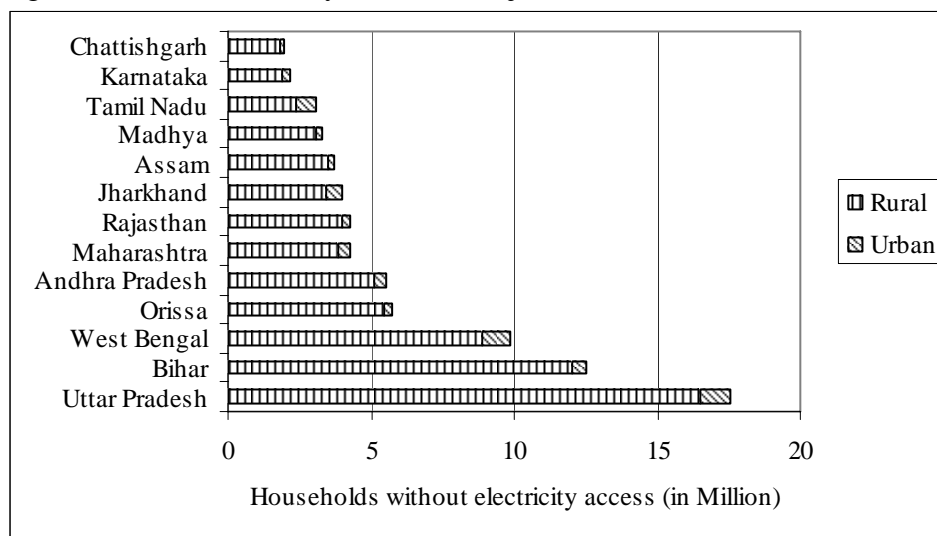
The organisation of the paper is as follows: section 2 provides a brief description of the programme being analysed in this paper. Section 3 illustrates the methodology of

the research. Section 4 is devoted to identification of risks. Section 5 presents risk analysis using risk mapping while section 6 proffers some mitigation options and section 7 concludes the paper.

2. Project background

India faces an important challenge in terms of providing electricity access to its population because of high concentration of population without energy access. According to Census 2001 data, out of around 192 million households in 2001, around 85 million do not have access to electricity¹. 78 million rural households lack access to electricity while the remaining 7 million are urban households. In percentage terms, 56.5% of rural households and 12% of urban households lack access to electricity in the country. According to IEA (2002), India houses the largest number of people in any country in the world without electricity. There is significant spatial variation in electricity access in the country and the situation is particularly grim in some bigger states (see figure 1). The figure covers more than 90% of the non-electrified households of the country and shows that five states (with more than 5 million households without electricity access) account for around 60% of those lacking electricity access in the country.

Fig. 1: Status of electricity access in major states



Data source: Census 2001 and Ministry of Power website (<http://powermin.nic.in>).

The Indian government has announced an ambitious plan for electrification of all villages by 2007 and universal electrification of households by 2012. It aims to ensure at least 1 kWh of electricity consumption by all households by 2012, round the clock supply of electricity in rural areas and availability of electricity on demand. The main vehicle chosen for implementing the universal access objectives of the Electricity Policy is a new programme (called Rajiv Gandhi Grameen Vidyutikaran Yojana) launched in April 2005. It aims to develop the rural distribution backbone and to create village electrification infrastructure by installing at least one distribution transformer in each village within next five years. The scheme intends to provide free

¹ According to Census 2001, the average household size is 5.3 persons. Accordingly, the size of population without electricity access is around 450 million.

electricity connection to all rural households lying below poverty line and to provide round-the-clock electricity supply to villages.

The main features of this programme are as follows (MoP, 2005):

- a) The federal government will provide 90% of the capital cost of the programme as a grant. This is a major shift from the earlier system of providing loans for rural electrification. If projects are not successfully implemented, capital subsidy will be converted to interest bearing loans.
- b) The scheme will help develop rural electricity backbone, install one distribution transformer in each habitation and promote decentralised and distributed generation and supply in remote areas where grid extension is not cost-effective or feasible.
- c) The scheme will be implemented through the Rural Electrification Corporation (REC).
- d) The projects financed under this scheme will be managed by franchisees, which can be local level organizations (such as NGOs, rural committees, etc.) or private entrepreneurs. States' prior commitment in this regard will be enlisted before project approval.
- e) For commercial viability of the franchisees, state revenue subsidy and suitable bulk power purchase tariffs will be determined. The scheme will employ bidding scheme wherever possible for determining the BST.

This programme merges the “Accelerated Electrification of 10 million households and 100,000 villages” and the Minimum Needs Programme for rural electrification. The first of these two was created by merging schemes like Kutir Jyoti (or Bright Home scheme) and Accelerated Rural Electrification Programme as recently as in May 2004 but because of the political changes since then, the programme did not receive much attention.

The government has estimated the cost of the universal electrification programme to be around Rs. 160 billion (\$ 3.8 billion) and the work will be spread over 10th (2002-2007) and 11th plan (2007-2012) periods. An allocation of Rs. 11 billion (\$ 0.26 billion) has been made for this purpose in the federal budget for 2005-06 (GOI, 2005a).

This is a major and ambitious rural electrification initiative taken by the government. As a new initiative, the programme involves a large number of potential risks that could affect the success of the programme. Rural electrification is nothing new to India, as the country embarked on such initiatives just after its independence. However, despite launching a number of schemes and initiatives, only 45% of the rural households have gained access to electricity in more than 50 years. Therefore, identifying the risks of such an ambitious project is important for proper management of such a programme.

3. Methodology

Risk analysis results in mitigation measures to ensure success of a project. It strengthens the project plan from the beginning and ensures time, cost and quality achievement. The subjective nature of risk implies that the experience of project executives helps in deriving the chance of occurrences and the effect of risks on project outcomes. It allows the project executives to be proactive for handling critical incidents that affect projects negatively.

Rural electrification projects aim at enhancing electricity access in a previously non-electrified area either by extending grid-based supply or where grid-supply is not feasible, by making alternative arrangements through non-grid distributed systems. Normally, these projects involve less technical complexities, and often standardised systems are used. However, given the limited funds, there is often a need to prioritise the areas to be electrified, which is often politically motivated. The revenue earned by the projects may be limited due to low consumption and non-remunerative tariffs, making the activity often a commercially unviable undertaking. Subsidies for capital expenditure and for meeting operating costs become an integral part of such projects.

As the programme under consideration involves the Central government, the states and the project sites, a three-level analysis has been carried out here. The Central government provides the funds for the programme, which is managed by the REC. In fact, REC is the implementing agency for the Central government. It receives the project proposals from the states, decides about their acceptability, enters into contractual arrangements with the states for project funding, disburses funds, monitors the progress and takes necessary actions at different stages of the programme implementation. States through their electric utilities identify the areas to be electrified, develop project proposals, submit proposals to the REC for approval, enters into contractual arrangements with REC, engage franchisees for projects, carry out tendering and other procurement processes, and are responsible for completing the tasks as required under the agreement with REC. Depending on the areas to be electrified, states may have a varying number of projects and at the project level, a contractor will be responsible for implementing the project (i.e. building the necessary infrastructure and connecting the consumers to the grid). Once the contractor finishes the work, it hands over the completed facility either to the franchisee appointed by the state utility or to the state utility itself as specified in its contract. The franchisee or the utility then undertakes necessary activities related to the supply business.

The risk management framework adopted in this study has the following 8 steps (see fig. 2).

Step1: developing project scope.

Step2: Forming work breakdown structure (hierarchical classification of the project work).

Step3: Identifying and analyzing risk in each level with the involvement of the concerned stakeholders.

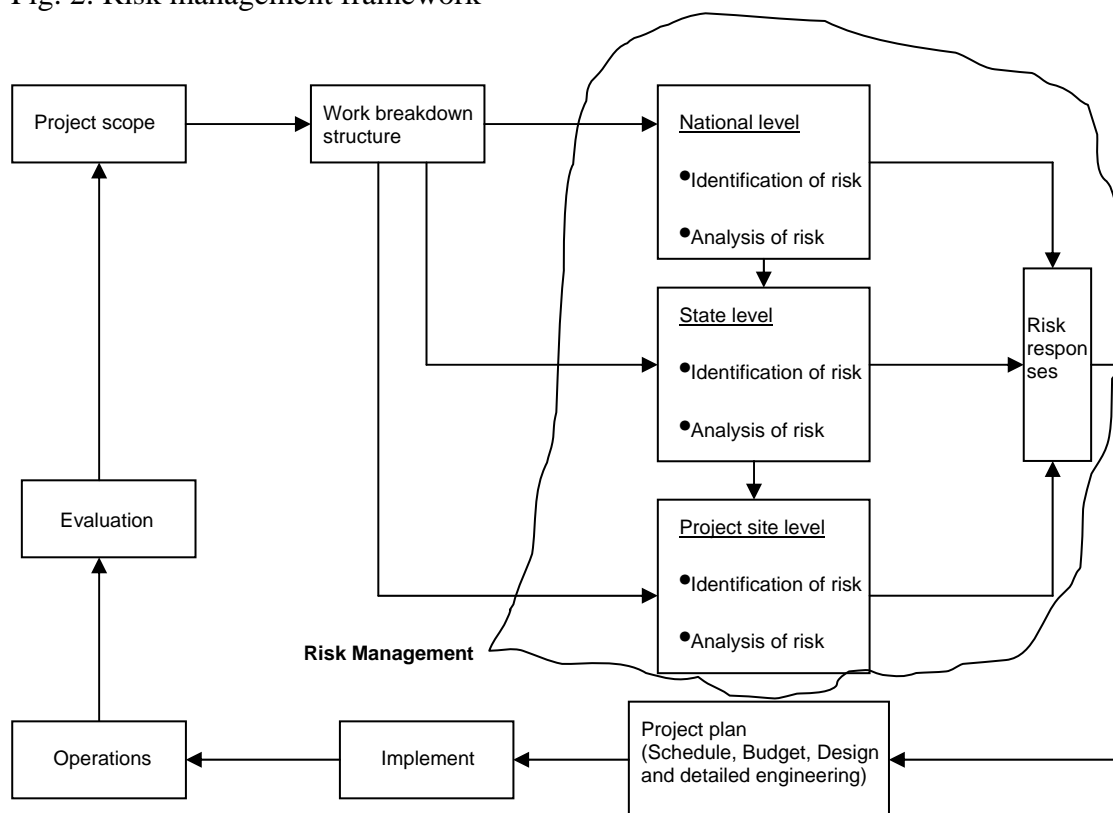
Step4: Developing risk responses.

Step5: Developing detailed project plan covering schedule, design and detailed engineering.

- Step6: Implementing project
- Step7: Operating the completed facilities
- Step8: Evaluating performance dynamically

The project information was gathered using secondary sources like website and published project-related documents. Risk factors have been identified initially through personal discussion with a number of specialists working on similar areas. After the specialists were briefed on the purpose of the study, Delphi technique (Stough et al. 2000) was adopted to identify the risks involved in each level. The authors worked as facilitators for the entire processes. They subsequently selected a risk analysis tool and Delphi method was again adopted in order to determine probability and severity of risk. Evidences and support from relevant literature have been used by the authors to justify the importance of the identified risks.

Fig. 2: Risk management framework



The remainder of the paper demonstrates the risk management processes of the rural electrification program under consideration in this paper.

4. Risk identification

As indicated earlier, the universal rural electrification programme in India involves tasks at three different levels. Accordingly, the risks have been identified at three levels: a) national, b) state and c) project and are discussed below.

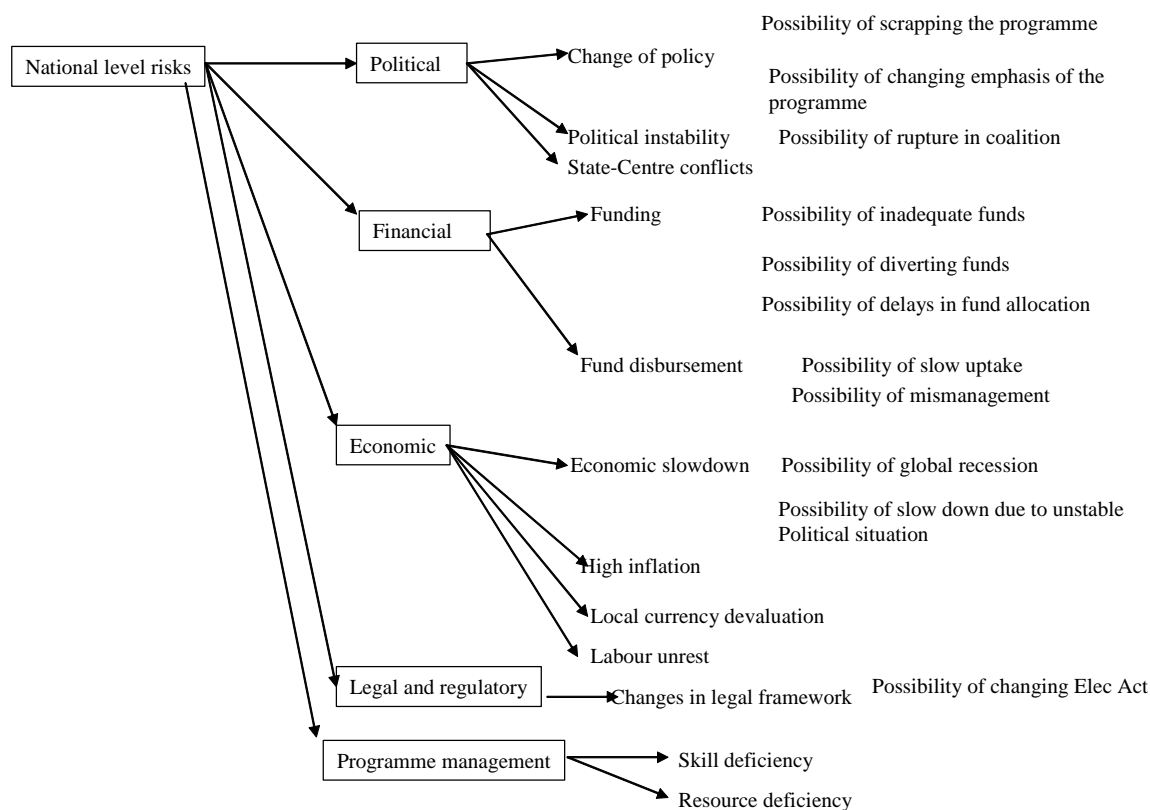
4.1 National level risks

Being a central government initiative, risks at the national level would involve macro-level concerns about the economy, finance, politics, project management, and legal and regulatory aspects that could influence the programme adversely (see fig. 3).

4.1.1 Political risk

The political risk arises because as a government sponsored programme, it required political support of the present coalition government. The National Common Minimum Programme promised creation of rural electricity infrastructure and completion of universal electrification within five years. The programme is designed to achieve these objectives.

Fig. 3: National level risks for the new rural electrification programme



However a change in the political support to the programme would adversely affect its successful implementation. This can arise due to three main factors:

- a) a shift in the policy of the government due to a number of factors, including changes in the economic environment, changes in political environment, and changes in the social context. A change in policy can lower its importance in the overall government policies, thereby affecting it adversely. In a more adverse situation, the programme may even be scrapped.

- b) a change in the coalition partners or a change in government due to inherent instability of any coalition politics. The present coalition government depends on the support of a large number of political formations and there are little ideological or other similarities among them. There is no guarantee that the coalition will be in office for full five years.
- c) A rise in the state-centre conflicts. As the state/regional-level political formations have gained strength in Indian politics, conflicts with states could adversely affect the support base of the coalition government, which in turn could affect the political support for the programme. State-centre conflicts can also affect implementation of the programme, as the projects will be implemented by the states.

The importance of the above risks can be appreciated from the following facts:

- a) The previous government launched the Accelerated Rural Electrification Programme and aimed at achieving very similar objectives as the present programme. But electoral loss in 2004 meant death of the programme and launching of its new avatar one year later.
- b) The period of one-party domination in the Indian politics has ended in late 1980s with the rise of regional level political powers, which led to the experiment of coalition governments at the national level. Between 1989 and 1999, 5 general elections were held to elect a new government and 7 governments were formed. As no single party had requisite numbers to form a government, managing the diverse aspirations of coalition partners constituted a main activity of the government.

4.1.2 Financial risks

The programme envisages a huge investment of Rs. 160 billion in rural electrification over a period of five years spread over two planning periods (10th Plan 2002-07 and 11th Plan 2007-2012). The actual budgetary support from the Central government for the power sector during the Ninth Plan (1997-2002) was around Rs. 140 billion (PC, 2002). Thus funding Rs. 160 billion just for rural electrification would be a major financial undertaking for the government. Moreover, PC (2002) indicates that the actual expenditure in the previous plan period was below the approved level due to non-mobilisation of funds.

For this programme, 90% of the Rs. 160 billion will be provided as Central grants to the states. Thus the central government has the responsibility of funding Rs. 144 billion while the rest Rs. 16 billion will be raised by the projects as loans. Two main financial risks for the project would be:

- a) risks related to fund availability. Inadequate funds arising from non-mobilisation of funds, inadequate allocation of funds or untimely allocation would adversely affect the project. Similarly, states were successful in the past in diverting plan funds to non-plan activities. Funds earmarked for rural electrification could find its way in other activities.
- b) Risks related to fund use. Even if funds are available, states may fail to utilise them in time due to lack of project identification, contracting or other implementation difficulties. PC (2002) indicates that states could spend 53%

of the approved allocation for the power sector during the 9th Plan. The problem of corrupt practices in such major projects cannot be ignored either. Thus, out of any given allocation, only a fraction will reach the project, the rest siphoned away through corrupt practices.

4.1.3 Economic risks

This category of risks is related to both financial and political risks. Often political instability leads to economic crisis, which in turn would make financing such programmes more difficult. Although a large number of factors can affect economic viability of the programme, we consider the following:

- a) Economic slowdown – the 10th Plan aimed at an economic growth of 8% per year. However, during the first three years of the Plan period, the economy did not grow at this rate. The economy grew at 4.6% during 2002-03, at 8.3% during 2003-04 and at 6.9% during 2004-05 [(PC, 2004) and GOI (2005b)]. The average growth is less than the targeted growth and it is unlikely that the shortfall in growth target could be made up in the remaining period. Moreover, external environment has changed significantly in recent times with oil prices reaching \$60 a barrel, leading to a prospect of global economic slow down and readjustment of economic activities. In this condition, high economic growth may not be feasible and may not last long. An economic slow down will affect resource mobilisation and shift economic priorities. This will affect the programme prospects.
- b) Inflation – The 1990s was the decade of benign global inflation and India was no different. The inflation rate reached 1.6% in 2001-02 but increased to 6.4% in 2004-05 (GOI, 2005b). This was fuelled by increases in fuel and power prices due to a hardening of international oil and mineral prices. Increasing oil prices risks higher inflation, which would affect the cost estimates for the programme.
- c) Currency devaluation – Some components of the rural electrification project may require import of equipment, spare parts and materials. International oil price volatility puts pressure on foreign exchanges and terms of trade of any importing country. India faced balance of payment problems earlier. Although the situation has improved significantly and India now has a large foreign exchange reserve, yet high oil prices could lead to economic difficulties, prompting weakening of local currency. The cost estimates in such a case would be affected, which in turn would adversely affect the programme.
- d) Labour unrest – The trade unions recently threatened to go for strike unless their demands for review of the Electricity Act 2003 are met. Employees concerned about their job prospects could engage in disruptive activities, thereby creating a negative environment for investment in the industry.

4.1.4 Legal and regulatory risks

A number of legal and regulatory risks surround investment, implementation and management of rural electrification infrastructure. The basic legal framework for the electricity sector is provided by the Electricity Act 2003. The Act requires the Central

government to formulate a rural electricity policy, which has not yet been formally adopted. The present government upon assuming office agreed to review the Electricity Act 2003. The government is under continuous pressure from the trade unions and other leftist parties to undertake a comprehensive review of the act. The review may alter the legal position with respect to rural projects.

Another major concern lies in the ambiguity regarding organisation of the projects funded through this programme. REC suggests that the states should agree to involve franchisees for the newly funded projects. However, their scope and mode of work, selection procedure, qualifying skills and capabilities and other details have not yet been worked out. This can turn out to be a major stumbling block for the programme implementation.

The regulatory aspect also remains unclear at this stage. Under the provisions of the Electricity Act 2003, rural supply can be arranged through the utility, by an agent of the utility or by engaging electricity service providers in notified areas. For the latter option, it appears that the regulatory bodies will not have any supervisory role. This would bring the issues of consumer protection, prevention of misuse of monopoly power and protection of investment of the supplier. Ambiguities in this area are a source of concern for the programme.

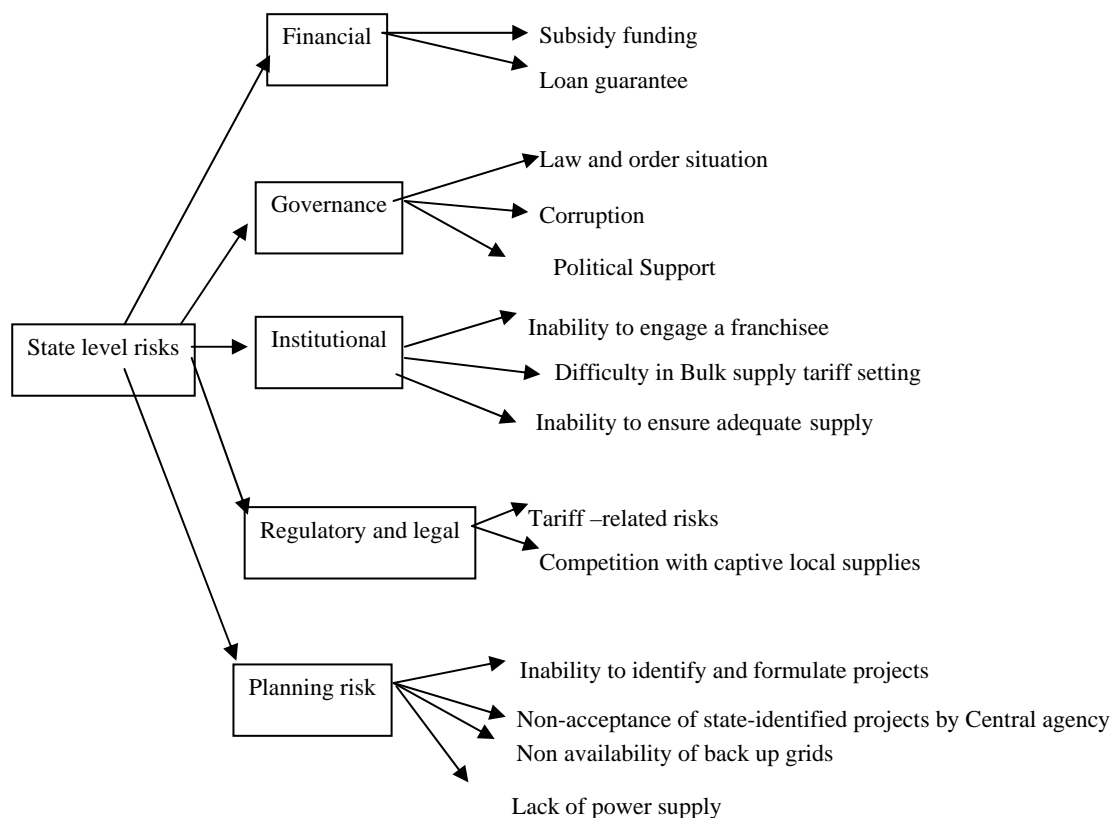
4.1.5 Programme management risks

Managing such a programme is no mean task. The implementing agency will be involved in project appraisal, approval, monitoring and funding of hundreds or thousands of projects proposed by various states. These activities will affect the resource planning of the agency, as being one time activities the agency is unlikely to hire new people to complete these tasks. At the same time, it may be hard for existing employees to manage this volume of work. Similarly, finding requisite skills at a short notice may be an issue as well.

4.2 State level risks

The state agencies would identify the projects, prepare project documentation for seeking REC approval, enter into agreements with the REC and the Central government for undertaking necessary actions, and implement the projects either through the state utilities or with the help of central sector utilities or through a turn-key contract. A number of risks can be identified at this level (see fig. 4).

Fig. 4: State level risks in the new rural electrification programme



It needs to be mentioned that three categories of states could be identified in India in terms of level of rural electrification: areas of high rural electricity access (more than 70% of the population having access, totalling around 7 million households)², moderate level of rural electricity access (above 40% but less than 70%, with 20.5 million households)³ and areas of low electricity access (less than 40% access, with another 50.5 million households)^{4,5}. The risk is likely to vary from one state to another due to different levels of economic growth, political condition, and other factors. A comprehensive analysis should take this variation into account but there is always the trade-off between realism and manageability of analysis. In our case, risks in the low access areas would affect the programme most, followed by those in the moderately electrified areas. Accordingly, more consideration would be given to these areas.

4.2.1 Financial risks

Although the programme has made provision for financing capital investments, it is recognised that many rural electrification projects may not be viable without revenue subsidy, at least in the initial years. The programme envisages that the states would be providing such funds. In fact, at the time of proposing any project, the state

² These areas include: HP, Punjab, Delhi, Goa, Haryana, Sikkim, J&K, Karnataka, Gujarat, Tamil Nadu, Pondicherry, Dadra and NH, Lakswadeep, Daman and Diu, and Chandigarh.

³ These areas include: Andaman & Nicobar, Maharashtra, Kerala, MP, AP, Nagaland, Manipur, Uttaranchal, Chattishgarh, Arunachal Pradesh, Mizoram and Rajasthan.

⁴ These areas include: Tripura, Meghalaya, West Bengal, UP, Orissa, Assam, Jharkhand and Bihar.

⁵ Data Source: Census India 2001 and Ministry of Power, GOI, India.

undertakes to provide necessary revenue subsidy. However, most of the Indian states are facing financial crisis and are already burdened with subsidy for the power sector for agricultural and residential consumers. According to GOI (2005), the states transferred Rs. 98 billion to the power sector in 2004-05 as subvention, yet Rs. 175 billion remained as uncovered subsidy in that year. Additional subsidies for new rural electrification projects would impose heavy burdens on the state finances, especially those having poor electricity access. The financial condition of these states is already precarious. Inability of states to provide revenue subsidy is expected to affect programme implementation considerably.

The state also assumes two other financial risks. If any project is not successfully implemented, the grant component will be converted to interest bearing loans. The added financial responsibility will then effectively be borne by the state. Similarly, the state will have to guarantee the loans funds used for such projects, thereby increasing its contingent liabilities.

4.2.2 Governance risks

Governance related issues can be a major concern in some of the areas where electricity access is low. Low rural electrification and poor governance is likely to have a close link. Three factors could affect successful completion of electrification projects:

- a) Law and order situation in some areas may not be conducive for undertaking such investment projects. Terrorist activities, kidnapping and other anti-social activities may prevent implementation of projects in some rural areas. The states where rural electrification has progressed less are the states facing similar problems. Examples include Bihar, Jharkhand, Tripura, Assam and UP.
- b) Similarly, high levels of corruption may lead to paper projects without any real basis for them. According to a recent survey, Bihar was the most corrupt state in the country. Jammu and Kashmir, Assam and Jharkhand also appeared as significantly corrupt states⁶.
- c) Finally, given high level of central support for the project, political conflicts may arise in states where opponents of the central government have a strong presence. The politicisation of the electrification projects can lead to delays and law-order problems and other conflicts as well, affecting progress of the project.

4.2.3 Institutional risks

A number of institutional arrangements have to be met before the projects can be taken up. The Project Guidelines issued by the REC suggest that the states would have to ensure that franchisees would be involved in the management of the projects created through this programme. However, the jurisdiction and scope of work of such

⁶ Transparency International India, 2005, India Corruption Study 2005 to improve governance, Vol. 1, Key Highlights, New Delhi, India (see http://www.prajanet.org/newsroom/internal/tii/ICS2k5_Vol1.pdf, last visited on August 19, 2005).

franchisees have not been clarified so far. It is our understanding that under the Electricity Act 2003, states can follow two options: they can notify certain areas as rural and such areas are then exempt of licence requirements. Private or other investors can develop rural systems there. For such notified areas, the issues of tariff setting, consumer protection, management of subsidies, and other regulatory issues remain unresolved. A second option would for the licensee or state utility to engage an agent to carry out certain activities on behalf of the utility (or licensee). Either of the options should qualify for the REC requirement, although it appears that the REC implies the latter option. But none of the approaches has been tested so far, practical and legal problems are quite likely to arise. Failure to involve franchisees can arise as an important institutional issue affecting the programme implementation.

Another requirement is that the states will be able to set bulk supply tariffs so that the franchisee is commercially viable. Practical difficulties may arise in satisfying this requirement. Electricity tariffs are decided by the regulatory commissions, who consider the commercial viability as well as other factors of different stakeholders. As rural supply created through this programme would bear mostly operating costs (because assets are created through 90% grant capital), separate costing has to be done for each new project area. Depending on the number of projects in each state, the tariff determination would become complex. Similarly, depending on the rural consumer mix, each project will have its own earning potential, requiring separate accounting for subsidies to be claimed from the state. Average bulk tariffs as is normally decided by the regulators may not be sufficient for new RE projects. Additionally, discriminatory differential bulk supply tariffs may not be legally tenable and could lead to legal conflicts. Finally, regulatory capability may be lacking for such complex tariff determination and the entire process may be delayed.

States are required to ensure that non-discriminatory round the clock supply would be available for new project supplies. Given that the country has peak shortage, and such shortage is likely to continue in the future, committing to such a requirement may require either new capacity addition, or buying power from others or reducing supply to other areas. Each of these options bears own risk and can lead to violation of other agreements or imposition of penalties or social problems. Non-satisfaction of this commitment could lead to breach of agreement and consequent penalties.

4.2.4 Regulatory and legal risks

Any RE project will be affected by tariff policy and tariff determination process. In India, states have mostly followed uniform tariff policy in the entire state. Some states offer some discounts for rural areas but this is mostly on ad-hoc basis. Regulators would face a dilemma in respect of new projects: whether to charge consumers of project area at the same rate as elsewhere or to apply differential rates. Such a decision would have to consider the following issues:

- a) lower fixed costs for the distribution assets, as assets are created through grants;
- b) higher energy costs due to higher losses in distribution;
- c) possibility of higher commercial losses due to poor billing and collection;
- d) higher operating costs due to remoteness of areas and possible increase in costs due to franchisee involvement.

While differential tariffs could be justifiable, they may be more prone to legal challenges and disputes. Similarly, regulators may not adopt cost-reflective tariffs, which would affect the viability of the projects.

Grid supply may come in direct competition with informal, local supplies that may be operating in some rural areas. Although such operations are legally prohibited without licence from the regulator, they are known to be operating in many areas. Even in urban areas, captive supply is quite common during periods of forced load-shedding. Such suppliers may turn hostile to grid extension and could try to block project implementation.

4.2.5 Planning risk

The programme relies on the states to formulate the projects. Depending on the preparedness of the states and their utilities, it may not be possible to formulate attractive projects covering all non-electrified areas. This may cause delays in project approval and implementation, leading to non-achievement of the targets.

Another factor that can delay project planning is the non-acceptance of projects identified and formulated by the states. One area of confusion appears to be use of off-grid technologies for rural supply. The programme brochure indicates that the programme would cover both grid extension and off-grid supplies. However, it appears that off-grid supply comes under the purview of Non-Conventional Ministry and would require their approval, while REC would approve grid-extension projects. Similar confusions could delay project and programme implementation.

Lack of satisfactory back up grid arrangement and power supply arrangements could impede project development in a number of states.

4.3 Project level risks

Distinct risks can also be identified at the project level. Figure 5 indicates some such risks.

4.3.1 Economic risk

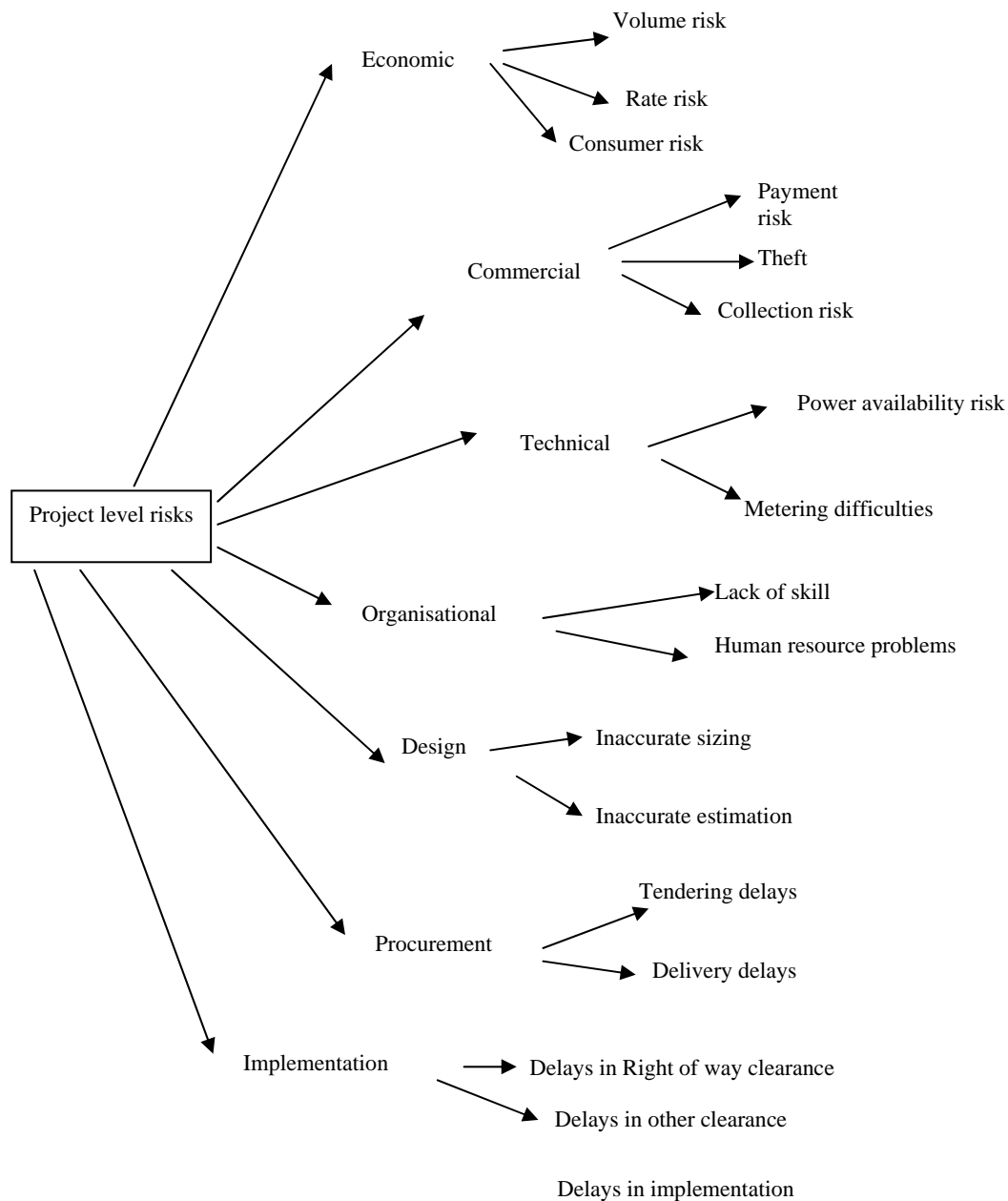
Each project faces at least three economic risks, namely volume risk, rate risk and consumer risk.

- a) The volume risk arises due to variation between design demand and actual realised demand. A major area of risk would be demand from productive use of electricity. It is likely that for project viability, a certain amount of productive use of electricity would be considered but such demand may not be realised in practice, at least in the short-run.
- b) Rate risk arises due to uncertainty in the electricity purchase and selling rates, both of which would be regulated. Indian states have not yet implemented

long-term tariff principles. In absence of such tariffs, any assumption about future tariff rises could go wrong.

- c) Consumer risk arises because of the difference in design and actual level of consumer size and mix. A project may expect all households would be connected after electrification but some consumers may not afford the connection charges and initial costs. The assumed consumer mix may not realise in practice. Another source of variation is the change in population in the area. The projects are likely to be based on 2001 Census data but the population size would surely change between 2000 and 2007, when the projects are likely to be implemented, leading to substantial differences.

Fig. 5: Project level risks



4.3.2 Commercial risks

Commercial viability of the project would depend on timely billing and collection, minimisation of commercial losses and payment of dues. These areas remain problematic for many electric utilities.

- a) Billing and collection efficiency remains low. For example, techno-commercial⁷ losses in the distribution system in Orissa post-reform were around 70% (Kanungo Committee Report, 2001). Billing and collection efficiency is expected to be low in rural areas but the project may not use such realistic levels of billing and collection factors for fear of objections in the approval process.
- b) Commercial theft is a particular problem in Indian electricity scenario. Non-metering of consumption led to use of estimation procedures, which offered room for manipulation. All consumers would be metered in this programme but meter tampering, mal-functioning of meters, incorrect meter reading and incorrect billing would lead to commercial losses. Any difference between the projected level of loss and actual loss would affect the project.
- c) Payment default is another particular problem in India. This problem is quite pervasive covering all types of consumers - government offices, public sector undertaking units, large and small consumers. Arrears in payments lead to cash flow problems for the supply provider and non-payment of its dues to its suppliers, creating a chain of defaults. Although consumers should be disconnected even they default beyond a certain period, this option is not employed quite regularly.

4.3.3 Organisational risks

Two particular issues could be relevant here.

- a) Lack of requisite skill at the local level for operating and maintaining the system is a major concern. Franchisees, if they are NGOs or local administration, engaged in these projects are not likely to possess requisite skills for electricity supply.
- b) A related concern is inability of the utility to transfer and engage a section of its distribution business staff to manage these rural projects. Staff used to work in urban areas would be quite unlikely to move to rural areas. Most state utilities did not have adequate staff for managing their existing rural activities. Human resource issues could become a major constraint at the project level.

4.3.4 Design risks

Each project will design the distribution system for the project area and decide the voltage level of the system, sizes and numbers of the substations and distribution transformers. The number of meters and other consumer connection kits would also

⁷ Techno-commercial loss captures the totality of loss, both technical as well as commercial, owing to non-billing, non-collection, theft etc. This is estimated as follows: $1 - \frac{\text{billing in kWh}}{\text{input in kWh}} \times \frac{\text{collection in monetary units}}{\text{Billing in monetary units}}$.

be estimated at this stage. Inaccurate system sizing and estimation could have a significant bearing on the project implementation.

As indicated earlier, the baseline information expected to be used for these projects is Census 2001 data. However, as the projects are implemented between 2007 and 2012, the basic information will undergo significant changes. Unless the information is updated, undersized system and shortage of meters and connection kits is quite likely.

Another source of error would be the assumptions relating to consumer mix and consumption pattern. If project design relies on standard, average mix and consumption pattern without paying attention to the local specific conditions, inaccurate estimation is quite likely.

4.3.5 Procurement related risks

A number of procurement related risks could arise for such multiple site projects. Each individual project is likely to be small but the procurement would involve a large number of small projects which are not identical. Specifications have to be prepared for each project but to achieve a critical mass of procurement, tendering may be done for a number of projects. Tendering for each individual project could lead to poor response and could attract small suppliers with limited experience. Combined tenders could receive better response but may lead to tendering delays.

As each project would procure its requirements individually, little or no co-ordination on the part of the procurer may result. Even if projects are tendered at the state level through a single agency, there would be little co-ordination with other states and each state would compete for placing orders and securing supply within a limited period of time. Given a limited number of suppliers locally, this could expose them to the risk of placing the order to a limited number of suppliers, who may not be in a position to ensure delivery in time due to limited capacity at their plants. Using international suppliers has its own set of risks and unless these aspects are taken care of, procurement delays could result.

4.3.6 Implementation risks

Right of way clearance is required for each project. As electrification projects require passing live lines through residential areas, some difficulties can arise where residents are unaware of the benefits and hazards.

Similarly, environmental and other clearances could delay project implementation. Although there is no significant environmental concern of electrification projects, forest clearance may be required in some areas, which may cause delays.

Delays may result due to poor mobilisation of workers, poor transportation of equipment and materials, unfavourable weather conditions, and other factors. Manual stringing of lines could be affected in extreme summer or rainy seasons. This season is also prone to storms, which could affect the implementation. Mobilising locally

available unskilled workers and transportation difficulties in rural areas could delay implementation.

5.0 Risk Mapping

A two dimensional risk mapping has been used to prioritise the risks identified earlier. The probability of occurrence of a risk and the severity of impacts have been categorised under three qualitative scales: high, medium and low. Evidently, risks occupying the high probability and high severity space will receive highest priority. Risks occurring in the high-medium combinations would also require careful attention. On the other hand, risks occurring in any other space may be managed more easily. Risks identified at three levels are mapped separately below.

5.1 National level risk mapping

At the national level, funding risk appears as the high probability –high impact risk due to huge funding obligation (more than \$3 billion), only a fraction of which has been committed so far. Fund utilisation problem, especially in poorly electrified states, is another risky area. This is dependent on state-level risks of project identification, satisfying franchisee requirements, and subsidy funding. Although economic slowdown would severely affect the programme, it is considered as a low probability event. Table 1 presents the risk mapping at the national level.

Table 1: National level risk mapping

Severity of impacts	Probability of occurrence		
	High	Medium	Low
High	<ul style="list-style-type: none"> • Funding 		<ul style="list-style-type: none"> • Economic slowdown
Medium		<ul style="list-style-type: none"> • Fund disbursement 	<ul style="list-style-type: none"> • Political instability • Currency devaluation • Skill deficiency
Low		<ul style="list-style-type: none"> • Inflation • Labour unrest • Resource deficiency 	<ul style="list-style-type: none"> • Change of policy • State-Centre conflicts • Change in legal framework

5.2 State level risk mapping

At the state level, availability of revenue subsidies would affect projects critically. Accordingly non-availability of revenue subsidies or inability to fund revenue subsidies would be a high risk event. Electricity supply shortage is expected to have a high probability of occurrence but as the electrification project could go ahead even with partial supply, the impact is considered as medium. Similarly, inability to engage franchisee would affect the programme adversely, violating the contractual agreement with states. But as the states can choose from a list of options, the probability of

occurrence of such an event can be considered as medium. Bulk supply tariffs being dependent on regulatory bodies, it is quite likely that suitable tariffs as required by the programme may not be available. This would affect the project viability, subsidy requirement and eventually programme implementation. This has been considered as a medium risk event. Table 2 shows the risk mapping at the state level.

Table 2: State level risk mapping

Severity of impacts	Probability of occurrence		
	High	Medium	Low
High	<ul style="list-style-type: none"> • Subsidy funding 	<ul style="list-style-type: none"> • Inability to engage franchisee 	<ul style="list-style-type: none"> • Tariff related issues
Medium	<ul style="list-style-type: none"> • Inadequate supply 	<ul style="list-style-type: none"> • Bulk supply tariff problems 	<ul style="list-style-type: none"> • Political support • Law and Order • Non-acceptance of identified projects
Low		<ul style="list-style-type: none"> • Corruption 	<ul style="list-style-type: none"> • Loan guarantee • Competition with captive local supplies • Non-availability of back up grids

5.3 Project level risk mapping

At the project level, human resource related issues are expected to have high probability of occurrence given the large number of projects to be covered under the programme and unwillingness of electric utility staff to move to rural areas. However, use of franchisee options or agents would allow engaging non-utility staff for certain important activities (such as billing and collection) thereby mitigating the impact to some extent. Accordingly, the severity of impact has been considered as medium. Risks involving commercial operation of rural schemes (such as metering, theft of electricity, collection, payment, etc.) are likely to occur quite frequently (and hence considered as a medium probability) but the severity is likely to be moderate because of partial nature of the influence on the concerned activities. Table 3 presents the risk mapping at the project level.

Table 3: Project level risk mapping

Severity of impacts	Probability of occurrence		
	High	Medium	Low
High	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> • 	<ul style="list-style-type: none"> •
Medium	<ul style="list-style-type: none"> • HR problems 	<ul style="list-style-type: none"> • Rate risk • Payment risk • Theft • Collection risk • Metering difficulties • Lack of skill 	<ul style="list-style-type: none"> • Delivery delays • Delays in right of way clearance
Low	Power availability	<ul style="list-style-type: none"> • Volume risk • Consumer risk 	<ul style="list-style-type: none"> • Tendering delays • Delays in other

-
- | | |
|---|------------|
| <ul style="list-style-type: none">• Inaccurate sizing• Inaccurate estimation | clearances |
|---|------------|
-

6.0 Risk mitigation

All risks identified above could affect the project performance but as mentioned earlier, those with high or medium probability and impact combinations would require most attention. The rest could be mitigated by taking adequate care at the time of project development/ implementation. In the following paragraphs we discuss mitigation of important risks identified above.

Funding risk – Project prioritisation could be used to mitigate this risk. Instead of starting all feasible projects that would be required to provide universal electrification, projects that could be financed with already allocated funds could be taken up first. Those projects with high impact in terms of access provision could be considered on a priority basis. However, instead of locating all projects in a single area, a suitable mix of projects from different states would have to be selected taking into consideration credible revenue subsidy commitments from states, states capability to manage projects, and likely HR issues. This would limit the project exposure to available funds and would ensure better project management. As the programme is planned to be carried out in 5 to 7 years, phased implementation of projects would be highly desirable.

Subsidy funding – Reliance on government commitments to provide revenue subsidy may not be enough for commercial operation of new facilities. Budgetary allocation for revenue subsidies or an arrangement to provide subsidy from Centre's allocation to states could reduce risk in this respect. The problem with subsidy is unlike capital funding, revenue subsidy is a recurring cost and could affect project viability at a future point in time unless projects become self-reliant. Encouragement and commitment to reduce reliance on subsidies would also be required.

Inadequate electricity supply – A number of alternative strategies could be adopted to ensure adequate electricity supply. On a longer term perspective, the national electricity capacity expansion plan should be formulated taking the effect of universal rural electrification into consideration. In the short term, promotion of energy conservation measures, improved maintenance and loss reduction could provide some respite. Another alternative could be to examine the possibility of integrating local level generation based on alternative energy sources (such as biomass, small hydro, etc.) with grid supply.

HR problems – Resolving this potentially risky area would require a transparent and open dialogue with the staff of the electric utilities to address their genuine concerns. Financial incentives, non-discriminatory treatment and flexibility in approach would be essential.

Fund disbursement – Slow or undesirable utilisation of allocated funds could be checked by adopting a proper project management framework. Close project monitoring scrutiny, taking corrective action at appropriate time, adopting proper accounting and record-keeping practices should reduce this risk.

Inability to engage franchisee – This potential risk could be mitigated in two ways:

- 1) Developing a clear framework for engaging a franchisee. As indicated earlier, this aspect has received little attention at the programme development stage. By clarifying the issues surrounding franchisee engagement, the risk could be reduced.
- 2) By amending or removing this requirement from the set of pre-conditions. However, it may be politically sensitive to remove the requirement.

Bulk supply tariff problems – As state regulators are unlikely to accept discriminatory bulk supply tariffs or tariffs affecting the financial health of electric utilities, resolution of this problem would depend on the state revenue subsidy policy.

Risks related to project operation – Proper operations management practices should be able to mitigate most of the risks. Theft of power is quite unlikely without connivance of the staff. Accurate metering, timely billing, regular collection and payment of dues fall under commercial management of utility activities. Computerised record keeping systems, flexible arrangements for payments and judicious application of legal provisions are required to contain these risks to a large extent.

7. Conclusion

The objective of this paper was to highlight the risks involved in a large rural electrification programme. We have identified risks at three different levels: at the federal government level, at the state (or provincial) level and the project level. Detailed risk factors have been identified and discussed. These risks were then prioritised using risk mapping. We have identified that funding risk remains the most important for the programme. Committing a staggering \$4 billion for the programme requires careful consideration and political will. Funding revenue subsidies for individual projects, inadequate electricity availability and HR-related issues also appear as important risks. We suggest that project prioritisation could help reduce funding risk while revenue subsidy for the projects may be directly recovered from the Centre's allocation to states. Encouragement to reduce reliance on subsidies will also make the programme sustainable. Use of local level generation facilities using alternative resources, energy conservation and loss reduction could help avoid electricity availability problem in the short-term. Better internal communication with staff and transparent transfer policies could help resolving human resource related problems.

A gigantic programme of this magnitude involving many stakeholders at different levels requires careful project management skills. By identifying the risks involved and taking mitigating actions better results could be achieved. It appears that the

programme so far has not given careful consideration to the risk aspects and only better risk management practices could improve the prospects of programme success.

We think the hierarchical risk analysis framework presented here is appropriate in this case. We also believe such a method would be useful in managing risks in other large development programmes and infrastructure projects in large developing countries where stakeholders at various levels affect project success and outcome. We see scope for further analytical and application-oriented research using such a framework.

References

Biswas, W., M. Diesendorf and P. Bryce, 2004, Can photovoltaic technologies help attain sustainable rural development in Bangladesh? *Energy Policy*, 32(10), pp. 1199-1207.

Chapman, C. B. and Cooper D. F. (1983). Risk analysis: testing some prejudices. *European Journal of Operational Research*, 14: 238-247.

Chaurey, A., M. Ranganathan and P. Mohanty, 2004, Electricity access for geographically disadvantaged rural communities—technology and policy insights, *Energy Policy*, 32(15), pp. 1693-1705.

Cooper, D. F., MacDonald, D. H. and Chapman, C. B. (1985). Risk analysis of a construction cost estimate. *International Journal of Project Manage.* Vol 3 no 3: 141-149.

Dey, P.K. Tabucanon, M.T. and Ogunlana, S.O. (1994). Planning for Project Control through Risk Analysis; a case of Petroleum Pipeline laying Project. *International Journal of Project Management.* Vol. 12 no. 1:23-33.

Dey, P. K. and Ogunlana S. O. (2001). Project time risk analysis through simulation. *Cost Engineering*, Vol. 34. No. 7: 24 – 32.

Dey, P K, (2002), “Project Risk Management: A Combined Analytic Hierarchy Process and Decision Tree Analysis Approach”, *Cost Engineering Journal American Associate of Cost Engineering International (AAACEI)*, Vol. 44 no. 3 March 2002. 13 – 26.

Dey, P K, and S O Ogunlana, (2004), “Selection and application of risk management tools and techniques for Build-operate-transfer Projects”, *Industrial Management and Data Systems*, Vol. 104 No. 4, pp 334 – 346

ESMAP, 2005, Meeting the challenge of rural electrification in Developing nations: the experience of successful programs, Energy Sector Management Assistance Program, World Bank, Washington, D.C. (see http://www-wds.worldbank.org/servlet/WDS_IBank_Servlet?pcont=details&eid=000160016_20050719102924, last visited on August 31, 2005).

Foley, G., 1992, Rural electrification in the developing world, *Energy Policy*, 20(2), pp. 145-152.

GOI, 2005a, Key features of Budget 2005-06, Government of India, February 2005, New Delhi (see <http://indiabudget.nic.in/ub2005-06/bh/bh1.pdf>, last visited on August 31, 2005).

GOI, 2005b, Economic Survey, Ministry of Finance, Government of India, New Delhi (see <http://indiabudget.nic.in>, last visited on May 25, 2005).

Halman, J. I. M. and Keizer, J. A. (1998). Risk Management in product innovation projects. *International Journal of Project and Business Risk Management*, Vol. 2, No. 2..

IEA, 2002, World Energy Outlook, International Energy Agency, Paris. (Chapter 13, which deals with energy access and the poor is available from <http://www.worldenergyoutlook.org/pubs/weo2002/EnergyPoverty.pdf>, last visited on March 25, 2004)

Kangari, R. and Riggs, L. S. (1989). Construction risk assessment by linguistics. *IEEE Transaction on Engineering Management*, Vol. 36 No 2: 126-131.

Kanungo Committee Report, 2001, Report of the Committee of Independent Experts, Submitted to Government of Orissa, Bhubaneswar.

MOP, 2005, Rajiv Gandhi Grameen Vidyutikaran Yojana, Brochure, Ministry of Power, Government of India (see http://recindia.nic.in/download/RGGVY_brochure.doc, last visited on May 4, 2005).

PC, 2002, Chapter 8.2, Power, in Chapter 8 on Infrastructure, 10th Five Year Plan (2002-2007), Planning Commission, Government of India, New Delhi (see http://planningcommission.nic.in/plans/planrel/fiveyr/10th/volume2/v2_ch8_2.pdf, last visited on August 15, 2005).

PC, 2004, Approach to the Mid-term appraisal of the Tenth Plan (2002-2007), Planning Commission, New Delhi (see http://planningcommission.nic.in/plans/planrel/mta_10th.pdf, last visited on August 15, 2005).

Perry, J.G. and Hayes, R.W. (1985). Risk and its management in construction projects. *Proceedings of the Institute of Civil Engineering* 78/1: 499-521.

Ranganathan, V., 1993, Rural electrification revisited, *Energy Policy*, 21 (2), pp. 142-151.

Schramm, G., 1993, Rural electrification in LDCs as a tool for economic development: facts and fiction, *Opec Review*, Winter, pp. 501-517.

Stough S. Eom S. and Buckenmyer J., (2000), "Virtual teaming: a strategy for moving your organization into the new millennium", *Industrial Management & Data Systems*, Volume 100, Number 8, pp. 370-378(9)

Tummala, V. M. R and Leung, Y. H. (1999). Applying a risk management process (RMP) to manage cost risk for an EHV transmission line project. *International Journal of Project Management*, Vol.17no. 4: 223-235.

Williams, T. M. (1995). A classified bibliography of recent research relating to project risk management. *European Journal of Operational Research*, Vol. 85, No. 1: 18-38.

Yang, M., 2003, China's rural electrification and poverty reduction, *Energy Policy*, 31(3), pp. 283-295.

Yeo, K. T. (1990), Risks, classification of estimates and contingency. *Journal Management in Engineering*, Vol. 6 No 4: 458-470.