3 | POWER

The importance of the power sector was recognized in the mid-1990s and the sector has since witnessed innovative financial engineering as well as the introduction of incentive-based schemes funded by the central government. Different states are at dissimilar stages of development and no one superlative model of reorganization of erstwhile state electricity board has emerged. The experience of the privatization of Delhi power distribution suggests that there is no short cut to improve efficiency of the distribution system. There are many private power generation companies and under the Electricity Act 2003, there will be many others in the foreseeable future.

The power sector, an early pioneer of reform, has progressed through a decade of trial and plenty of error. The expectation of extensive private sector involvement in the power sector, especially in the generation segment, could not materialize. This is perhaps because the financial health of the distribution system was not capable of sustaining such large private investments in generation. The key indicator reflecting the sustainability of the sector is aggregate technical and commercial (ATC) losses.

It is argued in many circles that the root cause of the worsening power crisis is the failure of successive governments to pursue reforms. The repeated efforts to improve the finances of SEBs by reducing heavy cross-subsidies and curbing thefts have failed to bear fruit mainly because of the lack of political will and fiscal prudence. Even after well over a decade, power sector reforms continue to be short-circuited by vested interests. Political populism gets precedence over economic pragmatism. While the Electricity Act 2003 delicensed generation, issues relating to land acquisition, fuel linkages, and so on, continue to remain major hurdles.

Orissa was the first to privatize power distribution, but it was an unhappy experience. The privatized distribution companies could not provide quality power to the consumers. When the monopoly of the state utility was dismantled in July 2002 in Delhi, it not only corporatized the component entities, but also privatized the distribution companies. Unlike most states, the utility was not just unbundled, but restructured. Private companies invested Rs 5300 crore in upgrading the network, and cut 'transmission and distribution losses'—a euphemism for theft—by 22 per cent. Unlike Orissa, Delhi settled for a minority 49 per cent stake in the distribution companies and provided a bridge loan of nearly Rs 3500 crore to keep tariffs down in the initial years. Orissa has not allowed a tariff hike for six years, but in Delhi, they have risen by 23 per cent in five years. Police support has come late, but the Central Industrial Security Force can now be hired to check theft and special courts have been set up. This model is replicable in all 1 million plus cities. This is an urban model and probably not suitable for rural electrification.

The revised reform programme for the power distribution sector lays stress on only one parameter, namely, that states have to improve their collection efficiency, irrespective of whether they have unbundled their boards or have set up a regulator or not. Earlier, 25 per cent of the loan component of states was converted into grants if the target was achieved. In the revised programme, if a state exceeds certain percentage (yet to be decided) of collection efficiency, the entire loan amount would be converted into a grant.

In previous reports we have tackled issues related to distribution reforms and APDRP; rural electrification was covered in earlier India Infrastructure Reports (3iNetwork 2003, 2004, 2006, and 2007). However, the challenge of power distribution in rural India remains. The first paper in this chapter is contributed by Jim Hogan with the specific objective of creating a profitable, sustainable, replicable, and scalable model that will enhance the quality of service to all customers and improve the commercial results for both the licensee and operator of power distribution services. Hogan offers a franchisee model for power distribution in rural areas wherein a third-party operator under an agreement with the licensee can take up all field operations, including O&M, dispatch and feeder control, meter-billing-collection and customer relations as soon as practicable of the franchise, but not later than three months afterward. The operator can eventually become a full service provider having the added responsibility of asset management.

The next paper, also by Hogan, presents the findings of an agricultural demand-side management pilot project for a site in Doddaballapur, Karnataka, wherein inefficient irrigation pumps are being replaced with high efficiency pumps to reduce the amount of electricity needed to pump irrigation water. The sustainability of this approach must rest on a pact between the state governments and farmers' groups, other stakeholders being power distribution companies and regulatory commissions, implementation contractors, the Ministry of Power/Bureau of Energy Efficiency, the Ministry of Water Resources, PRIs, financial institutions, and pump manufacturers.

Power transmission is considered to be a monopoly and is best kept that way. The merchant transmission model is a new concept that has been tried in the US and Australia. Anupam Rastogi and Shreemoyee Patra present a theoretical justification for adopting the merchant transmission model in situations where the users are not able to access cheap power being generated elsewhere in the absence of connecting transmission facilities, and are forced to consume power from more expensive local generation sources.

3.1

DRUM's Franchisee Model for Electricity Distribution[1]

Jim Hogan

The goal of the model presented in this paper is to foster the creation of centres of excellence in electricity distribution and to accelerate the pace of reform in the electric distribution sector in rural areas. The specific objectives to achieve this are to:

- Enhance the quality of service to all customers.
- Improve the commercial results for both the licensee and operator.
- Create a profitable, sustainable, replicable, and scalable model.

Creating a viable model requires an integrated approach emphasizing quality customer service and recognizing the impact of the model on the licensee and operator alike. The classic people—process—technology model was used to analyse the distribution company model. Five business processes, namely, asset management, system operations and dispatch, field operations, customer processes, and corporate processes, were identified, as shown in Table 3.1.1.

Most of these business processes, as shown in Figure 3.1.1, can be segmented and performed by a third-party operator under an agreement with the licensee.

The hierarchy of business processes, as shown below, reflects the ingredients that could be combined as part of a model. Most early approaches—cooperatives of various types and certain franchise models—emphasize collections, at least as a first step. If all the elements were included in a model, it would constitute a management contract or concession where the operator runs the business for the licensee.

[1] This article is made possible by the support of the American people through the United States Agency for International Development (USAID) through the Distribution Reform, Upgrades and Management (DRUM) Project, under Contract No. EPP-I-00-03-00008-00, Task Order 801. The contents of this article concerning a franchising model for the electricity distribution sector are the sole responsibility of PA Government Services Inc. and do not necessarily reflect the views of USAID or the United States Government.

TABLE 3.1.1
Analytic Framework of DRUM's Franchisee Model

People	Process	Technology
Organization Structure Work Management – Work Analysis & Staffing – Work Management Systems Compensation and Benefits Training	*Asset Management*—Includes planning and managing the company's investment in the physical assets employed in providing high quality electric service. *System Operations & Dispatch*—This includes the activities involved in optimizing the flow of electricity including purchasing and trading plus economic dispatch. At the field level, this includes feeder control. *Field Operations*—This includes the classic operations and maintenance (O&M) activities of the distribution business, including construction, new hook ups, trouble calls and turn offs as well as meter testing and repair and other activities involved in day-to-day operations. *Customer Processes*—Includes the meter-billing-collection (MBC) process plus all customer interfaces, including customer relations and marketing (including advertising) as well as consumer education and outreach. *Corporate Processes*—Including activities that support management of primary business processes or that are purely executive functions.	Distribution Network – Wires – Transformers – Capacitors – Substations – Poles – Others Metering Equipment O&M Equipment (trucks, tools, etc.) Computing and Telecommunications

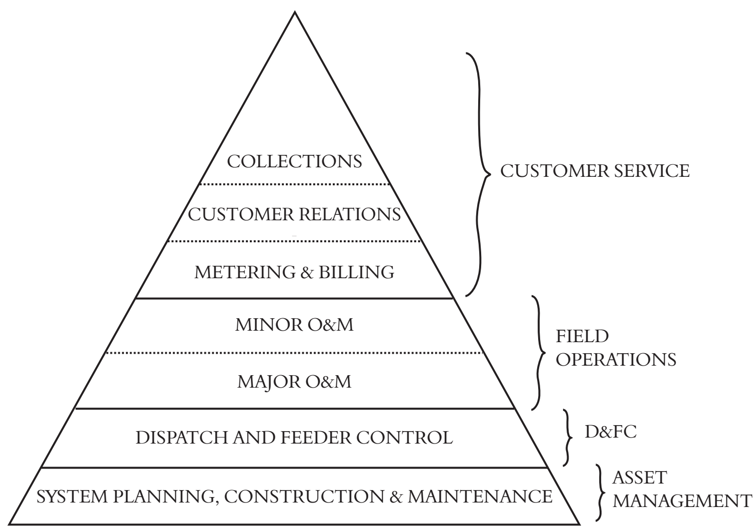


FIGURE 3.1.1: Hierarchy of Business Processes

IMPLEMENTATION OF THE FRANCHISEE MODEL

The proposed model has three stages as shown in Figure 3.1.2. The intent is for the selected operator to take up all field operations, including O&M, dispatch and feeder control, meter-billing-collection, and customer relations as soon as practicable after award of the franchise, but not later than three months. Upon the completion of Stage 2, the operator will become a full service provider having the added responsibility of asset management.

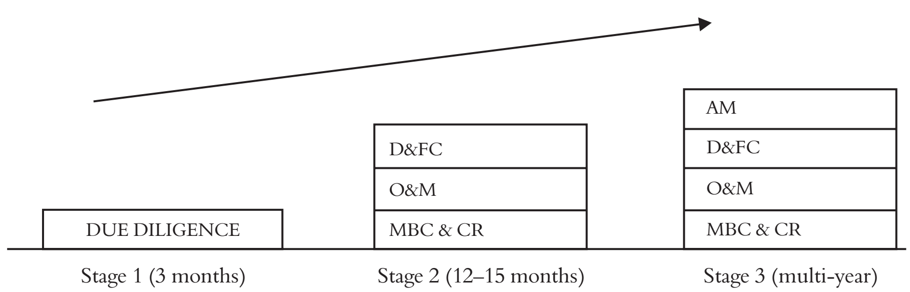


FIGURE 3.1.2: Three Stages of the Franchisee Model

DIVISION OF RESPONSIBILITIES

The intent of the franchisee model is to clearly enunciate the responsibilities of the licensee and the operator at each stage so that they can complement each other in achieving superior results. The following section describes the responsibilities of the licensee and the operator at each stage.

Stage 1

This stage consists of a Due Diligence activity with a term not to exceed three months during which the operator will deploy its team to verify and validate the data provided by the licensee and to develop an implementation plan to achieve the targets included in its bid and also incorporating the desired performance standards agreed upon between the licensee and the franchisee.

During Stage 1, the operator will not receive any compensation nor will it attract a penalty if it withdraws. The operator may accelerate the process by terminating Stage 1 and proceeding to Stage 2 any time after completion of the first month.

Stage 2

The business processes incorporated as part of Stage 2 include all field activities, including the meter-billing-collection process, customer relations, and minor O&M as well as dispatch and feeder control. The specific activities in Stage 2 are metering, billing, collection, customer relations, new connections, O&M activities on a feeder basis and, finally, responsibility for switching and dispatch of the 11 kV feeders. This will enable the operator to manage load on the feeder more effectively, with a resultant increase in customer satisfaction. In Stage 2, the licensee shall continue making capital expenditures, but in coordination with the operator. Stage 3 is the mature stage of the model where the licensee and the operator will continue with all the activities of Stage 2 and should be able to get return on their investments.

PROFITABILITY ANALYSES

A profit and loss (P&L) statement based on hypothetical data, but grounded in real world examples, is shown in Table 3.1.2.

The data illustrate one of the thorniest problems in the design of a model concept. The gross margin from the sale of electricity is low and often insufficient to cover a modest level of operating expenses. From first-hand observation, we know that the rural facilities of electric distribution companies are in poor condition. The Detailed Project Reports (DPRs) developed under the DRUM Project reveal the need for significant additional capital expenditure. Likewise, understaffing in field operations is a common problem. Thus, the current level of spending may have to increase.

This problem derives from policy positions and tariff decisions that are in the purview of the government and the regulator and within the bounds of the Electricity Act 2003. What is clear, however, is that sustainability of the model may require pricing control over retail tariffs or, alternately, compensation on a per-transaction or cost plus bonus basis.

One of the main objectives of the DRUM projects is to increase sales of electricity and reduce AT&C losses and thus reduce the cost of purchased power. An impact analysis of effective implementation of the DPR shows that the profitability of the business unit would notch a profit of Rs 182 lakh (or 3.1 per cent of revenues) from a loss of Rs 355 lakh (or 6.2 per cent of revenues). The projects proposed in the DPR will also catalyze continuing systemic and procedural improvements with the potential to reduce losses further.

The bottom line—quite literally in this case—is that the business unit should be able to improve its profitability while improving the quality of service to customers. Ultimately, bankers must make the decision on the bankability of the enterprise and some key statistics on the credit ratings associated with certain indicators would suggest the post-DPR business unit in the zone of bankability.

This model was designed for implementation under the DRUM's Water and Energy Nexus (WENEXA) project at Doddaballapur.[2] However, the conclusions about Doddaballapur must be presented with a caveat.

TABLE 3.1.2
Hypothetical Profit and Loss Account of a Distribution Business Unit

Item	Amount (Rs Lakh)	Share in Retail Revenues (%)
Retail Revenues	5712	100.0
Purchased Power	5537	96.9
Gross Margin	175	3.1
Depreciation	199	3.5
Employee Expenses	199	3.5
Repairs & Maintenance	25	0.4
Admin & General	35	0.6
Total Operating Expenses	458	8.0
Operating Income	(283)	–4.9
Less:	0	0.0%
Interest	22	0.4
Taxes	0	0.0%
Other Income/(Loss)	(50)	–0.9%
Net Income	(355)	–6.2%

[2] *www.waterandenergynexus.com*

The caveat is that the sales mix is critical to profitability. In Doddaballapur, about 45 per cent of electricity is sold under agricultural tariffs at 25 per cent of cost (a loss of Rs 1.5 per unit), another 30 per cent of electricity sales are to commercial and industrial customers at 225 per cent of cost (a gross margin of Rs 2.5 per unit). The highly profitable sales to commercial and industrial customers roughly offset the loss-making sales to agricultural customers. Thus, changes in customer mix would have a major impact on the profitability of the business unit.

The model discussed here has adopted the language of game theory to emphasize the advantage of a 'win-win' situation. Developing a workable model in India's electricity distribution sector is like trying to create a 'win-win-win-win' situation. The winners must include the licensee, the operator, the government, and, most importantly, customers. That involves a difficult equation but one that can be solved if the parties approach this challenge with reasonable expectations, a firm commitment, and a pragmatic assessment of the ground realities.

3.2
An Agricultural Demand Side Management Model[3]

Jim Hogan

Background

There are 20 million 'irrigation structures' (such as wells, tube wells, canals, and tanks) in India. That is four times the number of irrigation structures in China, Iran, Mexico, Pakistan, and the United States combined. Based on the knowledgeable estimates of leading experts in this field one may assert that between 1980 and 2000, ground water consumption in India doubled.[4, 5]

The rapid deployment of tube well technology has contributed to improving the lot of farmers. However, it is increasingly clear that underground aquifers are being depleted and the free power policies that helped enable the lifting of ground water have imposed a ruinous financial burden on the country's erstwhile SEBs. Unhappily, there is neither enough water nor enough electricity to allow the continuation of the practices of the past three decades for another three.

Reversing the policies of the past might not be enough to restore equilibrium and create conditions that would allow sustainable growth. Worse, the consequences of an abrupt reversal could be devastating for the millions of small, poor farmers who comprise most of rural India.

The success of efforts to improve the lot of poor rural farmers has come at a price. Today, India's agricultural sector consumes 30–40 per cent of total electricity, up from 10 per cent during the 1970s. The high rate of growth in agricultural electricity consumption results from aggressive rural electrification for irrigation purposes (not to be confused with rural household electrification which is still limited) coupled with a policy of below-cost pricing to farmers. The result—a high share of total electricity used for irrigation pumping and very low revenue generation on agricultural sales—has created an increasingly unsustainable situation.

As Figure 3.2.1 shows, the growth in ground water (GW) usage[6] in India outstrips other nations in the region as well as some of the world's advanced economies that have large agricultural bases. The structure of India's ground water economy is also distinctly different from the ground water economies of other countries. As the data in Table 3.2.1[7] show, it presents a different kind of challenge. The number of GW structures in India is almost six times higher than the second highest, China. India also has the smallest quantum of water extracted per structure and is a close second to China in the percentage of the population

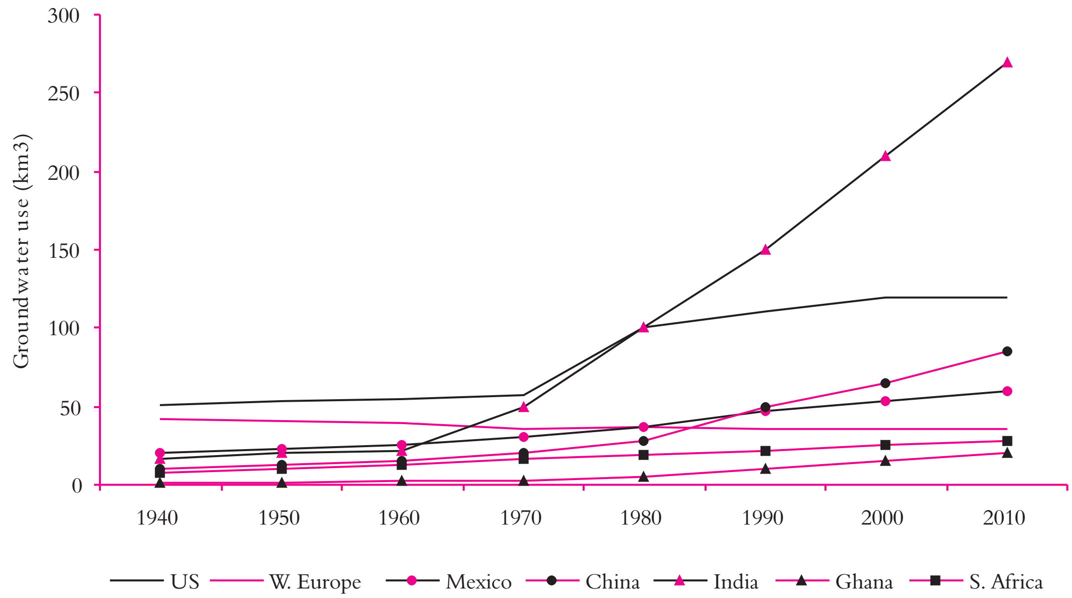
[3] This article is made possible by the support of the American people through the United States Agency for International Development (USAID) through the Water-Energy Nexus Activity, Phase II (WENEXA II) Project, under Contract No. GS-10F-0052P, Order No. 386-O-00-04-00189. The contents of this article concerning Agricultural Demand Side Management are the sole responsibility of PA Government Services Inc. and do not necessarily reflect the views of USAID or the United States Government.

[4] To appreciate political compulsions of India at that time see Lall and Rastogi (2007).

[5] Sharma et al., 2006.

[6] Op. cit., Tushaar Shah in Sharma et al. (2006).

[7] Op. cit., Tushaar Shah in Sharma et al. (2006).



Source: Estimates by IWMI: Tushaar Shah

FIGURE 3.2.1: Growth in Ground Water Use in Selected Countries

TABLE 3.2.1
Structure of National Ground Water Economies of Selected Countries

Country	Annual ground water use (km^3)	Millions of ground water structures	Extraction/structure (m^3/year)	Percentage of population dependent on ground water
India	185–200	20.0	9000–10000	55–60
Pakistan	45	0.5	90000	60–65
China	75	3.5	21500	22–25
Iran	29	0.5	58000	12–18
Mexico	29	0.07	414285	5–6
USA	110	0.2	550000	<1–2

Source: Tushaar Shah in Sharma et al. (2006), IWMI.

dependent on water. The degree of dispersion suggested by the following data indicates that a broad, grass-roots level effort will be required to implement significant change to the status quo.

The resultant situation presents a dilemma. On one hand, the proliferation of tube wells in India and the increased availability of the water for irrigation contributed significantly to increasing farmer incomes of the past three decades. On the other hand, the current situation is clearly unsustainable.

FINANCIAL LOSSES AND THE DEPLETION OF AQUIFERS

Price elasticity of demand has played a powerful if silent role in the drama now known as the water–energy nexus. Figure 3.2.2 below charts the growth in agricultural and industrial tariffs for the last twenty-five years of the 20th century in Andhra Pradesh, one of the largest states in India.[8] Based on our experience, we believe the trends depicted in this and the following two exhibits are representative of the trends throughout India.

While industrial tariffs increased by a factor of 13 (for a compound average growth rate of 11.3 per cent per year), agricultural tariffs increased by a mere 10 paise over the same time span, for a compound average growth rate of less than 2 per cent per year. In practice most farmers do not pay their electricity bill, so the real increase in price is effectively zero.

Figure 3.2.3 shows the comparative growth in consumption by agricultural and industrial users. While

[8] The data and analysis in Figures 3.2.2–3.2.4 were developed as part of the support to the Andhra Pradesh Power Sector Reform Programme provided by Arthur Andersen when the author of this paper was project director.

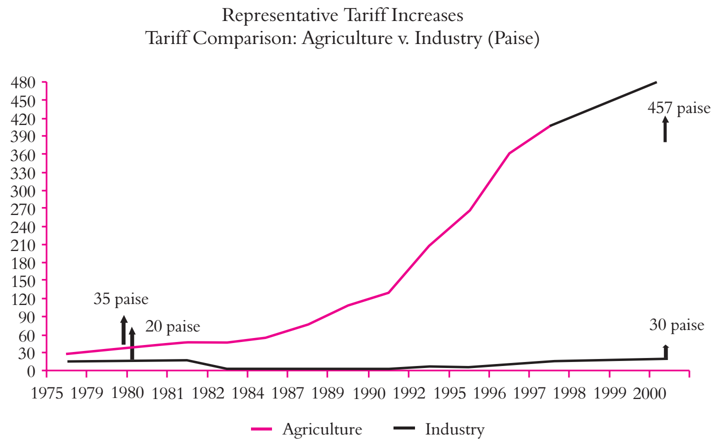


FIGURE 3.2.2: Per unit Power Tariff imposed on Agricultural Consumers vs Industrial Consumers in AP (1975–2000)

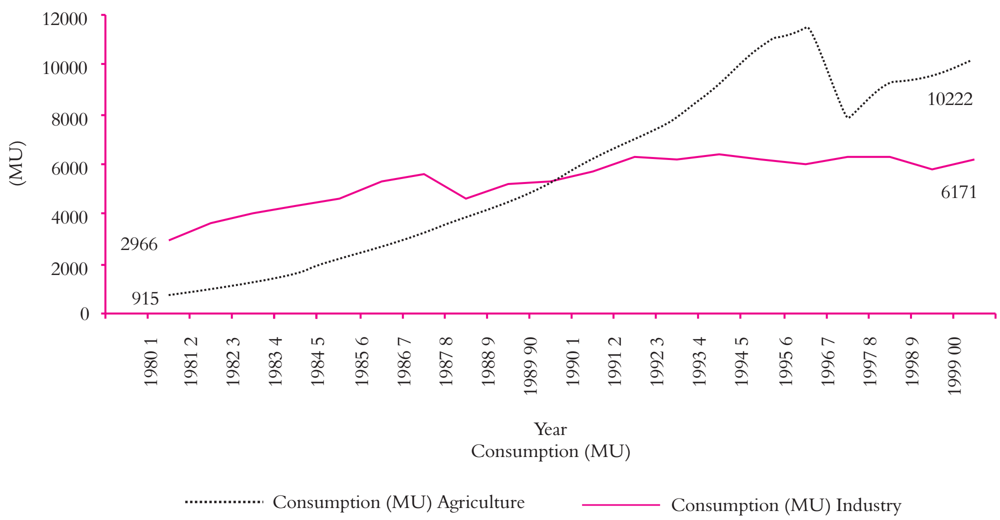


FIGURE 3.2.3: Comparative Growth in Power Consumption (MU per annum) in AP (1980–2000)

industrial usage increased at about 4 per cent per year, agricultural consumption increased at a compound growth rate of 13.5 per cent per year. At that rate, agricultural consumption would double every five years or so whereas it would take about 18 years for industrial consumption to double.

In view of the fact that discoms typically collect less than 10 per cent of cost for electricity sold to the agricultural sector, attempts to continue the pattern of consumption of this 25 year period may well lead to the ruin of many discoms.

Figure 3.2.4 shows what these trends have done to the consumption mix. In the mid-1970s when agricultural power consumption was 18 per cent of total power sales and highly profitable sales to industrial customers amounted to 58 per cent of total sales, the financial burden was much less than in the year 2000 when agricultural sales accounted for almost 40 per cent of the total and industrial sales were down to only 24 per cent.

One inference that can be drawn from these charts is that industrial users are being forced increasingly to resort to captive generation to satisfy their electricity needs. Furthermore, the current trajectory will leave the erstwhile SEBs with a disproportionate share of the unprofitable and non-paying customer segments within the foreseeable future. In addition to contributing to the destruction of aquifers by excessive pumping, there are concerns that these conditions may crowd out the electricity supply needed to support the country's economic growth.

AGRICULTURAL DEMAND-SIDE MANAGEMENT MODEL

In the power sector, Agricultural Demand-side Management (AgDSM) consists of those activities, methodologies,

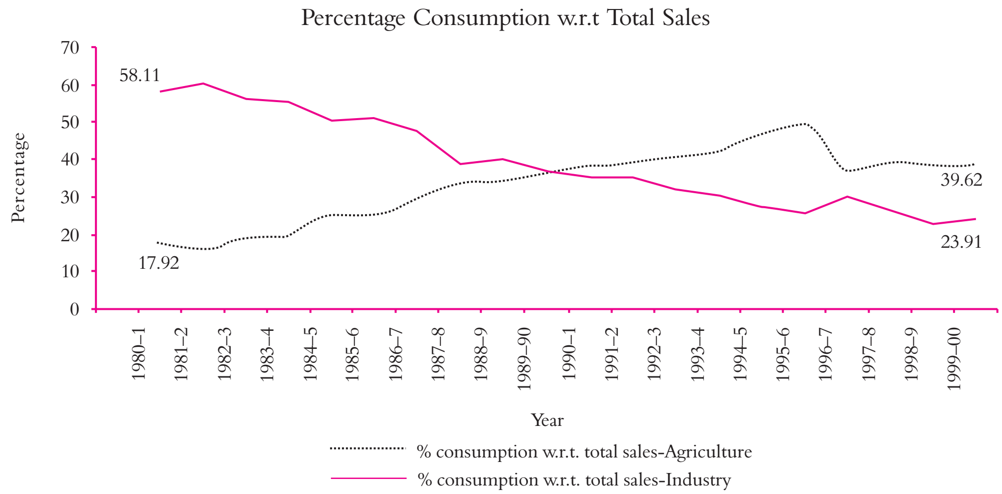


FIGURE 3.2.4: Growth in Per cent Sale of Power to Agricultural Consumers vs Industrial Consumers in AP (1980–2000)

and technologies that influence consumer behaviour and modify their consumption patterns. The objective may be to reduce peak demand, shift the time during which electricity is consumed to off-peak hours or to reduce the total quantum of consumption.

The AgDSM proposition is simple. Replace inefficient irrigation pumps with high efficiency pumps to reduce the amount of electricity needed to pump irrigation water. By doing so, electricity usage can be reduced dramatically.[9] If the savings from the reduction in electricity usage can be sustained and the total cost of the electricity saved exceeds the total installed cost of the pump over its useful life, there will be a net economic gain.

PRE-CONDITIONS FOR THE MODEL

The efficient pump set DSM programme can appear so compelling initially that there is a risk of not doing enough detailed analysis to adequately assess the full cost of the activities required to make the programme work. There is also a danger that the project will be evaluated in isolation from other potentially beneficial activities.

One of the key ingredients to success—and one of the biggest hurdles to getting started—is finding a way to fund the new, high-efficiency pumps. The installed cost of a high-efficiency pump can be significant, with estimates ranging from Rs 20,000 to Rs 40,000, each, depending on the nature of the pump and its installation. Some indicators suggest the total cost including the annual O&M costs could even be double the initial cost of the pump and possibly more.

IMPLEMENTATION OF THE MODEL

Over the course of the last several years, a number of parties have invested significant efforts to design and implement several AgDSM pilot projects with the aim of identifying a solution to this vexing problem. Much has been learned from those efforts as well as from other relevant analyses and studies.

The Base Case assumptions, which were developed from informed estimates after discussion with knowledgeable representatives of discoms, pump manufacturers, and industry experts, are:

- Installed cost of a pump = Rs 30,000
- Electricity Savings = 45 per cent
- Average cost of wholesale power saved = Rs 2.22 per unit[10]
- Government grant = 10 per cent of installed pump cost
- O&M for efficient pumps = Rs 1000 per unit per year
- Economic life of IP sets = 10 years
- Loan term = 10 years
- Interest rate = 11 per cent

These assumptions, and the specifics of the Doddaballapur pilot site, produce a return on invested capital (ROIC) of 4.4 per cent per annum over the life of the programme. The goal is to provide a return equal to the cost of capital which, in this case, is estimated at 11 per cent.

The model allows 'what if' analyses to help assess what kind of changes in certain key assumptions would

[9] One pilot project at Doddaballapur, Bangalore reduced the amount of electricity needed for pumping by about 50 per cent and several studies indicate potential savings in the range of 45 per cent (Source: *www.waterandenergynexus.com*).

[10] This estimate excludes the impact of line losses on the effective cost per unit.

produce an ROIC equal to the cost of capital (that is, 11 per cent). Several scenarios include:

- *Base Case Scenario:* As noted above, the basic assumptions would produce an ROIC of 4.4 per cent.
- *High Grant Scenario:* An increase of government grants to 50 per cent (without any changes in other assumptions) would produce an ROIC of 11.2 per cent.
- *Farmer O&M:* If farmers took responsibility for O&M for the new pumps, the ROIC would be 7.7 per cent.
- *Mixed Case:* If farmers took responsibility for O&M for the new pumps and a government grant of 30 per cent was provided, an ROIC of 11.1 per cent would result.

As with the base case, all of these scenarios will also produce savings that will free up electricity for sale to paying customers with positive margins.

STAKEHOLDER RESPONSIBILITIES

In the absence of economically efficient tariffs to continuously send correct pricing signals to customers, we must resort to a 'second best' solution. Top down administrative mechanisms imposed by the government tend to be complex and they have a low success rate, according to studies of integrated water management schemes attempted in other countries. Nonetheless, the AgDSM pump set efficiency concept appears to be relatively simple—perhaps deceptively simple—but the actual implementation of this 'second best' administrative approach will involve a significant number of stakeholders including:

- State governments
- Farmers or farmer groups
- Electricity distribution companies
- Electric Regulatory Commissions
- Implementation contractors
- Ministry of Power/Bureau of Energy Efficiency
- Ministry of Water Resources
- Panchayats
- Ministry of Panchayati Raj
- One or more financial institutions
- Pump manufacturers

As we see it, a sustainable solution must rest on a pact between farmers and their state governments; the governed and the governing. In fact, we believe success will depend on the strength of this pact. A profile of the key responsibilities of the major stakeholders would include:

- *State Government:* Strong backing by state government is essential. The degree of enthusiasm shown by the state government will send a signal to farmers and also to other key stakeholders about the relative importance of this programme and how responsive they should be in doing what is necessary to make it a success. One item that will be critical is an agreement by government not to take any action that will have an adverse impact on the level of subsidy to electric distribution companies. In the case of our pilot project at Doddaballapur, our analysis suggests that the company is receiving less than half the subsidy that would be indicated by the volume of agricultural sales at low to no cost.

  It would also be very helpful, indeed perhaps essential, for the government to openly and strongly endorse this programme. One action the government can take to show visible support would be to endorse and encourage the creation of 'centres of excellence' in distribution in rural areas. This will create the necessary pre-conditions for implementing efficient pumps.

  Another area where the government, and only the government, can support this programme is in the development and enforcement of a policy requiring a testing and branding of efficient pumps. Cracking down on the sale of cheap and inefficient pumps—parallel with upgrading the service quality of rural distribution networks—will provide critical practical support to the proliferation of the use of efficient pumps.
- *Farmers:* Conceptually at least farmers and their families should be the principal beneficiaries of this programme. However, they will receive little additional economic reward for the reduction in energy consumption because of tariff policies that do not require full payment for electricity. Thus, for this AgDSM model to achieve its potential, it will be necessary to identify and implement an incentive to induce supportive behaviour on the part of farmers.
- *Electricity Distribution Company (Discom):* The discom may be the best entity to manage the investment required in high-efficiency pump sets. Under the right conditions, it would stand to benefit financially. Furthermore, as a state-owned enterprise, it can serve as the government's agent in the implementation of its policy and AgDSM programme.
- *Energy Service Company (ESCO):* Where discoms do not make the investment and manage the AgDSM activities, the ESCO business model has been proposed as an alternative. Conceptually, this has merit although it may not be easy to operationalize. A key test will be the bankability of the deal. It may be difficult for an entrepreneur to raise the capital necessary to make the substantial initial investment required in

the face of the operating risks and the uncertainty of timely and full repayment even if it achieves the desired result.

- *Electricity Regulatory Commission (ERC):* The AgDSM programme has several regulatory dimensions. For one, the ERC may be asked to review and approve (or not) a company's investment in high-efficiency pumps. It must also approve the discom's annual revenue requirement, including the amount of subsidy from the state government. If the ESCO business model is employed, the ERC may be asked to approve a risk mitigation device that would enable a discom to enter a bankable agreement with an ESCO. Thus, it must be fully informed of the details of the programme and satisfied that it is economically sound and has the backing of government.
- *Implementation Contractors:* The roles of the implementation contractors include a range of essential tasks. First is a communication and education process to persuade farmers and local panchayats that this programme makes sense for individual farmers as well as for the community and the nation. Once the farmers are committed, it will be necessary to conduct a survey of the area involved as well as detailed analysis and inspection of pumps to be replaced. These activities should conclude with the development of an implementation plan and a baseline of data to measure progress. This would be followed by the implementation stage and, finally, a monitoring and verification process. It is unlikely that all of these different activities will be performed by a single contractor. Thus, we would expect either the discom or perhaps an ESCO to be responsible for planning, contracting and managing these activities.
- *Ministry of Power/Bureau of Energy Efficiency:* As one accomplished CEO once said: 'Everybody needs a boss.' The same CEO also said that a manager's job is to help those who report to him do their job as well as possible. And so it is with the Ministry of Power (MOP) and its Bureau of Energy Efficiency (BEE). Their job should be to help other stakeholders do what is expected of them to achieve a successful implementation of the AgDSM programme. The scope of BEE's responsibility is restricted to energy efficiency, that is, reductions in the use of electricity per unit of work and a reduction in total electricity consumption for irrigation pumping but it may be able to play a 'pump priming' role in jump-starting a nationwide programme.
- *Ministry of Water Resources:* In the electricity sector, the Ministry of Power is the nodal and dominant agency. By contrast, the water sector is more fragmented with several agencies having overlapping responsibilities, including the Ministry of Water Resources and the Ministry of Panchayati Raj as well as others responsible for rural development, farming, water management, and local governments. While the policy work stream should strive to involve these various agencies, the pilot project will also make an effort to solicit feedback and encourage their involvement.
- *Financial Institution(s):* One of the most significant hurdles is the initial investment required to install high-efficiency pump sets. A corollary is the attendant investment and operating risk. One or more of the financial institutions with a mission that is compatible with rural and agricultural development will likely be required to facilitate these investments. Additionally, there may be significant value to applying risk management techniques to mitigate some of the risks that may stall investment. For example, even when a diligent initial survey and analysis is performed, there is a risk that the geological conditions beneath the surface may make it impossible to achieve the targeted savings. This, it seems to us, should be an insurable risk. Further, it seems to us that this would be an appropriate task for one of the PSU banks that specializes in this sector.
- *Panchayats:* As part of any bottom-up programme, it would be advisable to involve panchayats as well as individual farmers or farmers' groups. The results achieved will vary depending on the calibre and inclination of various panchayats, but that is a ground reality we must deal with. In certain cases the panchayat may act as a sponsor of the concept and offer encouragement and in other instances the panchayat may elect to take on some operational responsibilities.
- *Ministry of Panchayati Raj:* The activities involved in the AgDSM pilot project fit comfortably within the umbra of the Ministry of Panchayati Raj and they should be kept informed. If, beyond that, they can help to accomplish the project goals, that could be an added resource.
- *Pump Manufacturers:* The manufacturers of high efficiency pumps stand to be big winners if this programme is successful in developing a practical, workable, replicable, and sustainable model. In addition to providing the best possible pricing, pump set manufacturers—perhaps through the Indian Pump Manufacturers Association (IPMA)—could also facilitate the process by contributing their know-how to support the development of a pump certification programme, including the development of standards and specifications.

A key practical issue relates to providing warranty service as well as ongoing maintenance and repair for an expanding population of high-efficiency pumps. A corollary to this need relates to the many local pump specialists who currently handle the maintenance and repair of the installed base of low-efficiency pumps who will be put out of work if the AgDSM high-efficiency pump set programme works.

ASSUMPTIONS

There are some basic assumptions implicit in the proposed AgDSM efficiency programme. This AgDSM initiative will produce an economically viable result if the value of electricity saved, net of the O&M costs of achieving the savings, is sufficient to repay the investment required to purchase and install high-efficiency pumps, including borrowing costs. In order for that to happen, there are several critical assumptions, including:

- The essential deal calls for a pact between government and farmers. Government established a policy condition that created the conditions that require relief and their full support and backing will be required for success.
- For their part, farmers are already receiving a substantial benefit in the form of free or almost-free power. As such, they have an obligation to society to wisely use the two precious resources involved—water and power.
- The discom is best positioned to implement and oversee the investment and efficient operation of the AgDSM project, although an ESCO business model may be a necessary alternative.
- The cost-volume dynamics of the business model suggest that a capital grant may be required to make the deal financially viable. Thus, our economic analysis assumes a 10 per cent investment grant by the central government in the base case. Based on the data for the Doddaballapur site, however, that may not be enough to close the gap.
- Another basic assumption is that the discoms will, on their own, implement high quality electric service in the areas where the AgDSM programme will be implemented. Since this is part of the mission of power discoms, and as the DRUM project demonstrated, doing so will reduce ATC losses and also improve the quality of service, we have not incorporated the investments required for network upgradation in our analysis.

TWO MODALITIES

Our assessment is predicated on the belief that one of the two modalities will exist. One is that the discom will be receiving a subsidy payment from the government that is significantly less than the cost of electricity delivered under an agricultural tariff. Under that modality, the discom can create an economic gain by reducing the amount of power delivered for irrigation.

The second is that the discom will be receiving the full subsidy amount. Under that modality, the discom can create an economic gain by reducing the amount of electricity delivered to the agricultural sector as long as the government allows it to recoup the investment in efficient pumps. These circumstances may allow the scope for some reduction in tariffs, if the value of energy saved exceeds the amount required to repay the cost (including interest) of the initial investment in high-efficiency pumps.

Both modalities assume that neither the government nor the regulator will take any adverse action with regard to subsidies that would reduce the economic viability of the deal.

RISKS AND RISK MITIGATION

Two of the apparently intractable risks associated with this AgDSM project are the issue of capturing games (that is, minimizing the risk that farmers will take a gain for themselves by using the more powerful pumping capability to pump more water) and the question of measurement (that is, the absence of ubiquitous metering hampering the localized measurement of consumption to document savings and/or identify problems and take corrective action).

A third significant risk relates to (re)payment. Based on our discussions with many parties, it is clear that one of the hurdles to implementing this proposed AgDSM pilot project relates to the substantial financing required to purchase and implement efficient pumps. The candidates to do this—be they discom or energy service companies—are concerned that they will not recover their investment from the savings achieved.

With regard to the first two, the implementation and operation of an effective remote load management (RLM) system in conjunction with the separation of agricultural feeders from those serving domestic and commercial customers can mitigate the risk of excess pumping. While this system will remain subject to human intervention and manipulation, it provides the discom with a tool to manage this risk. Additionally, if a discom implements nodal metering, say, for clusters of twenty or so pumps, it would enable measurement of consumption and over time the identification of changes in consumption trends by cluster.

The costs of feeder segregation and implementation of an RLM system are intrinsic costs of a discom's network upgrades. Thus, the investment required to accomplish these should not be attributed to the cash flow analyses of AgDSM.

If these technical fixes are implemented, the greatest remaining known and unmitigated risk relates to investment risk (that is, the risk of not receiving compensation even if the targeted savings are achieved). This is a significant risk factor that must be resolved by the time the proposed pilot project is completed. Otherwise, the probability of achieving sustainable replication will be greatly reduced.

THE STRUCTURE OF THE DEAL

The essential structure of the deal for the AgDSM pilot model at Doddaballapur is relatively straightforward. It should be mostly the same in the early stages for other sites, but in all cases it should be viewed as the first step in the move towards a broad-gauged and holistic approach to an integrated water and energy management regime. After implementing high service quality levels in the target area, the discom will establish several agreements and contracts:

- The preliminaries include an MOU between and among the state government, the regulator, and the discom. This MOU should specify the assumptions and the interests of the parties including the benefits each will receive and the commitments each must make for this project to be successful.
- Initially, the discom will need to establish an agreement with an NGO to provide the significant education and communication activities required to persuade farmers to participate in the programme and provide full support for its success.
- Another agreement or group of agreements would involve one or more contractors to conduct the analysis required to assess the potential for savings and to plan the most efficient method to implement a new irrigation system. That may also include the load research necessary to establish a baseline.
- Another major contract would be with a pump set manufacturer for the sale and installation of pumps. Post-sales service and maintenance under warranty and beyond code would also be incorporated in this contract.
- The central government shall provide a capital grant. While the long-term goal will likely be a 10 per cent capital grant, the initial AgDSM pilot project at Doddaballapur and perhaps other pump-priming projects implemented in the near term may warrant a higher grant.
- The penultimate agreement would be the one with an ESCO or ESCO-like contractor. This could be the same contractor that did the initial analysis and planning. This contractor will be responsible to ensure that pumps are being used properly, that issues and problems that arise are addressed and resolved promptly and to maintain an active line of communication with farmers.
- The final major contract would be for monitoring and verification (M&V).

CONCLUSIONS

The water–energy nexus is as critical to the future of India as it is complex. The model we have elaborated is complex and, we recognize, includes several risky elements that must be mitigated to ensure its sustainability. Two of these risks—the issue of capturing gains (that is, limiting the improper use of higher pumping capability) and the measurement of results (that is, metering)—must be resolved to reduce the inherent risks. Otherwise, the general conclusions we have reached are:

- Decision-makers must be ruthlessly realistic about the forces at work. Nothing should be taken for granted and every assumption, including strongly-held truisms should be open to challenge and reconsideration.
- A key area of focus should be finding a way to align the incentives of key stakeholders, especially farmers, discoms, ESCOs (if that model is adopted), and the state governments.
- An effective process will require a balance between the need for top-down involvement of the government to develop a framework and set the boundary conditions with the bottom-up 'grassroots' involvement of farmers and local bodies.
- Administrative overheads and unnecessary activities should be held to an absolute minimum.
- The nascent AgDSM pilot at Bescom's Doddaballapur site can serve as an important learning laboratory and every effort should be made to ensure it proceeds without further delay.

3.3
Merchant Power Transmission Model

Anupam Rastogi and *Shreemoyee Patra*

Merchant power transmission is defined as an arrangement where a third party constructs and operates electric transmission lines through the franchise area of an unrelated utility. It is said, in support of the model, that competition to construct the most efficient and lowest cost additions to the transmission grid is triggered in such an arrangement.[11]

The merchant transmission option is attractive for the competitive 'market driven' transmission investment that it entails. By adopting such a model, the imperfections of a regulated monopoly can be completely eliminated. The private entrepreneur, within this arrangement, invests in enhancing the capacity of the transmission network, thereby connecting 'points of power injection to points of power consumption'. In return for her pains she earns transmission rights to the same. The value of these transmission rights may be calculated in two ways. It could be equated to the expected congestion charges avoided due to the network augmentation (physical rights) over the life of the transmission system. Else it could be rebated by the system operator (financial rights) over the life of the transmission investment. It is this value of transmission rights (physical or financial) that then determines whether there is enough incentive for the incumbent power utilities or new competitors to invest in new transmission capacity.[12]

The Cross Sound Cable from Long Island, New York to New Haven, Connecticut in the US is a merchant transmission line. Developed by TransEnergie US as a merchant transmission facility and contracted on a long-term basis to the Long Island Power Authority (LIPA), the CSC is a 330 MW high-voltage direct current (HVDC) underwater cable. Linking five states in Australia, there are five merchant transmission interconnectors: the DirectLink, MurrayLink, and Southern Link between New South Wales and South Australia and Basslink between Tasmania and Victoria.

Although a merchant power transmission line may be conceptually as commonplace as a gas pipeline, there are certain hurdles in the way of applying the model extensively. Primary among these is the fact that direct beneficiaries from the capacity expansion are not easy to identify. Consequently it is difficult to levy a toll on the targeted end users. Further, for a merchant transmission line to be feasible in an area, there should be no other alternate transmission lines of adequate capacity operating there that are subsidized by other utility businesses.

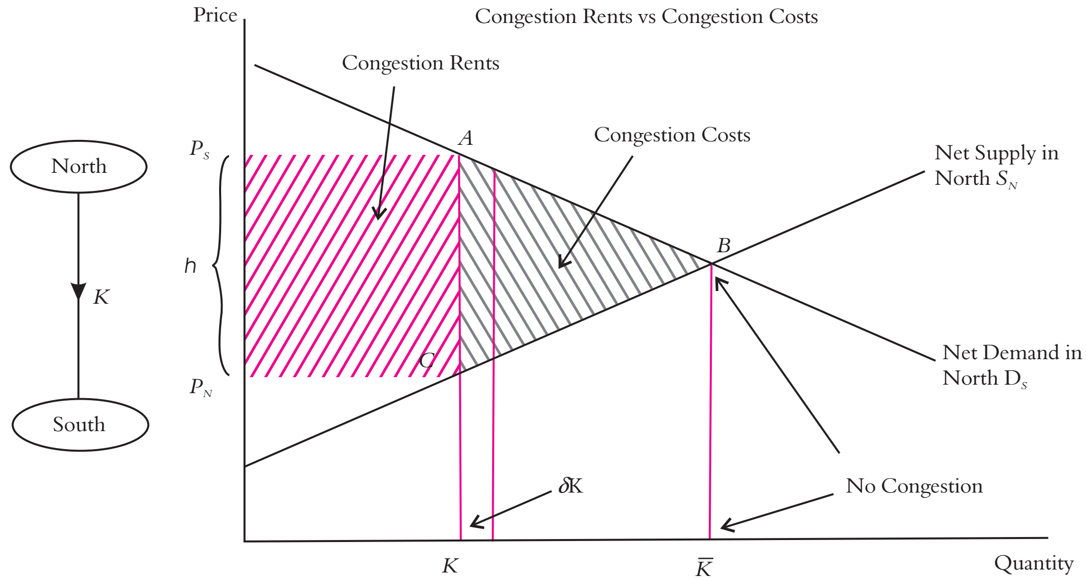
A Theoretical Case for Merchant Transmission Investment

The basic economic argument in favour of a merchant transmission line can be illustrated using a two-node framework[13] (Figure 3.3.1).

Figure 3.3.1 depicts a situation in which a distribution company or a large industrial customer wants to buy electricity directly in the South from a cheap generation source in the North. There is electricity available in the South but it is more expensive and the capacity of the line from North to South is limited to K, and faced with net demand/supply curves in the North and the South, the system operator is forced to dispatch 'out of merit'. That is, the system operation is forced to buy power from the more expensive generators in the South even though the generation plants in the North are willing to supply this amount at a cheaper rate. The constraint lies in the non-availability of adequate transmission capacity. The rationing of the scarce North–South capacity is implemented by setting two nodal prices P_S and P_N that clear the markets in the South and the North, respectively. The difference $\eta = P_S – P_S$ is the shadow price of the transmission capacity constraint.

A *marginal* (unit) increase in transmission capacity (δK) allows one more kWh to flow from North to South, replacing a marginal generator in the South with cost P_S by a cheaper generator in the North producing at cost P_N. That is, the social value of the investment is given by the reduction in the area ABC in Figure 3.3.1. The area δK is the *congestion rent* and the triangle ABC is the *congestion* or *redispatch cost*. The latter represents the cost of running more costly generation in the South because less costly imports from the North are limited by transmission congestion.

[11] *http://en.wikipedia.org/wiki/Electric_power_transmission# Merchant_transmission*
[12] *http://econ-www.mit.edu/faculty/download_pdf.php?id=538*
[13] Joskow and Tirole (2005).



Source: *http://econ-www.mit.edu/faculty/download_pdf.php?id=538*

FIGURE 3.3.1: Congestion Rents vs Congestion Costs in a Merchant Transmission Power Line

ADVANTAGES OF EXPANDING TRANSMISSION NETWORK THROUGH THE MERCHANT MODEL

Transmission expansion not only goes into meeting key energy demands but makes it possible for generation facilities to be located at a distance from the point at which the load is to be delivered. The positive implications in terms of price and quantity of power are manifold in such a scenario as are the advantages that can be drawn for increased reliability of meeting that load.

Merchant transmission expansion will be triggered only in situations where the local market dynamics are such that appropriate price signals are emanating for the market participants to read them and embark upon expanding the transmission system. Regulatory and policy environment along with market practices should adequately reward transmission capacity expansion where ever it improves deliverability and reliability.[14]

Some of the broader benefits of transmission expansion include the following:[15]

- Reliability is enhanced because power can be delivered from point of generation to point of load with greater ease within a system that would otherwise be highly stressed.
- Power gets transmitted from an area where its value is low to one where its value is high. This includes situations where large volumes of high priced emergency power need to be moved.
- The rest of the system is subject to less pressure; hence it is better able to deal with contingencies. In a security-constrained dispatch, this can improve normal flow limits on constrained transmission elements outside of the expansion.
- Merchant transmission lines can offer value added ancillary services such as voltage support service by providing controllable reactive power output, irrespective of whether there is flow over the expanded facilities or not.
- Wherever transmission expansions connect multiple control areas, these areas become better able to operating reserves.
- The size of the geographic markets is expanded. As a result, competition in energy, capacity, and ancillary service markets is intensified and market power reduced.
- Within a control area, reducing the number of units that must be committed to meet expected regional loads by allowing a wider pool of generators, and potentially diverse loads to be considered in the unit commitment decision, thereby reducing system uplift costs associated with unit commitment.

In practice, in the competitive market, if the transmission solution is to be credible, it must not cost more than alternative ways to bring power and ancillary services or to continue to rely on existing generation assets and it must meet the usual reliability criteria.

[14] *http://www.pur.com/pubs/4146.cfm*
[15] *http://www.pur.com/pubs/4146.cfm*

Merchant transmission projects typically involve DC lines, because it is easier to limit flows to paying customers.

Market Transmission Regulation and Pricing

If one were to adopt an extreme version of market driven investment, investors would be allowed to enter the market freely and engage in constructing transmission lines. They would be able to determine the charges they wished to levy without any regulation. The owners of these transmission lines would earn rewards commensurate with the congestion rents associated with these lines.

However, in reality all developments within the power sector are moored in governing institutions, regulatory bodies, policy formulations and the like. The determination of electricity prices, operating reserves, contingency constraints, congestion management, and the specification of transmission capacity and increments to it are fairly well defined by governing agencies. No single paradigm has emerged from the liberalization effort of the last decade for these attributes of the design and operation of wholesale markets, system operations, and congestion management. In India, the Electricity Act 2003 provides a framework for the wholesale market but the congestion management and price determination for transmission are left to state and central regulatory authorities.

No restructured electricity industry anywhere in the world has adopted a pure merchant transmission model of the type described above. Australia did implement a mixed merchant and regulated transmission model. Directlink is a 180 MW, 40 mile merchant DC link connecting Queensland and New South Wales and began operating in 2000. Murraylink is a 220 MW, 108 mile merchant DC link connecting South Australia and Victoria which began operating in October 2002.[16] Both these lines were supported by differences in spot prices in the two market areas they connected.

Neptune Regional Transmission System, USA[17]

The Neptune Regional Transmission System (Neptune RTS) is a 65-mile, 660 MW undersea/underground electric transmission link that starts from Sayreville, New Jersey and delivers power to homes and businesses on Long Island.

The Neptune RTS was developed by a Delaware limited liability corporation formed by Atlantic Energy Partners, a Maine-incorporated LLC which assumed all the risk of the project as a merchant developer. It planned to award 80 per cent of the project's transmission capacity under long-term contracts to the highest creditworthy bidders through an open season. These long-term transmission scheduling rights were to be tradable in a secondary market. The rights were to have been awarded on a use-it-or-lose-it basis, providing financial incentive for a secondary market. Unused long-term transmission rights would be made available for bidding on an hourly basis. The remaining 20 per cent of transmission capacity would be auctioned through similar open seasons for short-term transactions, monthly, weekly or hourly.

Neptune had proposed to sell 30 per cent of the project's capacity through negotiated bilateral contracts prior to the open-season auctions as a means of assuring an adequate financial interest in the project. But the Federal Energy Regulatory Commission (FERC) of the United States rejected that. The commission believes that the open season that Neptune has proposed will provide it with the assurance it needs to go forward and will not approve the bilateral negotiations. 'There is no financial benefit to Neptune by negotiating for 30 per cent of its capacity prior to the open season.' The order said that, as a matter of policy, it would require all merchant transmission projects to make capacity available through open seasons. 'This will help ensure the commission and all parties that the allocation of capacity is transparent, nondiscriminatory and fair.' FERC's order excluded Neptune affiliates from acquiring capacity in initial open seasons, but left them free to participate in secondary capacity markets.

The order also rejected Neptune's proposal to collect fees from existing transmission systems in the region to reflect the systems benefits the project will provide. 'As a merchant project with the authority to determine the project's size and to negotiate rates, Neptune must be prepared to bear 100 per cent of the risks of constructing the project.' The commission also conditioned its approval on Neptune joining the Northeast Regional Transmission Organization that FERC is promoting. The Northeast RTO would independently manage the Neptune transmission assets in accordance with FERC rules. The order requires Neptune to make non-public information available to the RTO's market monitors, and to file quarterly transaction information with FERC. In short, the FERC order has forced the merchant power transmission model to be an open access system which is to make its transmission capacity available to users on first come-first serve basis.

[16] On 18 October 2002, Murraylink applied to the regulatory authorities in Australia to change its status from a merchant line to a regulated line that would be compensated based on traditional cost of service principles combined with a performance incentive mechanism.

[17] *http://archive.pulp.tc/html/ferc_oks_seabed__merchant__pwr.html*

At present, Neptune RTS is owned by Energy Investors Funds (EIF), on behalf of United States Power Fund, L.P., United States Power Fund II, L.P., and Starwood Energy Investors LLC, an affiliate of Starwood Energy Group Global LLC, both established private equity fund managers. EIF and Starwood Energy are the principal equity investors in Neptune RTS, the developer, owner, and operator of the Neptune project. The firms began funding the development of Neptune RTS in June 2004.

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