

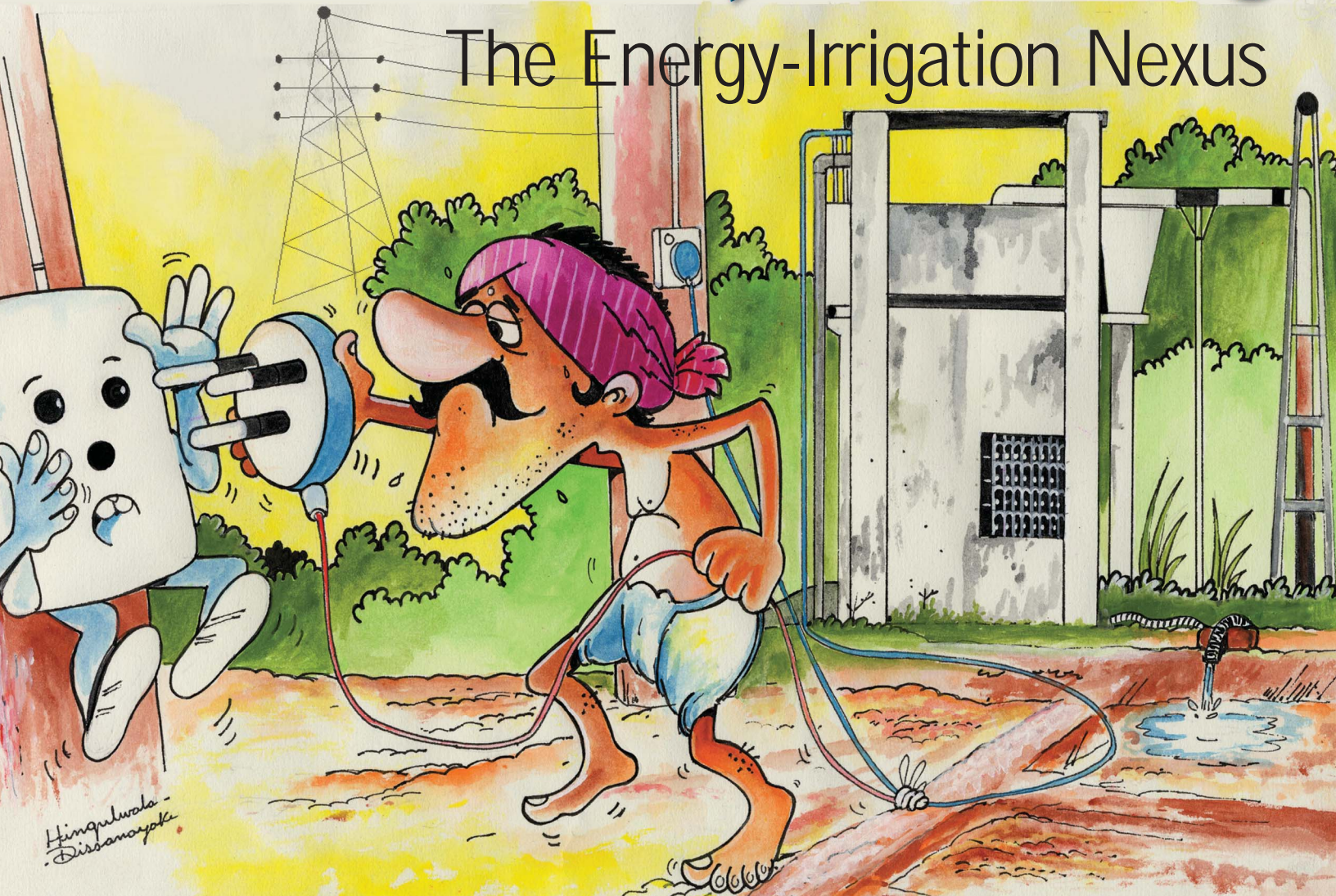
Water Policy Briefing

Issue 10

IWMI-Tata Water Policy Program

Putting research knowledge into action

The Energy-Irrigation Nexus



A rational power supply and pricing policy for pump irrigation could be a powerful tool for the indirect management of both groundwater and energy use—if the two sectors can work together to take advantage of this opportunity.

Consumption-linked pricing of power can improve efficiency of water and power usage. However, metering, the solution advocated by the World Bank and others, has the drawbacks of high transaction costs and strong farmer resistance. Another solution, which has not received enough attention, is a transformed, rational flat-rate tariff, combined with restrictions on power supply.

The Energy-Irrigation Nexus

Electricity subsidies for farmers are an expensive legacy of past development policies. The result is overuse of both energy and water in groundwater-irrigated agriculture—threatening the financial viability of the power sector and the future of the groundwater resource itself, along with the livelihoods of the millions who depend on it.

The most popular solution is the metered tariff, promoted by international donors and many of India's state governments. But metering is the ideal solution only if the cost of metering and billing 14 million scattered, small users in India, Pakistan and Bangladesh is ignored. Easier, more feasible and more beneficial in the short run in many parts of South Asia would be the use of a rational flat tariff, which avoids the transaction costs and strong farmer opposition associated with metering.

The flat-tariff option has been ignored because, in its current incarnation, it has proved a complete failure. However, combined with intelligent power supply rationing, it is a logical, viable alternative which could cut wasteful groundwater use by 12-18 km³ per year in Western and Peninsular India alone.

The approach would involve (1) gradually raising tariffs to cut power utility losses; (2) supplying farms with fewer hours of power per year, but ensuring a quality power supply during periods of moisture stress; and (3) metering at the feeder level to measure and monitor farm power use, to allow good management.

Metering may not be the answer

The key reason for power utility losses is commonly thought to be the flat tariff, which is based on pump capacity rather than metered consumption of power. In mainstream thinking, metering is the only solution. But farm-level metering was used all over South Asia until the 1970s. Due to the huge logistical difficulties and transaction costs involved, this approach was abandoned in favor of the flat tariff. Since no radical new solutions to these problems have been found, there is little hope that metering will succeed if reintroduced in India. Reintroduction of farm-level metering in Pakistan in 1999 has benefited neither farmers nor power utilities, and power theft and meter-tampering are rife.

Two alternative 'business philosophies'

The metered and flat-tariff regimes are not simply alternative pricing policies—they are completely different business philosophies. Using a metered tariff, a power utility can confidently recoup its costs and supply customers with as much power as they want, when they want it. The flat tariff, by contrast, allows

power utilities to use sophisticated management to provide a high-quality, but carefully rationed, power supply and yet remain viable.

The flat tariff currently used is 'degenerate', because it does not involve strict controls on supply. Paying a flat rate for an almost unlimited supply encourages consumers to maximize consumption, often wastefully—as has happened in pump irrigation. As a result, the reliability and quality of the power supply has been sacrificed—severely threatening farmers' crops at the height of the dry season.

A short-run solution: the rational flat tariff

So, the key to making a flat tariff work is supply rationing. For example, Gujarat does not need to supply 3,000 hours of farm power per year. It can make its farmers happy (and cut its losses) by supplying only 1,200 hours, provided those 1,200 hours are made available when most needed (Box 1). Gradual tariff increases would be necessary, but subsidies should not be removed completely—that would be political suicide, given the farming community's often violent

This issue of *Water Policy Briefing* is based on research presented in: *Energy-Irrigation Nexus in South Asia: Improving Groundwater Conservation and Power Sector Viability* (IWMI Research Report 70) by Tushaar Shah, Christopher Scott, Avinash Kishore, Abhishek Sharma. The full text of this report is available at www.iwmi.org/pubs. IWMI's research on the energy-irrigation nexus was carried out with support from USAID's Water-Energy Nexus Activity (WENEXA) and the Sir Ratan Tata Trust.

opposition to attempts to rationalize energy prices. Farmers would benefit greatly, although these gains would need to be guaranteed by the utilities, and communicated clearly to farmers (Box 2). Power utilities would also benefit—fewer hours of supply, and better upkeep of farm-supply infrastructure, would cut their transmission and distribution power losses.

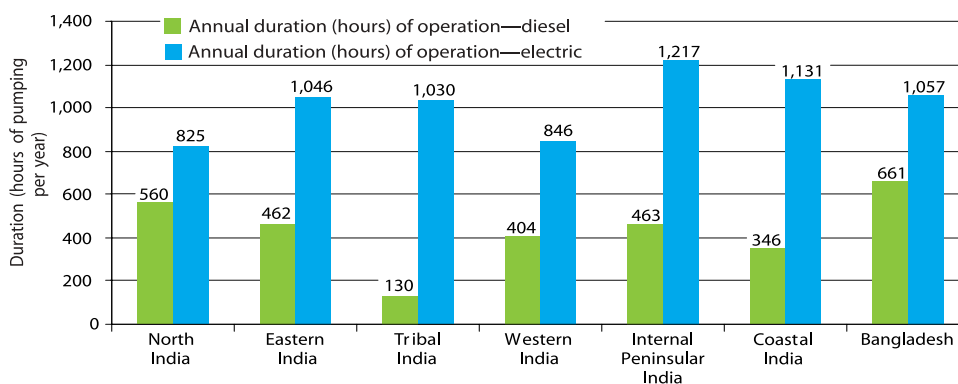
The nexus—and the problem

In South Asia, the fortunes of the groundwater and energy economies are closely tied. Little can be done in the groundwater economy that will not affect the energy economy. Plus, attempts to make the energy economy viable (by raising the current flat tariff or cutting subsidies) have been blocked by farmers, who are an extremely important vote-bank.

Box 1. Transforming the flat power tariff: from dysfunctional to functional

- **Restrict the annual supply of farm power**—but schedule that supply so that power is available when farmers need it most. The supply pattern necessary can be deduced by studying farmers with rational pumping behavior—e.g., diesel-pump owners, who pay real prices for their power. This supply management is the key element in the philosophy behind a functional flat-rate tariff.
- **Increase the tariff, though gradually and regularly**—towards covering the real cost of the electricity supply.
- **Keep the power subsidy, but make it explicit**—specify the total amount the government will spend on subsidizing power at the start of each year, then calculate the number of hours of farm power this sum will buy from the power utility at the flat-tariff rate (taking into account the lower cost of off-peak supply).
- **Use more off-peak power**—increase the percentage of power supplied to the farm sector during off-peak hours (currently around 50%), and factor this into the calculation of the number of hours provided by the subsidy.

Figure 1. Comparison of annual hours of pump operation, electric (flat tariff) and diesel pumpsets



Flat-rate electricity tariffs induce farmers to pump more. Electric-pump owners pump groundwater for more hours per year than diesel-pump owners, according to an IWMI survey of 2,234 tubewell irrigators across India and Bangladesh conducted in late 2002. Cutting the number of hours of electricity supplied annually would 'close the gap' between electric and diesel pump use, and so cut 'waste' of power and water.

Source: IWMI Research Report 70

The outcome is that a farmer in Gujarat, for example, with a 5-horsepower (hp) pump pays only Rs 2,500 (US\$51) per year for electricity, while in two of India's states (Indian Punjab and Tamilnadu) farmers receive up to 14 hours of power per day free. Electricity board losses in India alone are estimated to stand at Rs 26,000 crores (US\$5.3 billion) per year. What's more, these losses are growing at 26% per year.

But do subsidies really encourage overuse of power and groundwater? A recent IWMI survey showed clearly that farmers accessing greatly subsidized electricity supplies run their pumps for between 40% and 250% longer than those who must buy diesel at market rates to run their pumps (Fig. 1).

The case for indirect management

To halt the unsustainable use of groundwater, decision makers commonly use the direct management approach—involving tools such as laws, water pricing policies and reform of property/water rights. This has worked in some developed countries, in countries with a relatively small number of large pumpers, and in countries in which the proportion of the population dependent on groundwater-irrigated agriculture is small. But, even these countries have found it difficult to remove agricultural energy subsidies and stop overdraft completely.

In South Asia (in particular in India, Pakistan, Nepal and Bangladesh) direct management is all the more

Box 2. To overcome farmer resistance to rationed power supply:

- **Enhance the predictability and certainty of supply**—announce the annual schedule for power supply (tuned to match the demand pattern of farmers) and stick to it.
- **Improve the quality of supply**—supply power at full voltage and frequency, thus minimizing damage to motors and downtime of transformers.
- **Match supply with peak periods of moisture stress**—guarantee farmers the power they need to pump during the 6-8 weeks a year of critical moisture stress.
- **Invest in upkeep of farm-supply infrastructure**—pass on to farmers the benefits of the additional revenue gained, by ensuring they receive a reliable power supply.

difficult. First, the extremely large number of small users scattered over large rural areas pose huge logistical problems. Second, bodies regulating groundwater use are often ill-equipped, inexperienced, and have few field staff. Third, agriculture in these developing countries is extremely important, so direct management is particularly 'painful' as many people rely on groundwater for their incomes and livelihoods.

The power sector's proposed solution: metering

As a method for indirect management of groundwater use, there are strong theoretical arguments in favor of the metered electricity tariff. Farmers would learn the real cost of power and water and be forced to economize on their use. Plus, the power utilities would gain valuable information on actual power usages (essential for efficient management and cutting commercial losses).

Transaction costs would be huge

However, metering may not be feasible. In India alone, the direct costs of installing, maintaining and operating 14 million scattered rural meters (plus meter-reading, billing and collecting charges) are massive. A 2002 World Bank estimate for one small state (Haryana) was US\$30 million in capital costs and US\$2.2 million each subsequent year. This did not include the indirect, far larger, costs of containing pilferage, meter-tampering, and under-reading/under-billing by meter readers in collusion with farmers.

Even now, logistical problems mean that utilities are not able to collect the full billed amount from metered customers in the industrial and domestic sectors. Minimum charges, or estimates based on past consumption, are often used instead.

Violent farmer opposition

Farmers are against metering—it will mean the end of their power subsidy. Plus, many farmers suspect that, once it is underway, state electricity boards will introduce extra new charges. Memories of corrupt meter readers in the 1980s (at the end of which Gujarat abandoned meters) are also still fresh in farmers' minds.

This explains why there are not many takers for new metering schemes, despite the extremely large incentives state governments have provided. These include very low tariffs—Rs 0.20-0.70/kWh (US\$0.004-0.014/kWh) against the actual cost of supply of Rs 2.00-3.80/kWh (US\$0.04-0.08/kWh)—and even free drip-irrigation systems as in Gujarat. In 2002, IWMI researchers interviewed 188 electric-pump owners, in 3 states, about pump usage. They found that if the farmers in Haryana and Indian Punjab accepted metering, along with the low-tariff incentives, they would spend Rs 2,530 and Rs 6,805 less (US\$52 and US\$139, respectively) per year on power. In effect, this is the price they are willing to pay to avoid the 'hassle' and expected future costs of metering.



Making a power subsidy explicit is vital to effective management of the nexus. Presently, state governments provide a certain number of hours of electricity per day, but don't know the cost of that subsidy—which depends upon how many farmers pump during those hours, and for how long.

Making metering work?

North China provides a good example of a successful metering system. Farmers benefit from a modernized, rehabilitated supply infrastructure and are prepared to pay a high price for a good quality power supply and support/maintenance services. A 'village electrician', who receives a wage and incentive payments, ensures that all power used at the level of the village transformer is paid for. But, unlike much of South Asia, agricultural productivity is high in China, so the cost of electricity is low in relation to the value of agricultural output and farmers' incomes. Also, there are strong authority structures, in particular the Village Party Leader, which avoid the problem of corruption at the village level.

In South Asia, metering could work in agriculturally dynamic states (e.g., Punjab and Haryana) with high agricultural productivity and a high (and growing) use of electricity outside agriculture. However, micro-entrepreneurs should be used to retail the power, to meter individuals' power consumption and to collect revenue, as privatized meter reading and billing have already cut commercial losses in Delhi.

Metering may not save water

Although unsubsidized metered charges could make power utilities viable, water use would not necessarily be cut. There is a growing body of evidence that agricultural water demand is inelastic relative to pumping costs, and that conservation measures are a reaction to resource scarcity rather than high prices. Indeed, the pockets of India where drip irrigation is spreading rapidly are areas where water and/or power is scarce rather than costly.

The rational flat tariff: conserving groundwater and cutting power losses

The second method for indirect management of groundwater—and the one likely to be most successful—is the rational flat tariff. Flat-rate pricing is a recognized business philosophy, often used when an important objective is reducing the transaction costs of doing business.

Successful examples span the commercial world. In India, for example, a flat rate is charged by the telecom department for the first 250 phone calls made. Many customers thus try to keep their calls within this limit,



A farmer operating a 10 hp tubewell in Tamilnadu, where farmers are supplied with 14 hours of 3-phase power throughout the year, can theoretically receive a subsidy of Rs. 45000/year (app. US\$1,000) in free power (operating his pump 3000 hours/at Rs 2/kWh).

and the company's billing costs are cut. The system is also used for canal irrigation around the world—it is not possible to measure and charge for individual usage when a 5,000-ha command may contain 6,000–8,000 customers.

Flat-rate electricity pricing in agriculture does not carry the logistical problems and large transaction costs metering does. And, if key points are considered when implementing the system (Box 2), it should not provoke farmer opposition.

Farmers like the flat tariff because it is simple and transparent (unlike metering). Plus, it is a subsidy that reaches them directly.

Farmers like the flat tariff because it is simple and transparent (unlike metering). Plus, it is a subsidy that reaches them directly, without being 'creamed off' by intermediaries (as other subsidies can be). When transforming the current dysfunctional flat-rate tariff, policymakers should appreciate this; indeed, all of the measures in Box 1 (and expanded upon below) need to be included in one policy.

Making the power subsidy explicit

Keeping the power subsidy is important, not just for the political life of state governments, but to keep farmers farming. If charging farmers realistic energy

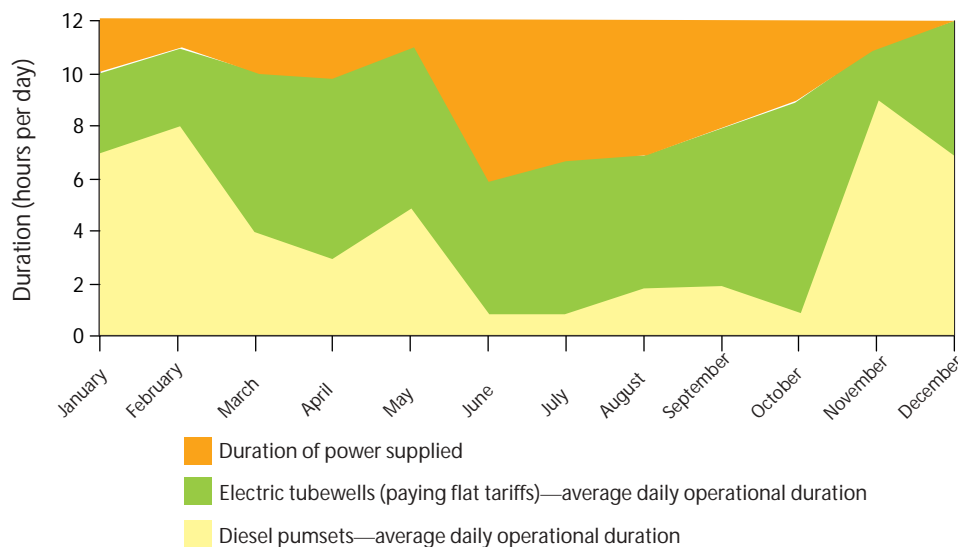
prices means bankrupting them, all the progress made since the 1950s in groundwater-based livelihood creation would be lost.

Making a power subsidy explicit is vital to effective management of the nexus. Presently, state governments provide a certain number of hours of electricity per day, but don't know the cost of that subsidy—which depends upon how many farmers pump during those hours, and for how long. For example, a farmer in Tamilnadu (where farm electricity is free) may use between 0 and 14 hours of power/day. If the real cost of power is taken to be Rs 2/kWh (US\$0.04/kWh), then subsidizing that one farmer could cost the state anywhere between Rs 0 and 75,000 (US\$1,531) per year. Reducing the number of total hours supplied to a set level and increasing power supply when irrigation is needed most would greatly reduce this uncertainty, as well as the cost of the subsidy.

Raising the flat tariff: gradually and regularly

In most states, tariffs have not been changed for 10-15 years, though generation and distribution costs have soared. Inevitably, infrastructure has decayed and supply quality has dropped. Raising the flat tariff is, unfortunately, unavoidable—to halt this decline and stop large rural areas losing their electricity supply completely (as has happened in eastern India).

Figure 2. Average daily pumping hours, electric and diesel pumpsets



Providing 12 plus hours of daily power supply to the farm sector throughout the year leads to wasteful use of power and water under a flat tariff regime. A more sustainable option would be to match power supply to farmer need—using the pumping patterns of diesel pump owners as a guide.

Figure 2 is a schematic diagram which is based on the evidence of Figure 1.

Source: IWMI Research Report 70

The difference between farmers using electric and diesel pumps gives some indication of the 'waste' of energy and groundwater the current 'degenerate' flat-tariff regime encourages.

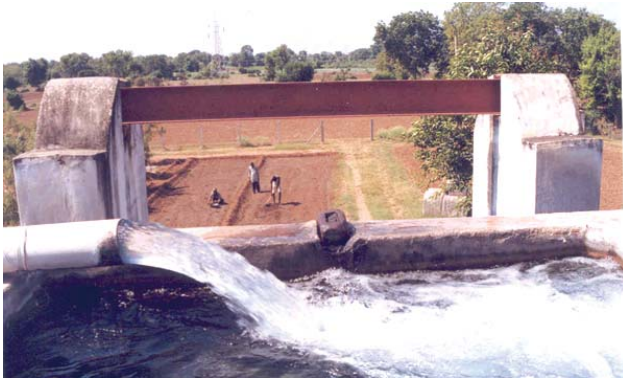
But, frustrated by farmer resistance to metering, many Indian state electricity boards are threatening four-to-five-fold increases in the current flat tariff. Gujarat's board intends to hit farmers with a 350% price-hike, raising the annual charge from Rs 500/hp (US\$10.41/hp; unchanged since 1989) to Rs 1,700/hp (US\$35.39/hp). Eventually this will become Rs 2,100/hp (US\$43.72/hp), to comply with demands from the Gujarat Electricity Regulatory Commission. However, if the state does this, the farmers may well unseat the government.

A regular 10-15% annual increase, would be easier for farmers to cope with, and thus more likely to be accepted. Combined with the other measures outlined here, this would allow farmers to see improved quality and reliability of supply as the benefits of the price rise.

Finally, the price-hikes planned in India are designed to cover the cost of supplying power for the high number of hours that politicians have promised farmers. These costs would be much lower if a lower number of hours were supplied, through intelligent supply management.

Supply management—the crux of the matter

Farmers who use diesel-powered pumps pay real/market costs for their power supply. So, they are unlikely to waste money pumping water they don't need. Their behavior is rational and



Some borewell owning farmers lift water during the night to fill an open well using an automatic switch, and then lift water during the day from the open well to irrigate their fields. Charging farmers a metered rate of Rs 2/kWh would certainly put an end to this type of practice; but so would cutting the hours of supply and following power a pre-announced schedule.

based on economics, rather than on maximizing benefits from a free or artificially low-cost resource. They are the benchmark against which ‘excess’ use of power by electric tubewell owners can be measured.

Each month, electric pumps are used for a greater number of hours than diesel pumps (Fig. 2). The difference between farmers using electric and diesel pumps gives some indication of the ‘waste’ of energy and groundwater the current ‘degenerate’ flat-tariff regime encourages. Certainly there is scope for cutting the hours of power supplied to farmers under a rational flat tariff, and diesel-pump usage can also be used to guide the annual scheduling of a restricted electricity supply, by showing when farmers need water most.

Irrigators perceive a good quality service to be the provision of power of a uniform voltage and frequency when their crops face critical moisture stress. Therefore, with intelligent management of power supply, it is possible to satisfy irrigation power demand by ensuring 18-20 hours of power a day for 40-50 key moisture-stress days in the kharif and rabi seasons (around 2 and 5 weeks respectively). Some power (e.g., 1-2 hours/day) would also be made available on other days of the year.

Through this regime, supply could be restricted to 1,200 hours/year. This would mean that a typical pump (5 hp, lifting 25 m³ of water/hour) could provide its owner with 30,000 m³ of water—sufficient for most small farmers in the region. Such ‘water entitlement’ compares favorably with that in a canal irrigation system.

Use of off-peak power would further reduce the cost of electricity—by around 25% if all power was off-peak. And, as many farmers irrigate at night, this would not affect their farming practices.

So, the most viable and practical solution to the current crisis involves raising the flat tariff to Rs 900 (US\$18.37) (and eventually to Rs 1,200 [US\$24.49]), using 100% off-peak electricity, and restricting annual supply of farm power to 1,000-1,200 hours/year, rather than the uneconomical 3,500-5,000 hours/year currently provided. The challenge for power utilities would be to match the timing of power supply to the periods when crops need water most. This would vary a great deal as crops grown vary across and even within regions.

The benefits of the rational flat tariff

If well managed, such a strategy could cut wasteful use of groundwater by 12-18 km³ of water/year in western and peninsular India alone, reducing power use in groundwater extraction by some 2-3 billion kWh of power—valued at Rs 4,000-6,000 crores/year (US\$0.8 billion-1.2 billion/year). Plus, it could actually improve farmer satisfaction with the power industry.

The strategy would also make groundwater and power use more sustainable (compared with the present regime or a metered tariff) by placing an effective check on total use of both resources, and thereby cutting blatant overuse. For example, farmers who use automatic switches to maximize the amount of groundwater they pump could not indulge in such waste if they only received a rationed quota of good-quality power on a pre-announced schedule.

A rational flat tariff combined with supply management could cut wasteful use of groundwater by 12-18 km³ of water/year in western and peninsular India alone.

Providing power for 1-2 hours/day outside the main irrigation seasons will encourage farmers to build small on-farm storage tanks, to meet their water needs. And, as the flat tariff is greater for pumps with higher horsepower ratings, raising the tariff would encourage farmers to purchase and use smaller capacity pumps to irrigate smaller areas—thus reducing overdraft in regions where depletion is rampant.

Water Policy Briefing Series

The *Water Policy Briefing* Series translates peer-reviewed research findings into useful information for policymakers and planners. It is published several times yearly, with the goal of bringing new and practical approaches to water management and planning into the policy recommendation process.

The Series is put out by the International Water Management Institute (IWMI) in collaboration with national and international research organizations.

The Series is free of charge to development professionals. It is available on-line or you can sign up to receive the series via e-mail or post. See www.iwmi.org/waterpolicybriefing for more information.

Comments and questions are welcome. Please send correspondence to:
Sarah Carriger, Water Policy Briefing, IWMI, P.O. Box 2075, Colombo, Sri Lanka
Telephone: 94-1 2787404 Fax: 94-1 2786854 E-mail: waterpolicybriefing@cgiar.org

IWMI-Tata Water Policy Program

The IWMI-Tata Water Policy Program was launched in 2000. This is a new initiative supported by the Sir Ratan Tata Trust. The program presents new perspectives and practical solutions derived from the wealth of research done in India on water resources management. Its objective is to help policy makers at the central, state and local levels address their water challenges—in areas such as sustainable groundwater management, water scarcity, and rural poverty—by translating research findings into practical policy recommendations.

Through this program, IWMI collaborates with a range of partners across India to identify, analyze and document relevant water management approaches and current practices. These practices are assessed and synthesized for maximum policy impact in the *Water Policy Briefing* Series.

The Policy Program's website (www.iwmi.org/iwmi-tata) promotes the exchange of knowledge on water resources management, within the research community and between researchers and policy makers in India.

About IWMI

IWMI is a nonprofit research organization focused on improving land and water management in developing countries for food, livelihoods and nature.

IWMI's research centers around five core themes:

- Integrated Water Management for Agriculture
- Sustainable Groundwater Management
- Smallholder Water and Land Management Systems
- Water Institutions and Policies
- Water, Health and Environment

The Institute fields a team of over 200 researchers from some 30 countries in Africa, Asia, Australia and North America. IWMI is headquartered in Sri Lanka with regional offices in India, Pakistan, South Africa and Thailand.

All IWMI research is done with local partners (universities, government agencies, NGOs, research centers, etc.). The Institute's outputs are public goods that are freely available for use by all actors in water management and development. The IWMI Research Reports, data and other publications can be downloaded from the IWMI web site. A series of tools for improved water management is also available.

For further information see www.iwmi.org or write to iwmi@cgiar.org

Research in India

Over the past decade, researchers from IWMI have been collaborating with Indian scientists and development organizations in the areas of: irrigation performance; satellite remote sensing; irrigation management transfer; analysis of gender, water and poverty; and malaria control.

IWMI's research and cooperation in India focus on three key areas: river basin water productivity, water and land management in watersheds, and groundwater management. Research is coordinated from IWMI's offices in Anand, Gujarat and Hyderabad, Andhra Pradesh. In November 2003, the Institute opened a liaison office in New Delhi.

Partners include the Indian Council of Agricultural Research (ICAR), the International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), and a host of state irrigation departments, agricultural universities, and NGOs.

For further information, see www.iwmi.org/india or write to iwmi-india@cgiar.org

