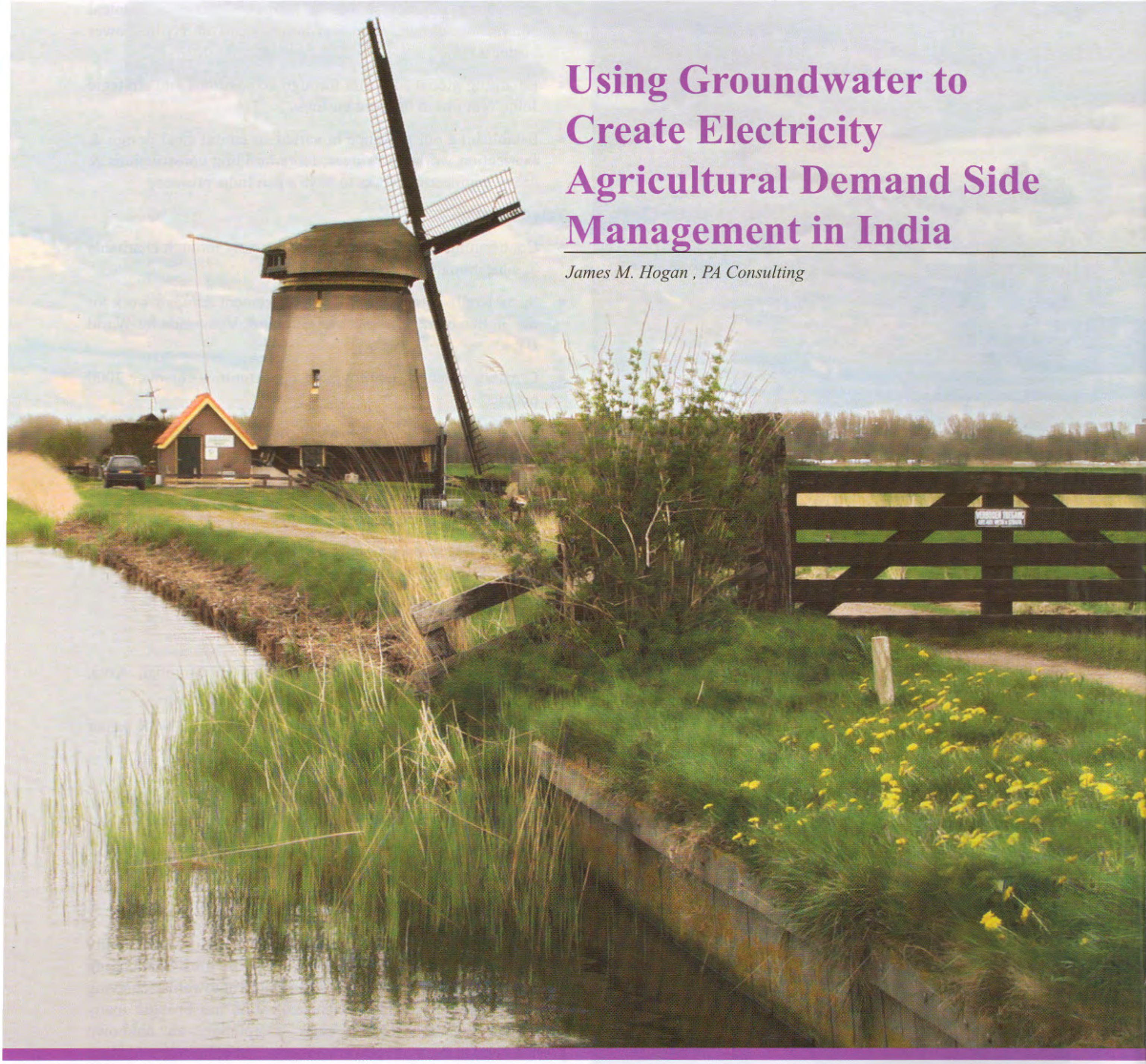


# Using Groundwater to Create Electricity Agricultural Demand Side Management in India

*James M. Hogan , PA Consulting*

Solving India's water - energy crisis could ease power shortages by reducing the amount of electricity needed for irrigation while increasing the security of food supply through more sustainable crop irrigation methods. The pumping of ground water for agricultural irrigation currently uses 50% of India's fresh water and consumes 30-40% of the country's electricity. Agricultural Demand Side Management (Ag DSM) offers a way to halve agricultural electricity usage while using precious water resources more parsimoniously.

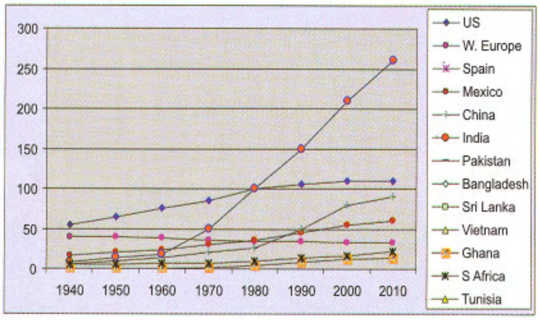
**Background**

The rate of growth in India's groundwater use outstrips several advanced economies as well as many major developing countries (See Figure 1). But this surge in agricultural groundwater usage has come at a high price. Between 1980 and 2000 groundwater use in India doubled, and, today, India's agricultural sector consumes between 30-40% of the country's base, up from 10% on a much lower base during the 1970s . Widespread free power policies for the agricultural sector mean that power used for irrigation is mostly unpaid. If left unabated, the contributing factors will lead to an inevitable crisis that will be more difficult to cure after the fact than if addressed in advance.

**Financial Losses and the Depletion of Aquifers**

Price elasticity of demand plays a powerful role in the drama labelled the 'water-energy nexus'. Figure 2 charts the growth in

*Figure 1: Growth in Groundwater Use in Selected Countries*




*Source: Tushaar Shah Estimates, IWMI*

agricultural and industrial tariffs for the 25 years to 2000 in Andhra Pradesh, one of the largest states in India. Our experience suggests the trends in this and the following two exhibits are representative of trends throughout India.

While industrial tariffs increased more than ten-fold (a compound average growth rate of 11% per year), agricultural tariffs hardly increased at all over the same time span, for a compound average growth rate of less than 2% per year.

*Figure 2*

***Representative Tariff Increases***

*Tariff Comparison: Agriculture v. Industry (Paise)*

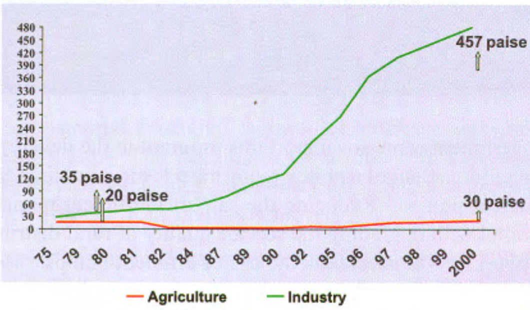



Figure 3, shows the growth rates of agricultural and industrial consumption. While industrial usage increased about 4% per year, agricultural consumption increased at a compound growth rate of 13.5% per year. At that rate, agricultural demand doubles every five years whereas it would take 18 years for industrial consumption to double.

*Figure 3: Per unit power tariffs for Agricultural vs. Industrial consumers in AP (1975–2000)*

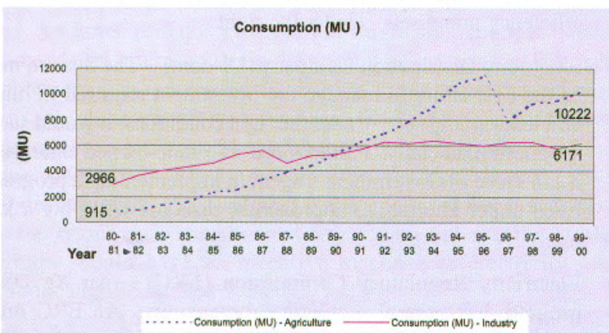
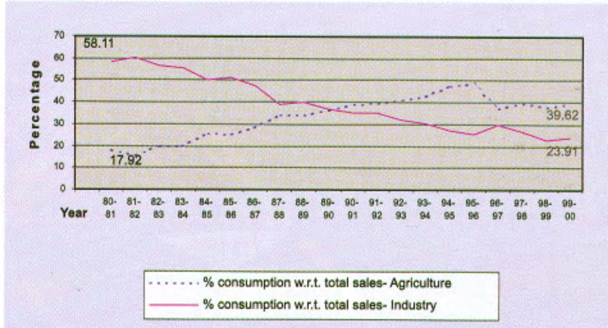



Figure 4 shows what these trends have done to the consumption mix. In the mid-1970s agriculture used 18% of total electricity at a time when highly profitable sales to industrial customers were 58% of the total. As a result, the financial burden was much lighter than in the year 2000 when agricultural sales accounted for almost 40% of the total in this example and industrial sales were only 24% of the mix.

On a national basis, the balance tipped toward loss-making sales to agriculture, triggering the need for a Rs. 40,000 crores subsidy to the power sector. Although the logical solution of implementing economically efficient tariffs is often mentioned, the social and political realities of power and agriculture — a nexus not unique to India — have rendered that an unlikely outcome.

*Figure 4*

*Percentage Consumption w.r.t Total Sales*




One inference that may be drawn from the differential growth rates of agricultural vs. industrial electricity sales is that industrial users are increasingly adopting captive generation to satisfy their electricity needs, albeit at higher costs . Another is that current trends will leave the erstwhile SEBs with a disproportionate share of unprofitable customer segments. This situation is crowding out the electricity needed to support the country's economic growth.

### The Agricultural Demand Side Management Model

In the power sector, Agricultural Demand Side Management (Ag DSM) consists of those methodologies and technologies that influence consumer behaviour and modify consumption patterns. The goal is to reduce peak demand, shift the time when electricity is used or reduce the total amount of electricity consumed.

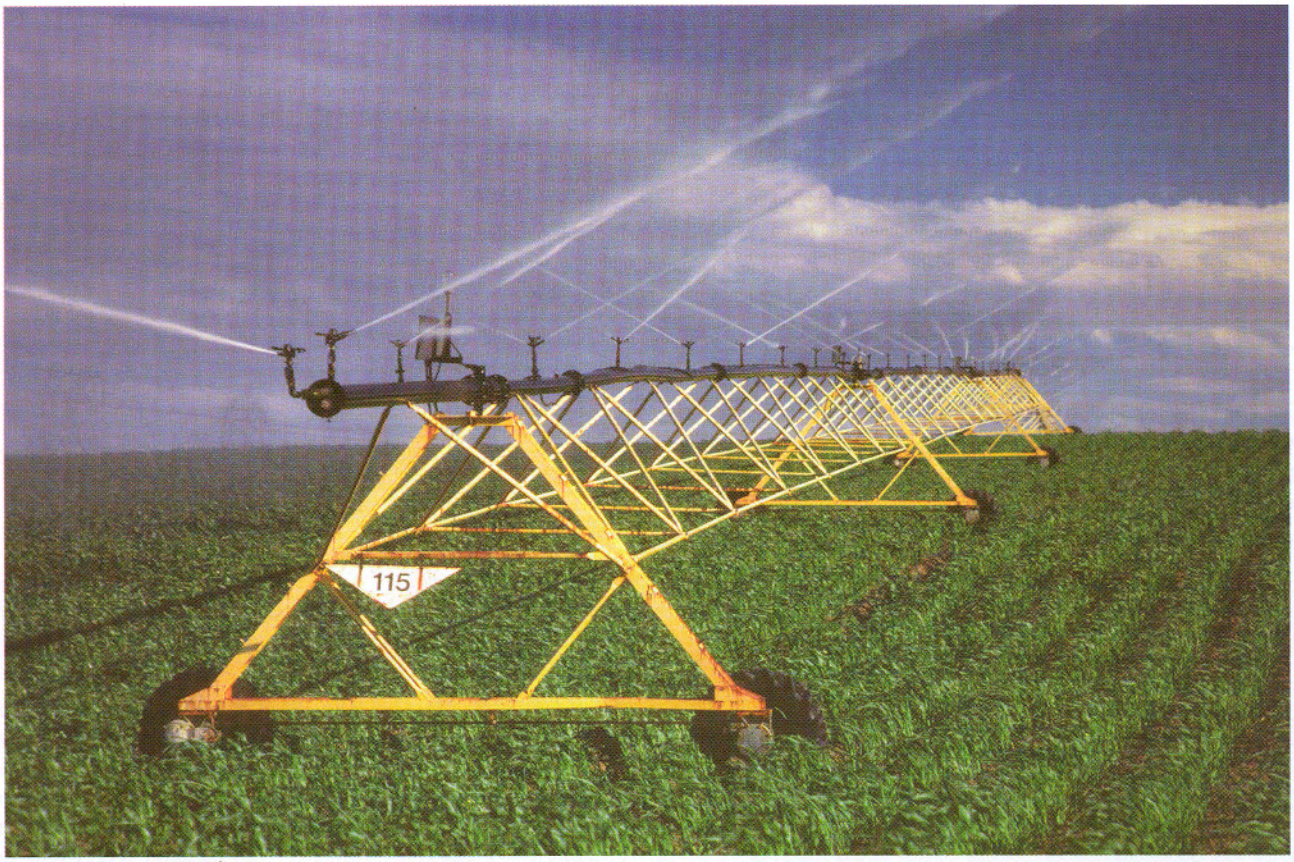
The Ag DSM proposition is simple. Replace inefficient irrigation pumps with high efficiency pumps to reduce the amount of electricity needed to pump irrigation water by 40-50% . If the reduction in electricity usage is sustained and if the cost of the electricity thus saved exceeds the cost of the new pump over its useful life, there will be a net economic gain.

The economics of an efficient pumpset DSM program appears 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 program work. There is also a danger that the project will be evaluated in isolation from other complementary activities like drip irrigation.

### Preliminary Financial Assessment

WENEXA retained an experienced international expert in energy efficiency financing to develop a preliminary assessment of the economics of Ag DSM. Based on informed estimates obtained from discussions with knowledgeable representatives of discoms, pump manufacturers and industry expert, WENEXA's analysis indicates that a properly structured Ag DSM project could produce an internal rate of return of 25% per annum over a 10 year program life. Adding the value of carbon credits could increase the IRR to 40% or more.

These results are preliminary and indicative and actual results may vary based on site-specific conditions. They also assume strong




support from Government and an efficient discom to implement it. However, the robustness of the preliminary analysis suggests there is ample scope to overcome the known problems with Ag DSM implementations.

**Stakeholder Responsibilities**

In the absence of economically efficient tariffs to continuously send correct pricing signals to customers, a workable 'second best' solution is needed. 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 Ag DSM pump efficiency concept seems relatively simple - perhaps deceptively simple - but the actual implementation of this approach will involve a number of stakeholders including state governments, farmers, electricity distribution companies, regulators and pump manufacturers, among others.

Ultimately, a sustainable solution involves a pact between farmers and their state governments. A profile of the key responsibilities of 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 program and how responsive they should be in doing what is needed to make it a success.

  It will be critical for Government to openly endorse the program, and strongly too. Government endorsement of the creation of 'centers of excellence' in distribution in would foster creation of the necessary pre-conditions for efficient pumps. Government can also support this program in the development and enforcement of a policy requiring a testing and branding of efficient pumps. Reducing the sale of inefficient pumps - in parallel with upgrading the service quality of rural distribution networks - will accelerate the use of efficient pumps.

- Farmers – Conceptually, farmers should be the principal beneficiaries of this program. 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 Ag DSM model to achieve its potential, it will be necessary to identify and implement an incentive to induce supportive behaviour by 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

- 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 Government's agent in implementing a program. Even under alternative approaches, discoms will play a key role.

- Electricity Regulatory Commission (ERC) – An Ag DSM program has several regulatory dimensions. An ERC must 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. In order to make an informed decision, it must be fully informed about the details of the program and satisfied that it is economically sound and has Government's backing.

- Pump Manufacturers – The manufacturers of high efficiency pumps stand to gain many new customers if this program develops a practical, workable, replicable and sustainable model. In addition to providing the best possible pricing, pump manufacturers could contribute their know-how to support the development of a pump certification programme, including the development of standards and specifications.

**Risks**

WENEXA studied the results of major pumpset efficiency initiatives conducted during the past two decades. Much has been learned from those efforts as well as from other relevant analyses and studies, but our survey concluded that there was a high risk of "snapback" where electricity consumption quickly returned to its original level after efficient pumps were installed. This resulted from farmers taking a benefit from the program by using the more powerful pumps (and free power) to expand pumping, either to expand acreage under irrigation or perhaps to resell water to other farmers.

Two troublesome risks associated with pump efficiency Ag DSM projects are the issue of capturing gains (i.e., 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 (i.e., 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 major hurdles to implementing this proposed Ag DSM 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 savings achieved.

The most fundamental approach to implementing Ag DSM would be for a discom to manage and finance the Ag DSM program. Conceptually, this has considerable merit since the discom is an agent for the government and both would be primary beneficiaries of a successful program. On the other hand, the relationship between farmers and discoms is characterized by a level of mistrust that will make it difficult for companies to implement successfully and the idea of DSM is alien to the culture of most electric utilities.

Getting farmers to behave correctly is central to the success of Ag DSM. This involves a grass-roots educational effort and getting the proper alignment of incentives. The former requires a diligent effort and the latter remains elusive, but might be achieved under a farmers' user group similar to the water users groups that have been implemented in some areas. Each users' group would be entitled to the same allotment of free power as in the year before the Ag DSM program is implemented but with the proviso that they could "sell back" unused power to the discom. If the protocol allowed farmers to consume above the baseline (i.e. the amount of free power based on the prior year's actual use of free power) but at full cost, then farmers would have an incentive to conserve electricity - but without sacrificing their subsidy.

Two other approaches offer interesting potential. One is the energy service company (ESCO) model that inserts an independent company to manage and fund the specialized activities involved in Ag DSM on behalf of a discom. The ESCO would be paid out of the savings achieved.

The other involving industrial customers who could reap the benefits of saved electricity in exchange for managing and financing an Ag DSM program. That approach could have unique application for companies in the agri-business sector who are implementing contract farming approaches that wrap several components of the value chain, including technical advice, seeds and fertilizer as well as distribution and processing. Ag DSM offers the potential to improve agricultural outputs and enhance farmer incomes while strengthening the ties between farmers and their agri-business counterparties in an enhanced value chain.

**Conclusions**

Solving India's water - energy crisis would be a major breakthrough with benefits for millions of people. It could help ease power shortages while increasing the security of food supply by providing a more sustainable approach to crop irrigation. Admittedly, the Ag DSM model is complex and certain risks must be mitigated to ensure sustainability and some issues are not fully resolved.

However, if economically efficient tariffs cannot be used to send correct signals and balance usage, Ag DSM offers a workable alternative. The makings of a do-able deal are on the table. Ag DSM offers the potential for states to close the capacity gap, at least partly, with an implementation timeframe shorter than the construction cycle for new power plants and at a lower cost.

Ag DSM has been vetted and validated as much as it can be. The next step is to move the concept from desktop analysis to a proof-of-concept field trial.

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