

Can Energy Pricing Save India's Groundwater? Evidence from a Field Pilot in Gujarat

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1 Introduction

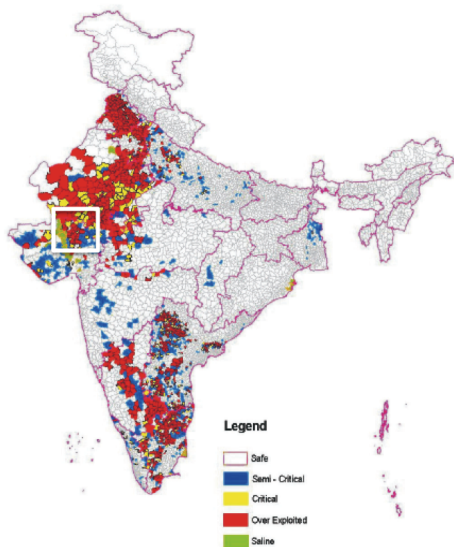
The Groundwater-Energy Crisis in India

- Groundwater depletion - a global problem (Konikow and Kendy 2005, Wada et al 2010)
- India - world's largest consumer and the country probably most vulnerable to this threat (Fishman et al, 2011; Sekhri, 2011; Shah, 2010; World Bank, 1998; World Bank, 2010).

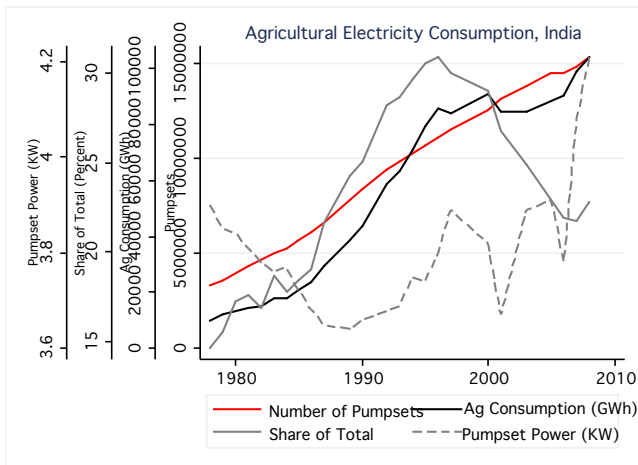


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The Groundwater-Energy Crisis in India



Number of electrical pumpsets (red), Agricultural electricity consumption (GWh, black), its share of total electricity consumption (percent, grey) and the average pumpset power (KW, grey dashed) from 1978 to 2008. Source: All India Electricity Statistics, annual volumes.

Low Water Use Efficiency

- Maintaining food production while reducing water/energy use is a key challenge.
- Despite increasing scarcity, adoption of water saving technologies remains low (MOWR 2001)



Distorted Incentives

- Groundwater use/access is not directly regulated in India.
- Since the 1980s, electricity for pumping groundwater is mostly un-metered and billed at flat, subsidized rates, if at all (Shah 2007).
- Flat rates widely blamed for groundwater depletion and inefficient use, deterioration of power utilities finances and infrastructure (Dubash 2007, Planning Commission 2011).
- Electricity Act of 2003: Mandatory Metering
- Attempts to restore pricing by financially stressed state govts. have all but failed (Dubash and Rajan 2001).

Research Questions

- Can metering and/or accurate pricing be re-introduced to agricultural electricity use?
- Will a marginal price change water usage patterns (reverse GW depletion)?



A New Approach

- Provide consumers with Electricity Entitlements reflecting current usage, and compensate them per unit voluntary reductions in electricity use (Morris 2006, Gulati 2011).
- Farmers must agree to have meters installed and read regularly, but are otherwise under no commitment to reduce power use.
- A politically feasible way to re-introduce a marginal cost structure and an incentive to reduce water/energy use.
- A theoretical win-win: revenue neutral for state, farmers make no commitment...

The idea was piloted In April 2011 through a partnership between the Govt. of Gujarat (GoG) the North Gujarat Utility (UGVCL) and Columbia Water Center.

Main Results

- **Prior:** Farmers will refuse to install a meter
- **In Fact:** 65% of candidate consumers consented to participate.
- **Prior:** Farmers will tamper with meters
- **In Fact:** Only 3% of meters malfunctioned (unlikely due to tampering)
- **Prior:** Farmers can easily save water if they only have an incentive
- **In Fact:** No evidence of response to the price signal.

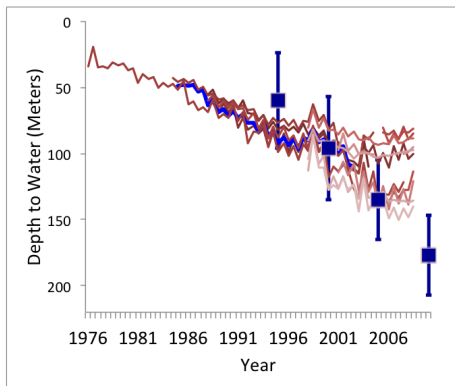
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Study Area



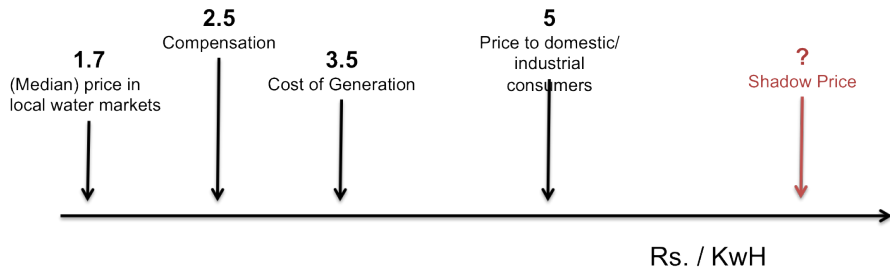
- Rapidly declining water tables (last three decades)
- Deep wells (≈ 1000 ft), Powerful pumps (≈ 60 HP)



- Pumping consumes more than half of all electricity supply
- A precursor for the rest of groundwater intensive parts of India?
(Shah 2007)

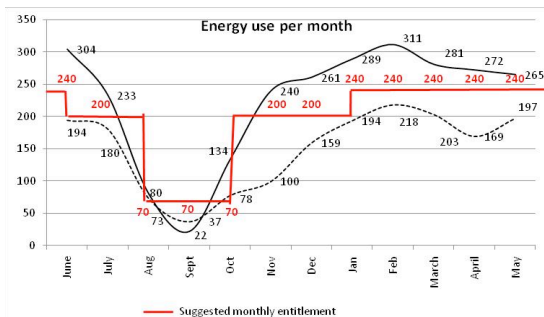
Pilot Design

- In Gujarat, ag. consumers pay a bi-monthly flat rate amounting to about 15% of total value of electricity used.
- GoG decided to deliver the compensation in the form of reductions to flat bill - compensation thus capped at 15%.
- Price was set at 2.5 Rs. / Kwh.



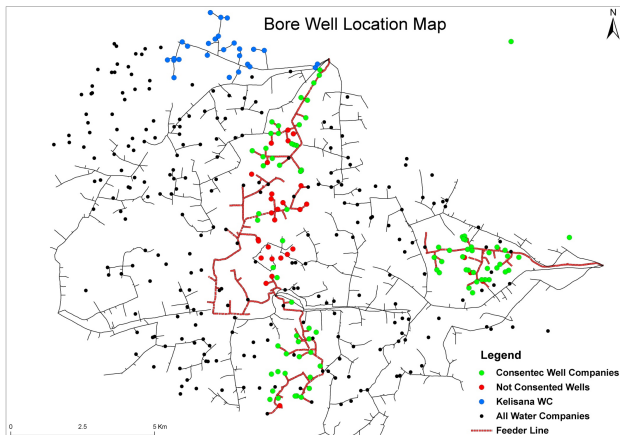
Pilot Design - Baseline

- Determination of baseline is complicated by the lack of individual metering of past consumption.
- All consumers receive the same duration of poser supply, but differ in their pump capacity.
- Baseline consumption was determined as: Pump HP \times Average hours of use
- Issue: similar to grandfathering plus (lack of) rewards to (real) false reductions in use.

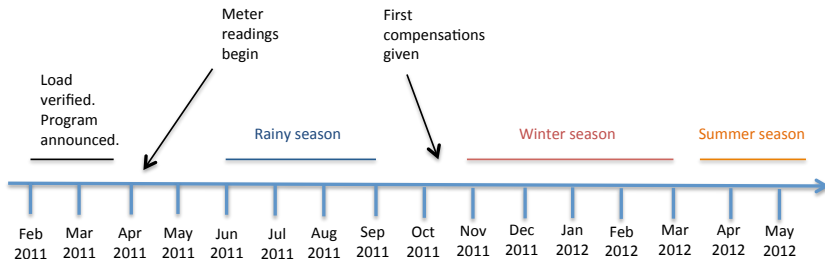


Pilot Implementation

- UGVCL implemented the program at 4 feeders of the Kukarwada sub-station.
- Out of 113 eligible consumers, 85 consent.

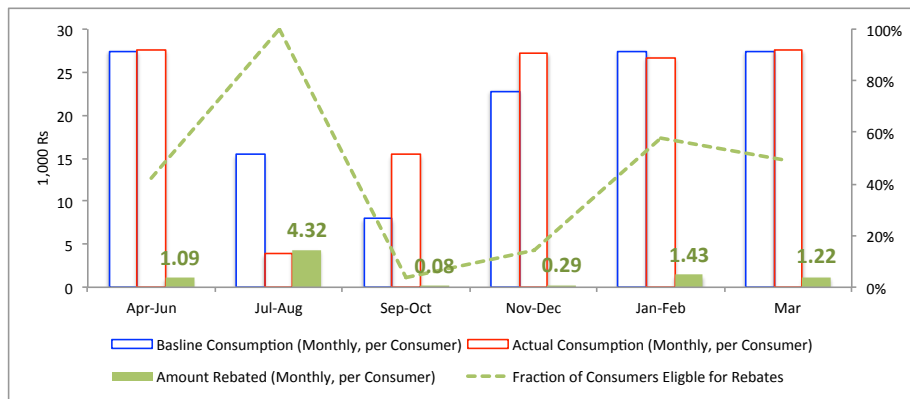


Pilot Implementation - Timeline



Pilot Implementation - Timeline

- 2012 Monsoon was very abundant.
- Consumers had high degree of awareness and confidence about the program (at least from November onwards).



Evaluation I - Feeder Level Data

- The pilot was implemented in 4 feeders (not randomly chosen) out of 32 starting April 2011. Feeder level data available since 2009.
- Difference in Difference estimation: no effect found. With 95% confidence: less than 7% saving.

$$\log C_{f,y,m} = T_{f,y,m} + a_f + b_{y,m} + \epsilon_{f,y,m}$$

	2012	2012+2013	2012	2012+2013
Treatment	0.0238 [-0.137,0.184]	0.0609 [-0.0694,0.191]	0.0258 [-0.0742,0.126]	0.0627 [-0.0235,0.149]
<i>N</i>	927	1251	927	1251
Feeder FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	No	No
Month FE	Yes	Yes	No	No
Year,Month FE	No	No	Yes	Yes

95% confidence intervals in brackets

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Evaluation II: Hour Meters

- The evaluation is challenging because the control group is not metered (and suspicious)...
- Solution: we provided consumers with *hour meters*: devices that measure duration of pump operation rather than electricity consumption.
- Virtually all consumers approached were willing to install.
- Treatment effect on the consenting consumers (upward biased) is bound by 0.6 hours (95% confidence).



Self Reported Impacts

- Consumers were asked What are you doing to save energy?
- Treated consumers reported significantly more (unobservable) effort, and most claimed this was a response to the incentive.

	Mean	Full Control	Village FE	In same villages	Village FE
Saving water	0.20	0.16* (0.08)	0.33** (0.15)	0.19* (0.10)	0.33** (0.15)
Efficient irrigation	0.11	-0.00 (0.07)	0.06 (0.12)	0.03 (0.08)	0.06 (0.12)
Reducing hours of use	0.11	0.22*** (0.06)	0.20* (0.12)	0.22** (0.09)	0.20 (0.13)

Why did farmers not respond to the incentive?

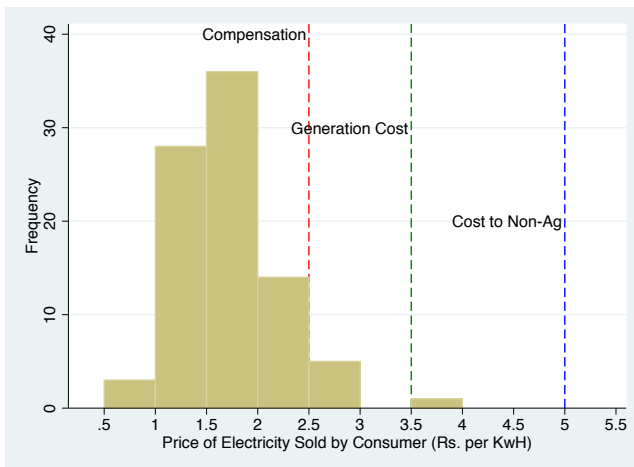
Possible reasons:

- Compensation was too low, in level and in cap
- Lack of familiarity with water saving technologies
- Specific local factors, in particular the shareholding pattern.

Discussion

Why did consumers not reduce water sales in favor of the compensation?

- Strong social norms control water markets
- Contrast to results from West Bengal (Mukerjee 2012)



Conclusion

- The pilot has shown that voluntary shift to metering and billing is possible: first time in decades in a groundwater intensive part of India.
- Social norms around water sales and lack of availability of water saving technologies may limit the response to the incentive.

Next Steps

- A better designed, larger experiment is needed, with higher compensation.
- A survey of the surrounding areas found more favorable conditions for an expansion (Fishman et al, 2013). Other states?
- Private sector involvement?