

# **Impacts of energy pricing, power supply regulation and energy rationing on groundwater use in agriculture**

M. Dinesh Kumar

Institute for Resource Analysis and Policy

Hyderabad

[dinesh@irapindia.org](mailto:dinesh@irapindia.org)

# Objectives

- To analyze the differential impacts of pro rata pricing of electricity, power supply regulation and energy rationing on groundwater use in the farm sector
- To discuss the technological choices for introducing the most effective tool for efficient, equitable and sustainable use of groundwater

# Scope of the presentation

- ❑ Objectives and outcomes of different modes of electricity supply & pricing to agriculture in the past & at present
- ❑ Certain myths about metering & consumption based electricity tariff
- ❑ Impacts of pro-rata (consumption based) pricing of electricity in farm sector
- ❑ Technological innovation for metering electricity use in farm sector
- ❑ Outcomes of various scenarios: metering; restricting power supply; rationing energy use for groundwater pumping

# Past modes of pricing electricity to farm sector: objectives & outcomes

- ❑ Flat rate pricing: objective was to maximize welfare benefits; and reduce transaction costs of metering
- ❑ It creates incentive to use groundwater excessively
- ❑ Increase the monopoly power of large well owners
- ❑ Did not reduce the price of water for water buyers
- ❑ Increased inequity in distribution of subsidy benefits
- ❑ Lack of information about actual power thefts; transmission losses
- ❑ Overall, led to reduced the sustainability of groundwater use; collapse of energy economy
- ❑ Even after feeder line separation, power use is increasing

# Why metering?

- Farm level electricity metering generates information about the use of both energy and groundwater
- Farm level metering helps:
  - Detect electricity theft by individual farmers
  - Assess the actual energy requirements in farming different seasons; and
  - Assess technical losses separately
  - Reduce carbon emission (28 million ton of CO<sub>2</sub> from 107 billion electricity units) in India
- Therefore, it is the first step towards managing both groundwater & energy economy

# Theoretical framework for analyzing impacts of different electricity pricing & water allocation regimes

- Theoretical framework
- The farmers try to maximize his net return under all situations
- The water use efficiency improves under pro rata pricing & goes higher under volumetric pricing
- Modeling studies in the US showed that 1 cent increase in power tariff could result in a reduction in groundwater pumping of . acre feet of water

# Myths about metering & pro rata pricing of electricity in farm sector

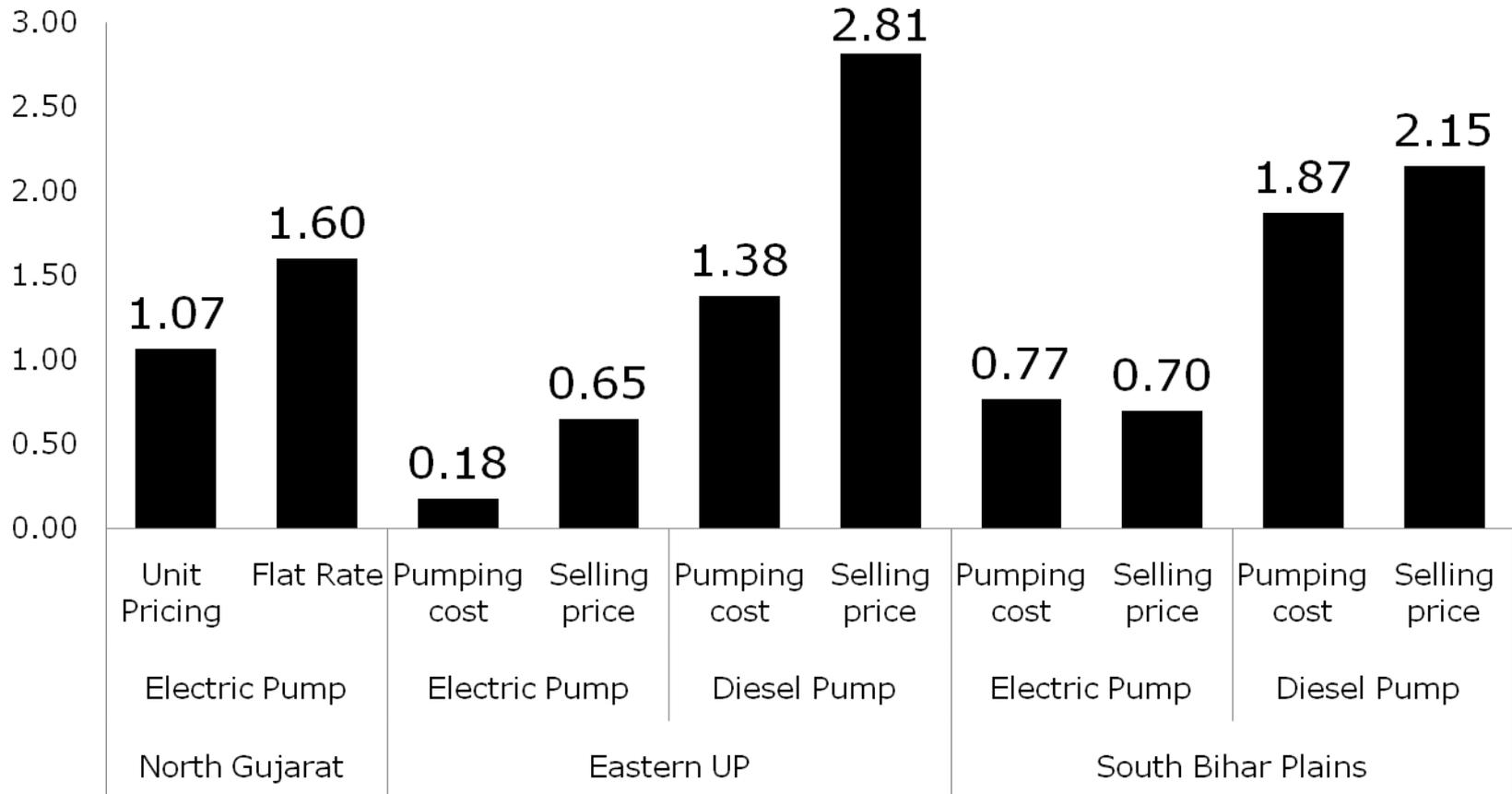
- That metering involves huge transaction costs
- That it reduces social welfare benefits
- Meters would be easily tampered with, and theft would increase, whereas the same would not happen with flat rates
- Farmers across classes resist metering
- With technological innovations, this can be drastically reduced
- It is the other way round; it increases the efficiency; improves welfare benefits, with pro rata charges
- Tendency would be more with flat rate, as the supply will have to be restricted
- Only large farmers are against metering

# Approach and methodology

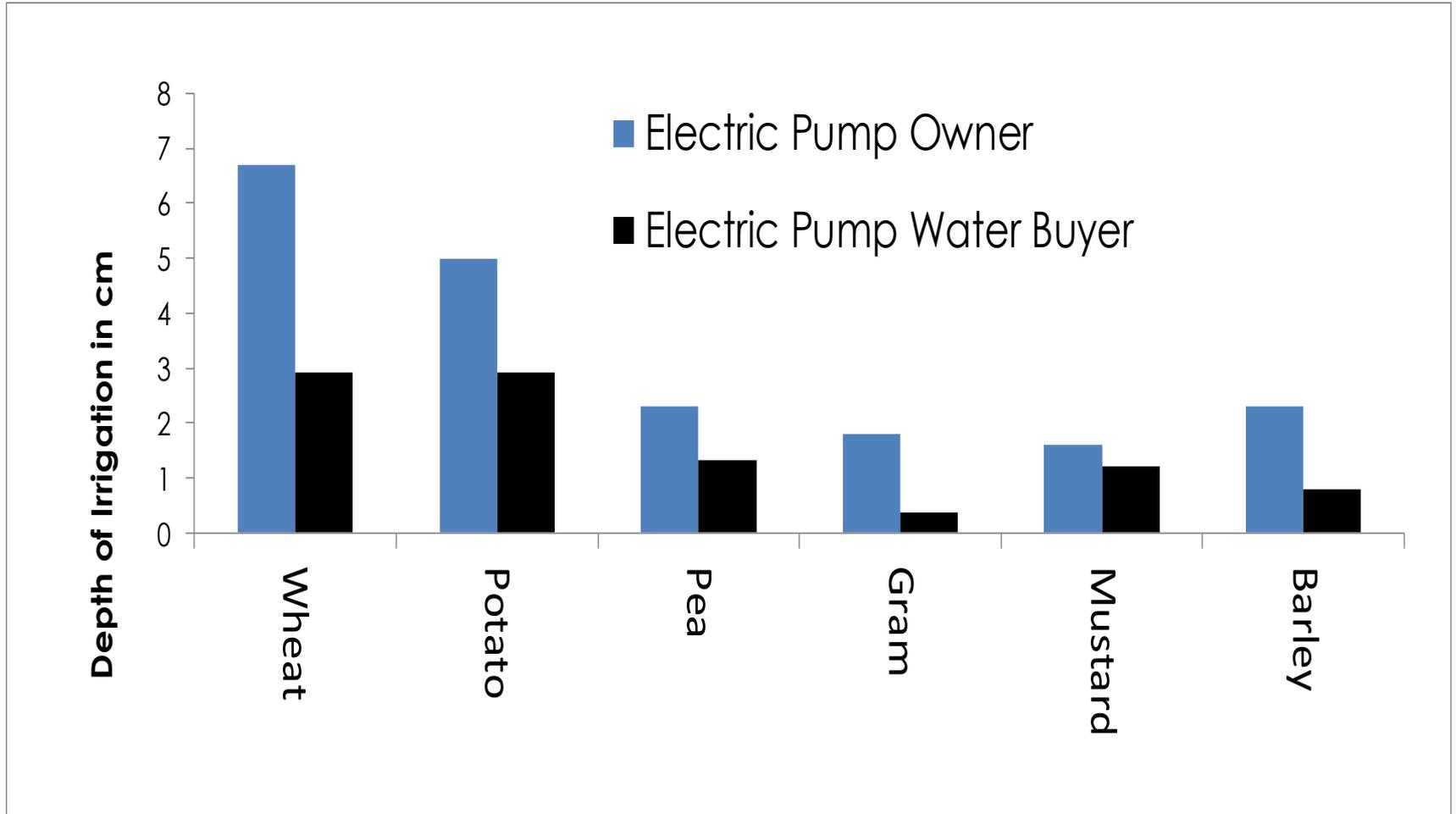
- Farmers who are using diesel wells for irrigation and water buyers are used as proxy cases for pro-rata tariff
- Impact of change in mode of pricing on economic viability of farming is examined by comparing the overall water productivity of the farming system, an indicator of the efficiency of both electricity & groundwater use, of electric well owners and water buyers of electric & diesel commands
- Sustainability impacts is analyzed by looking at the differences in water withdrawal per unit irrigated area

# **Impacts of pro rata pricing of electricity: results from empirical studies**

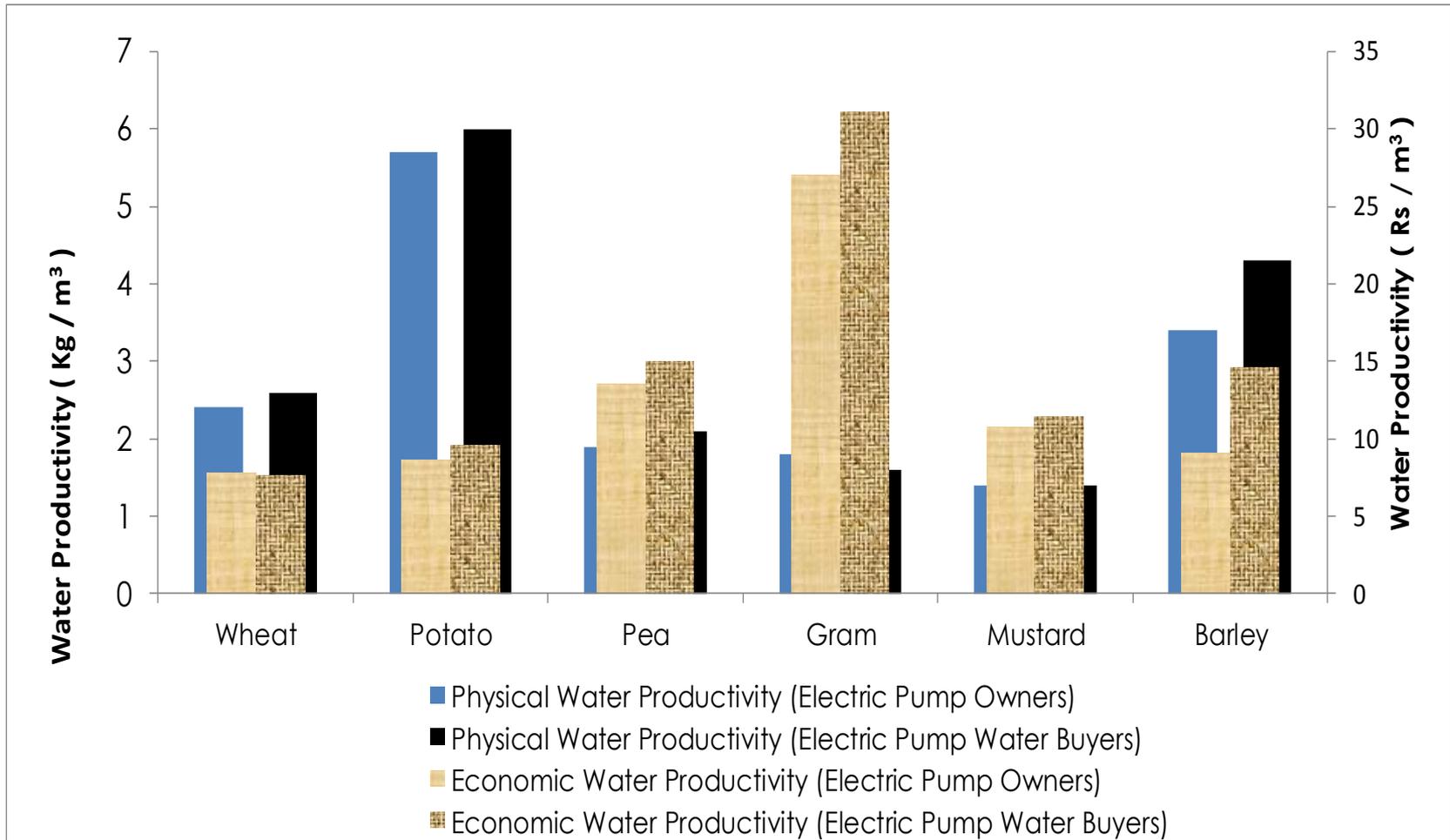
# Cost of groundwater irrigation



# Efficiency impacts of pro rata Pricing: irrigation water use



# Efficiency impacts of pro rata pricing: water productivity



# Efficiency impacts of pro rata pricing

Name of the Regions	Name of the district	Electric Well Command		Diesel Well Command	
		Flat Rate	Unit Pricing	Well owner	Water buyers
North Gujarat	Banaskantha	6.20	7.90	NA	NA
		Well Owner	Water Buyer	Well Owner	Water Buyer
Eastern UP	Varanasi and Mirzapur	10.95	11.18	8.67	12.89
South Bihar Plains	Patna	9.28	10.13	11.97	12.43

# Sustainability impact of pro rata pricing

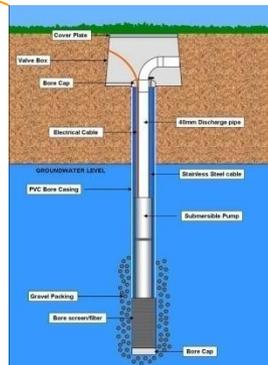
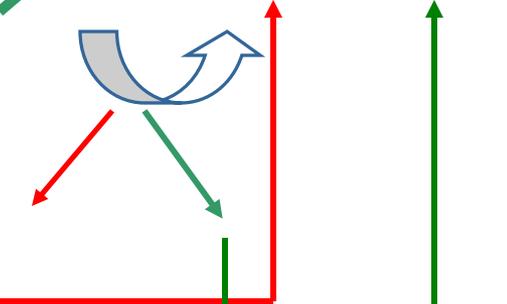
Name of the Regions	Name of the district	Groundwater Pumpage by Electric Pump Owners		Groundwater Pumpage by Diesel pump	
		Unit Pricing	Flat Rate	Well owner	Water buyers
North Gujarat	Banaskantha	303.88	443.88	NA	NA
		Groundwater Use in Electric Well Command by		Groundwater Use in Diesel Well Command by	
		Well Owner	Water Buyer	Well Owners	Water Buyers
Eastern UP	Varanasi & Mirzapur	175.38	183.93	222.23	148.00
South Bihar	Patna	329.97	249.74	231.11	197.91

# Impact of pro rata pricing on economic viability of farming

Type of Well Command	Type of farmer	Gross cropped area (Ha)	Net income from crops (Rs)	Net income from dairying (Rs/day)	Total Farm level Income (Rs)	Farm level net income (Rs/Ha)
Electric Well	Well owner	5.29	124587	7152.3	131739.6	24880
	Water buyer	2.21	54637	6165.0	60802.6	27570
Diesel Well	Well owner	5.66	74764	7429.5	82193.9	14528
	Water buyer	3.79	62323	6260.6	68583.7	18075
Electric Well	Flat Rate	13.35	369119	30048.0	768287.4	57531
	Metered	11.77	311807	45636.0	669250.2	56882
Electric Well	Well owner	3.14	120477	10292.6	130769.5	210345
	Water buyer	1.70	61518	8130.9	76023.9	190031
Diesel Well	Well owner	2.49	140105	9958.1	150063.6	191387
	Water buyer	1.60	71810	12232.2	84042.5	197895

# Advantage of pre-paid meters?

- It helps prevent electricity pilferage through manipulation of pump capacity etc.
- Can be operated through tokens; scratch cards, magnetic cards or recharged digitally through internet & SMS.
- It helps electricity company restrict the use of electricity
- The company can decide on the "energy quota" for each farmer on the basis of either:
  - Reported connected load, and total hours of power supply
  - Sustainable abstraction levels per unit of irrigated land
- Database for every agricultural consumer of the connected load, location etc.
- Farmers can pay & obtain activation code through mobile SMS



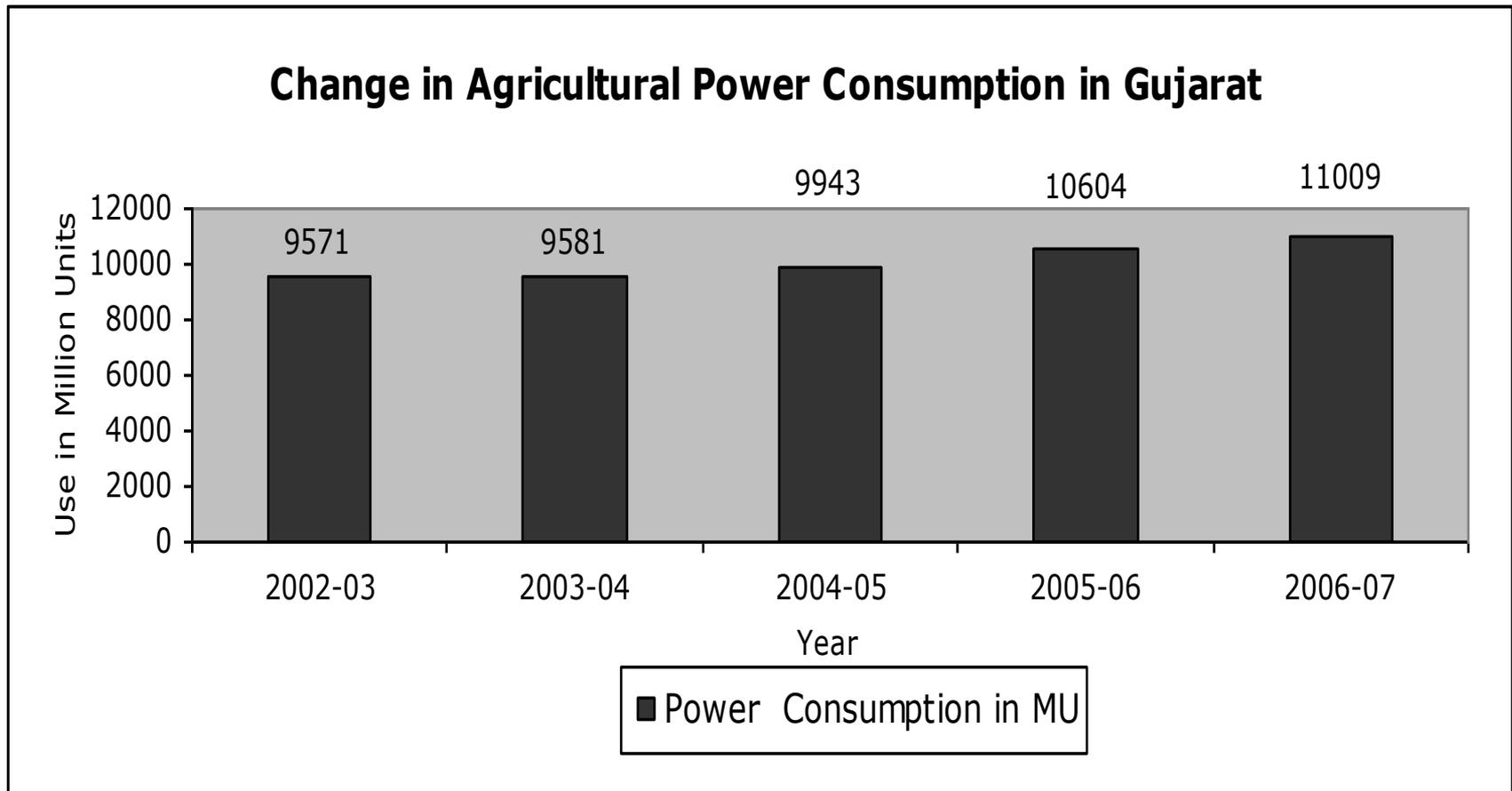
Mobile activation code

Source: Slim Zekri, 2008

# Different modes of pricing & expected outcomes under different energy use regimes

<b>Energy Supply Policy</b>	<b>Monitoring</b>	<b>Pricing Policy Option</b>	<b>Outcomes at farm level</b>	<b>Outcomes for Company</b>
<b>Fixing Energy Quota of Each Farmer</b>	<b>Use is metered</b>	<b>Option 1: Pro rata tariff</b>	<b>Improved efficiency of energy/water use; water productive crops</b>	<b>Theft prevented; revenue loss reduced; Sustainable groundwater use possible</b>
<b>Fixing Energy Quota based on Connected Load &amp; Supply Hours</b>	<b>Use is metered</b>  <b>Do</b>	<b>Option 2: Pro rata tariff</b>  <b>Option 3: HP based Charges</b>	<b>Improved efficiency of energy/water use by all</b>  <b>Improved efficiency of energy/water use by large farmers only</b>	<b>Theft prevented; revenue loss reduced</b>  <b>Do</b>
<b>Unrestricted Energy Supply</b>	<b>Use is metered</b>	<b>Option 4: Pro rata tariff a must</b>	<b>Improved technical efficiency of energy/water use + High productivity gains due to improved reliability</b>	<b>No losses to the company</b> <b>But, groundwater use may not be sustainable</b>
<b>Fixing Supply Hours</b>	<b>Use is not metered</b>	<b>Option 5: Fixed tariff based on reported connected load</b>	<b>Poor energy use efficiency; monopoly of large farmers</b>	<b>Theft high; revenue losses to the company</b> <b>Unsustainable</b> <b>Groundwater Use</b>

# Increasing electricity use & groundwater withdrawal under Jyotigram



# Conclusions

- ❑ **Option 3:** The easily implementable for managing energy economy.
- ❑ **Option 2:** Slightly difficult option. This would conserve some groundwater also
- ❑ **Option 1:** The best option for co-management of groundwater and electricity; but needs political will
- ❑ Government can offer subsidies for meters if farmers are willing to go for option 1 and 2

# Reduction in carbon footprint and positive externality

- A 20% reduction in energy use means 21.56 billion units of electricity saved in farm sector
- The reduction in carbon emission is in the order of 5.60 million ton of carbon; and CO<sub>2</sub> emission to the tune of
- The cost of capturing the carbon emission from 1 kg of CO<sub>2</sub> from fossil fuel based power generation is Rs.0.49.
- The positive externality due to reduction in carbon emission is 709 crore rupees per annum, if we assume 70% of power generation comes from fossil fuel