Agricultural Irrigation Pumping-Energy and Costing Scenarios

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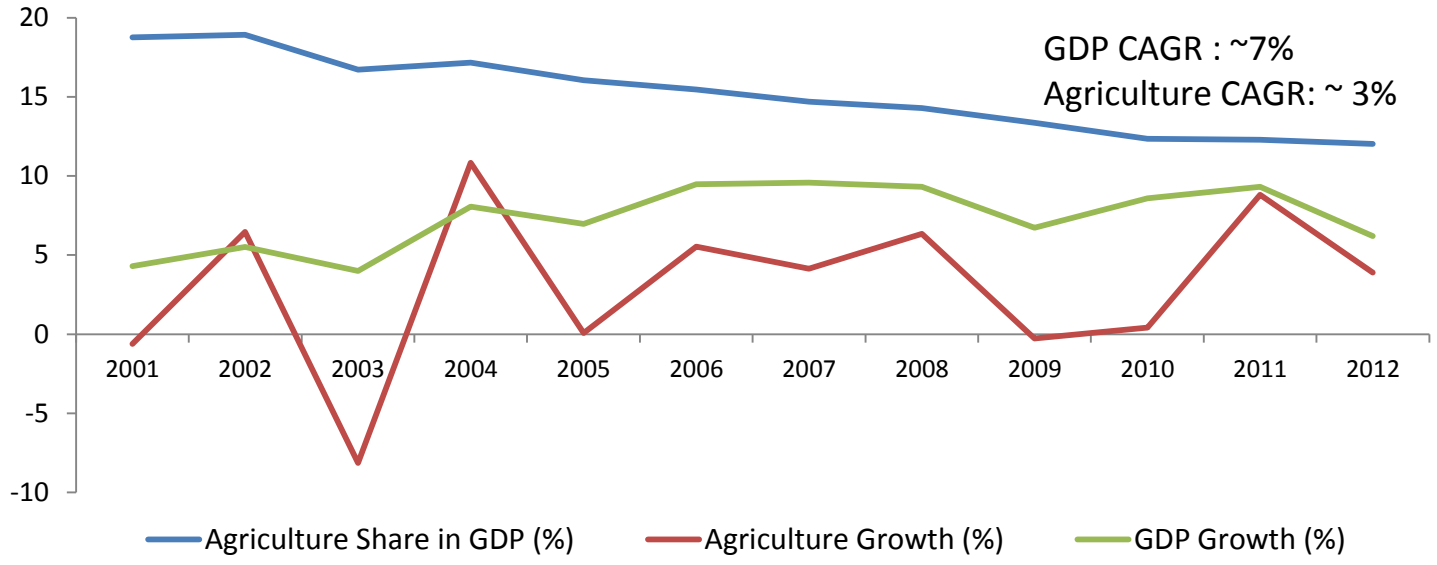
Introduction

Context

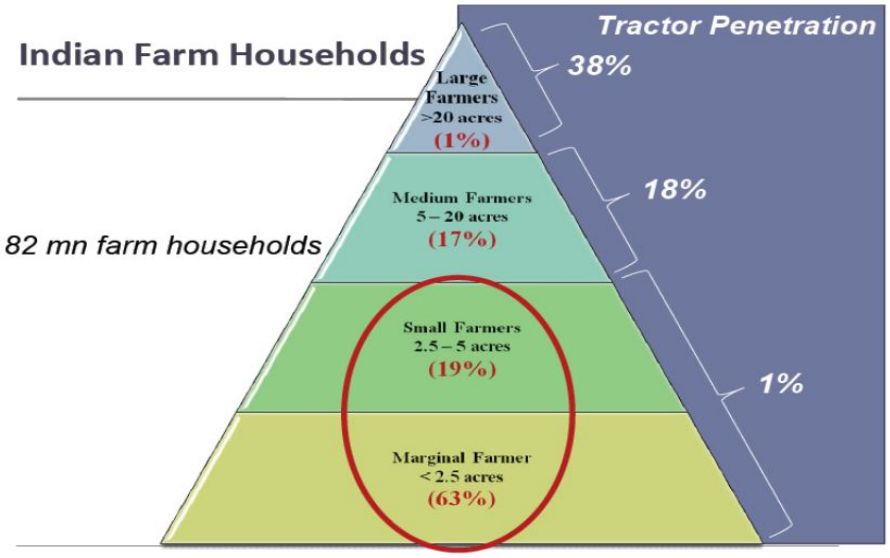
- India supports 17% of world's population and 15% of world's livestock
  - On 2.4% of world's landmass and 4% of world's water resources

- Agriculture accounts for 14% of GDP, 11% of exports and employs 52% of India's work-force

Trends in National GDP and Agriculture's Contribution



Land-Use in Agriculture



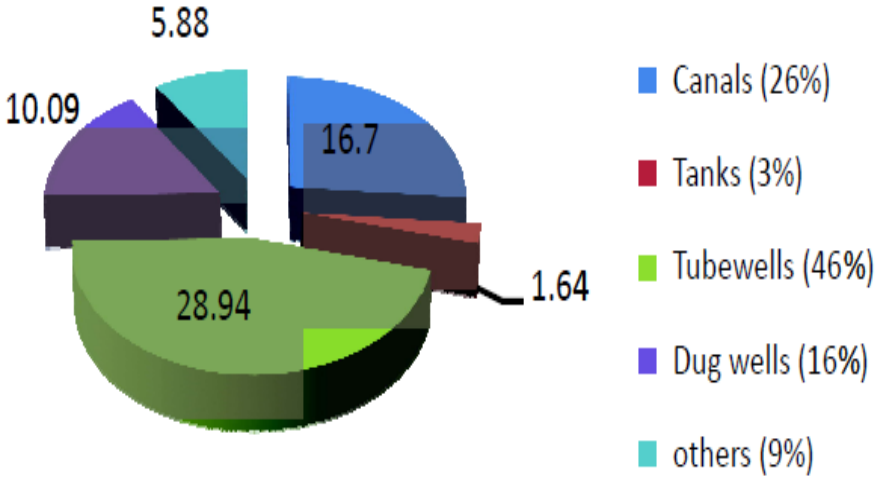
- Average Landholding sizes : 1.16 ha in 2010-11 vs. 2.28 ha in 1970-71
- Small & Marginal Farmers comprise 85% of all holdings and 44% of the total area

Source: Kotak Institutional Equities, *kie.kotak.com*

Cropping Pattern in India

Years	1990-91	2003-04	2009-10
Gross Cropped Area(M ha)	185.74	189.67	191.70
Net Sown Area (M ha)	143.00	140.71	140.02
Cropping Intensity (%)	129.89	134.8	137.26
Food Crops (M ha)	141.03	142.12	141.06
Non- Food Crops (M ha)	44.71	47.55	51.14
Net Irrigated Area (M ha)	48.02	57.06	63.25
Gross Irrigated Area (M ha)	63.20	78.04	86.42

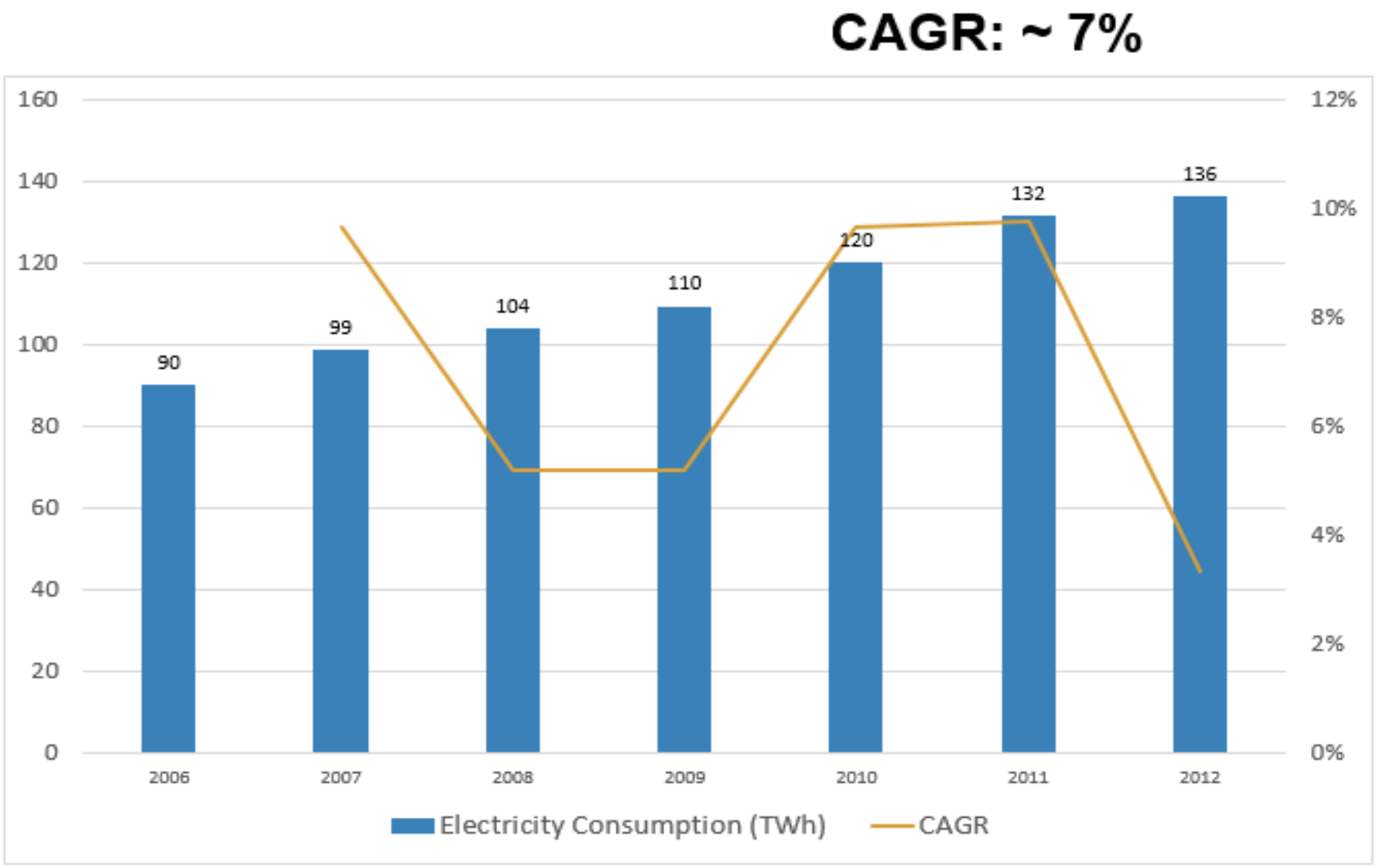
Sources of Irrigation (2010)



Source: Ministry of Agriculture, *State of Indian Agriculture 2012-13*

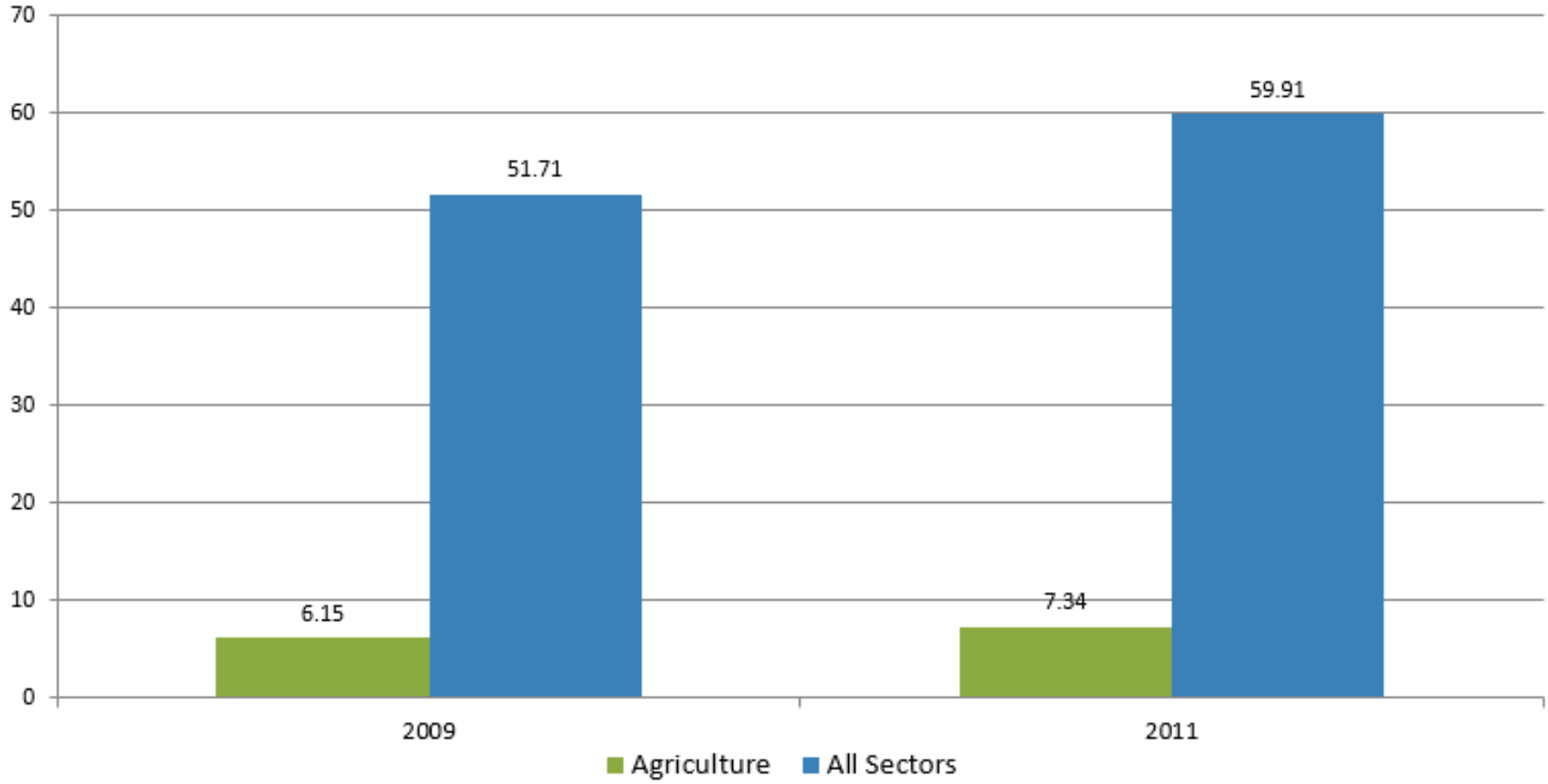
Energy Trajectories: Irrigation

Trend in Electricity Consumption



Source: Energy Statistics 2013. MOSPI

Trend in Diesel Consumption (mmtpa)

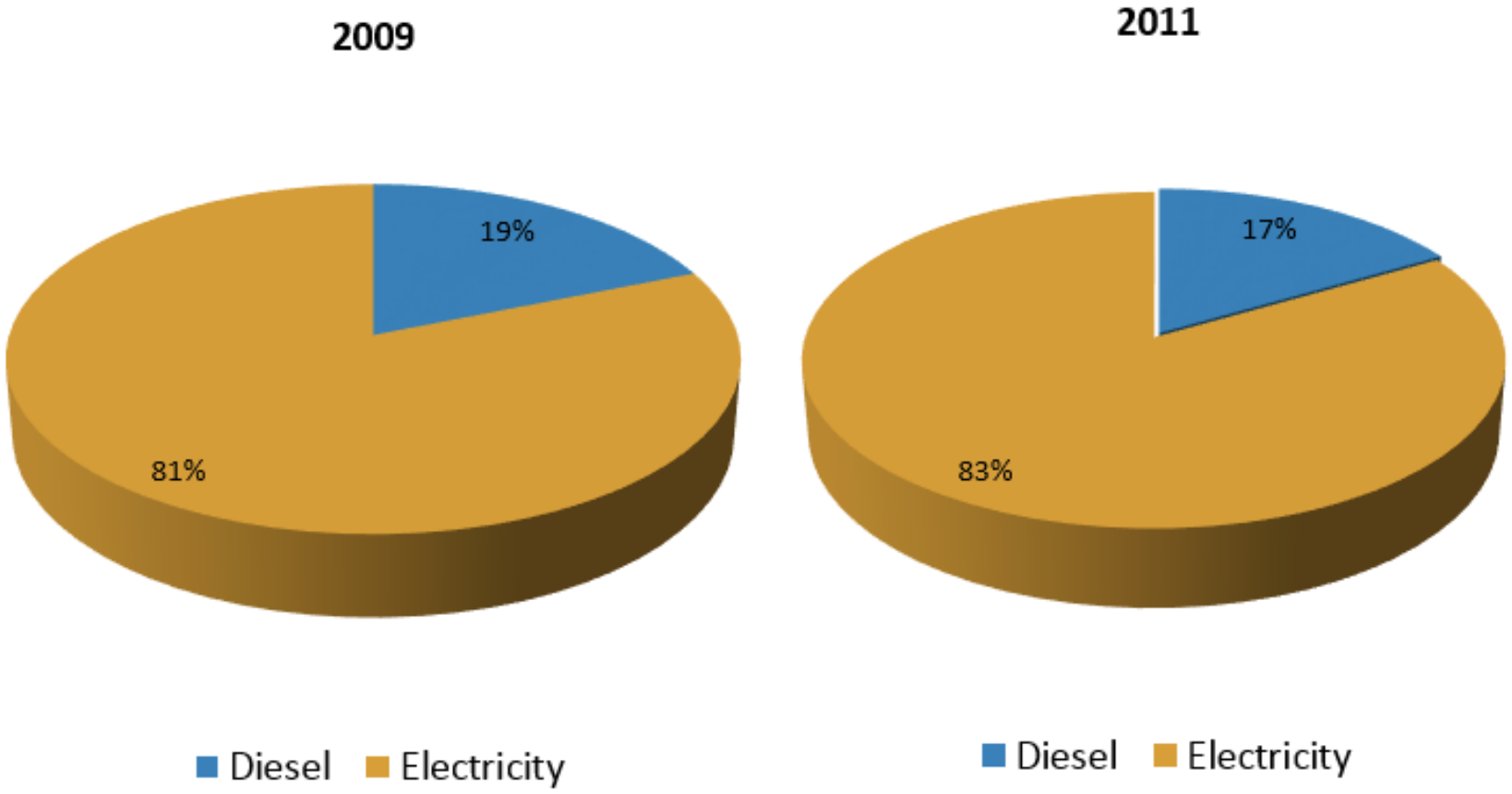


Share ~12%, CAGR: ~ 9%

Comparable to CAGR for electricity consumption in the same time-period

Source: PPAC

Estimated Fuel Mix in Pumped Irrigation



Source: Business Standard; MOSPI; CSTEP Analysis

Estimating all- India Pumping Energy Requirement (2012)

Methodology and Data

- Estimating pumping requirement for all land under agriculture barring that under surface irrigation
- Eight cases emerging from
  - type of pumps used (electric & diesel)
  - current and best efficiency assumptions
  - Min and max irrigation requirement (m^3/ha) for eight major crops under cultivation

NCA (m ha)	141	30% of this area cropped more than once a year
GCA (m ha)	195	
% Irrigated	45.25	40% of this is under surface xirrigation
Input Power for a 5 HP Electric Pump (kW)	6.42	Best Performance = 4.00 kW
Input Power for a 5 HP Diesel Pump (lph)	1.20	Best Performance = 0.85 lph
Average Discharge (lpm)	600	
Minimum irrigation requirement (mm)	580.91	Groundwater use Efficiency = 10-15%
Maximum irrigation requirement (mm)	874.73	

Estimating all- India Pumping Energy Requirement (2012)

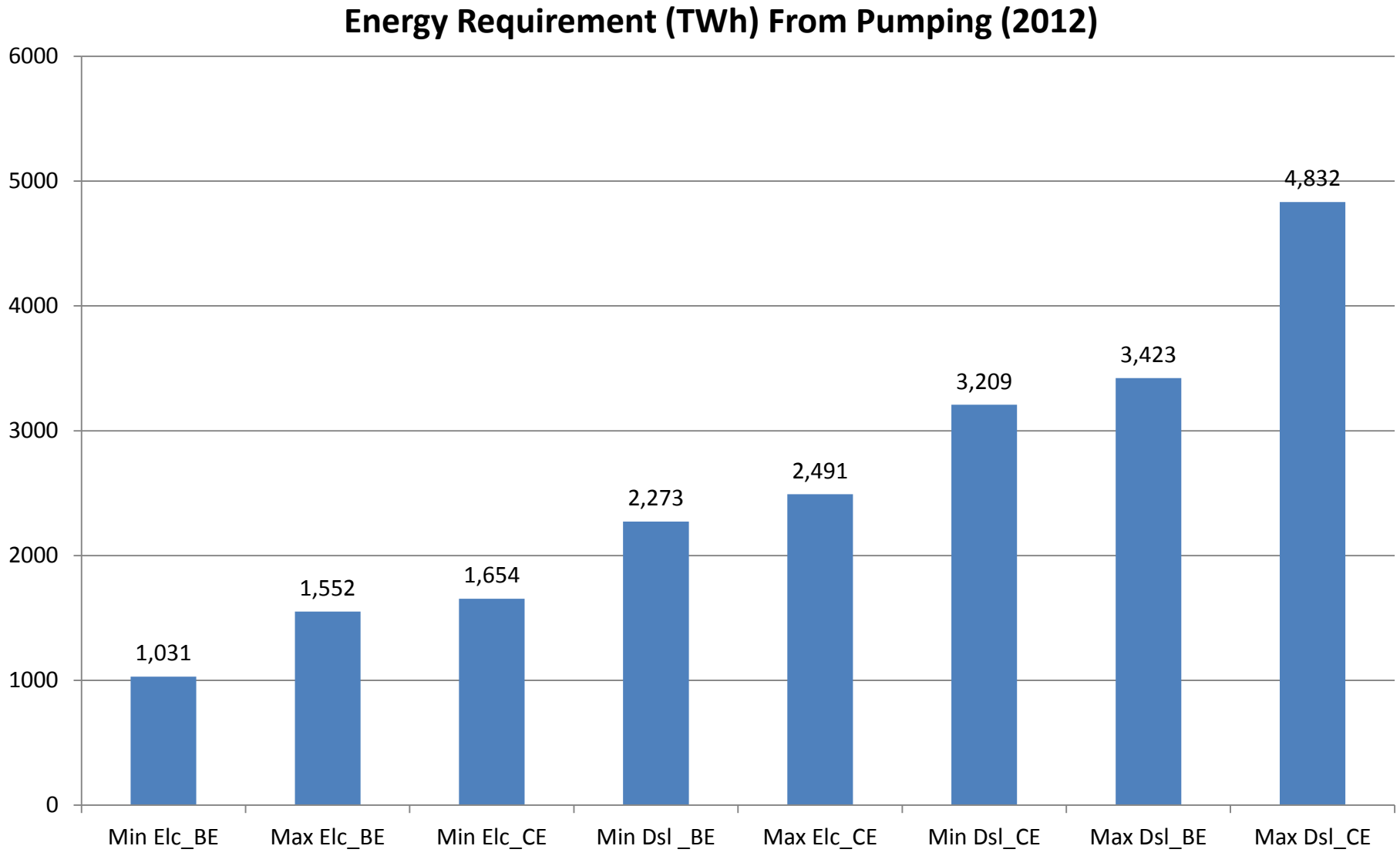
Irrigation Requirements for different crops

Crop	**GCA** (m ha)	**Min** (mm)	**Max** (mm)
Paddy	43.97	1200	1200
Wheat	29.9	220	420
Cotton	12.18	210	725
Maize	8.71	150	1250
Pearl Millet	8.69	150	500
Sorghum	6.32	150	500
Groundnut	5.31	225	690
Sugarcane	5.09	620	1750

Total GCA~ 60% of all-India GCA

Source: Dr. K. T. Chandy (1995), *Water Requirement for Different Crops*

Estimating all- India Pumping Energy Requirement (2012)



Drivers and Assumptions

Energy Demand

- Demand for agricultural production
- Availability of other sources of irrigation→ change in groundwater dependency
- Water Table
- Water efficiency- micro irrigation and protected cultivation
- Cropping patterns- intensive/off-season cultivation
- **Policies**
  - *Ag DSM*
  - *State solar irrigation/pump-replacement schemes*
  - *Electricity tariffs*
  - *Major and minor irrigation schemes; micro-irrigation schemes*

Pumping Efficiency

- Quality of power supply
- Technological improvements
- Capital costs of pumps
- Fuel Substitution

Choice of Fuel

- Electrification (*RGGVY, 24x7 Electricity Supply*)
- Operating Costs *(Policy on Diesel Subsidy)*
- Technological breakthroughs (cost of solar panels- *Make in India*)

Technologies

Levels	Electric (kW)		Diesel (lts/ hr)	
	Input	Improvement	Input	Improvement
1	6.00	7%	1.20	0%
2	5.25	18%	1.10	8%
3	4.50	30%	0.95	21%
4	4.00	38%	0.85	29%

Input under current efficiencies-6.42 kW for Electric and 1.20 lts/hr for Diesel pump-sets

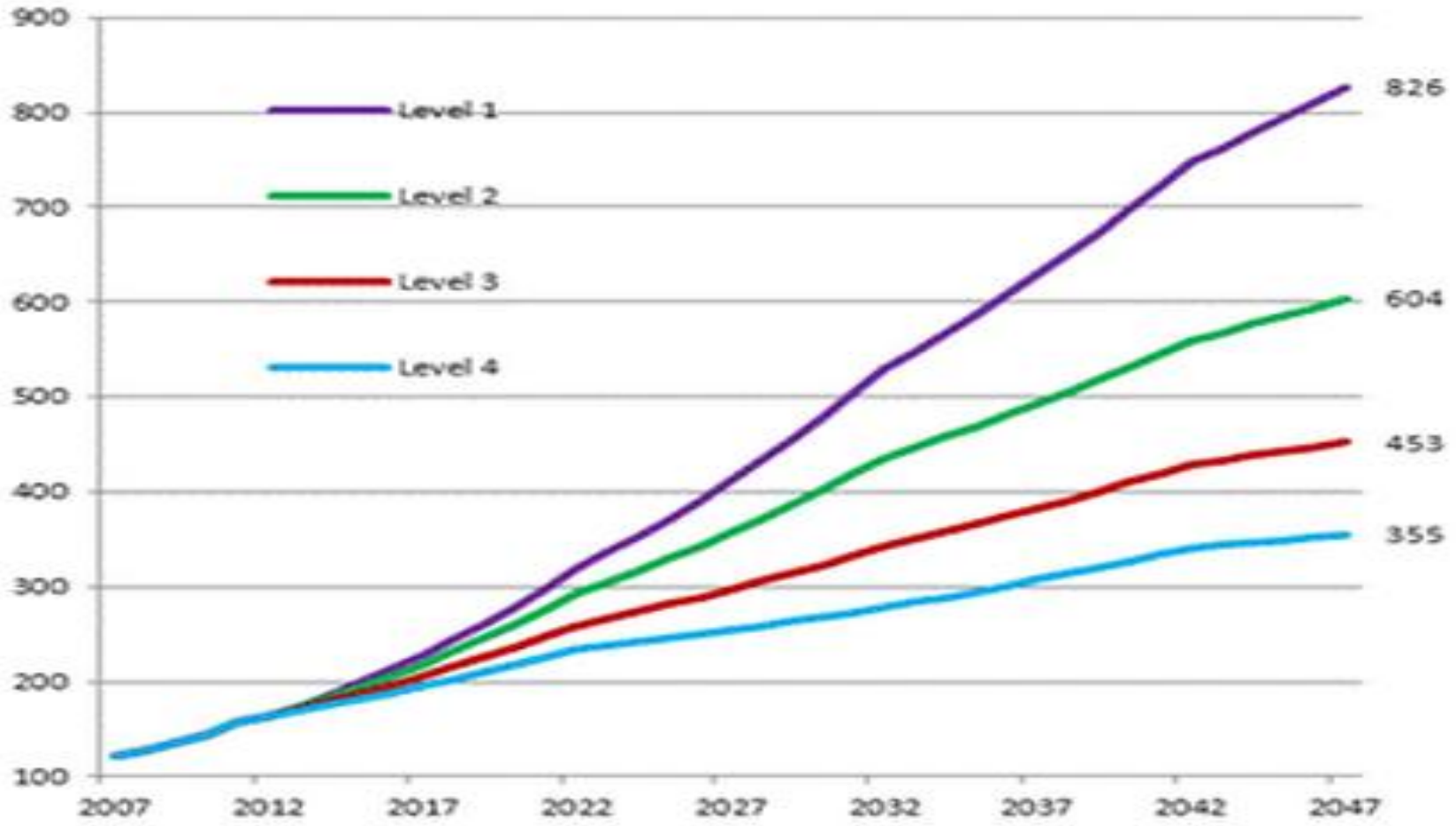
Best efficiencies obtained by 2032 and stabilised thereafter

No efficiency improvement in solar pumping

Choice of Fuel

Fuel	Level A	Level B	Level C	Level D
Diesel	20%	10%	5%	-
Electricity	80%	85%	80%	75%
Solar	-	5%	15%	25%

Aggregate Pumping Trajectories (TWh)



Heroic Effort (Level 4)

- Savings from efficiency and reduction in ground water dependence (~60%)
- Overall, avoidance of ~ 80 GW, 511 Mt CO2

Thank You

Annexure: Costing

Data and Methodology (TWh)

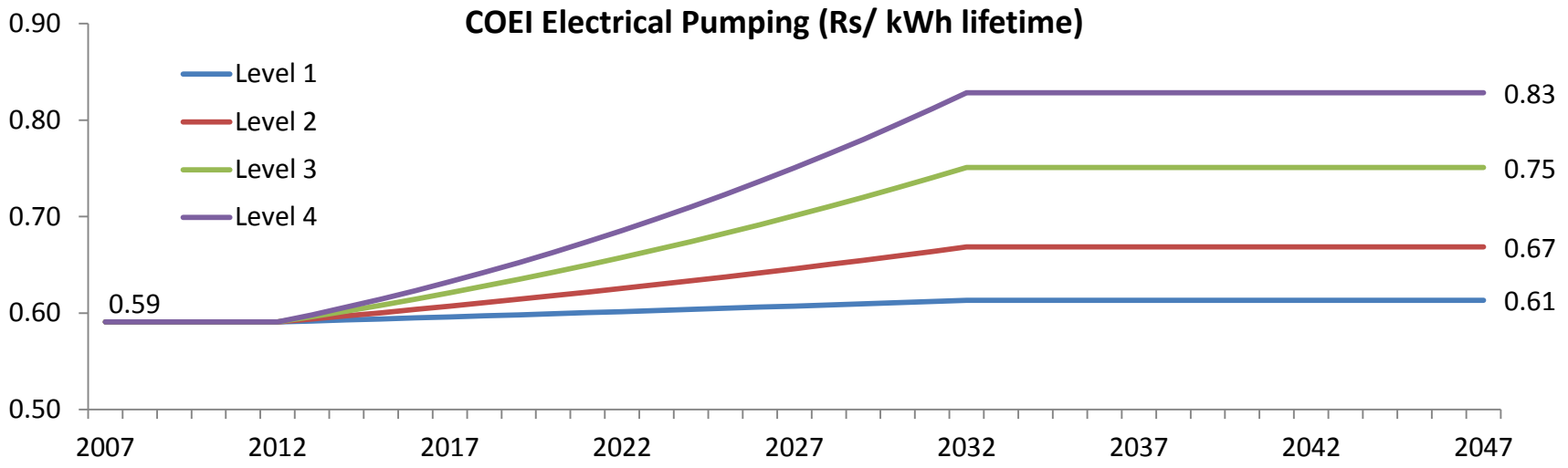
Electric Pumps		Tech 1		Tech 2	
Rating (kW)		7.5		7.5	
Efficiency (at 100% electrical loading)		61.91%		73.60%	
Input Power		12.34		10.20	
Hours per year	Life (years)	1000	7	10000	7
Price		28,509		37,232	
Price/ kW output		3,741		4,964	
Elasticity	Input Power	-1.88			
	Efficiency	1.73			
Price wrt base year input (6.42 kW) and efficiency (34.58%)		15,508			

		Diesel Pumps		Solar Pumps	
Rating (kW)		3.75		2.25	
Input		1.20 litres per hour		6.42 kW	
Hours	Life	500	5	1200	25
Price		18,000		6, 00, 020	

The above costs are annualised over the lifetime of pump-sets (INR/ kWh lifetime)

Cost of Efficiency Improvement (COEI)

Efficiency improvement in electrical pumping is a continuous variable rather than discrete technologies (as in case of Commercial Lighting & Appliances)



COEI for diesel is zero, as specific energy consumption can be brought down to Level 4 without increase in costs (CIAE)

Costing Scenarios

Assumptions-Irrigation Pumping

Base year costs (INR/ kWh lifetime)

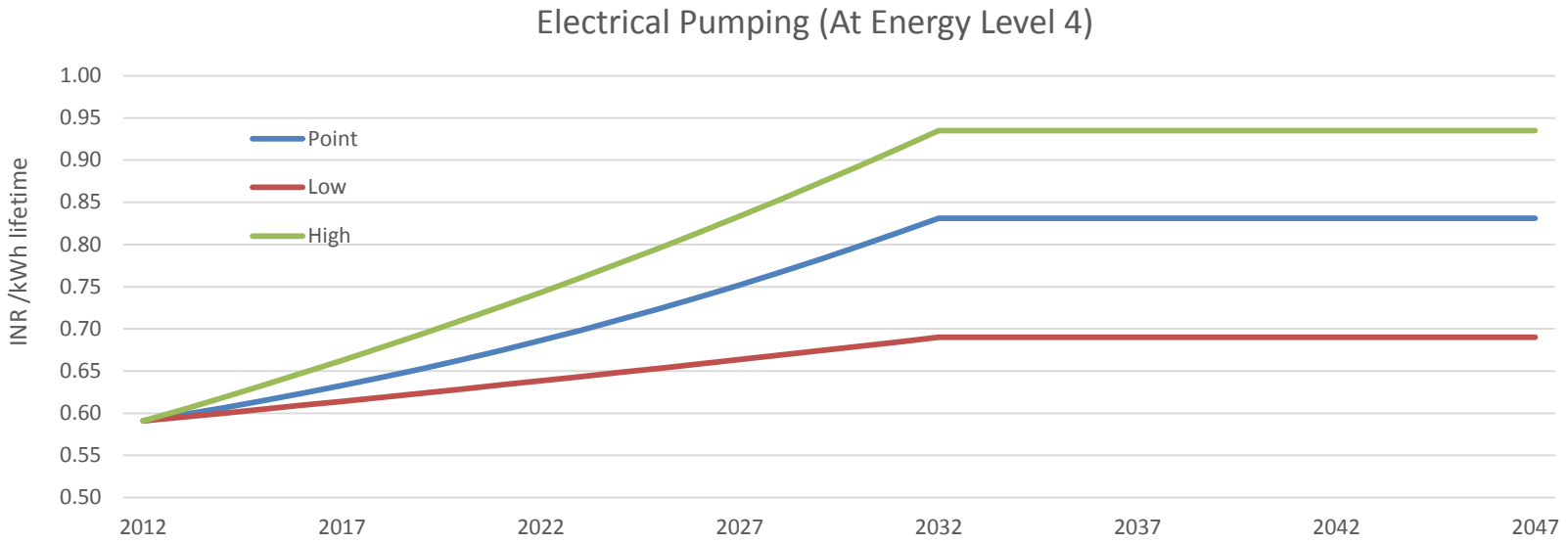
	Cost
Electrical	0.59
Diesel	1.92
Solar	5.07

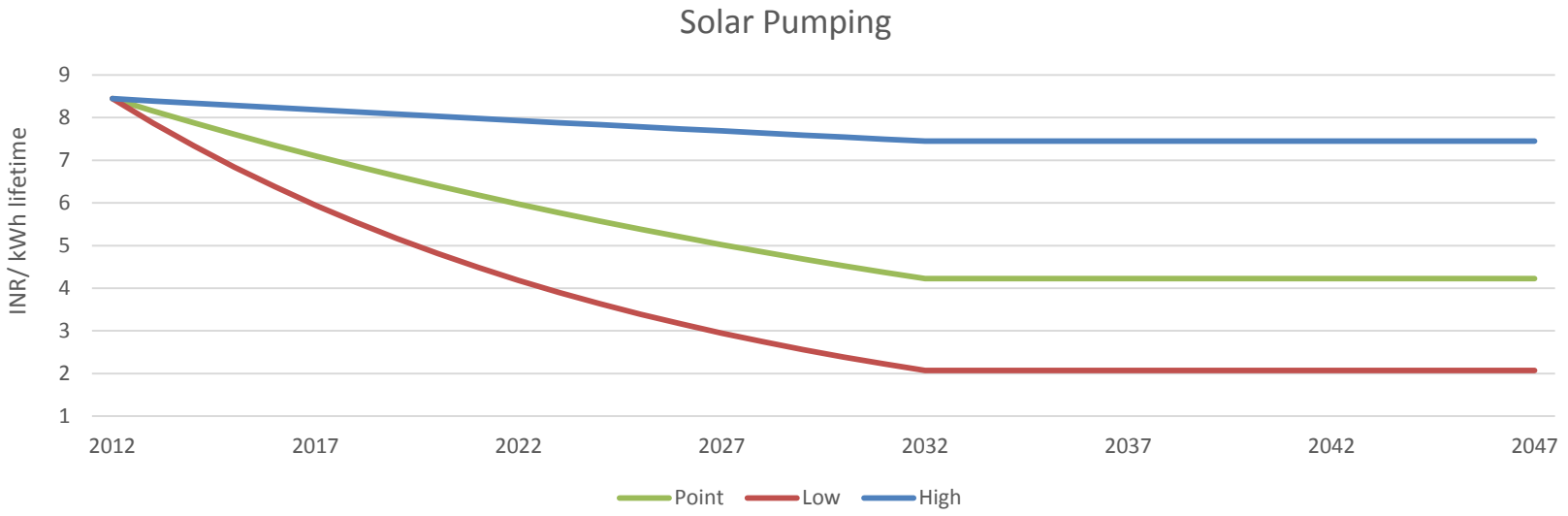
Future Costs (% change over base year)

	Low	Point	High
Electrical	-10%	0%	23%
Diesel	0%	0%	0%
Solar	-12%	-75%	-50%

The above changes obtain by 2032 and prices stabilise thereafter

Technology Cost Scenarios: Pumping





Energy Level Cost Scenarios: Pumping