Dissemination and Development of Rural Energy Technologies: Lessons from Indian Experience

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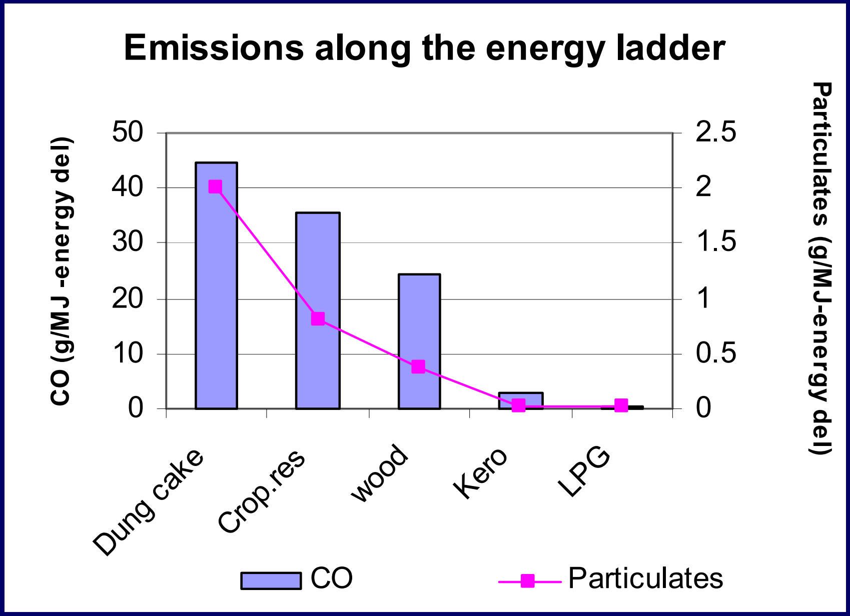
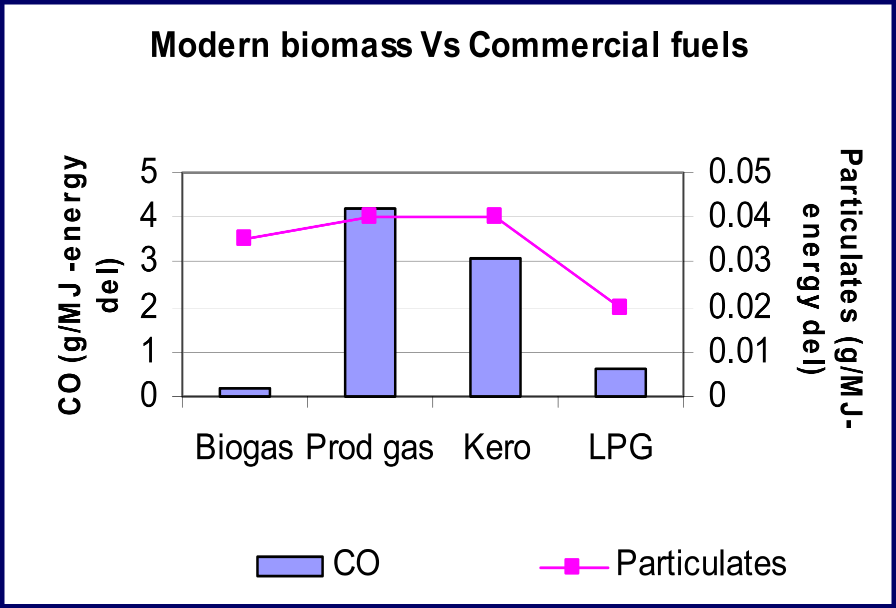
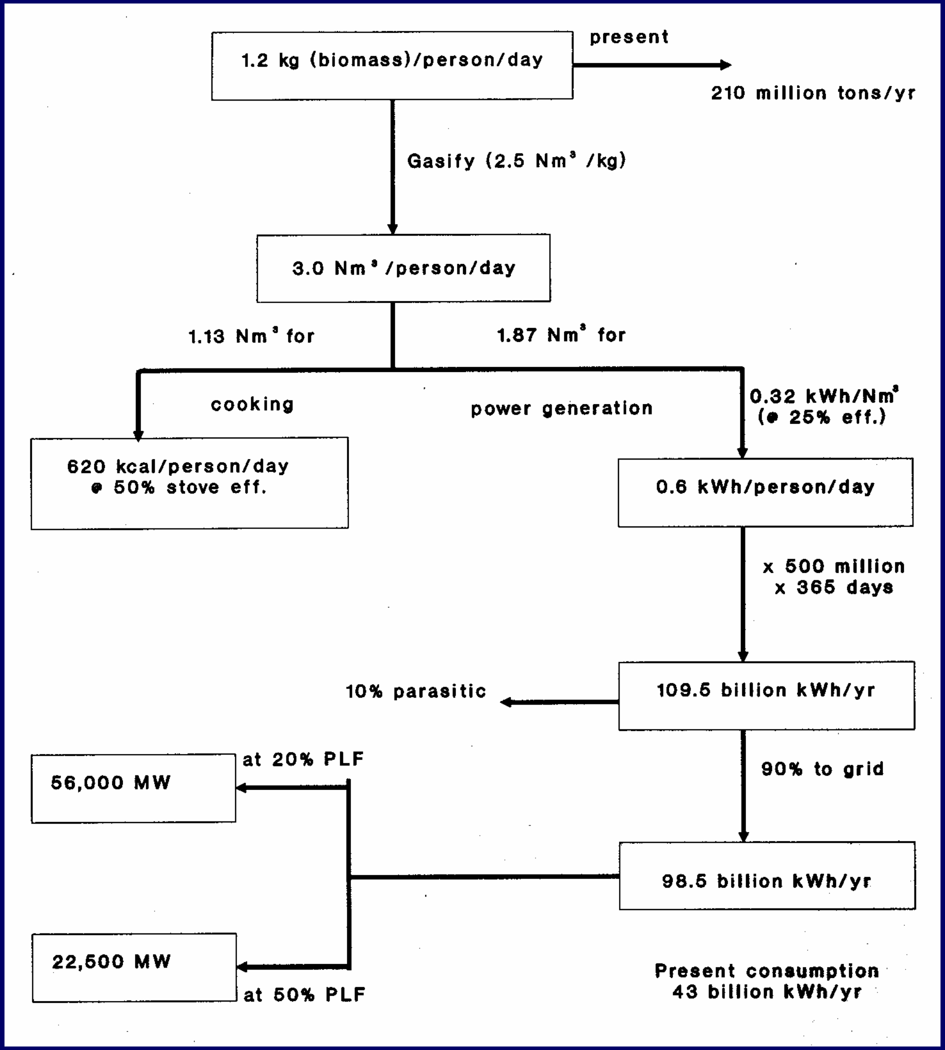
Rural Energy Technologies have the potential to achieve sustainable rural energy transitions





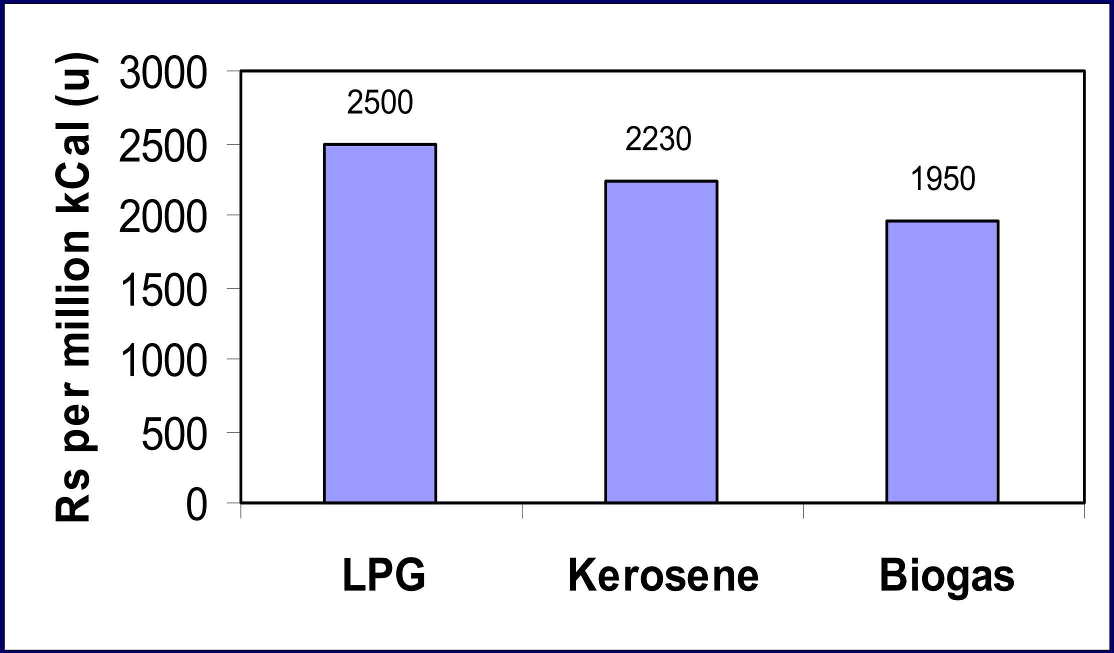
A hypothetical scheme for producing cooking gas and electricity from biomass consumed presently for cooking alone



How development/dissemination of these technologies was handled by welfare state programmes/market based actions/entrepreneurs/independent institutes?
- A few case studies

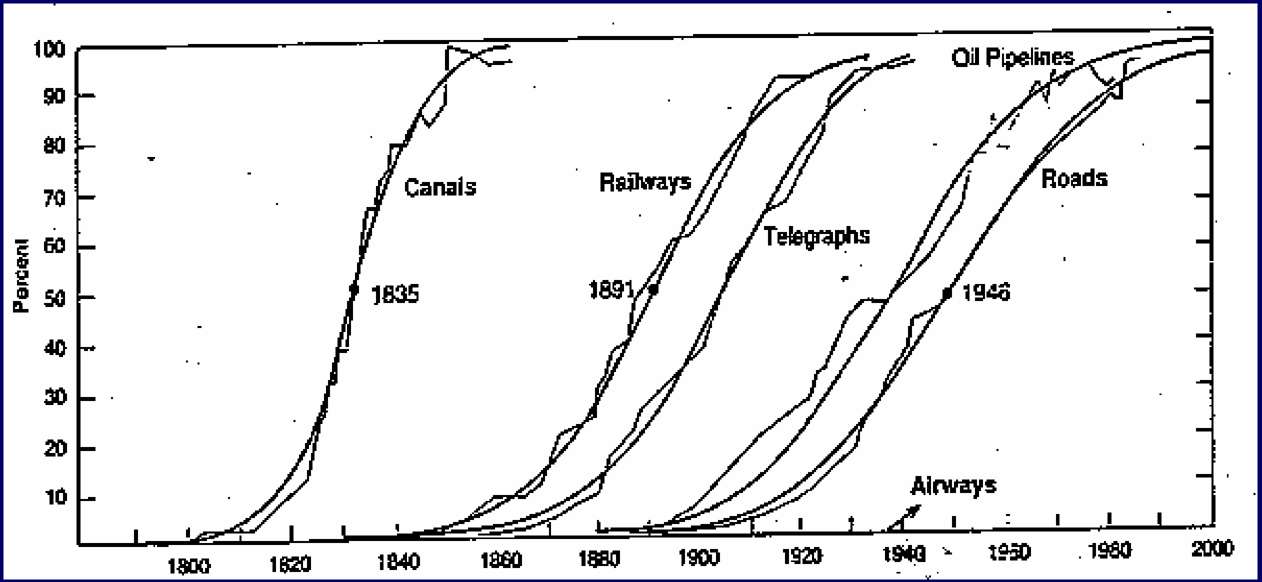
Cooking	Biogas technology
	Improved stoves
Irrigation pumping	Gasifier systems
Income generation	Biomass briquetting

Physical and economic potential of biogas in India



- Production potential: 36.2 billion m^3/year
- ~73% of all cooking energy requirements in rural areas can be met from biogas
- Economic cost of biogas comparable to modern commercial fuels

Diffusion of technologies: The known trends



Growth of biogas plants as a percentage of their ultimate potential

$$Y = \frac{K}{1 + e^{-b(t - tm)}}$$

Y = Cumulative growth

K = A measure of ultimate market potential

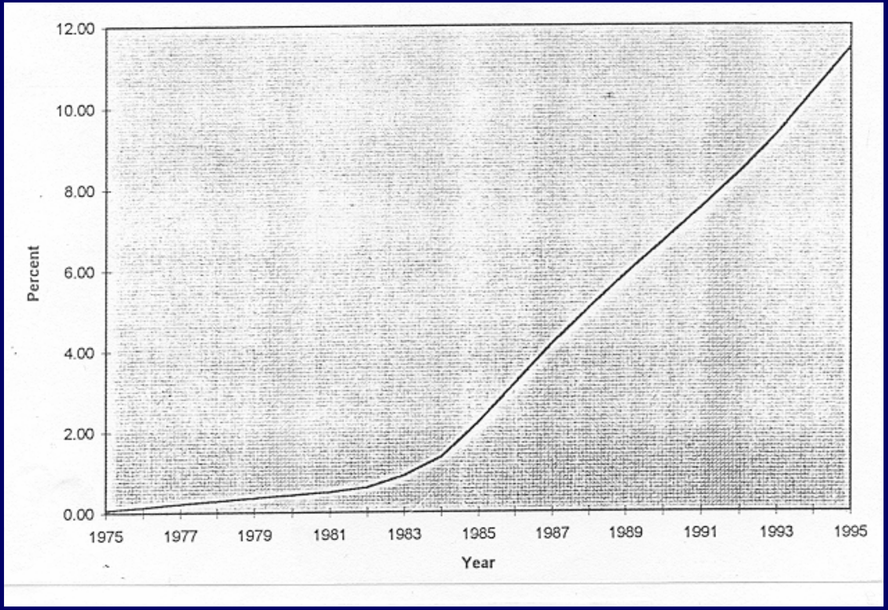
t = Time

tm = Time of mid-point growth

b = A measure of steepness of diffusion

$$\Delta t = t_{90} - t_{10} = (\ln 81)/b$$

How did the biogas technology fare in India?



Biogas installation

Δt = 35 years

Mean (for 265 diffusion processes) = 41 years with sd of 42 years

(Grubler)

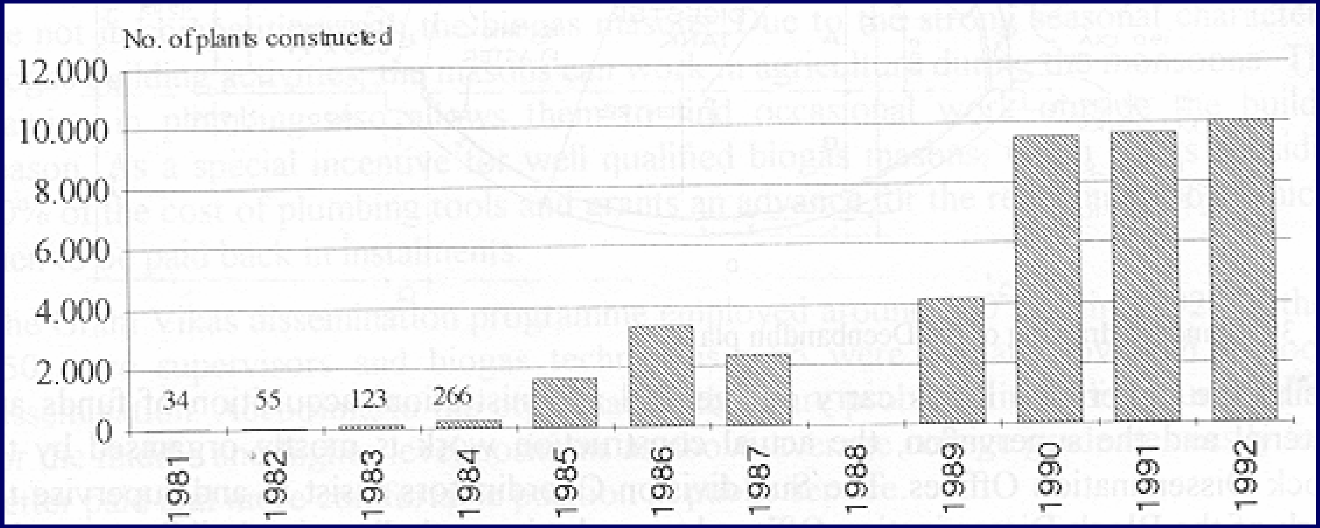
However, biogas could not be showcased as an important component of sustainable development

Q: What is the role of subsidies (direct or indirect) in the diffusion process?

Some local/regional cases of faster dissemination or iterative technology development

- Gram Vikas biogas programme in Orissa
- Shivsadan's entrepreneurial approach in Sangli, Maharashtra
- Biogas companies of Nepal
- Dhanawas experiment of TERI

Gram Vikas biogas programme in Orissa



Number of the biogas plants constructed by Gram Vikas between 1980-81 and 1991-92

Highlights

- Largest and most successful biogas organization during 90’s
- Targeted at some of the most underprivileged groups of Indian society
- Biogas disseminated as part of a package for rural development

Q: Why the Gram Vikas programme could not be sustained?

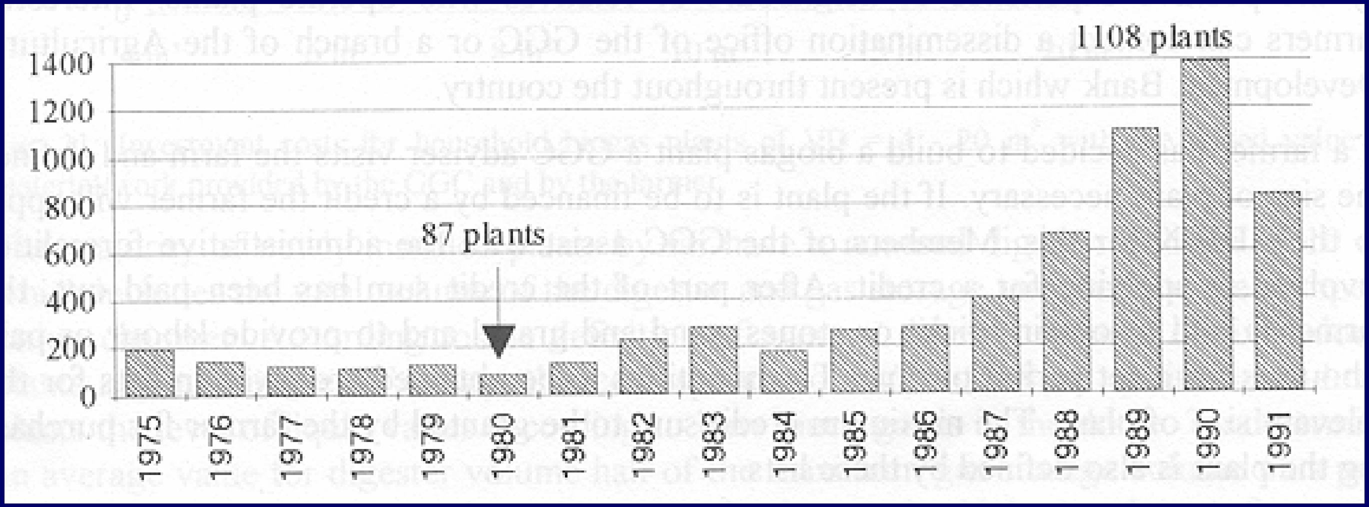
Shivsadan’s biogas programme

- Dissemination by a private company
- Building capacity of 4000 plants per year
- Relied on pre-fabricated structures (marketable products)

Comment

Shivsadan’s reach was more towards prosperous farmers.

Biogas companies of Nepal



Number of biogas plants installed annually

Highlights

- Demand and market-oriented dissemination programme
- Major share held by the state-owned ADB/N, but donors played an important role
- Showcases the influence of subsidies and various promotional instruments on demand

The Dhanawas experiment of TERI

Highlights

- Interative ‘land to lab to land’ process of product development
- Spherical models with faster construction, better performance
- Very high functionality and reliability

The Dhanawas experiment of TERI (contd…)

Model	HRT (days)	Shape	Inlet	Other features	Capacity m^3/day	No. of plants	Location
Mark-1	50	Cylindrical	Box	Flat bottom, stirrer	10	1	Varvala
Mark-2	50	Cylindrical	Box	Curved bottom, stirrer	2	1	Dhanawas
Mark-3	50	Cylindrical	Pipe	Flat bottom, nylon net	2	1	Dhanawas
Mark-4A	40	Spherical	Pipe	Nylon net	2	1	Dhanawas
Mark-4B	40	Spherical	Pipe	Diffuser, nylon net	2	2	Dhanawas
					2	1	Berka-alimuddin
					3	1	Dhanawas
Mark-4C	40	Spherical	Pipe	Perforated ferrocement plant 30 cm above bottom, mixing tank	2	2	Dhanawas
Mark-4D	40	Spherical	Pipe	Tangential inlet, with a deflecting chamber, 60% gas storage, mixing tank	2	24	Sultanpur
Mark-5A	30	Spherical	Pipe	Tangential inlet, with a deflecting chamber, 60% gas storage, mixing tank	2	10	Dhanawas

Some overall observations

- The programme was not **designed** to learn from field and provide feedback for better management and development of better models
- *Skewed R&D*: Emphasis on feed material other than cattle dung and on low temperature digestion
- No thinking on induction/promotion of commercial players in general (result of old welfare state policies)
- No exit policy, hence no exit programme

National Programme on Improved Chulhas

Stated objectives

- Fuel wood conservation
- Removal/reduction of smoke from kitchens
- Reduction of deforestation and environmental degradation
- Reduction in the drudgery of tasks performed by women and girl-children and their consequent exposure to health hazards
- Employment generation in rural areas

Dissemination method

- Multi-model, multi-agency approach
- Annual targets (number of chulhas to be installed) determined at the national level and then disaggregated at the state level to be implemented by nodal departments and agencies of states through district and block-level cells
- Some national level NGOs given separate targets
- Grass-root NOGs and Self Employed Workers (SEW) for implementation at village/household level

Overview

- Started in 1983, closed in 2002

Claims

- More than 30 million installed (later revised to 20 million)
- ~150 million tons of firewood saved (later revised to 50 million tons)
- 50 billion rupees saved so far in conservation [3072% ROI] (later revised to 20 billion rupees, 1230% ROI)

The other side

- Life of IC $\underset{\sim}{\sim}$ 18 months

  (Actual working population correspondingly less)
- Only about 60% use fuel wood
- Lower thermal efficiencies in the field

  (~ 12% fuel savings)
- Not all wood comes from forest
  - 48.5% from own trees
  - 29.8% from road side bushes
  - 17.0% from nearby forest

Year	Month	Stoves installed		Population	Fuel saved (tonnes)		Monetary savings (Rs. Million)
		Yearly	Monthly		Monthly	Yearly	
1983-84	1	300,000	25,000	25,000	375		
	2		25,000	50,000	750		
	3		25,000	75,000	1125		
	4		25,000	100,000	1500		
	5		25,000	125,000	1875		
	6		25,000	150,000	2250		
	7		25,000	175,000	2625		
	8		25,000	200,000	3000		
	9		25,000	225,000	3375		
	10		25,000	250,000	3750		
	11		25,000	275,000	4125		
	12		25,000	300,000	4500	29,250	11.7
1984-85	13	512,000	42,666.67	342,666.7			
	14		42,666.67	385,333.3			
	15		42,666.67	428,000			
	16		42,666.67	470,666.7			
	17		42,666.67	513,333.3			
	18		42,666.67	556,000			
	19		42,666.67	573,666.7			
	20		42,666.67	591,333.3			
	21		42,666.67	609,000			
	22		42,666.67	626,666.7			
	23		42,666.67	644,333.3			
	24		42,666.67	662,000	9930	96,045	38.418

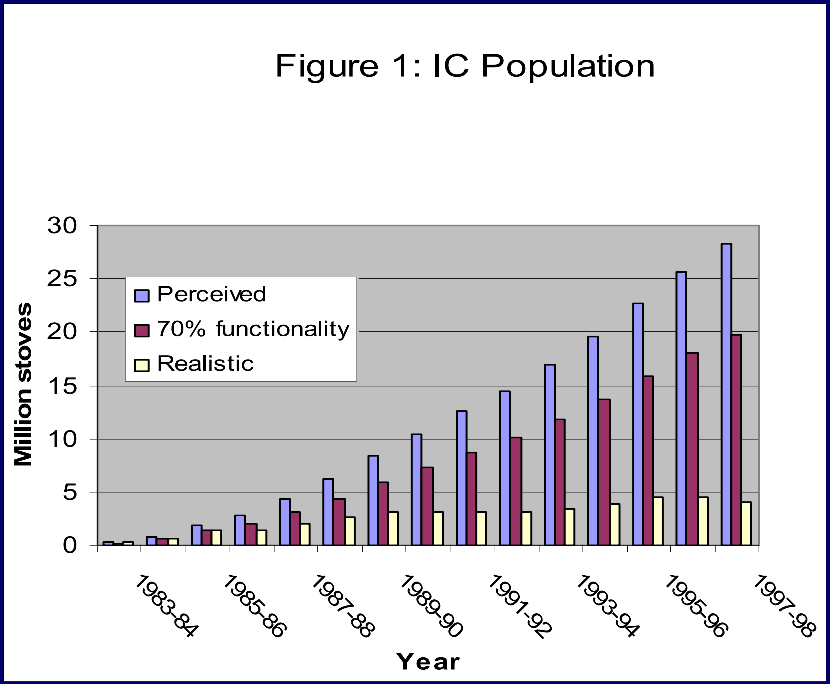


Figure 1: IC Population
Million stoves
30
25
20
15
10
5
0
Perceived
70% functionality
Realistic
1983-84
1985-86
1987-88
1989-90
1991-92
1993-94
1995-96
1997-98
Year

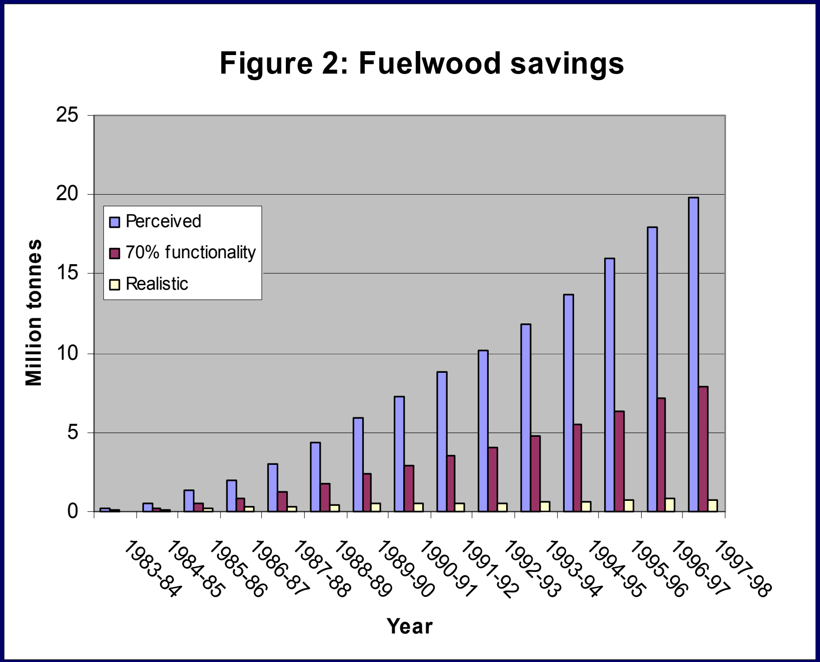


Figure 2: Fuelwood savings
Million tonnes
25
20
15
10
5
0
Perceived
70% functionality
Realistic
1983-84
1984-85
1985-86
1986-87
1987-88
1988-89
1989-90
1990-91
1991-92
1992-93
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1994-95
1995-96
1996-97
1997-98
Year

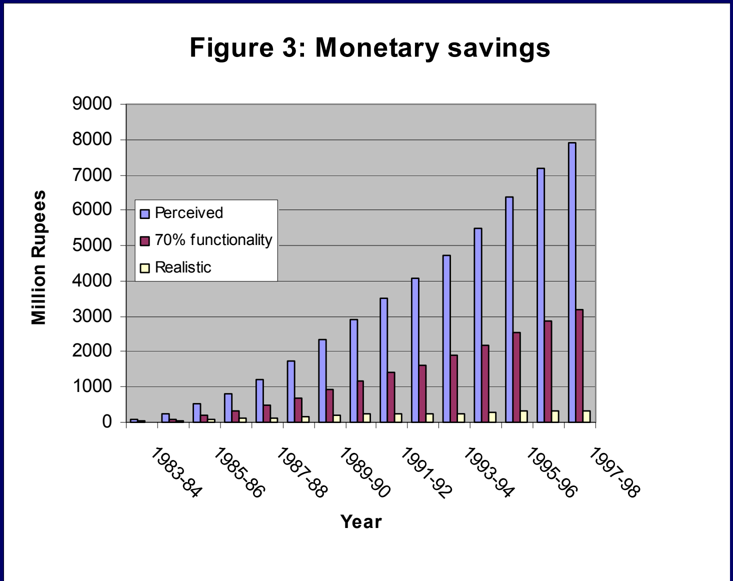


Figure 3: Monetary savings
Million Rupees
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
Perceived
70% functionality
Realistic
1983-84
1985-86
1987-88
1989-90
1991-92
1993-94
1995-96
1997-98
Year

- Realistic monetary savings: Rs 128 million/y
- Annual expenditure: Rs 150 million/y
- Net loser in the economic sense
- But gains are probably higher if health benefits are included

Some observations/comments

- Programme ended with a whimper (Natural death, No exit policy, No consolidation of lessons)
- Occasional evaluation studies, but with little focus on feedback into programme design and implementation
- No marketing methods tried out. No efforts on promoting entrepreneurs. Some NGOs tried out commercial dissemination methods
- Stove-fuel-pot packages could have been promoted for better results
- Smoke removal could have been emphasized as a major benefit instead of pursuing a multiplicity of objectives

Gasifiers/stirling engines for irrigation pumping and power generation

- Some 1040 gasifier/stirling engine systems installed between 1989 and 1992
- Negotiated cost of a 5 HP pumpset Rs. 20,000

Subsidy	Rs. 18,000
Cost to user	Rs. 3,000
Market price of diesel pumpset	Rs. 8,000

  Effectively subsidized diesel pumpsets
- Surveys revealed that nearly all users discontinued use of gasifiers
- Technology seen as too cumbersome, models promoted were premature prototypes with very low operational reliability
- Subsidy reduced later, but the programme did not take off.

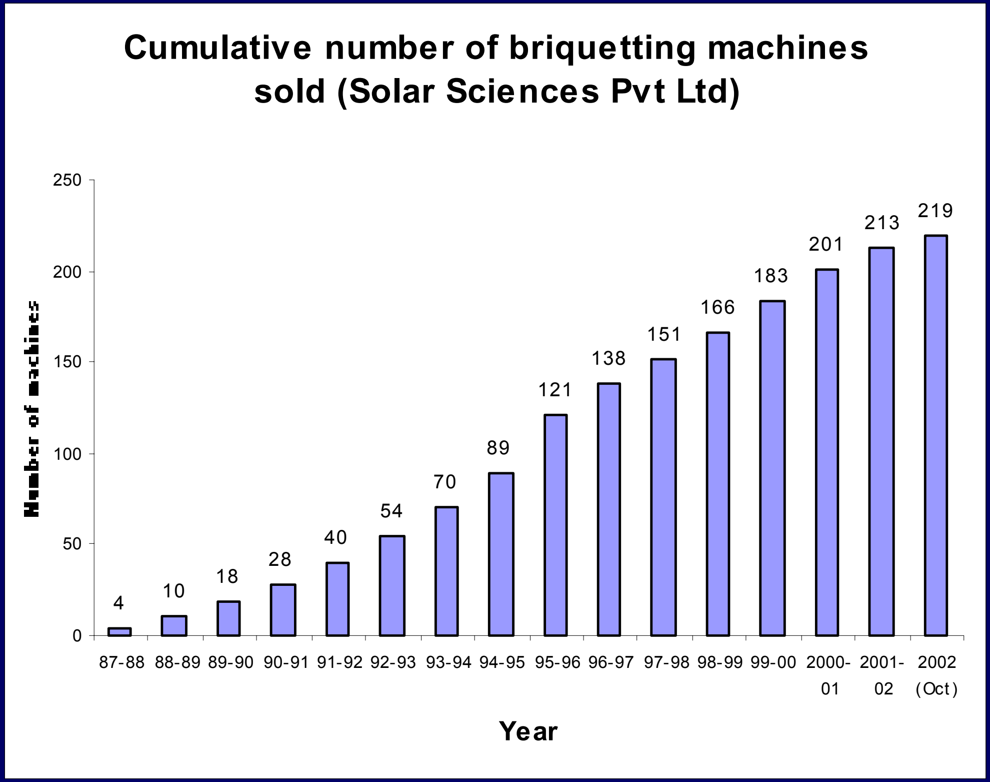
Current status for power generation

- Better technology, higher operational reliability
- Economics not yet favourable, especially in the subsidy regime for rural electrification
- Most available models tested only for firewood, which is either expensive or scarce
- Many non-technological issues to be sorted out (infeasibility of rural IPPs for micro power generation; management structures for maintenance, repairs, collection of tariff; no clear guidelines from regulators etc.)

TERI's experience with gasifiers for thermal applications

- Development of commercial prototypes based on continuous interaction with users
- Different end-use packages for different applications (silk reeling, textile dyeing, cardamom curing, rubber drying, crematoria etc.)
- Licensing to several entrepreneurs, technology backstopping, quality control
- Over 200 gasifiers installed and most of them operational

Biomass briquetting



- Total machines installed by all manufacturers: 500
- Total machines operational: 300
- Growth of briquetting industry largely through entrepreneurial efforts

Biomass briquetting (contd…)

M/s B.S. Fuel, village Kotputli, Rajasthan

• Annual production	10,000 MT
• Biomass catchment area	50 sq km
• Maximum distance covered	10 km
• Means of transport	Camel cart, tractor
• Number of farmers	70-80
• Number of villages	8-10
• Amount disbursed	20-30 lakh

Key questions

- What were the factors responsible for faster dissemination and development of certain technologies compared to others?
- Can a public-private partnership be fostered to achieve sustainable rural energy transitions?
- How can local actions for sustainable development be promoted through global partnerships?