

# Innovations for Sustainable Development of Bottom Billions

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# Structure of talk

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- Focus on rural areas since majority of bottom of pyramid population lives there. Focus on India
- Rural development strategy. High technology needed
- Possible high tech solutions
  - Energy from agriculture
  - Water issues
  - Cooking and lighting. 75% of total rural household energy.
- Need for corporate world, local NGOs and government to work together for sustainable development for bottom of the pyramid

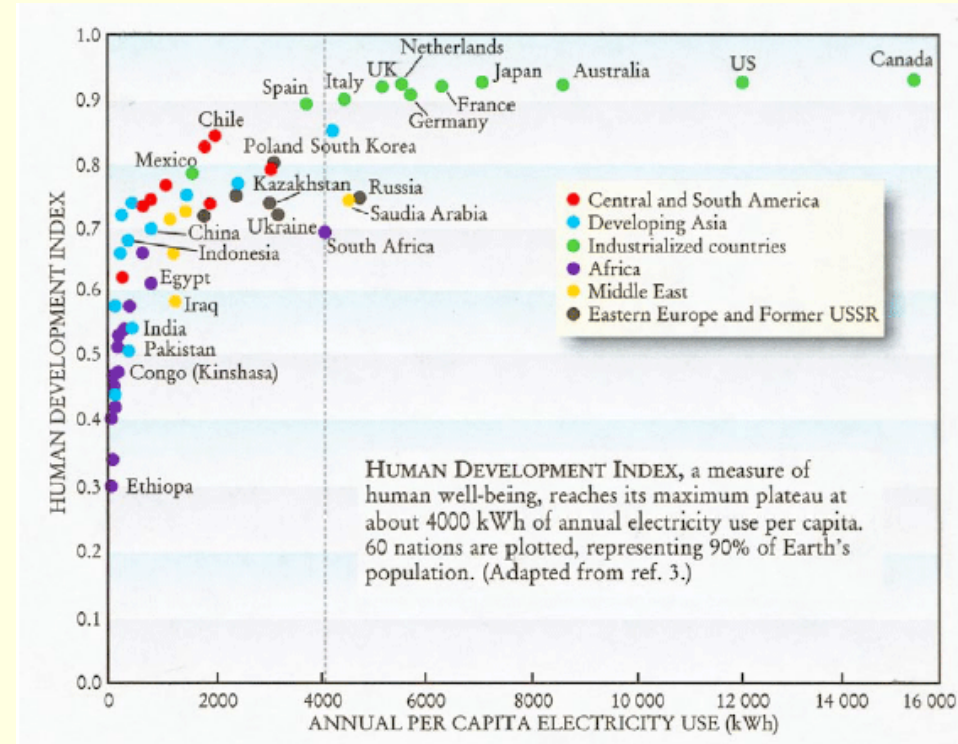
# Rural scenario in India

- 65% of our population is rural based. 20,000 villages have never seen electricity. 60% of rural population (~ 400 million) has nearly non-existent electricity. Sad state even 63 years after independence.
- Mostly use kerosene for lighting and 180-200 million tons/yr of biomass for cooking in inefficient, primitive and smoky stoves. Unclean drinking water.
- Around 300,000 deaths/yr (1.5 million world wide) because of indoor air pollution and 1.5 million because of polluted drinking water. Modern technology has not touched their lives. Other India has aspirations of sending man to the moon.
- 40% (~450 million) of rural population survives on less than US\$1.5/day.



# Rural energy scenario

- Energy is the basis of life. Lack of it produces economic stagnation and social upheavals.
- Energy situation in India is alarming. Average per capita consumption is 18 GJ/yr. or 5% that in US (350 GJ/yr.). Rural electricity consumption per capita is just 60 kWh/yr (~ 7 W) – the lowest in the world.
- HDI is directly linked to electricity consumption. In India there is a shortfall of 60,000 MW as of today. In Maharashtra ~ 5000 MW shortage. 10-12 hours daily blackouts in rural areas.
- With slight increase in electricity usage, tremendous increase in HDI.



# General energy scenario

- India's petroleum imports (80-85% of total consumption) this year ~ US\$ 90 billion. (8.5% of GDP). Serious outflow of foreign exchange. Need fuel for 8-9 %/yr. growth.
- Automotive usage >15% p.a. Poor roads  $\Rightarrow$  more energy/km and increased pollution.
- Developing countries following western transportation model. Need to develop alternative mass transport system. Metros, electric and CNG buses.
- In 15-20 years India and China might surpass oil consumption of developed world. May lead to strife/wars.
- Electricity shortfall is 150,000 MW by 2016. Will need \$ 120 billion! GOI short of cash. PP partnership has not yielded good results since focus on big power projects.

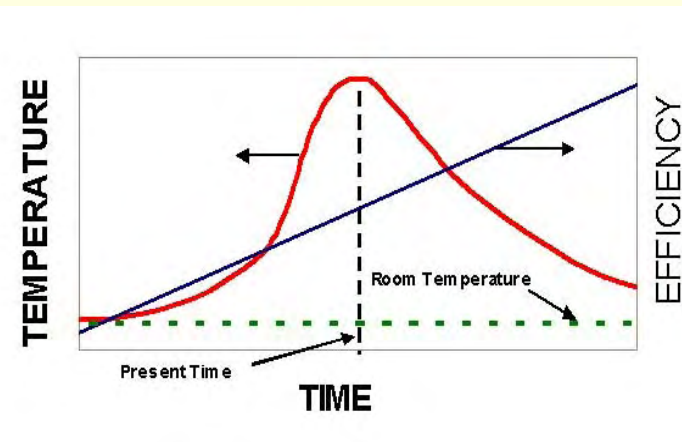
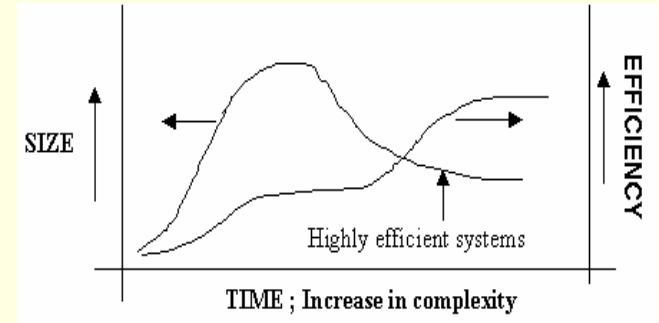
# Rural energy strategy

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- Decentralised energy production from agriculture can solve the twin problem of electricity and liquid fuel shortage and will provide rural wealth and create employment.
- 54% of India's population < 25 years of age. Mass communication has raised their expectations.
- With 60% of these rural poor coming in mainstream development, huge intellectual capital will be made available. India and other developing nations then can become economically sustainable.
- Scientists, technologists, corporate world and local government should work together in solving the rural energy problems. Need for global effort.
- Philosophy and strategy of rural development.

# Strategy of rural development

- High technology needed for rural development.
- It allows maximum extraction of materials and energy from dilute locally available resources; biomass, solar, etc.
- Hallmark of evolution: size reduction; sustainability; increased efficiency; room temperature processes; equilibrium with surroundings and robustness.
- Most of the new designs are following this route. Biomimicry as mantra for design. Is also spiritual !
- Societies as Prigogine's dissipative structures. Decentralized high tech energy solutions  $\Rightarrow$  softer sustainable decentralized societies .





# Energy from agriculture

- India produces ~ 800 - 1200 million tons of agri. residues per year. Waste disposal problem and hence mostly burned in fields. Creates environmental pollution and loss of energy.
- Residues can produce three types of fuel
  - Liquid fuels like ethanol or pyrolysis oil.
  - Gaseous fuel like methane (biogas).
  - Electricity via biomass-based power plants.
- Theoretically these residues can produce 156 b l/yr of ethanol which is 42% of India's oil demand in 2012; or 80% of oil demand via pyrolysis oil; or 90,000 MW of electric power (55% of presently installed capacity).
- Can take care of major fuel requirements of India. NARI's contribution in biomass power.
- For extra ethanol, multipurpose crops needed.





# Energy production (cont..)

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- In any agriculture 25-40% of produce is food and rest are residues. No remunerations from residues, hence farming is uneconomical. No industry can survive on such norms.
- Need for proper pricing of residues. \$60-70/ton.
- Residues for energy can give an extra income of \$100-140/acre per season to the farmers. Insurance against distress sale. Increased agriculture will result in increased residues.
- Energy from agriculture can provide 50 million jobs and could be US\$ 40 billion/yr industry.
- Agriculture can provide food and energy security simultaneously. Farmers are the backbone of any country. They should be helped.

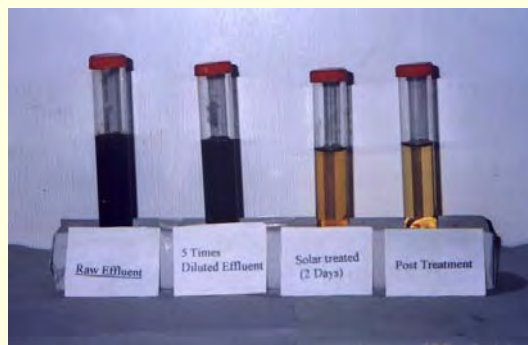
# Farming and water issues

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- Sophisticated technology needed in farming. Lacking in India. Best brains needed in agriculture.
- Small land holdings fit for precision agriculture. Need for developing small and high tech farm machinery.
- Increased farming will require adequate water supply.
- Rainwater harvesting provides the best solution. Need for setting up micro rural water utilities.
- Issue of ownership of water bodies needs to be resolved. Water Act similar to Electricity act needed.
- With increased industrial demand for fuel and electricity large tracts of farmland may come under fuel crops only.
- Food vs. fuel debate. Need to do R&D on multipurpose crops. Sweet sorghum is one of them.

# Sweet Sorghum

- NARI's pioneering work on ethanol from sweet sorghum. 1970s.
- Solar distillation and detoxification.
- Ethanol as cooking and lighting fuel.



# Cooking/lighting on ethanol

- 50-60% ethanol/water mixture. Easy to distill and very safe household fuel.
- Stove 2.5-3 kW capacity. Like LPG stove with high and simmer settings. Table top lanterns.
- Lanstove capacity 1.2 - 1.6 kW. Provides cooking, lighting (~ 250 W bulb) and clean drinking water.
- 3-5 times more efficient than electric lighting and cooking.
- Need to change draconian excise laws. Kerosene lanstove as an answer. Large scale testing underway.



ICENV2010



Lanstove



# Biomass gasification for thermal applications

- Loose leafy biomass gasifier.
- 500-800 kW (thermal) capacity. Also produces 25% (w/w) char.
- Excellent for process heat and community cooking applications. Good airflow needed.
- Cleaning of gas for power still a problem. Excellent chemical eng. needed to do so.



# Sustainable transport

- Electric cycle rickshaws. 1997
- Electric trike for handicapped persons.
- ELECSHA.
- 2 dozens exported to Europe, USA and Canada.



# Availability of devices in rural areas

- Excellent R&D should be backed by mass availability of its products.
- “Cell phone model” to be used.
- Provides an important function for communication in rural areas. Is robust, very high tech, low cost and good after sales service. So are human beings!
- Future manufacturing in rural areas will be desktop (rapid prototyping) with locally available raw materials.
- Will lead to sustainable rural communities with high standard of living. Gandhi’s dream village.





# Working together....

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- Need for corporate world, civil society (S&T NGOs) and local R&D institutes to work together. Sensitization of corporate world and R&D institutes regarding rural problems.
- Urban elite as role model? Need to live sustainably.
- A very decent lifestyle is possible with energy consumption of 50-70 GJ/person-yr. In India average consumption is 18 GJ/person. US is 350 GJ/person per year.
- If every citizen of the world follows US lifestyle we will need 4 earths to sustain it.
- Spirituality can help in curbing the greed for resources and making us sustainable. High technology with spirituality should be the mantra of development.
- Becoming sustainable in our personal lives and giving something back to the society is very satisfying and will help bring the bottom of pyramid population in mainstream development.

# Thank You

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## Useful sites

- [www.nariphaltan.org](http://www.nariphaltan.org) (main site)
- [www.nariphaltan.org/ncsd](http://www.nariphaltan.org/ncsd) (Sustainable center site)
- [www.nariphaltan.org/writings.htm](http://www.nariphaltan.org/writings.htm)  
(articles on spirituality, technology and sustainability)
- [www.nariphaltan.org/simplelife.htm](http://www.nariphaltan.org/simplelife.htm) (How to live sustainably)
- [www.nariphaltan.org/langmuirrural.pdf](http://www.nariphaltan.org/langmuirrural.pdf)  
(an article on use of high technology for rural areas)

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