

Rocket Science for Rural Development

(History of rural R&D at NARI is here)

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Structure of talk

- Rural scenario and problems
- Strategy for rural development
- Possible high tech solutions
- NARI's contribution to rural areas
- How IIT and NARI can collaborate in rural development

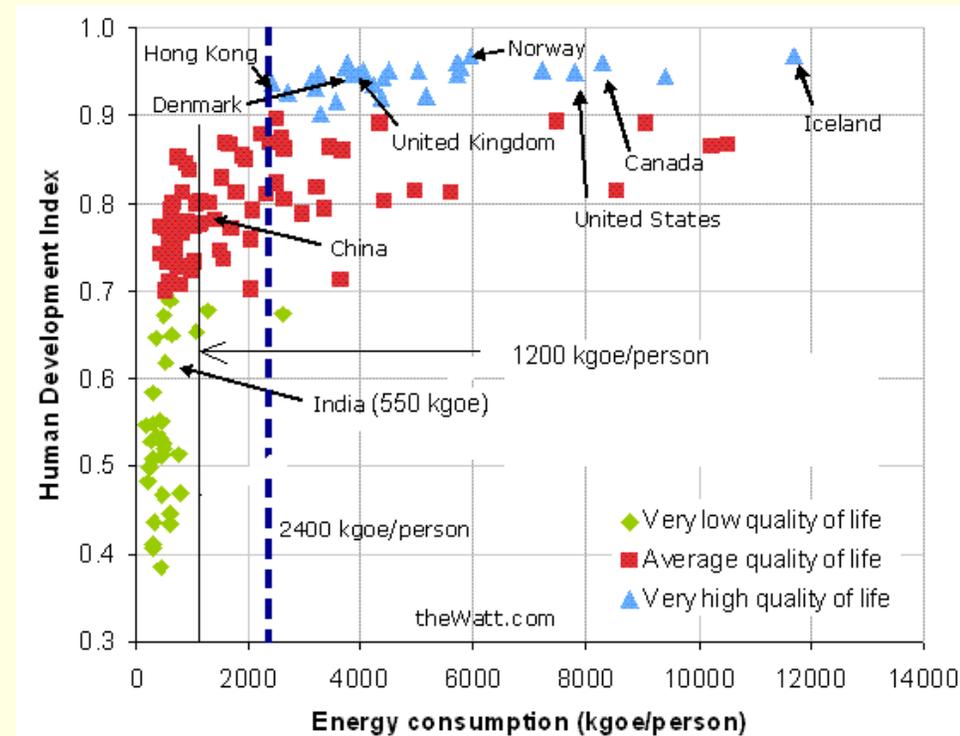
Rural scenario

- 65% of our population is rural based. ~50,000 villages have never seen electricity. 60% of rural population (~ 400 million) has nearly non-existent electricity. Sad state even 65 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 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.
- 25% (~260 million) of rural population survives on less than Rs. 100/day. With increased electronic mass media exposure aspire to a certain quality of life.



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 energy consumption. With slight increase in energy usage, tremendous increase in HDI.
- 50-60 GJ/yr (1200kgoe) capita consumption can bring HDI to 0.8 (1970s European quality of life). Doable goal.

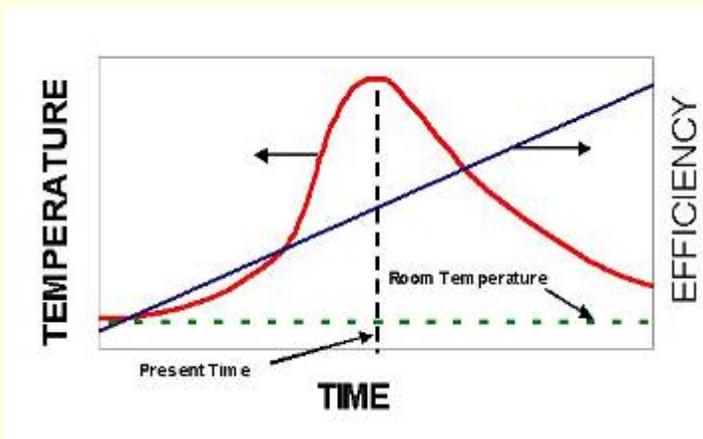
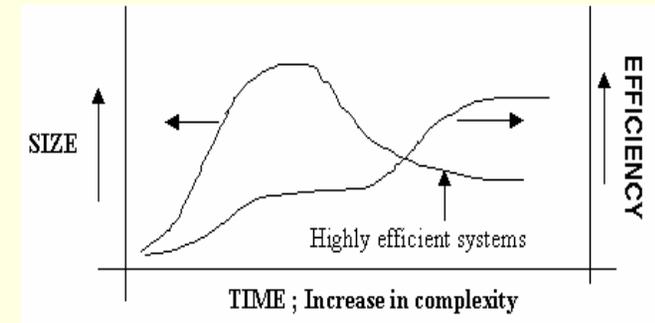


General energy scenario

- India's petroleum imports (80-85% of total consumption) last year ~ Rs. 3 lakh crores. (6% 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.
- In 15-20 years India and China might surpass oil consumption of developed world. May lead to strife/wars, even WW III !
- Planning Commission's estimate of electricity shortfall is 150,000 MW by 2016. Will need Rs. 6 lakh crores! Where is the money? PP partnership has no yielded good results.
- Energy from agriculture can solve the twin problem of electricity and liquid fuel shortage and will provide rural wealth and create employment.

Strategy of rural development

- High technology needed for rural development. Frugal innovations?
- It allows maximum extraction of materials and energy from dilute locally available resources, like solar, biomass, wind.
- Hallmark of evolution: size reduction; sustainability; increased efficiency; room temperature processes; equilibrium with surroundings and robustness.
- Most of our designs are following this route. Cell phones, power plants, etc.
- Biomimicry as mantra for design. Is also spiritual !
- Third industrial revolution (3D printing) is following the life reproduction strategy.
- 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.
- From residues we 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 80,000 MW of electric power (50% of presently installed capacity).
- Can take care of major fuel requirements of India. NARI's contribution in biomass power.

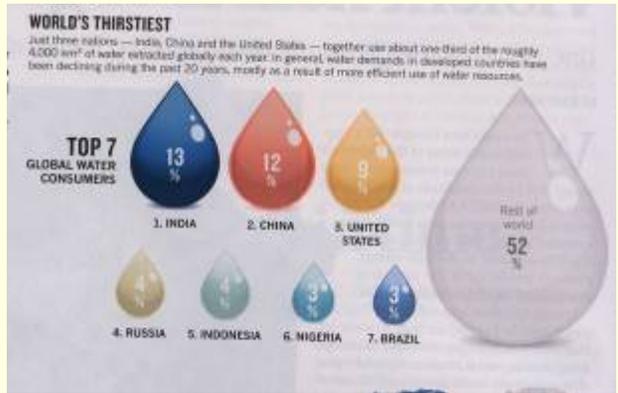
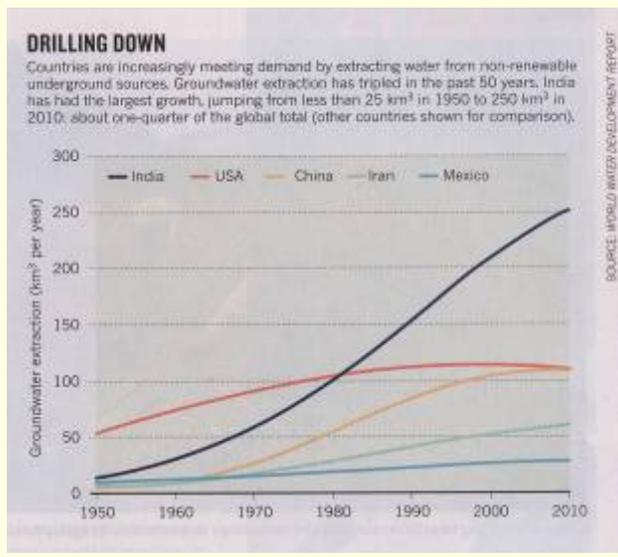


Energy production (cont..)

- 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.
- Residues for energy can give an extra income of Rs. 5000-7000/acre per year to the farmers. Insurance against distress sale. Increased agriculture will result in increased residues.
- Energy from agriculture can provide 50 million rural jobs and could be Rs. 200,000 crores/yr industry.
- Will help 60% of rural poor come in mainstream development. Thus huge intellectual capital can be made available and India can become an economic super power.
- 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. NARI's work on it.

Farming and water issues

- Sophisticated technology needed in farming. Lacking in India. Best brains needed in agriculture.
- Farming is non remunerative and unglamorous.
- Small land holdings fit for precision agriculture. Need for developing small and high tech farm machinery.
- Increased farming will require adequate water supply. Already shortage of water.
- Rainwater harvesting provides the best solution. India uses only 16% of its total rainfall. 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.
- Technologies needed to making water potable.



NARI's contribution to rural development

- Part of Saffola oil from some of our varieties. Whole plant approach.
- Pioneered the development of sweet sorghum for ethanol production. All India coordinated project with 2 dozen organizations participating.
- Cooking and lighting technologies for rural households. [Globe Award](#).
- Pioneered the concept and development of electric cycle rickshaws. [Energy Globe Award](#)
- NARI was principal author of national biomass power generation policy. Run by MNRE.
- Issues in agriculture and water.
- Introduced FecB gene in local sheep for twinning. [CSIR's highest award for rural development](#).



Sweet Sorghum

- Introduced sweet sorghum in India in 1970s. Four months crop and consumes 50% less water than sugarcane.
- Whole plant approach. Food (grain), fuel (ethanol) and fodder from same piece of land.
- Solar distillation and detoxification.
- Ethanol as cooking and lighting fuel.



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LANSTOVE™

- ◆ Draconian excise laws on use of ethanol for household purposes forced us to go for kerosene.
- ◆ Developed the concept of kerosene Lanstove.
- ◆ One device produces excellent light (250-300 W), cooks a complete meal for family of 4-5 and boils 10 liters of water. **3-5 times more efficient than electric cooking and lighting.**
- ◆ Tested in 42 huts which never had electricity. Excellent response. Present cost Rs. 7000/-. Women ready to pay Rs. 20/day. **Business plan needed.**
- ◆ Excellent combustion in lanstove. $CO < 3-4$ ppm and particulate emissions less than WHO standards.
- ◆ Lanstove is as easy to use and clean as LPG. **Need to incorporate TE element for cell phone charging.**



Lanstove



Biomass gasification for cooking

- Loose leafy biomass gasifier.
- 500-800 kW (thermal) capacity.
Controllable flame. CO + H₂
- 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.



Working together

- Need for corporate world, civil society (S&T NGOs) and R&D institutes like IITs to work together. Sensitization of corporate world and R&D institutes regarding rural problems.
- India Inc will not survive without the 60% rural poor coming in mainstream. Improving their quality of life is in interest of everybody. Maoist movement is an outcome of the tremendous disconnect between haves and have-nots.
- Possible mechanism of collaboration:
 - Getting IIT faculty (sabbatical) and few bright students at NARI
 - Doing jointly funded projects. Design at IIT and implementation at NARI. Time constraint?
 - Student internship or projects at NARI
- **Rural work is a mission and not another job.**

Possible projects

- Small water utilities for villages. Both for irrigation and domestic usage.
- Micro power utilities (100-500 kW capacity) running on renewable energy. Lease of SEB infrastructure. Agro residues based gasifiers.
- Mobility issues for short distances. Electric and hybrid cycle rickshaws?
- PV powered fans and refrigerators. High quality end use requires high technology. Biomass based absorption refrigerators.
- High tech agriculture. Precision and user friendly farming tools powered by farm derived fuels.
- Solar thermal low temperature power systems.
- IT based medical diagnosis and solutions. BP checking, ECG, eyes (Aravind EH), snake bites, plant identification, etc.
- Cooking/lighting and clean water for rural areas. Infrared reflecting glass (graphene?) needed. Spreading lanstove type technologies
Business plan? Kerosene from agricultural residues?

Philosophical issues

- Urban elite as role model?
- Need to reduce greed and 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/p/y.
- If every citizen of India follows US lifestyle we will need all the resources of the world 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 India become a holistic and sustainable country.
- Basis and philosophy of NARI's high tech center.

Thank You

Useful sites

- www.nariphaltan.org
- www.nariphaltan.org/ncsd (Sustainable center site)
- <http://www.nariphaltan.org/hitechcenter.pdf> (High Tech Center proposed)
- www.nariphaltan.org/writings.htm
(articles on spirituality, technology and sustainability)
- www.nariphaltan.org/langmuirrural.pdf
(an article on use of high technology for rural areas)

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