

Rural Energy Innovations

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Rural scenario

- In India 75 million households (~ 300 million people) have no electricity (2011 census). Sad state even 65 years after independence.
- Mostly use kerosene for lighting in polluting lanterns and more than 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 and Mars.
- Around 400 million people in rural areas survive on less than Rs. 100/day. With increased electronic mass media exposure (cell phones, TV., etc), they aspire to a certain quality of life.

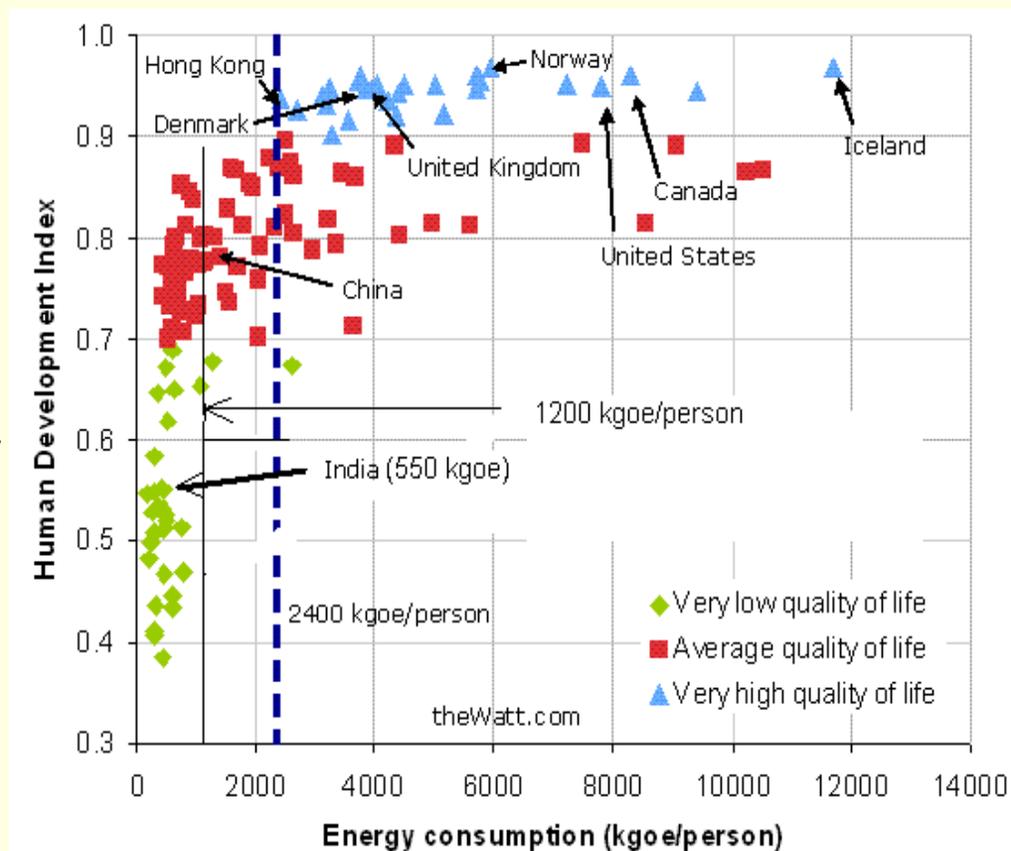


Rural scenario....

- Rural poor are not sub human beings. They have the same number of neurons as rest of us and aspire to have good quality of life.
- They cannot wait indefinitely for trickle down goods and services.
- Mass media has fueled their aspirations which can be fulfilled with affordable technology and services.
- How to provide goods and services which improve their quality of life is the biggest challenge for technologists.
- Provision of affordable energy from local resources can provide these services and increase wealth in rural areas.
- Energy innovations needed in;
 - Household sector (decent living)
 - Farming sector (decent livelihood)

Rural energy scenario

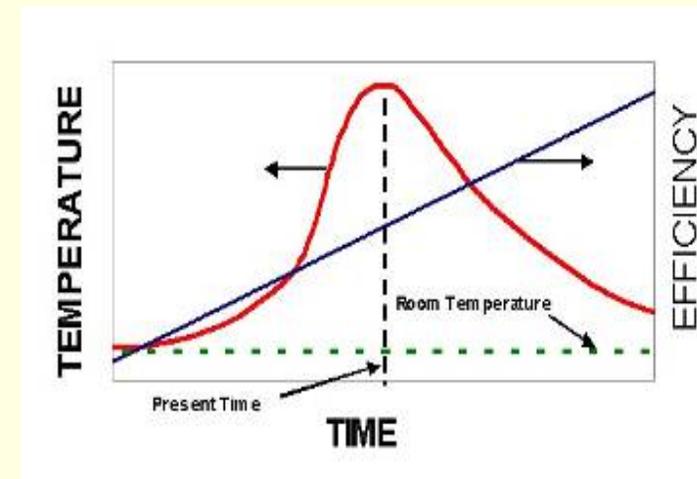
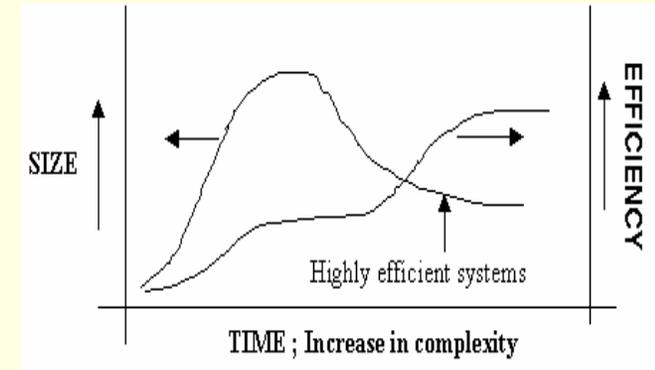
- **Energy is the basis of life. Lack of it produces economic stagnation and social upheavals.**
- **Energy situation in India is alarming. Average per capita consumption is 18 GJ/yr. or 5% that in US (350 GJ/yr.). Per capita rural domestic elec. consumption is just 96 kWh/yr (~ 11 W) – the lowest in the world.**
- **HDI is directly linked to energy consumption. With slight increase in energy usage, tremendous increase in HDI.**
- **50-60 GJ/yr (1200 kgoe) capita consumption can bring HDI to 0.8 (1970s European quality of life). Doable goal.**



Strategy of rural development

- High technology needed for rural development. Need to maximize efficiency. Frugal innovations?
- It allows maximum extraction of materials and energy from dilute locally available resources, like solar, biomass, wind.
- Hallmark of evolution: size reduction; increased efficiency; room temperature processes; equilibrium with surroundings and robustness.
- This is how nature has evolved. Biomimicry as mantra for design. Most of our designs are following this route. Cell phones, power plants, etc.
- Third industrial revolution (3D printing) is following natural systems. Can usher in Gandhian concept of self-sufficient rural areas.
- Societies as Prigogine's dissipative structures. Decentralized high tech energy solutions ⇒ softer sustainable decentralized societies .

Reliance2013



Rural huts



Even during daytime there is darkness in huts



Innovations for rural households

- Mantra for development; **Improving the lives of rural poor – one household at a time.**
- Need:
 - Excellent light (>3000 lm); solar lanterns < 600 lm.
 - Very clean cooking fuel (liquid or gaseous fuel preferred because of ease of control and high energy density)
 - A small refrigerator
 - Clean drinking water
 - A very efficient fan (maximization of m³ air/W)
 - **Availability of wholesome food**
- Provision of affordable electricity in rural India is a distant dream.
- Innovations needed in providing above services without electricity.

Kerosene LANSTOVE™

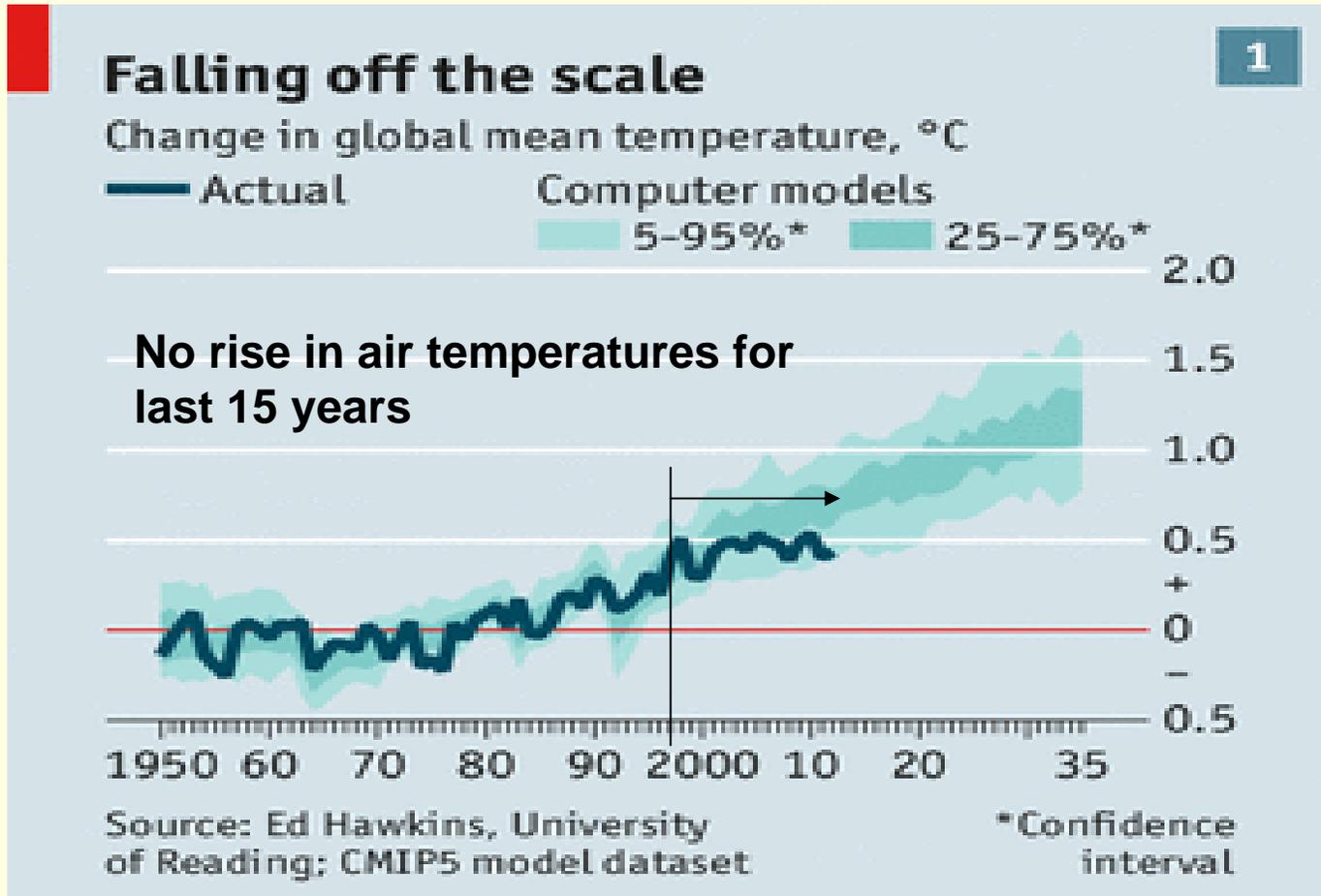
- ◆ One device produces excellent light (200-300 W bulb), cooks a complete meal for family of 4-5 and **makes 10 liters of water potable via NARI Technology.**
- ◆ **3-5 times more efficient than electric cooking and lighting. LCA analysis.**
- ◆ Tested in 25 huts (since August 2012) which never had electricity. Excellent response. Present cost Rs. 7000/-. In mass production expected Rs. 4000/-. Women ready to pay Rs. 20/day.
- ◆ 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.
- ◆ **All fuels are dirty. Excellent combustion makes them clean. Earth warming ???**



Kerosene Lanstove



Slow down in global warming



Economist. 30 March 2013

Further work.....

- Poor cannot wait indefinitely for renewables to be made available to them. We should use existing fuels and convert them through excellent technologies.
- Need cell phone charger with lanstove.
- Development of heat powered small absorption refrigerators.
- Availability of kerosene for rural poor is a major issue.
- Conversion of agricultural residues into kerosene type fuel.
- Making kerosene soot-less.
- NARI's water technology. Can be taken up as a solar powered village level water utility.
- Need very high efficiency fan. Max m^3 air/W.
- Wholesome food for rural poor.

Wholesome food availability?

- More than anything else rural poor need better food. Concept of rural restaurants.
- Tremendous pollution in rural households.
- Need utensils and fuel to cook. Costs money.
- After a hard day in the field the woman is in no shape or mood to cook. Very tiring and unpleasant chore.
- Very poor nutrition. Daily rations are bought from PDS shops. If not available they tend to eat less.
- Poor eating and hence rapid aging and poor physical and mental health including those of children.
- Best medical care for rural poor is to provide them with good food.

Rural restaurants (solution)

- Creation of rural restaurants. Regular ones but for BPL families subsidized meal. Use of UID card for meal purchase.
- Has a potential for producing 20 million jobs. Can be a large rural industry. Fit for public-private partnership. Part of CSR activity?
- Will also help reduce energy/kg for cooked food and may facilitate use of renewable energy for cooking in these restaurants. Biogas, producer gas, efficient wood fired stoves.
- Poverty to my mind is not an absence of material goods but not getting **enough wholesome food**. **We are what we eat!**
- Cooking is a luxury for rich and upper middle class. For rural and urban poor it is a chore and a misery. Hence subsidized meals in rural restaurants is a welcome step for these people.
- In the long run this strategy may provide better food security for rural poor than the existing (open to large scale corruption) system of cheap food availability through PDS.

Energy from agriculture (livelihood issues)

- Around 58% of India's population is engaged in agriculture. Mostly rural based.
- India produces ~ 800-1200 million tons of agri. residues per year. Waste disposal problem and hence substantial amount burned in fields . Creates environmental pollution, loss of energy and monetary loss to the farmers.
- 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.



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. 5000-7,000/acre per season 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.
- This rural wealth generation can help 60% of rural poor come into mainstream development and make India as an economic power.
- Innovations needed in farming sector. Precision agriculture for small farms. Power for farm machinery to be produced on farm.
- High tech electric or biogas powered farm machinery.

Electric farm machines

Electric thresher



Solar powered safflower petal collector

- Shortage of farm labor. Need to develop smart farm machines
- Need very efficient small electric powered tractors and harvesters.
- High tech mechanical planters and weed removers.

Other issues

- Land should always be used for food. Agricultural residues to be used either for energy, fertilizer or fodder.
- Health of land is most important. Hence agricultural residues should preferably be used first for fertilizer and then for energy.
- Dual purpose use for fuel and fertilizer needed. Biogas technology as a major strategy. Game changing technologies needed for biogas production, distribution (in nanostructures lined cylinders) and use.
- NARI – Stanford – Reliance partnership in rural energy.

Thank You

- Useful sites

- www.nariphaltan.org/ruralrestaurants.pdf
- www.nariphaltan.org/kerolanstove.pdf
- www.nariphaltan.org/kerosene.pdf
- www.nariphaltan.org

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Stanford - Reliance workshop 15-16 May 2013, Mumbai.

- Around 20 invited speakers gave talks on various topics. The [agenda of conference is here](#). The [video of the talk](#) is here.



AKR giving his talk

With Dr. Kirit Parikh and Dr.B.C. Jain during dinner



AKR moderating the breakout session.

[HOME](#)