NARI

Technologies for Sustainable Rural Development

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Present situation

- Majority of population in DCs lives in rural areas. In India this number is 65%.
- Around 3 billion people worldwide earn ~ $1-2/day.
- About 60% rural population in India has no electricity. In some states this number is ~90-95%. After 57 years of independence!
- These households use hurricane lanterns or open flames and large areas do not even get kerosine.
- Around 90% of rural areas in India use ~ 180 million tons of biomass through very inefficient and smoky stoves.
- 1.6 million deaths worldwide because of woodstove pollution.
- Cooking and lighting constitutes 75% of total rural energy.
- Tremendous water shortage and no safe drinking water.
- Rural population aspires to good quality of life.

Strategy

- Around 200-250 million rural population in India have reasonably good purchasing power. Can be agents of change.
- Strategies to increase level of living :
  - Employment generation
  - Wealth creation from land. Will help in attachment to the land.
- Can be achieved by use of high technology to produce energy and end products. Nano and Bio technology route?
- Energy is the basis of life. From it flow all other activities of technology, commerce and politics.
- Agr. country hence energy production via biomass energy.
- Need to cap greed for resources since not enough available.
- Strategy of matching energy to end use.

Strategy (contd.…)

- **Need for an alternative development model which is decentralized and based upon renewable energy.**
- **Our model is based on high tech development of Taluka so that it becomes food and energy self sufficient and hence sustainable.**
- **Taluka is like a county in US. It has a population of ~250,000 and an area of ~ 1500 sq.km. Mostly rural. There are 3500 Talukas in India.**
- **Avg. energy consumption in Taluka: 10-15 MW electricity and 10-15 million liters/yr. petroleum products.**
- **Biomass can meet all the energy needs of a Taluka. Besides it will create wealth and 30,000 additional jobs.**
- **Between village and megacity. *Middle path of Taluka is functional.***

Biomass Energy (Indian scenario)

- India produces > 400 million tons of agricultural residues/yr. Most of them are burnt in fields.
- Loss of precious energy besides creating pollution.
- Theoretically they can produce > 55,000 MW of power.
- Increased agriculture will produce more residues. Residue stream for fuel, fodder and fertilizer.
- R&D at NARI and in other Institutes has shown that electricity, liquid and gaseous fuels for motive power, transportation and household energy can be produced from biomass.
- To produce useful end products at affordable price requires extensive R&D in technologies.
- Lighting and cooking energy strategy for rural areas.

Lighting and Cooking Energy Strategy

- **Liquid fuel based lighting**
- **Liquid fuel production**
- **Distributed electricity based lighting**
- **Cooking energy technologies**

Liquid fuel based lighting

- **Light from open flame sources is poor <100 lumens (lm). 100 W bulb~1340 lm**
- **Petromax lanterns provide adequate light (~ 1300 lm) but need improvements in T/L mantles and combustion.**
- **“Noorie” lantern developed at NARI. Better combustion. Cooking as a by-product. Consumes 50% less kerosine than Petromax.**
- **Presently mantle efficacy~2-3 lm/W; light bulb~10-15 lm/W and CFL ~ 50-70 lm/W. Need to match mantle efficacy with that of light bulb.**
- **Power plant-to-light efficiency (PPL) point of view liquid fuel lighting will be superior to electric lighting. PPL of CFL is ~ 12-14 lm/W. If T&D losses increase then PPL will further reduce.**

Multifuel Noorie lantern

Attributes of Noorie lantern

- Lightweight. 1.7 kg
- Light output ~ 1350 lm.
- Runs on diesel, kerosene and ethanol(>80%v/v)
- Provides both heat and light
- Low cost. $10-12/-

Liquid fuel lighting (contd.)

- **Present T/L mantles are 1880's vintage. Made of silk cloth; coated with mixture of 99% ThO_2 and 1% CeO.**
- **R&D required in developing new mixtures which can produce thermoluminescence at lower temperatures (1000-1500 ^{0}C) with higher luminous efficacy. Nanotechnology R&D may provide direction.**
- **R&D required in developing sturdier mantles. Could be ceramic cloth based,carbon-carbon composites etc.**
- **Ultimate liquid fuel lighting will be to copy bioluminescence technology of firefly.**
- **With grid electricity still a distant dream for major portion of rural areas, efficient liquid fuel lighting needs to be encouraged. Future of small distributed energy systems.**

Liquid fuel production

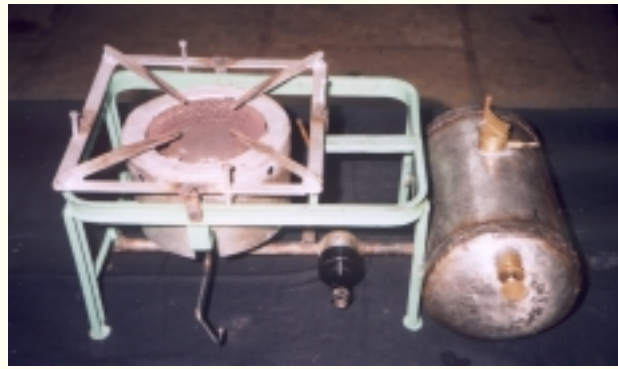
- Need to develop alternatives to kerosine. Ethanol, non-edible oils, pyrolysis oil, etc.
- Ethanol and non-edible oils can be used effectively for cooking and lighting. Need to ensure that liquid fuel production should not compete with food production. Biotechnology will help.
- Sweet sorghum - a multiple purpose crop as a solution.
- R&D needed for pyrolysis oil development. Can be produced from any dried biomass resource. Three units in US.
- Thermal depolymerization of wet plant and animal waste into light crude. 500-900 °C and 40 atm. One unit in US.
- Creation of liquid fuels in rural areas from available or new biomass resources will create rural wealth and increase the quality of life for its inhabitants.

Distributed Electricity based lighting

- **Medium scale plants (10-20 MW capacity):**
  - **Taluka level energy strategy developed by NARI. Electricity and liquid fuel requirements met from crop residues. Investments of $ 75 million, generation of 30,000 jobs and $ 25 million/yr wealth in each taluka.**
  - **Was implemented as a national policy by GOI till 2000 AD.**
  - **Forty biomass-based power projects of 6-10 MW each set up. New electricity act (2003) may spur this development further.**
- **Small scale plants (10-500 kW_e range):**
  - **R&D needed in this range. Gasifiers, space-age steam engines, stirling engines, biomass gas turbines, low cost PV, etc. Nuclear Power? Concept of microutilities (500 kW) in rural areas.**
- **Micro scale power units:**
  - **Thermoelectric elements for cookstoves. Can produce 40-50 W power. Need R&D in efficient batteries like ultracapacitors and LED units.**
  - **Human-powered small PMDC generators. Rare earth magnets. Gandhi ji's energy charkha.**

Cooking Energy Technologies

- **Liquid and gaseous fuels can provide clean cooking energy.**
- **Ethanol is excellent fuel for cooking. NARI's work. Need of liberal policy for use of ethanol for cooking.**
- **R&D is required for stoves development for pyrolysis oil, non-edible oil, etc.**
- **R&D required in high tech biogas reactors. Bio-chemical engineering needed in reactor design.**
- **Storage of biogas in hydrates, porous carbon and other organic structures. Need for medium pressure storage.**
- **Scenario of a small utility in rural areas which processes agro-waste into biogas and supplies it in small gas cylinders.**
- **High Tech biomass based industry for rural needs can be of the order of $ 9 billion/yr and can touch every aspect of rural life.**



Ethanol Stove:

- Runs on >50%(w/w) ethanol/water mixture
- 2.5 kW_{th} capacity(max)
- Easy to light
- Flame controllable
- Safe mixture
- Cost ~ $25/-

What should be done

- **Need for North-South cooperation on development of household rural technologies.**
- **A consortium of a US university, north/south NGOs and US entrepreneurs should be set up**
  - Train students from South to become rural energy entrepreneurs.
  - Develop high technologies to solve rural problems.
  - Will provide market for North companies.
- **International goal to provide reasonable rural services to the world by 2015.**
- **Spirituality can reduce greed in our lives and help in sustainable development.**

THANK YOU

- http://nariphaltan.virtualave.net (Institute)
- http://education.vsnl.com/nimbkar/criticalmass.html (Taluka)
- http://nariphaltan.virtualave.net/lantern.htm (lantern)
- http://pune.sancharnet.in/nariphaltan/housenergy.pdf (cooking and lighting strategy for rural areas)
- http://nariphaltan.virtualave.net/rocketscience.pdf (Nanotechnology for the poor)
- http://nariphaltan.virtualave.net/ethstove.pdf (alcohol stove)
- http://education.vsnl.com/nimbkar/spiritual.html (spiritual writings)