

Sustainable Energy for India's Rural Development

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Structure of talk

- Present problems in rural India
- Decentralized high technology solutions
 - Energy production from agriculture
 - Energy devices for cooking and lighting
- Financial and other instruments
- Other issues

Present problems in rural India

- 60% of rural population (~ 400 million) in India live in primitive conditions. This sorry state exists even after 60 years of independence.
- No electricity and primitive cookstoves. Around 300,000 deaths/yr take place because of pollution.
- 54% of India's population is below 25 years and most of them live in rural areas with very little employment opportunities. 1/4th of our population or 260 million live on < \$ 1/day.

Problems contd...

- Because of rural poverty large scale migration to cities takes place leading to serious urban problems.
- Increased aspirations because of mass media are leading to social unrest. Riots in various cities. Release of bottled-up emotions. Spark could be from any source.
- Energy is the basis of life. Lack of it produces economic stagnation and social upheavals.

Problems contd..

- Serious energy crisis in India. Per capita electricity in India 553 kWh/yr or 4% that in US and lowest in the world.
- In rural households 57 kWh/yr per capita electricity consumption. Linkage of HDI to electricity consumption.
- Last year India imported \$ 45 b worth of petroleum products. Serious balance of payment problems. 8-9% p.a. growth in petroleum consumption.
- India and China's Oil consumption at present rate will create world wide crisis. WW III ? Need for alternatives.

Governance

- All the above problems in India are result of non-governance.
- Centralized production and control inherently leads to corruption. Decentralization leads to accountability.
- Governance is the first casualty of corruption.
- Multiple ministries in GOI has further compounded the problem.
- With proper governance, one of the best technological solutions for the above problems is energy production via agriculture.
- Energy from agriculture can provide rural wealth and create employment. Can bring 60% marginalized people into mainstream India, without which India cannot become an economic superpower.

Energy Production

- India produces ~ 600-1000 million tons/yr of agricultural residues. Mostly burned in fields. Creates environmental pollution and loss of energy.
- 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 energy planners to seriously think of linking energy with agriculture.
- Residues for energy can give an extra income of \$ 50-100/acre/season to the farmers. Insurance against distress sale of crops.
- With increased agriculture the residues will increase.

Energy Production...

- From crops and residues we can produce three types of fuel
 - Liquid fuels like ethanol, biodiesel or pyrolysis oil.
 - Gaseous fuel like methane (biogas).
 - Electricity via biomass-based power plants.
- 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.
- Electricity and liquid fuel production in rural areas will bring tremendous wealth. In India it is estimated to be 10 billion dollars/yr. It can also provide 30 m jobs.

Energy Production (cont..)

- With increased industrial demand for fuel and electricity, large tracts of farmlands may come under fuel crops.
- Issues of food vs. fuel.
- Need to develop multipurpose crops. NARI's work on Sweet sorghum.
- Jatropha for biodiesel on poor lands. ½ million ha planted. Other non-edible oilseed crops needed.
- 50-60 biomass based power plants in India of 6-10 MW capacity. Many more to come because of Electricity Act and **Taluka energy policy**. For individual villages 500 kW strategy.
- Wind plants of 7200 MW. Major success in India.
- Farms and farmers are the backbone of any nation. They can produce food, fuel and hence wealth from the land.



Water Issues

- Increased farming for energy production will require adequate water supply.
- Already water shortage though adequate rainfall.
- Rainwater harvesting provides the best solution. Need for setting up private rural water utilities. Some experiments in Rajasthan and Gujarat.
- Issues of ownership of water bodies need to be resolved. Water Act similar to Electricity Act needed.
- Use of flue gases from power generation can provide potable water. Combined electricity and water plants will improve overall efficiency.

Development of Energy Devices

- High technology devices needed for rural areas.
- Resources and energy in dilute forms.
- Very efficient devices allow maximum energy and materials to be extracted for useful purposes.
- Hallmark of evolution is size reduction, increase in complexity and efficiency. All our modern devices follow this route. Sustainable size for high efficiency.
- Same strategy should be applied for lighting and cooking technology. 75% of total rural household energy in India is used for it.

Strategy for Lighting

Liquid fuel lighting

- ◆ Use of nanotechnology and new materials can make liquid fuel lighting better than electricity. Details are in the paper.
- ◆ New lanterns running on home grown fuel like ethanol and biodiesel can help in rural lighting.

Electricity based lighting

- ◆ Thermoelectric elements for cookstoves. Can produce 40-50 W power for small fans and LED. R&D needed in efficient batteries, ultra capacitors, paper thin batteries, etc .
- ◆ 10-30 W micro engines? No batteries needed.
- ◆ Human-powered small PMDC generators. Real play radios.



Noorie lantern

- Lightweight 2 kg
- Light output ~ 1350 lm
- Runs on kerosene, diesel or low conc. ethanol
- Lighting and cooking
- Low cost ~ \$15

Cooking Energy Strategy

- ◆ Gaseous and liquid fuels best.
- ◆ China and India pioneers in biogas technology.
- ◆ R&D required in high-tech biogas reactors and storage of biogas in hydrates, porous carbon, etc. Biotechnology for bacteria and nano materials for such structures.
- ◆ Scenario of a small utility in rural areas which processes waste into biogas and supplies it in small gas cylinders lined with storage materials. Will revolutionize rural cooking.
- ◆ Ethanol is an excellent fuel for cooking. 50% ethanol-water is easy to distill and a very safe mixture.
- ◆ Laws need to be modified for its availability for rural cooking and lighting.



NARI alcohol stove

- **50% (w/w) ethanol**
- **0.7 - 2.5 kW_{th} capacity**
- **Controllable flame**
- **Silent and easy to light**
- **Cost ~ \$50/-**

Financial and other Instruments

- Subsidies, tax incentives and benefits have been used. Also need rural energy venture funds.
- Special packages for farmers to produce energy.
- Modern energy systems in rural areas need management and technology. Success of wind production in India.
- Partnership of corporations, NGOs and villagers needed. NARI/NFCL.
- Makes lot of business sense for corporate world. Need to curb the excessive profit making greed.
- Need for highly trained manpower for RT. Duplicate the performances of IT and BT sector.

Other Issues

- There is a need to reduce our consumptive lifestyle. For rural areas urban lifestyle is role model. If we follow American lifestyle then we will need resources of 4 earths.
- A decent lifestyle is possible with energy consumption of 50-70 GJ/person/yr. US per capita consumption is 350 GJ and India's is 18 GJ.
- This can happen when we become spiritual and hence internally secure. Motto of **simple living and high thinking** as guide for rural development work.
- Becoming sustainable in our personal lives and giving something back to the society will help make India and China a holistic and sustainable society and show the world a new way.
- Story

Thank you

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Lot of work on renewable energy at NARI is
[described in this document.](#)