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India's Unique Sources of Fuel for Electricity and Transportation

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Outline

- Video
- Background
  - Indian energy sector
  - Bio-oils
  - Current levels of use
- Three Potential Business Models
  - Enablers
  - Risks and Barriers
- Recommendations
- Conclusion

Basic Statistics for India

- Enormous demand for cheap and indigenous fuels
  - Annual Diesel Consumption – 80 Million tonnes
  - 70% of crude oil is imported

- Enormous demand for electricity in rural areas and for peak power
  - 15% (~ 85,000) villages not have no electricity supply
  - < 40% of rural households have grid connection
  - ~ 15% shortage in supply during peak hours

- Wide prevalence of diesel generators for power supply
  - ~ 15,000 MW of captive diesel capacity in industries
  - Wide use of diesel generators in villages for water pumping

- Vast resource of inexpensive land and labour
  - Potentially available degraded land ~ 100 - 180 Million hec.

- Numerous hardy species suitable for cultivation on marginal land with minimal inputs of water and chemicals
  - Potential annual yield of oil ~ 1 to 5 tonnes per hectare
  - Required land for meeting RFS of 10% biodiesel ~ 1.6 - 8 M. hec

Oil Seed based Power Generation







Pongamia Tree → Pods → Oil + Cake → Chemical Treatment → Biodiesel → Genset/ Automobile

400 trees/hectare

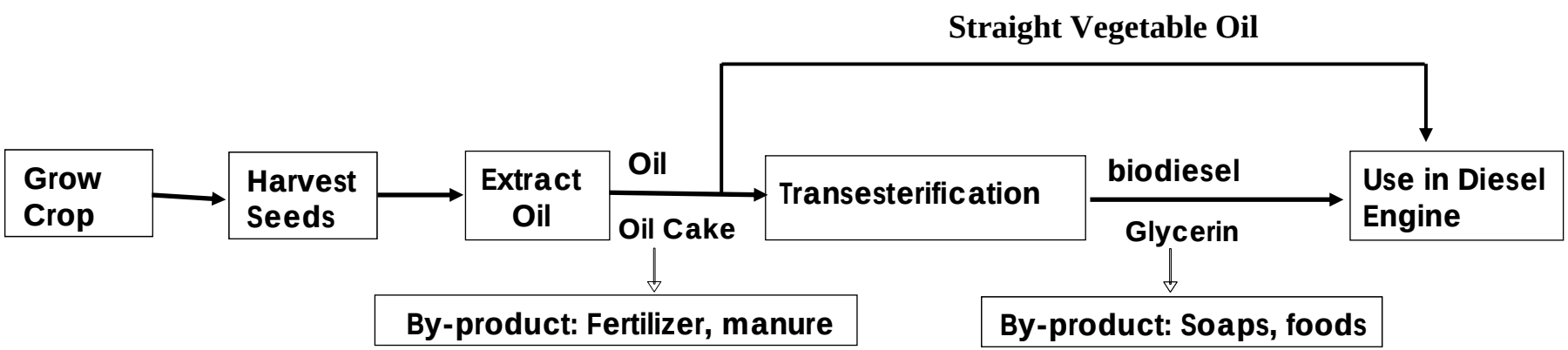
4 tons of seeds/year (after 6th year)

1 tonnes of oil

90% yield

1000 litres of biodiesel

0.5 kW per hectare



Flow Chart of biodiesel production and use

Bio-oils from oil seeds

- Can be used as Straight Vegetable Oil (SVO) or as biodiesel (transesterified oil) depending on type of engine and level of blend

- Can be produced from diverse sources
  - US : Soybean
  - Europe : Rapeseed, Linseed
  - India : Jatropha, Pongamia, Neem, Castor
  - Malaysia: Palm
  - Philippines: Coconut

- In Indian context requirements are
  - drought-resistance, ability to grow on degraded land, minimal requirements of water, fertilizers, pesticides

- Non-edible oil seeds are the most suited since edible oils are much more valuable as a cooking fuel in India
  - Market price of Diesel - $0.75/lit vs Cooking oil - $1.3/lit

Pongamia and Jatropha

	Pongamia Pinnata	Jatropha Curcas
Crop type	Nitrogen fixing tree	Shrub
Agro-climatic conditions	tropical or subtropical and soils with diff. fertility	tropical or subtropical and soils with diff. fertility
Oil content	25-35%	25-35%
Maturation Phase (years)	5	3
Expected useful life (years)	40-50	20-25
Planting density (plants per hectare)	100 to 500	1670 to 3330
Potential Yield per hectare upon maturation (kg/hec)	upto 5000	upto 1000
Characteristics of oil cake	More valuable	Less valuable

Current Status of Use

- Several successful pilots in villages and one instance of significant industrial use

- No organized production of non-edible oil seeds or biodiesel on commercial scale

- Wide spread consensus regarding the potential of bio-diesel (plenty of buzz in political and commercial circles)

It is important to remember that degraded lands are not really waste lands as often referred to – they could have significant opportunity costs due to existing uses (fodder for cattle, fuel wood etc.) or use for planting Eucalyptus, Acacia etc.

Three Potential Business Models

1. Rural electricity service

2. Industrial scale electric power generation

3. Industrial production of bio-diesel

1. Rural electricity service

Model: Village cooperative or small scale private electricity service provider operating small reciprocating engines (10-100 kW) and supplying power through mini-grids for household, agricultural and commercial use

Enablers

- Local demand for electricity and oil cake
- Local production of seeds using local land and labour
- Familiarity with use of small diesel engines

Risks and Barriers

- High initial capital cost and long maturation period of plantation require innovative financing schemes
- Market may not be as lucrative as the industrial sector and hence may not attract private entrepreneurship
- Lack of awareness about optimal planting and management during the initial years
- Competition for degraded land for grazing, fuel wood, other subsistence crops

2. Industrial scale power generation

Model: Production on the scale 1-50 MW by Independent power producers (IPP) either for supply of power to central grid or for captive industrial use

Enablers

- Rapid growth in demand for electricity and slow addition of capacity
- Deregulation of power sector enabling IPPs to sell power to the grid or to third parties (wheeling)
- Prevalence of large back up diesel generators in industries that can use cheaper SVO or biodiesel

Risks and Barriers

- Little opportunity to market peak power since peak demand is met through a combination of cheap hydro and load-shedding (yes that's right!!!)
- Low buy back tariffs for base load power
- Ensuring reliable supply of seeds at low cost

Supply Chain Cost Analysis

What is the average cost per kWh of electricity produced? Is there a market at this cost?

Approach: Detailed analysis of costs of

- Cultivation
- Seed collection and distribution
- Extraction of oil from seeds
- Power generation using diesel generators
- Expected revenues from sale of co-products

Scenarios

	Units	Case 1	Case 2	Case 3	Case 4	Case 5	Case 6
Capital Cost	Rs/kW	30,000	30,000	30,000	30,000	30,000	30,000
Cost of Seeds	Rs/kg	8	8	6	6	5	5
Sale Price of Oil Cake	Rs/kg	6	4	6	4	6	4
Average Cost of Elec.	**Rs/kWhr**	**4.8**	**6.1**	**2.99**	**4.3**	**2.1**	**3.4**
Effective cost of biodiesel	**Rs/lit**	**32.3**	**32.3**	**25.6**	**25.6**	**22.2**	**22.2**

Plant Rating	1 MW
Capacity Factor	50%
Plant Efficiency	35%
Discount Rate	12%
System Life	20
Annual Production	4400 MWhr

- Buy back prices offered by SERCs ~ Rs. 3 – 3.1 /kWh
- Cost of diesel ~ Rs.35/lit
- Cost of back up generation using diesel ~ Rs. 7 to 8/kWh

3. Industrial production of bio-diesel

Model: Industrial production of bio-diesel for selling to refiners and distributors of diesel (nationally and internationally)

Enablers:

- Rising prices of crude oil
- Government legislation to achieve 5% biodiesel by 2007 and 10% by 2010
- Multiple sources of seeds could be used in production
- Economies of scale may lower costs

Risks and Barriers:

- Procurement of seeds at least cost requires companies source seeds by directly engaging in farming or contracting individual farmers

Conclusions from Analyses

- Rural electric power generation would provide the maximum social gains
- Backup industrial power supply is a profitable electricity market
- Production of biodiesel is the most attractive from a business point of view
- The Oil cake is as valuable as the oil
  - In the case of Pongamia, 1 kg of seeds fetches the same amount of revenue from sale of oil and sale of oil-cake as a biofertilizer
  - In the case of Neem, the cake is a high heating value fuel that can be used for co-firing with coal

Environmental Aspects

- Positive environmental externalities like benefits of reduced emissions from use biodiesel, regeneration of degraded land and its impact on erosion, soil quality etc. are not being made to count in the economic benefits

- General pessimism among stake holders about CDM

- There is consensus that mono-cropping should be avoided

- Environmental and Ecological effects of large scale plantations of Jatropha are uncertain, Pongamia seems better

Policy Recommendations

The following recommendations are primarily aimed at encouraging cultivation on a large scale and not for specific goals like rural electrification or rural economic development etc.

1. Renewable Portfolio Standards (RPS) for **Electricity and Fertilizer** production that will be strictly enforced by a certain time frame. This creates a definite and diverse market for oil seeds

2. Focus on providing incentives for cultivation through
    1. Lease marginal government-owned land available to individual farmers at affordable rates
    2. Provide low interest loans and Micro-financing which enable repayment after maturation of crops to enable farmers to sustain cultivation during the long initial years

Next Steps

- Sustainability Analysis – economic, ecological issues

- Risk Characterization – Detailed assessment of
  - What type of risk?
    - Technological, Financial, Environmental/Ecological
  - From whose perspective?
    - Government, Entrepreneur, Society, Investor, Society

- Strategies for Risk Mitigation

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