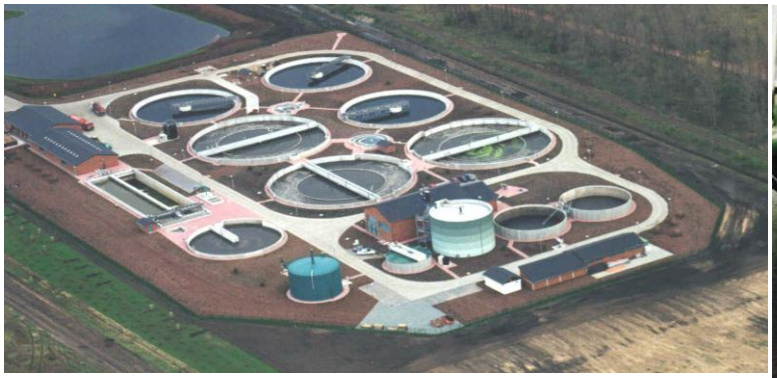



OVERVIEW OF BIO-ECONOMY – INDIAN INDUSTRY PERSPECTIVE

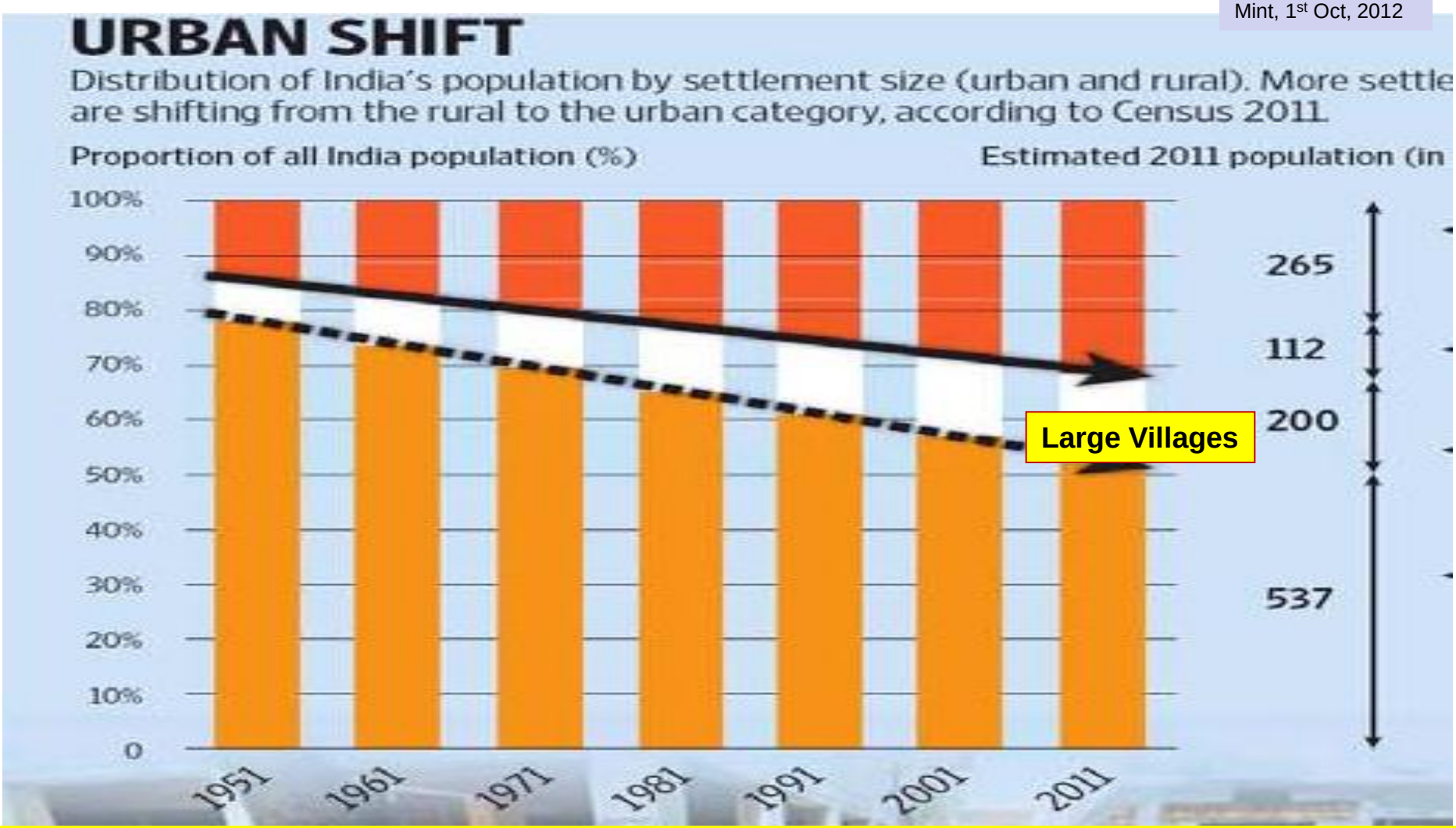


Organic Fertilizer

SOCIO – ECONOMIC IMPERATIVES : INCLUSIVE GROWTH + ENERGY ACCESS & SECURITY

Need to stimulate non farm economic activity

Mint, 1st Oct, 2012



Around 8,000 "Urban Centres" (including about 4,000 "Census towns").
These should be economic growth centres but <u>suffer from poor energy access</u>.
This could, potentially, lead to major socio-economic unrest.

Primary Energy Scenario

As per the IEP (Integrated Energy Policy), Report prepared by Planning Commission/GOI, India's total primary energy requirement, based on 8% GDP growth would be as follows:

- **2021-22 : 1089 million TOE**
- **2031-32 : 1836 million TOE**

India does not have any significant resources for fossil fuels and is largely dependent on imports.

As per Planning Commission, the net imports of fossil fuels is currently $ 120 billion and this is a major contributor to Current Account deficit.

Hence, there is a great imperative for India to reduce dependence on imported fossil energy.

India "Integrated Energy Policy" Projected Primary Commercial Energy (PCE) Requirements (9% GDP Growth Scenario)

Year	Coal		Oil		Natural Gas		Hydro	Nuclear	Total PCE
	Total (Mill TOe)	Non Power (Mill Ton)	Total (Mill TOe)	Non Power (Mill Ton)	Total (Mill TOe)	Non Power (Bill cum)	Mill (TOe)	(Mill TOe)	(Mill TOe)
2011-12	283	170	186	178	48	32	12	17	546
2016-17	375	237	241	231	74	45	18	31	739
2021-22	521	334	311	299	111	65	23	45	1011
2026-27	706	475	410	395	162	93	29	71	1378
2031-32	937	684	548	528	240	133	35	98	1858

Demand for (non electric) applications of Oil & Gas + Coal -> for Heating & Transport Applications will necessitate significant imports, impacting energy security & BoP status

Demand Scenario of Various Energy Items for Household Consumption in India

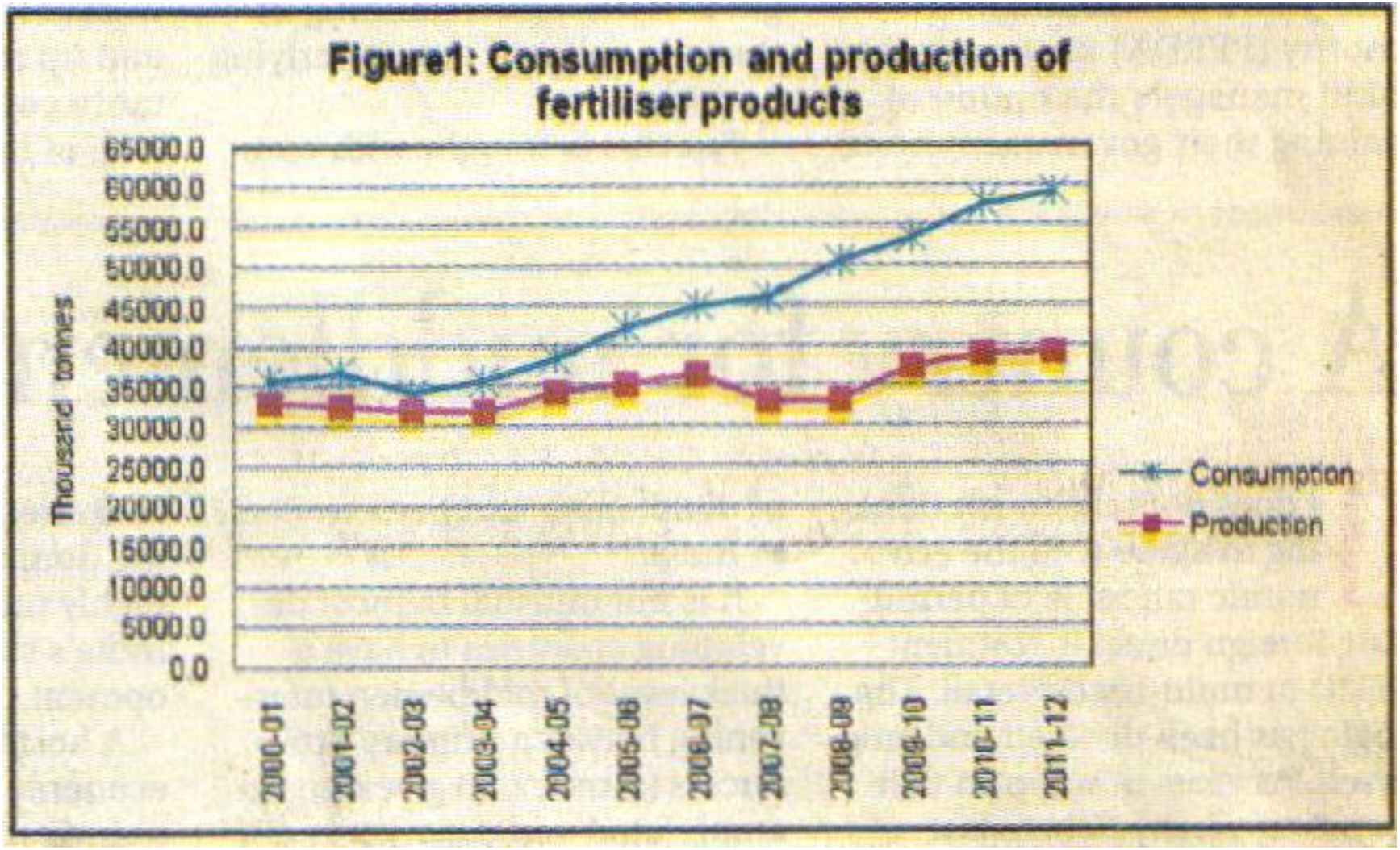
(Mtoe)

Year	Fire Wood & Chips		Electricity		Dung Cake		Kerosene		L.P.G.	
	8%	9%	8%	9%	8%	9%	8%	9%	8%	9%
2000	79.62	79.62	8.43	8.43	29.61	29.61	10.07	10.07	6.42	6.42
2006	88.64	88.78	18.17	19.26	36.97	37.33	12.68	12.77	15.85	16.87
2011	94.11	94.05	27.17	29.68	40.42	40.48	14.01	14.02	23.94	26.07
2016	98.44	98.50	38.38	42.28	41.93	41.35	14.84	14.70	33.11	35.93
2021	102.06	102.46	50.39	54.78	41.79	40.87	15.16	14.93	41.63	44.16
2026	104.64	105.07	61.37	64.95	40.95	40.28	15.17	14.93	48.11	49.63
2031	106.39	106.59	69.72	71.80	40.47	40.21	15.12	14.96	52.27	52.89

Demand for Fire wood & chips + Dung cake forecast as > 130 mill Toe in 2031 !

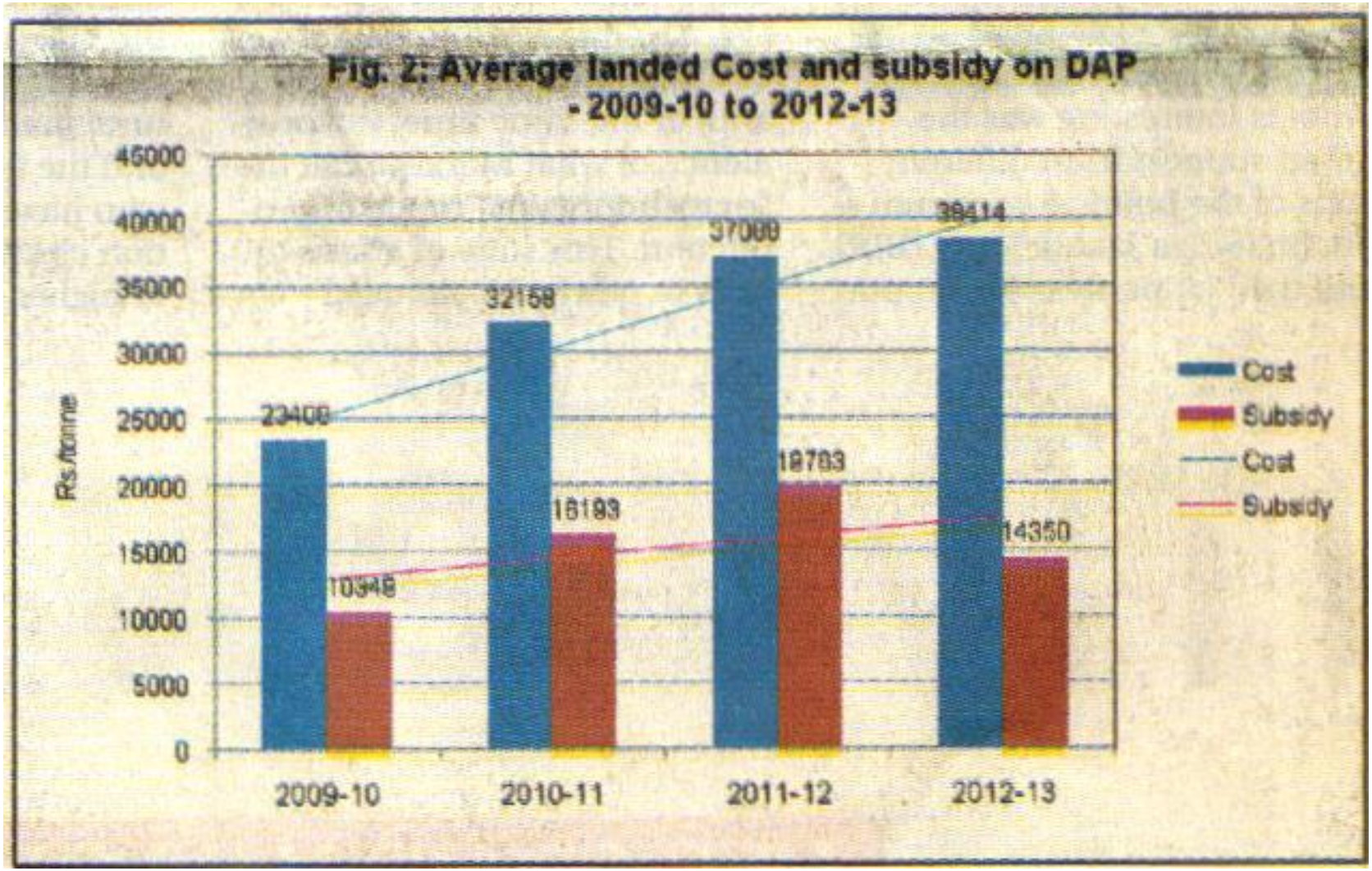
Need for technology interventions to enhance efficiency of use

Increasing Imports of Chemaical Fertilisers



Need to displace chemical fertilisers with assured quality compost

Increased realisation of Cost of Fertilser Imports



Assured quality Compost can be effectively monetised

Electricity Scenario

As per the IEP (Integrated Energy Policy), the electricity demand would be

- **1981 billion kWh (2021-22)**
- **3628 billion kWh (2031-32)**

For above electricity generation, IEP forecasts significant increase in fossil fuel needs.

- **Coal : 832 million MT (2021-22); 1475 million MT (2031-32)**
- **Natural Gas : 52 million MT (2021-22) ; 119 million MT (2031-32)**
- **Oil : 12 million MT (2021-22); 17 million MT (2031-32)**

From past trends it is evident that Indian fossil energy supplies would not be able to meet above demand and, furthermore, resistance to accept cost of electricity supplies from imported fossil fuels, as it is deemed to be beyond the affordable capacity of Indian electricity consumers. Displacement through RET based power is needed

Electricity Scenario (Cont.)

About 400 million households in India lack electricity access.

Furthermore, even where there is electricity access the quality as well as availability of supply is very poor.

Equally significantly, the actual cost of electricity supply to rural households is very high as the demand is typically from 6 PM to 11 PM, (coinciding with the Indian grids peak load) is very high due to (a) power purchase at peak rates (b) high distribution losses (c) high O&M costs due to low grid utilization factor.

DDG based on diesel generator sets has been a solution for many decades and regrettably often the only source of access to economically disadvantaged communities, forming part of the 400 million households without electricity access.

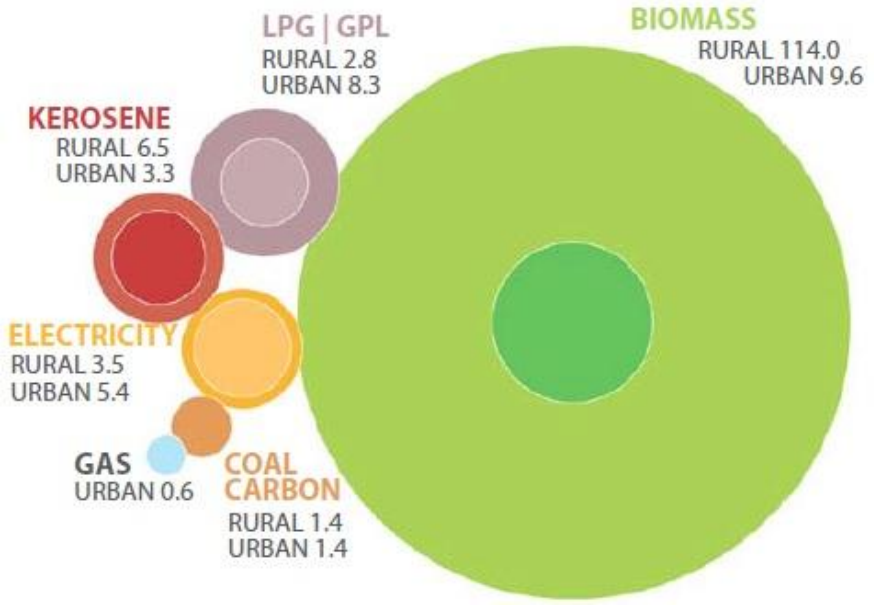
DDG based on RET's (Renewable Energy Technologies), has emerged as optimal techno-economic solution for enhancing electricity access. Many RET's, Solar PV, Biomass Gasification and Biogas Plants have proven business models, with potential for wide scale replication.

INDIA – BIO ECONOMY OVERVIEW

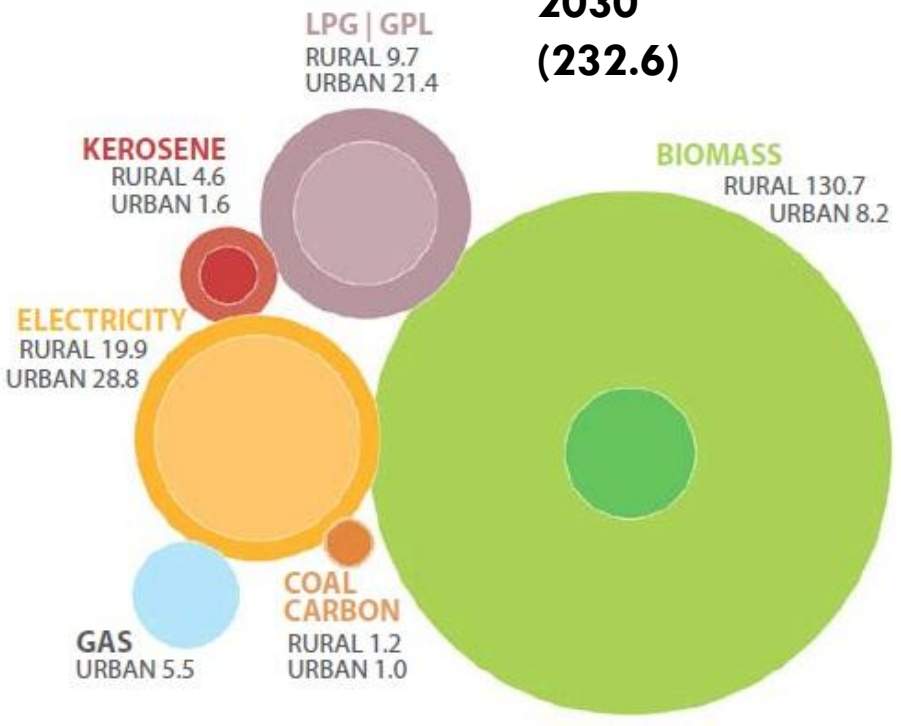
BIOMASS HAS VERY SIGNIFICANT CURRENT/FUTURE SHARE IN INDIAN HOUSEHOLDS ENERGY CONSUMPTION (mill TOE)

NEED TO ENHANCE EFFICENCY & OPTIMISE ENERGY YIELD

2005
(156.8)



2030
(232.6)



All H/H : Electricity : 8.9 -> 48.7; LPG/N.Gas : 11.7 to 36.6; Biomass : 123.6 -> 138.9

Rural H/H : Electricity : 3.5 -> 19.9; LPG/N.Gas : 2.8 to 9.7; Biomass : 114.0 -> 130.7

Bio energy, currently, contributes 23.5% of India's primary energy (750 mill TOE) .

Source: International Development Policy: Energy and Development, 2011
Data: IEA, World Energy Outlook 2007

BIO RESOURCES AVAILABILITY

- Sustainable Bio Resources, **linked to land & coastline** are summarized in chart below

SOURCE	AVAILABILITY (million hectares)	BIO RESOURCE	APPLICATIONS
Forests Land	70.0 overall 28.8 open forest	(a) Fast growing bamboo/tree species (under National Mission for Greener India) (b) Forest residues, lantana, etc., that can be sustainably harvested/collected	(i) Cooking/Heating fuel (ii) Feedstock for Boilers/Gasifiers (iii) Pyrolysis for Liquid BioFuels
Agriculture Land	141.0 nett cropped ≅ 200.0 gross cropped ≅ 55.0 lying fallow for 6 months.	(i) 120 million tons of Agro Processing units residues (bagasse, husk) …… (ii) 600 million tons of agricultural residues (iii) Short cycle leguminous/silage crops cultivated when land is fallow.	(i) Feedstock for Boilers/Gasifiers …….. (ii) Pyrolysis for Liquid BioFuels …… (iii) Feedstock for Bioethanol/Biogas Plants.
Grazing/Fallow Land	≅ 50.0 overall	(a) Non edible oil seeds (b) Algae with high lipid content …… (c) Appropriate species of bamboo/trees …… (d) Short cycle leguminous/silage crop (e) Algae which gives high Biomass yield	(i) Production of SVO/Bio diesel …….. (ii) Cooking fuel (iii) Feedstock for Gasifier/Boilers …….. (iv) Feedstock for Bioethanol/Biogas Plants. …… (v) Pyrolysis for Liquid BioFuels
Coastline	7517 km (including Islands)	(i)Algae with high lipid content or with high biomass yield. (ii) Sea Weeds	(i) Production of Biofuels through Bio Ethanol Refineries or Hydro treatment. ..... ii) Pyrolysis for Liquid BioFuels

Agriculture linked Bio waste processing

(Indian Agriculture*characterised by low farm yields – through sub-optimal farming of grains)*

Agricultural Crop	Gross Area (mill hectares)		Production (mill MT)	Yield (MT/ha)	
	Cultivated	Irrigated		India	China
Rice	43.5	22.4		4.1 (2 crops)	6.3
Wheat	26.6	23.5		2.6 (1 crop)	3.9
Other grains	29.4			1.8/1.9	
Pulses	22.4				
SUB TOTAL- FOOD GRAINS	***121.9***		***230-250***		
Oilseeds	27.7	6.5		1.0	3.0
Cotton	8.9	2.6			
Sugarcane	4.2	4.0			
Tea/Coffe	0.8				
SUB TOTAL- CASH CROPS	41.6		350-400		

- ***40% of land is under "1 season" mono cropping*** *: potential for sustainable cultivation of "short cycle" cellulosic biomass, as animal feed + make agri residues surplus (to be feedstock for bio energy projects). Yields improvement through adding compost (produced from processing manure/bio waste)*

Manure Treatment (anaerobic digestion) Systems

India has 283 million bovine animals, India, annually, produces 120 mill tons Milk → 200 mill tons (by 2020)

India has 500 million poultry birds, with high CAGR (eg Namakkal district)

(in lakhs)

Average strength of layer birds in Namakkal zone in the last 10 financial years

2000 - 01	171.18
2001 - 02	212.71
2002 - 03	225.42
2003 - 04	219.19
2004 - 05	234.49
2005 - 06	307.34
2006 - 07	339.79
2007 - 08	367.35
2008 - 09	398.62
2009 - 10	407.34
2010 - 11	447.19
2011 - 12	500*

*average strength after expansion

1250 million tons/year manure (18% DS)

10 million tons/year dry manure (75% DS)

To produce energy + assured quality compost (major/micro nutrients + humus)

Horticulture linked Bio waste processing

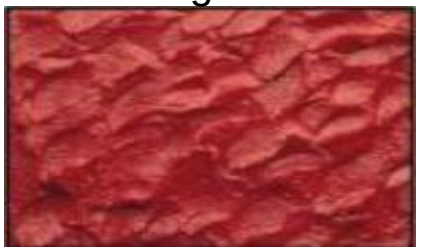
India's Horticulture output is 210 mill MT against NHM target of 350 mill MT → waste (30 to 40% of output, which can be processed to produce biogas + organic fertiliser)

China's vegetable output is 330 kg per capita (> 3 times Indian output & twice world average)

Cold Storage

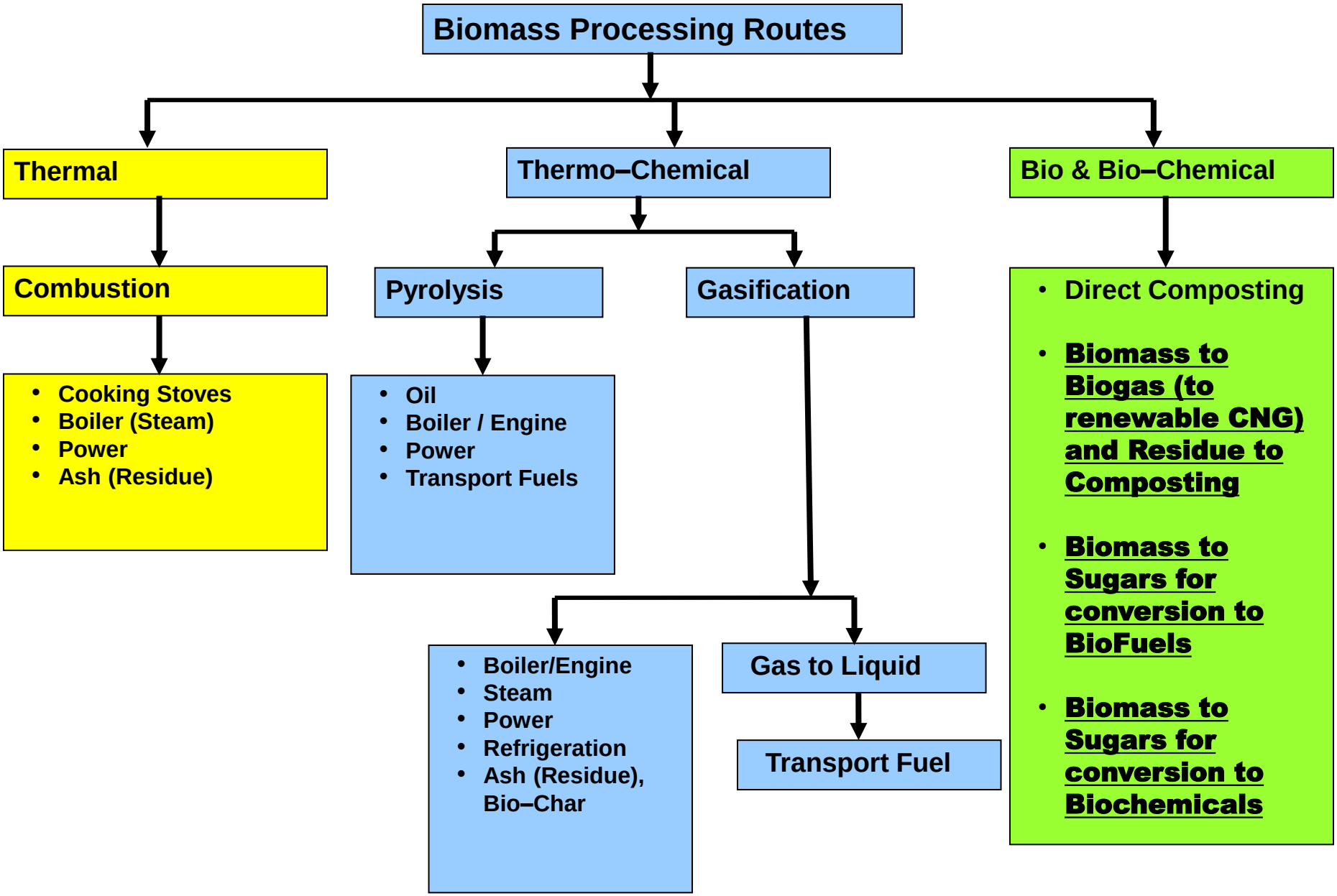
- **Indian farmers tend to cultivate grains (even with sub optimal returns, rather than vegetables) as they are not perishable.**
- **Food Processing/Preservation infrastructure would (a) stimulate non grain farming (b) enhance farmers income (c) meet nutrition needs of the community (d) open up significant opportunities for exports**
- ***CHP schemes, firing biogas, provide the energy component, which is a key deterrent for establishment of "Cold Chain"***
- ***Organic fertliser is well accepted in horticulture sector & will increase yield***

Cut Vegetables



Tomato Puree

Mango Pulp


Biomass Processing Routes
Thermal
Thermo–Chemical
Bio & Bio–Chemical
Combustion
Pyrolysis
Gasification
• Cooking Stoves
• Boiler (Steam)
• Power
• Ash (Residue)
• Oil
• Boiler / Engine
• Power
• Transport Fuels
• Boiler/Engine
• Steam
• Power
• Refrigeration
• Ash (Residue), Bio–Char
Gas to Liquid
Transport Fuel
• Direct Composting
• Biomass to Biogas (to renewable CNG) and Residue to Composting
• Biomass to Sugars for conversion to BioFuels
• Biomass to Sugars for conversion to Biochemicals

ECONOMICS OF BIOMASS TO BIOENERGY

- **Biomass cost needs to evaluated, not as Rs./MT (with variations in moisture & ash content) but as Rs./kg of "Dry organic matter", which will have a uniform Calorific Value of 4500 Kcal/Kg. Rs.4/Kg of dry organic matter would be realistic cost for biomass, benchmarked with landed cost of coal.**

- **Value realization from processing biomass to bioenergy would typically be**

Technology Option	Bioenergy/Kg Dry organic matter	Value realization
❖ Combustion (Steam Generation)		
a) Stand alone Power Plant	1.1 KWe	≅ Rs.6
b) Cogeneration Plant (with thermal energy ≅ 45% of total energy)	0.88 Kwe + 2.7 KWth	≅ Rs.7-8
❖ DDG (Biomass Gasifier)	1.1 Kwe	≅ Rs.7-8
❖ Combustion (Ind. Heating, replacing furnace oil)	4 KWth	≅ Rs.12
❖ 2nd Gen Bio Refinery	0.3 L Bio Ethanol + 0.7 Kg "pith"	≅ Rs.14-15
❖ Biomethanation (digestable organic matter ≅ 80% of dry organic matter)	0.25 Kg CBG +0.25 Kg Compost + 0.5 Kg CO2	≅ Rs.14-15

BIOENERGY – KEY SECTORS & POLICY INTERVENTIONS REQUIRED

 # PLANTATIONS & DEPOTS : National Mission for Greening India goals to be converted to specific PPP programmes, MoF & MoEF to facilitate funding mechanisms from NCEF & NABARD

 # COOKSTOVES : Registered PoA to made effective through Carbon price stabilisation mechanisms (NCEF, GCF, etc). Focus on mitigating health hazard

 # BIOWASTE PROCESSING : State Pollution Control Boards to mandate Bio waste processing to Compost & Energy. Capital subsidies for mitigating health/ environment hazard & displacing chemical fertilisers.

 # BIOFUELS & RENEWABLE CNG : MoP&NG to compute delivered cost of Petrol/ Regasified LNG/ LPG … this will justify 2nd Gen Biofuel price of Rs 40/litre & Biomethane price of Rs 50/Kg.

 # DDG : CERC/ FOR to compute delivered cost of electricity, 6 to 11 pm, to "rural" households with "peak power" purchase cost … this will justify tariff of Rs 8-9/KWh