Biomass Energy Strategies for Aligning Development and Climate Goals in India

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Rural Development and the Role of Food, Water and Biomass:
Opportunities for Development and Climate
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Presentation Agenda

Biomass Energy in India: History and Status

- *Traditional Biomass Energy*
- *Biomass Energy Policies, Programs and Technologies*

Biomass: Key Development and Climate Issues

- *Food vs. Fuel Security (Competing needs of Land & Water)*
- *Rural Energy Dynamics: Barriers, Access & Solutions*
- *Removing Barriers: Rural Development, Employment and Co-benefits*
- *Biomass, National Development Goals and Climate*

Integrating Climate Change & Economic Sustainable Development

- *Mainstreaming Climate Change in Development Choices*
- *Combining Mitigation and Adaptation Policies*

Biomass Strategies for Aligning Development and Climate Goals

- *Transition to Modern Bio-fuels*
- *Bio-fuels in Future Energy and Climate Scenarios*
- *Bio-energy: The Future Strategies*

Conclusions

Biomass Energy in India: History and Status

- *Traditional Biomass Energy*
- *Biomass Energy Policies, Programs and Technologies*

Traditional Biomass in Energy in Asian Countries

Country	Biomass in Total Energy (%)		Wood in Total Energy (%)		Biomass Share in Domestic Energy (%)	
	1992	2002	1992	2002	1992	2002
Bangladesh	73	61	13	10	89	74
Bhutan	82	74	72	66	95	86
Cambodia	86	75	83	72	98	
China	10	5			25	11
India	33	26	17	14	78	62
Indonesia	39	28	31	23	73	66
Laos	88	79	81	73	97	89
Malaysia	7	6	4	3	15	9
Maldives					84	71
Myanmar	74	60	38	29	81	69
Nepal	92	81	68	65	97	88
Pakistan	47	28	27	18	83	
Philippines	44	31	26	20	66	56
Sri Lanka	77	54			93	76
Thailand	26	17	9	6	65	45
Vietnam	50	38			84	73

Traditional Biomass Consumption in India

Biomass Consumption (2004)

Fuel	Million Ton
1. Fuel-wood	**205**
2. Crop-residue	**116**
3. Dry Dung	**35**

Fuel-wood Consumption by Sectors (2004)

Sector/ End-use	Million Tons
1. Household	
(a) Forested Rural	83
(b) Non Forested Rural	65
(c) Urban Areas	17
Sub Total	**165**
2. Cottage Industry	**22**
3. Rituals	**4**
4. Restaurants etc.	**14**
Total	**205**

Traditional Biomass: Market?

Percent Share of Biomass Collected versus Purchased in India for Household use

Energy Forms	Rural			Urban		
	Purchased	Collected	Home Grown	Purchased	Collected	Home Grown
Firewood	18.4 %	54.1 %	27.5 %	78.2 %	11.2 %	10.6 %
Dry Dung	12.6 %	22.2%	65.2 %	58.6 %	8.1 %	33.3 %
Crop-residue	12.9 %	52.3 %	34.8 %	77.4 %	22.6 %	0.00 %

Valuation of Traditional Biomass

Time spent per day for collection of Fire-wood by rural household:

Average: 1.46 hours
Range: 0.22 – 4.8 hours

Fire-wood collected Per day:

Average: 4.15 Kilograms

<u>Value of Fire-wood collected per day</u>

Average Opportunity Cost of Labor:

Cost of Collection by Unemployed labor = Rs. 0

Cost of Collection by Employed labor = Rs. 10.95
(@ guaranteed wage Rs. 7.5/hour)

Fuel Substitution (Kerosene Replacement Value)

Value to Household (with subsidy) = Rs. 4.65

Economic Value (without subsidy) = Rs. 9.24

Kerosene Replacement Value of Traditional Biomass (2004)

Fuel	Billion Rs. (Bill$ Equiv.)	% GDP
1. Fuel-wood	138 (3.08)	0.45%
2. Crop-residue	63 (1.39)	0.20%
3. Dry Dung	18 (0.41)	0.06%
Total	319 (4.88)	0.71%

Biomass Fuels substitute nearly a quarter of the oil import

Biomass Energy Policies & Programs in India

Manifestations of Rural Energy Crisis (1970's)

- Population, Land Pressure, International Oil Crisis
- Kerosene Subsidy
- Rural unemployment, affordability
- Oil Imports and Balance of Payment

Rural Energy & Biomass Policies (1980's and early 90's)

- Energy agencies in states and DNES at center
- Improved Cook-stove and Biogas Programs
- Interfaces with Joint Forestry Programs
- Energy agencies in states and DNES at center (later MNES)
- Integrated and community based village energy programs (not very successful)

Biomass Policies (Mid-1990's): Decentralized Technology Push

- Biomass Gasifiers (pumping and power)
- Cogeneration in Sugar Mills (steam and power)

Biomass Policies (Recent): Diversified Fuels and Integrated Technologies

- Liquid Biomass Fuels (Ethanol and Bio-Diesel)
- Grid Connected Power
- CDM Projects

Biomass: Key Development and Climate Issues

- *Food vs. Fuel Security (Competing needs of Land & Water)*
- *Rural Energy Dynamics: Barriers, Access and Solutions*
- *Removing Barriers: Rural Development, Employment and Co-benefits*
- *Biomass, National Development Goals and Climate*

Food–Water–Energy–Environment Nexus: Micro & Macro Issues

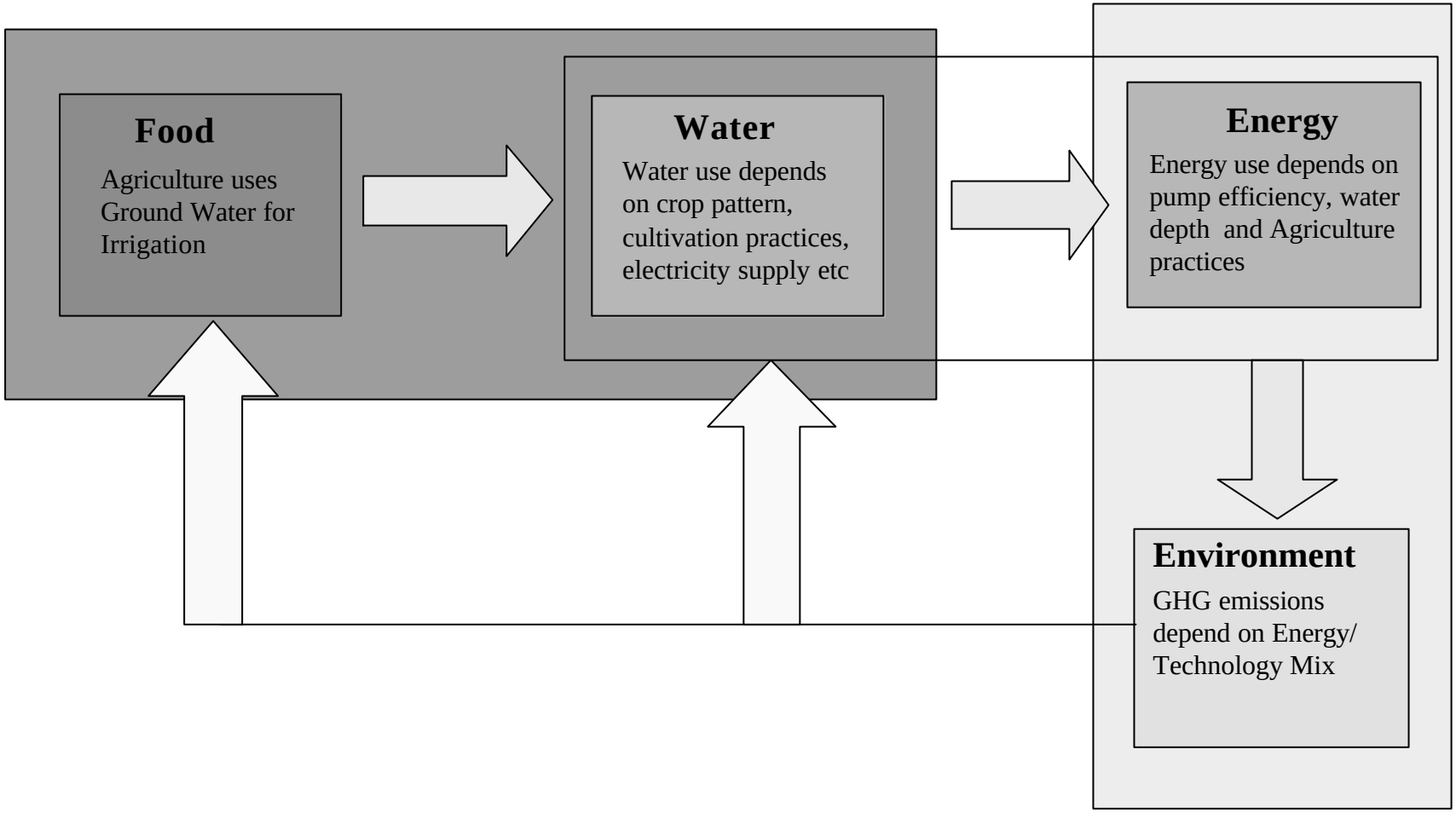
Micro-Level (Household/ Farm/ Local)

- Ground water irrigation & electricity tariffs
- Micro-Watershed Management
- Farmer level crop-mix decisions
- Degradation of local wood lots
- Household labor time for collection of fire-wood and water

Macro Level (Economy, Region)

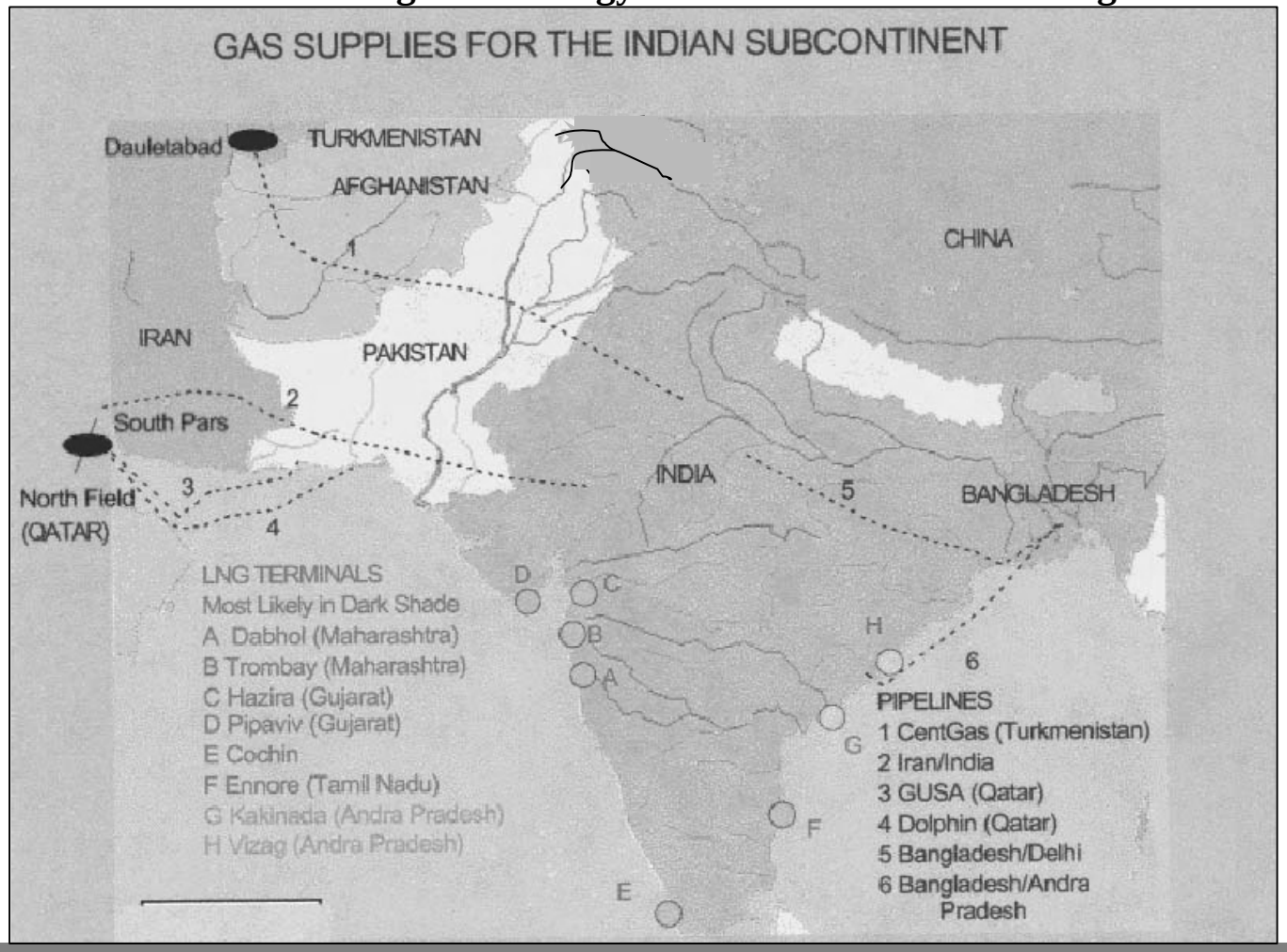
- Food and Energy Security
- Development of Regional Energy Market
- Stability of Price Energy Supply and Prices
- Affordability and Access to Energy and Water
- Pricing of energy and water resources
- Rational Management of Regional River Systems
- Land competition/ sustainability
- Environment standards/ taxes

Food–Water–Energy–Environment: Micro Nexus



Food–Water–Energy–Environment: Macro Nexus in South-Asia

South-Asia Regional Energy Markets and River Linking



Integrating Climate Change & Economic Sustainable Development

- *Mainstreaming Climate Change in Development Choices*
- *Combining Mitigation and Adaptation Policies*

Development and Climate: Mainstreaming

Climate policies and actions to be driven by

- *national development targets*
- *agreed goals under extant international agreements*

Expanding development and climate frontier though:

- *Innovations (technology, institutions)*
- *regional cooperation*
- *targeted technology and investment flows*
- *aligning stakeholder interests*
- *focusing on inputs rather than outputs (conduct vs.results)*

MDG, India's National Targets, Biomass and Climate Change

MDG and global targets	India's National plan targets	Interface with Climate Change
Goal 1: Eradicate extreme poverty and hunger Targets: Halve, between 1990 and 2015, the proportion of people with income below $1 a day and those who suffer from hunger	Double the per capita income by 2012 Reduce poverty ratio by 15% by 2012 Contain population growth to 16.2% between 2001-2011	Bio-energy can enhance rural income, substitute oil imports and enhance mitigative & adaptive capacity Lower population reduces pressure on land, water and energy consumption
Goal 7: Ensure environmental sustainability Targets: Integrate SD principles in country policies/ programs to reverse loss of environmental resources Target: Halve by 2015 the proportion of people without sustainable access to safe drinking water	Increase in forest cover to 25% by 2007 and 33% by 2012 (from 23% in 2001) Sustained access to potable drinking water to all villages by 2007 Electrify 80,000 additional villages by 2012 via decentralized sources Cleaning of all major polluted rivers by 2007 and other notified stretches by 2012	Enhanced sink capacity; energy security due to substitution of fossil imports; reduced pressure on land, resources and ecosystems Better quality of life and adaptive capacity due to access to electricity, enhanced supply of clean water, health & education in rural areas

Development: Combining Mitigation and Adaptation Policies

"Since the goals of sustainable national development are favorable to the issue of climate change, the achievement of these goals would accrue a double dividend in terms of added climate change benefits. The cascading effects of sustainable development would reduce emissions and moderate the adverse impacts of climate change, and thereby alleviate the resulting loss in welfare"

…. India's Initial NATCOM to UNFCCC

Biomass Strategies for Aligning Development and Climate Goals

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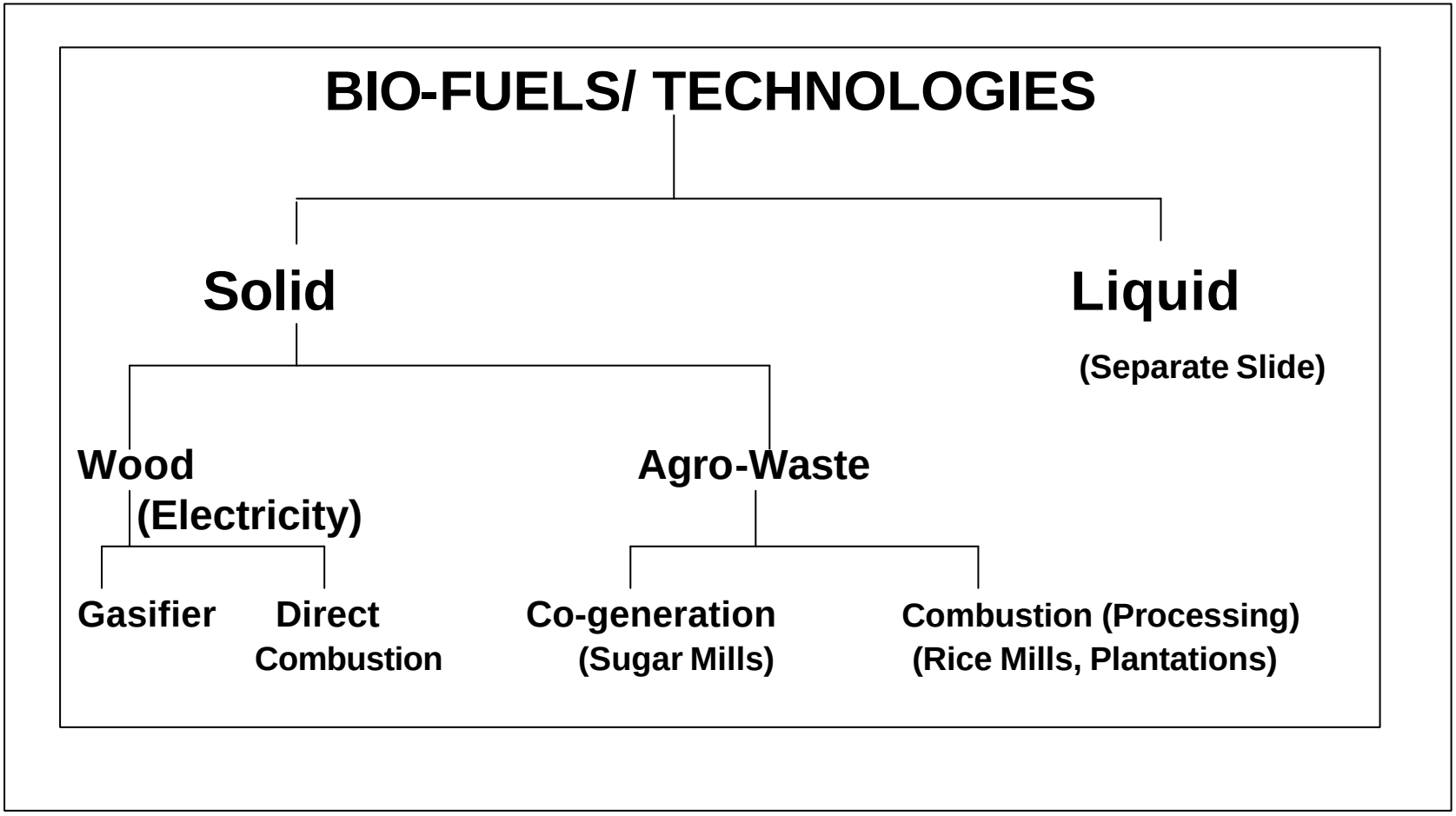
Modern Biomass Fuels and Technologies

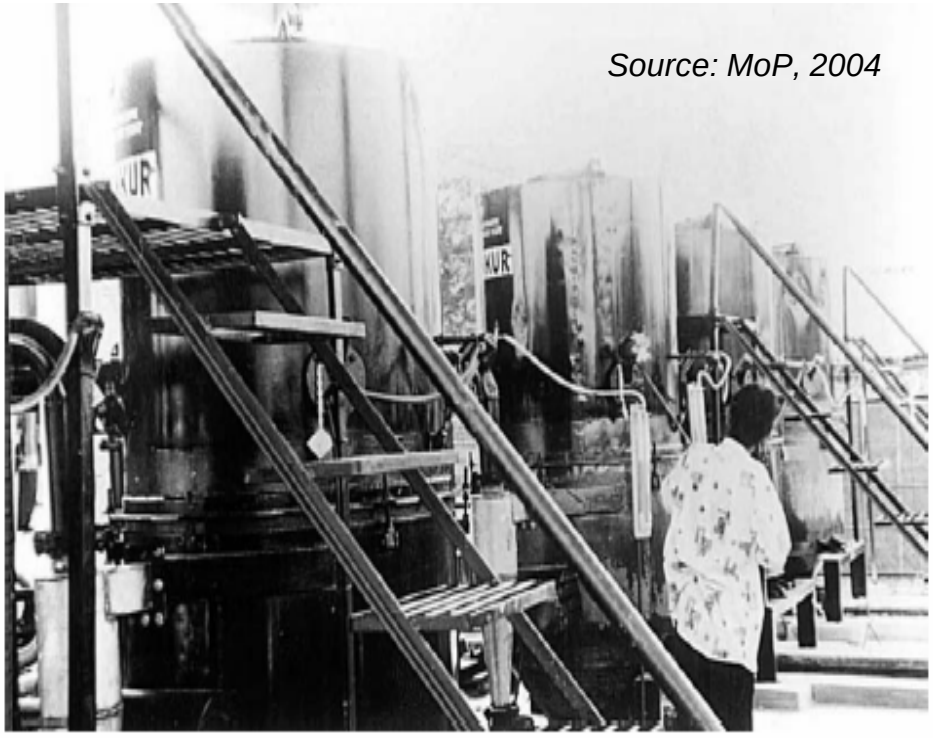


Biomass Gasifier

- **Niche & Decentralized Applications**
- **MW Size Equipments**
- **Technology R&D and Manufacturing in India**
- **Economics and supply-chain not yet favorable**

Gosaba Island, Sunderbans

- **500 kW, 5 x 100 kW AG series Gasifiers**
- **Supplying 800 households**
- **Managed by Rural Energy Co-operative**
- **No Disruption till date**



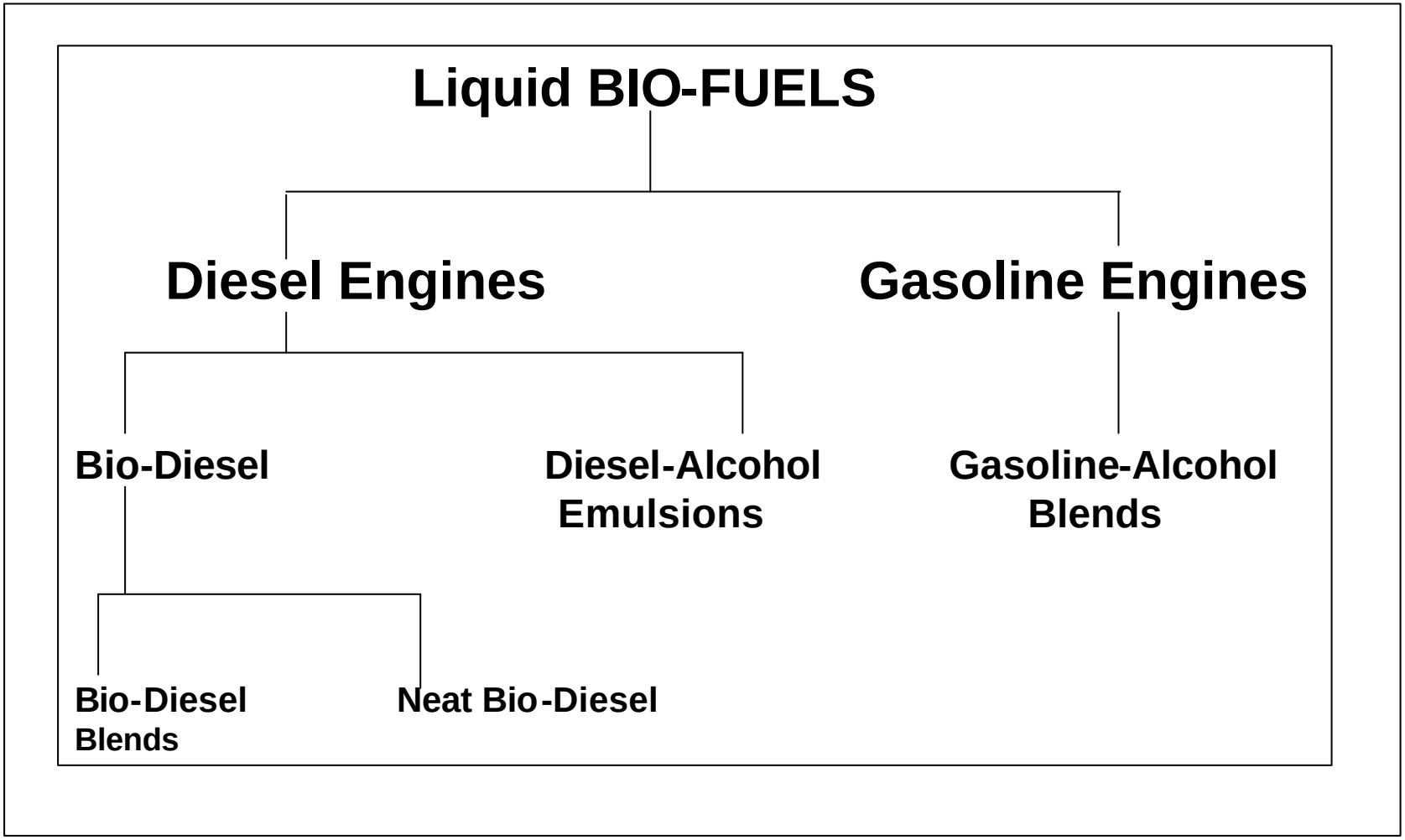
Source: MoP, 2004

Bagasse Based Power Generation

- **Installed Capacity: 632 MW (March 2005)**
- **50 MW Size Projects**
- **Introduction of High Pressure Technologies in some Sugar Mills**
- **CDM Projects**

Source: MoP, 2004

Modern Biomass Fuels and Technologies



Indian Experiences with Ethanol

- India Imports 70% of oil demand - annual 120 Million ton in 2004
- Subsidized petroleum products
- Ethanol introduced as a Gasoline Mix (5-10 %) in 1980's
- Mandatory use of 5 % blend in 9 states in 2001-2
- Large number of experimental studies
- Scientific studies conducted with auto industry
- Blend increased to 10%
- Crisis of Ethanol Supply in 2004
- Price of Ethanol?
- Relaxation of blending - down to 5%

Bio-Diesel: Energy vs. Food Security

Energy Security

- *High oil imports contributes to balance of payment/ trade deficit*
- *Oil subsidies is a major contributor to budget deficit*
- *Rising oil demand @ 6% annual growth rate*

Food Security:

- *2.4% of Global area; 16% of population & 17% of cattle*
- *India is amongst the largest importers of edible oil*
- *Where do we find the oil for bio-diesel?*
- *Sustainable source of vegetable oil is to be found before we can think of bio-diesel*

Bio-Diesel: Development and Climate

Development

- *Bio-diesel production in wasteland may help land restoration*
- *High rural employment potential in seed production and oil extraction*
- *Energy security and improved balance of payment would enhance investments due to reduced risks*

Climate:

- *Sustainable seed production can mitigate carbon emissions in oil substitution*
- *Rural Income can enhance adaptive capacities*

Preferred Material of Choice: JATROPHA?

Jatropha (Jatropha curcas, Ratanjyot, wild castor) thrives on any type of soil

- *Needs minimal inputs or management; Propagation is easy*
- *Has no insect, pests & not browsed by cattle or sheep*
- *Can survive long periods of drought*
- *Yield from 3rd year onwards, continues for 25-30 years*
- *25% oil from seeds by expelling, 30% by solvent extraction*
- *The meal after extraction an excellent organic manure*

Waste or degraded land in India are estimated at 65 million hectares

Jatropha Plantation in India

Jatropha plant

Jatropha plantation on reclaimed desert using sewage waste water in Middle East

Indian Mission on Bio-diesel

Phase I (2003-07):Demonstration Projects

- *Plantation on 400,000 hectares of land*
- *Seed Collection*
- *Oil Extraction*
- *Transesterification*
- *Blending*
- *Marketing*

Phase II (2007-2012)

- *Self Sustaining Expansion of Biodiesel*
- *One hectare plantation likely to produce 3.75 MT of seed, yielding 1.2 MT of oil*

Employment & Income Estimates

- **Estimated diesel demand in 2007: 52.33 MT**
- **5% blend would require 2.62 MT Bio-diesel**
- **Plan for 2.2 million Ha area to be brought under Jatropha plantation by 2007**
- **Additional Employment opportunities for 2.4 million**
- **Employment opportunities to rise to 12 million by 11th plan (2012) for 20% bio-diesel blend**
- **Seed yield of 4 MT / Ha, gives farm income of Rs. 20,000 per Ha per year from waste lands with minimum support price of Rs. 5 per kg of seeds.**
- **Secondary employment in oil extraction plants**

Bio-diesel vs. Diesel Emissions

B100: Pure bio-diesel
B20: Mixed bio-diesel (20% bio-diesel and 80% petroleum diesel)

Emissions	B100	B20
Regulated Emissions		
Total Unburned Hydrocarbons	-93%	-30%
Carbon Monoxide	-50%	-20%
Particulate Matter	-30%	-22%
NO_x	+13%	+2%
Non Regulated Emissions		
Sulphates	-100%	-20%
Polycyclic Aromatic Hydrocarbons (PAH)	-80%	-13%
NPAH (Nitrated PAHs)	-90%	-50%
Ozone Potential of HC	-50%	-10%
Life Cycle Emissions		
Carbon Dioxide	-80%	
Sulphur Dioxide	-100%	

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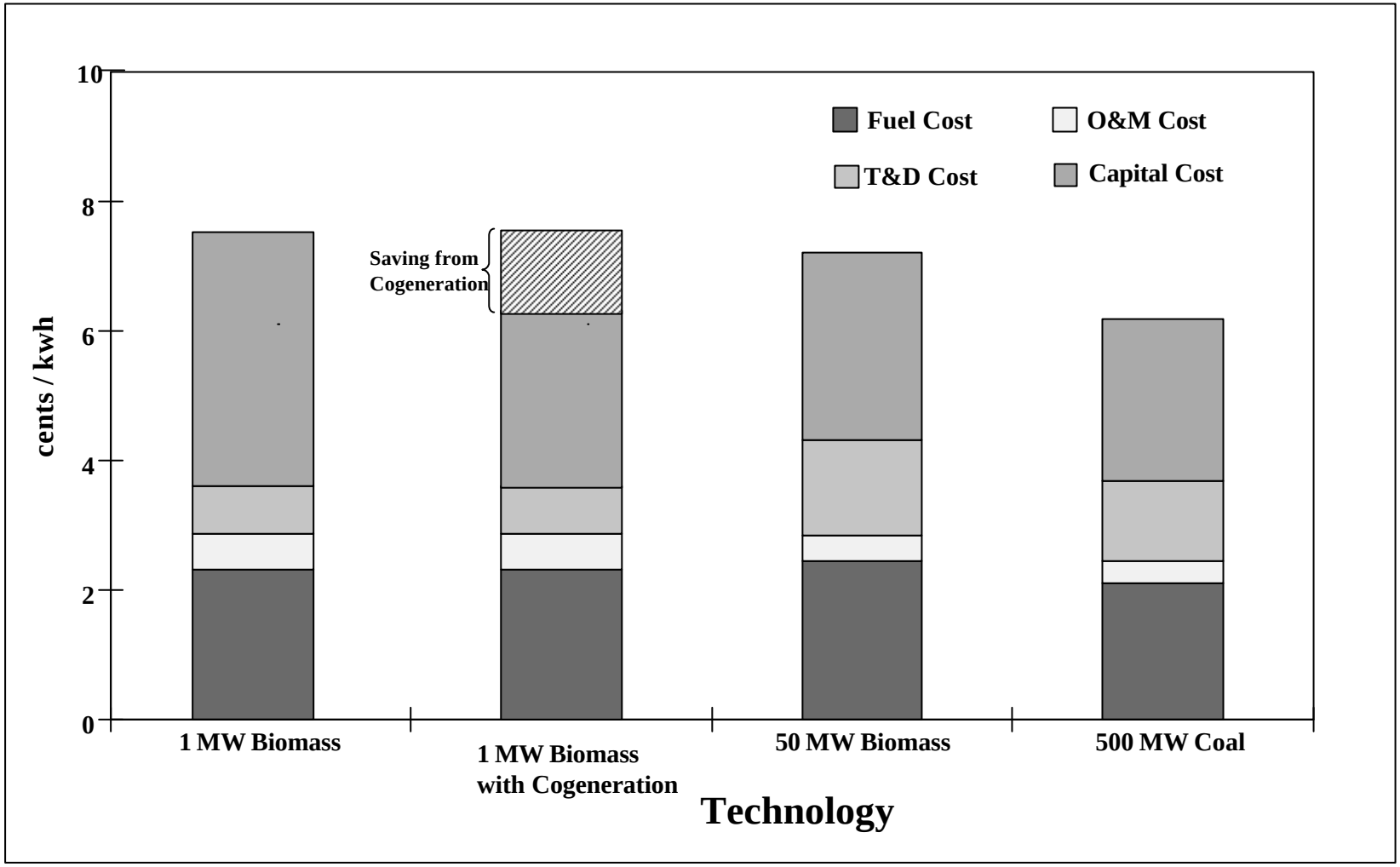
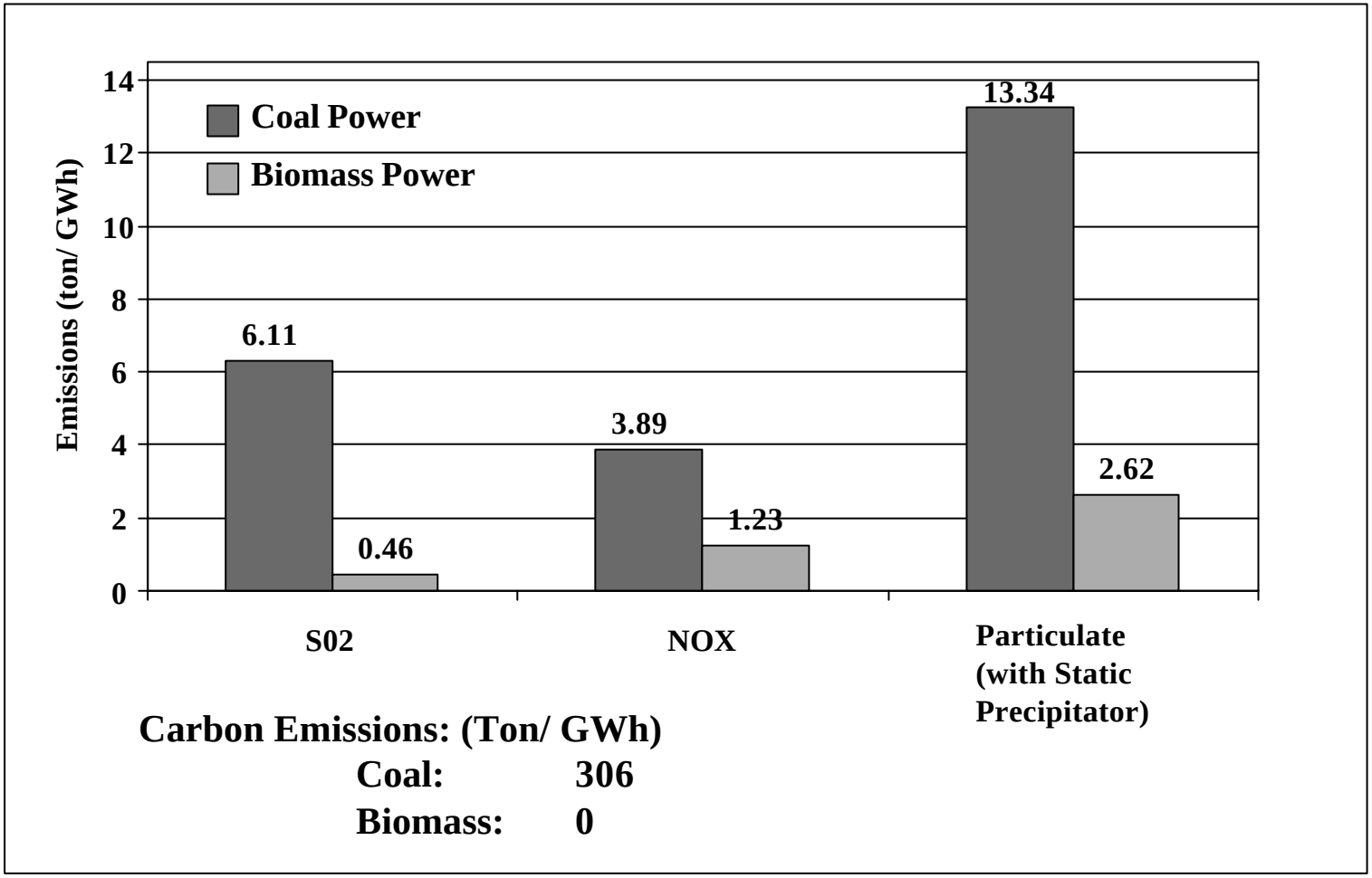
Cost of Delivered Electricity Cost



Ancillary Benefits of Biomass

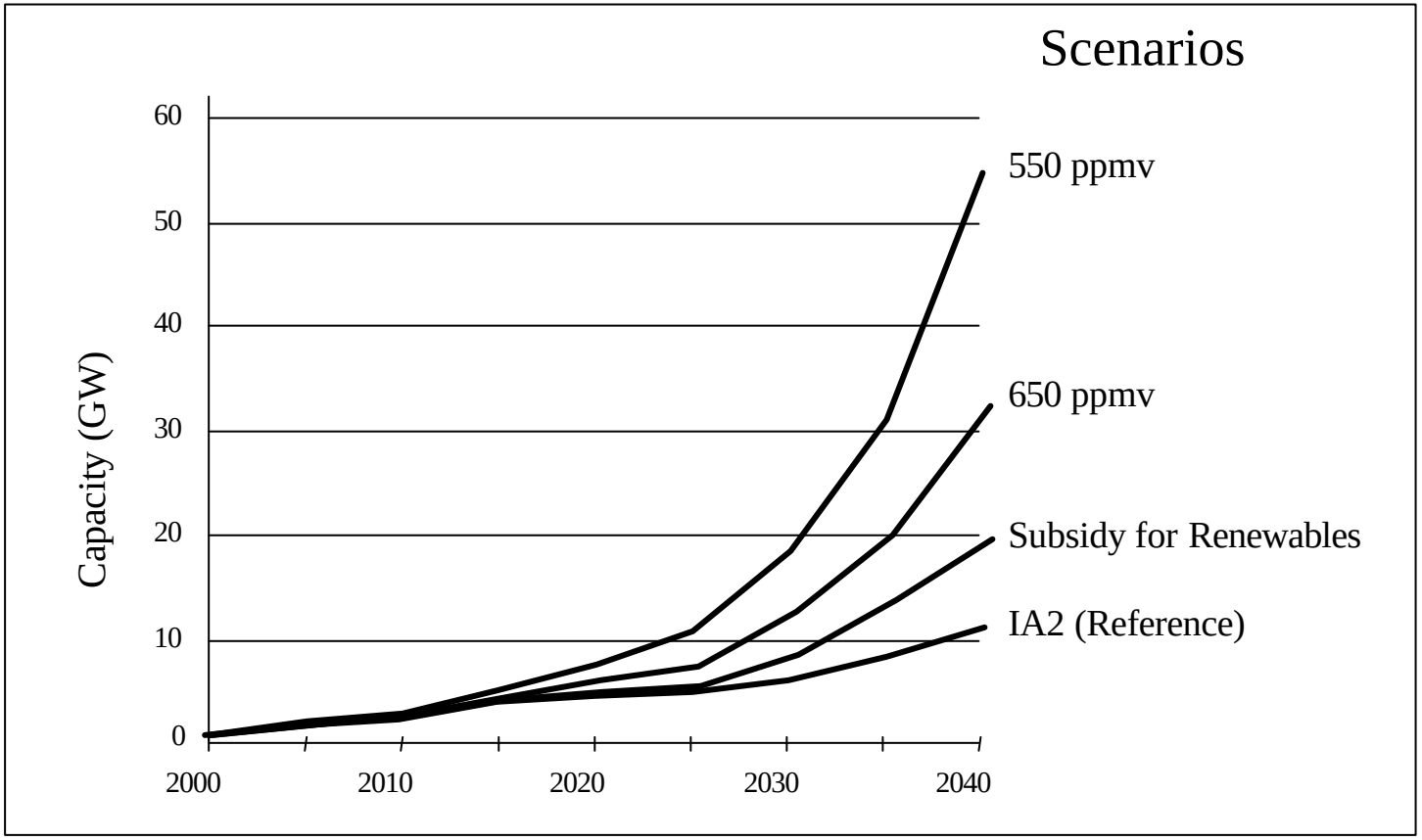


Carbon Emissions: (Ton/ GWh)

Coal:	**306**
Biomass:	**0**

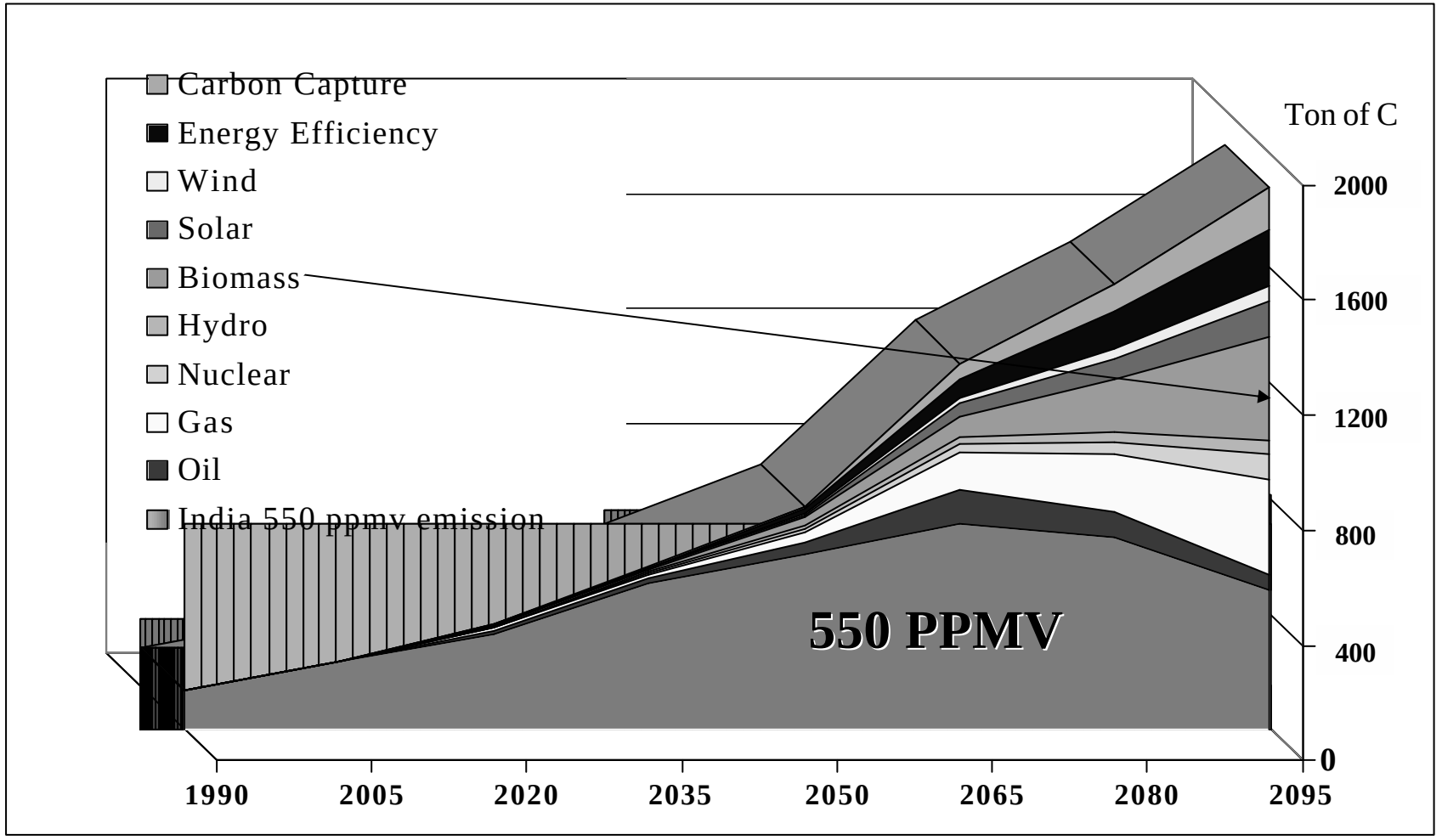
Biomass Electricity: Impact of Climate Policies

AIM + ANSWER-MARKAL Models



GHG Mitigation Options for India:

550ppmv Stabilization Regime



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Biomass: The Future Strategies

Short-term (1 to 5 years)

1) *enhanced utilization of crop residues and wood waste*
2) *information dissemination*
3) *niche applications (e.g. remote and biomass rich locations)*
4) *technology transfer (e.g. high pressure boiler)*
5) *co-ordination among institutions*
6) *demonstration projects*
7) *participation of private sector, community and NGOs*
8) *waste land development*
9) *subsidy to biomass technologies to balance the implicit subsidies to fossil fuels*

Biomass: The Future Strategies

Medium Term (5 to 20 years)

1) *R&D of conversion technologies*
2) *Species research to Match agro-climatic conditions*
3) *Biomass Plantation*
4) *Scale economy based technologies*
5) *Local Institutional Developments*
6) *Remove distortions in fossil energy tariffs*

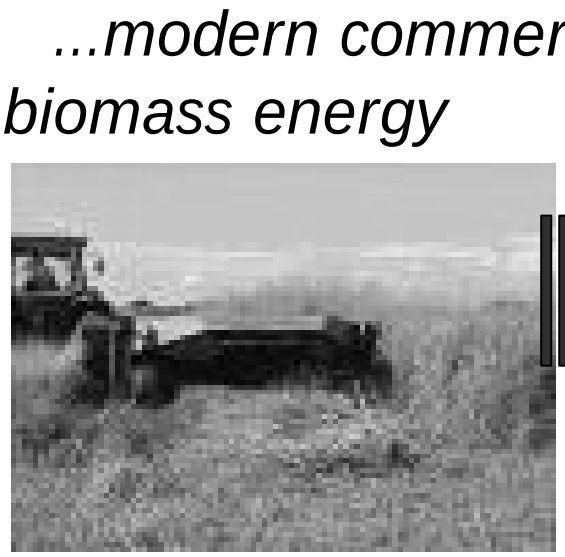
Biomass: The Future Strategies

Long term (over 20 years)

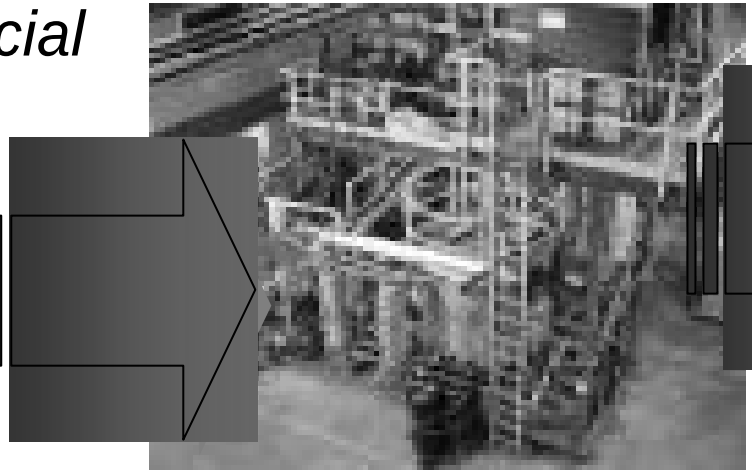
1) *Infrastructure (logistics, T&D)*
2) *Land supply for biomass generation*
3) *Multiple biomass energy products (e.g. gas, liquid, electricity)*
4) *Institutions and policies for competitive biomass energy service market*
5) *Advanced Biomass R&D – Bio-hydrogen, GM Crops, Nano-Bio Technologies*
6) *Integrated Bio-energy System – from farm to service*

Biotechnology

...modern commercial biomass energy



e.g. Switchgrass



Bio-refining

Bio
Fuels
Gas
Solids

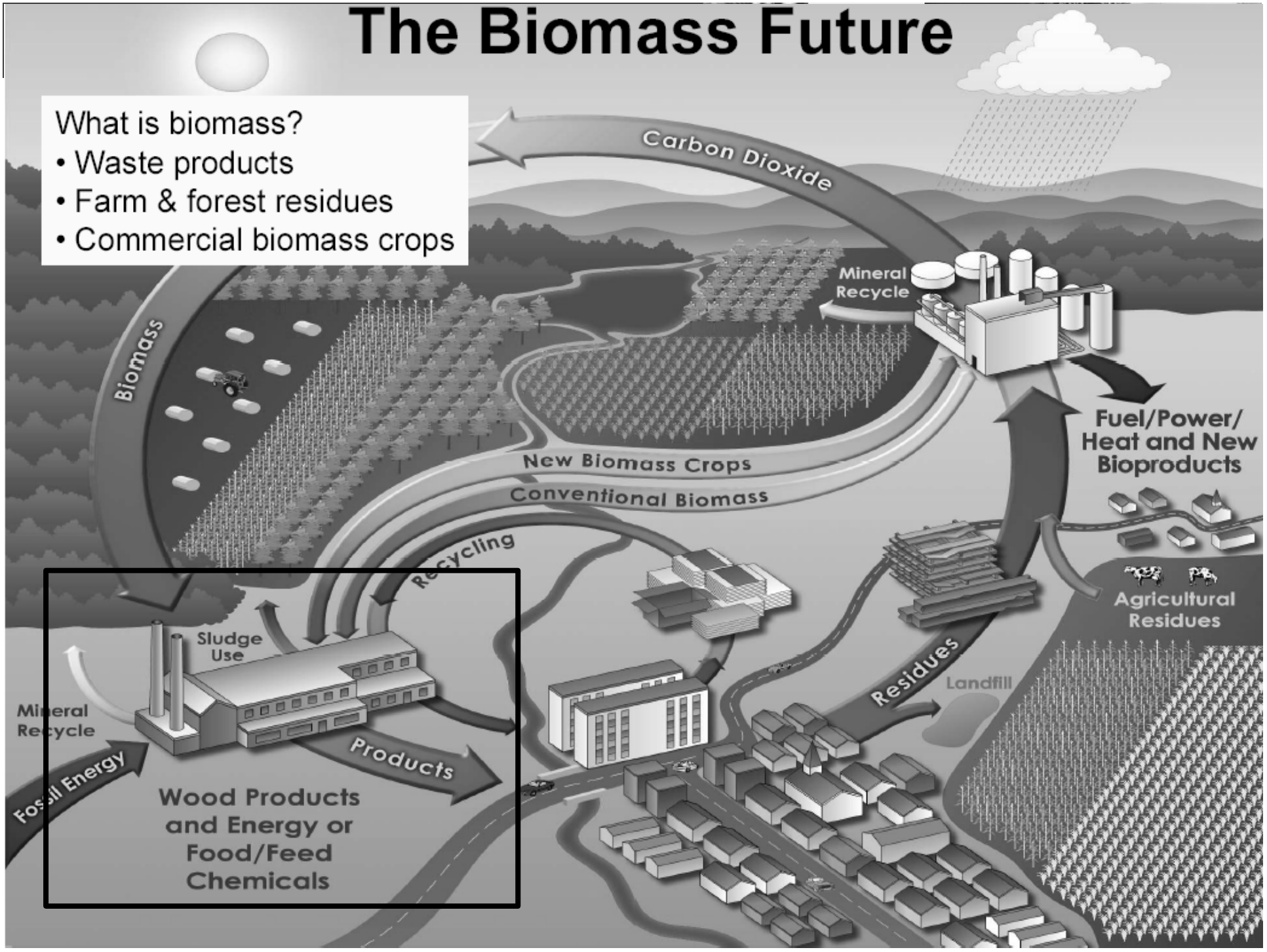
...bio-hydrogen

Biomass-Energy Crops

Hybrid Poplar

Switch Grass

The Biomass Future



Conclusions

- **Biomass is a key link between Energy, Local Environment, Climate Change**
- **Transition to modern biomass can deliver development & climate co-benefits**
- **In Developing Counties, Rural Employment is key to transition to modern biomass**
- **Rising productivity is vital to reducing pressure on land and resolving food vs. energy security conflict**
- **Mainstreaming climate in development would accrue multiple dividends**
- **The key biomass strategies in India are:**
  - ***Short-Term:*** *Removing barriers, Decentralized access, Niche Applications, Subsidy support*
  - ***Medium-Term:*** *Plantations, Scale economy, Energy tariff reforms, R&D for Conversion Technologies*
  - ***Long-Term:*** *Infrastructure, Land supply, Multiple biomass products, Advanced Biomass R&D, Integrated Bio-energy System from farm to service*