Biomass – Availability and Applications

DSM India Innovation Centre

Internal

HEALTH · NUTRITION · MATERIALS

Agenda

- Biomass Availability in India
- Biomass Value Chain
- Biomass Energy Conversion Overview
- Biomass Energy Focus : Biogas and Biofuels
- Biochemical's and End Application
- Succinic Acid Example : Use in Varied Industries
- Ongoing R&D Commercial Activities: India

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LARGE AVAILABILITY of BIO ENERGY RESOURCES IN INDIA

India has 184 million hectares of arable land

1.5 billion MT/year of food + agri residues is produced

40 % of arable land is under 1 season mono cropping

India has 58 million hectares of grazing land.

Large scope for Short Cycle Cellulosic Biomass

India has 280 million bovine animals & 500 million chicken

1.5 billion MT/year of Cow dung & Poultry litter

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Present Availability and Surplus Biomass and Projection for 2015 – Crop and Agri Residues are the biggest Source

In MT

Biomass wastes sources	Present Availability Status	Present Surplus	Availability Projections (2015)	Projected Surplus (2015)
Crop and Agro-processing waste	523.4	127.3	680.5	226.0
Roadside*	10.7	6.4	17.3	10.4
Wasteland*	27.1	16.3	40.9	24.5
Forest waste*	157.2	94.3	196.8	118.1
Agro-forestry waste*	9.1	5.4	9.2	5.5
Dung -livestock	267.8	-	266.3	-
Poultry droppings	4.9	-	6.9	-
Total	1000.1	249.7	1217.9	384.5

Source: Secondary Search, Biomass Asia Workshop

* *Only 60% of the surplus quantity of the biomass is assumed to beavailable for energy generation.

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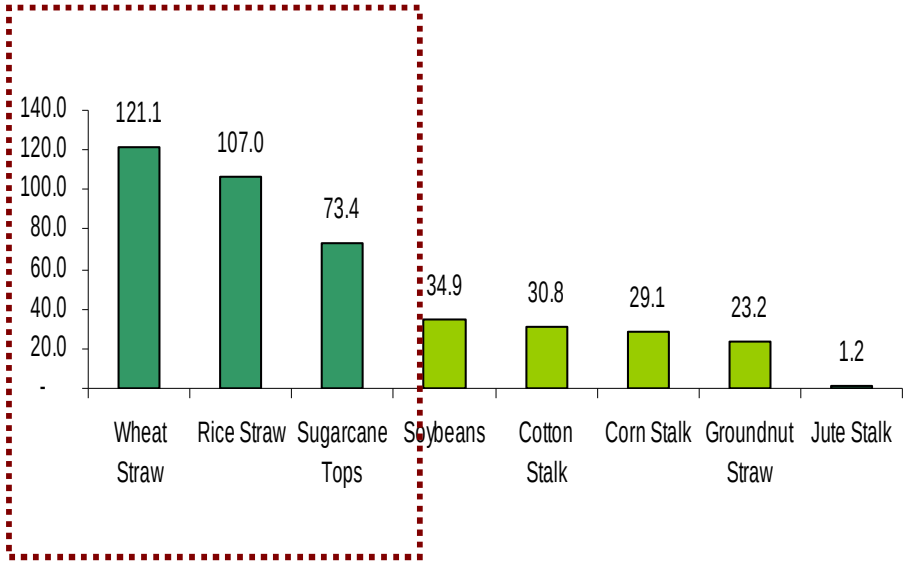
Wheat Straw, Rice Straw, Sugarcane Tops, Bagasse and Rice Husk – Key Biomass Agri Residues

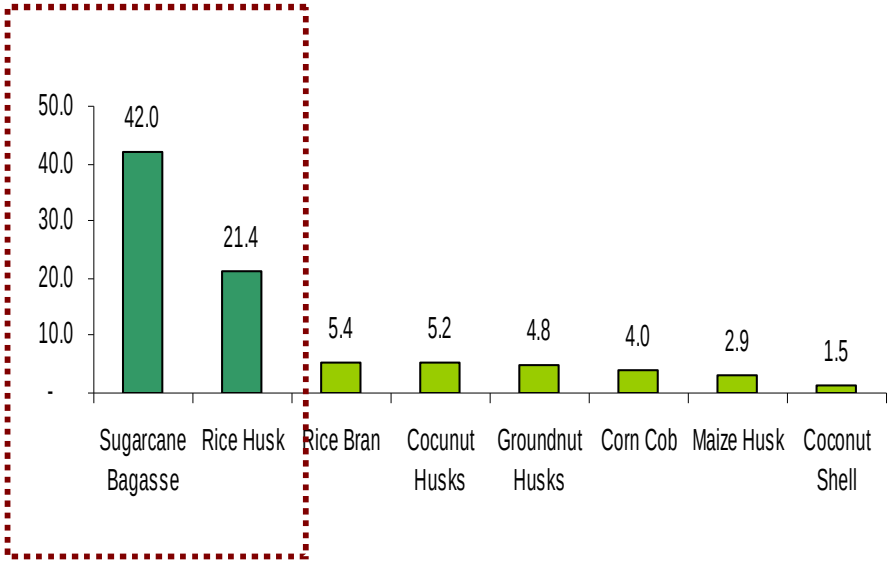
Field Crop Residues for FY10

Mln Tons



Processing Crop Residues for FY10

Mln Tons



* Source: Universal Consulting

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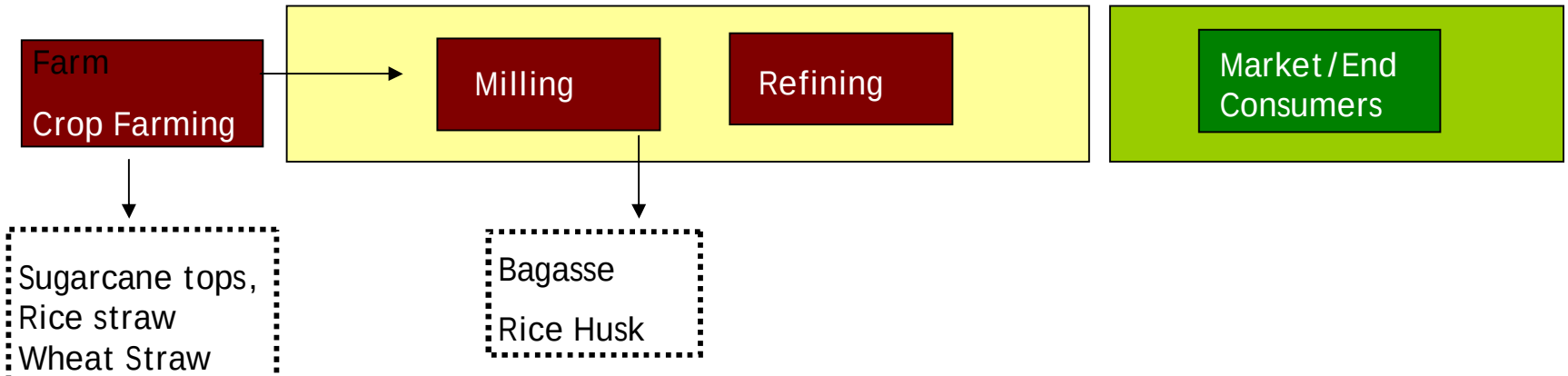
Alternative Uses of Key Biomass – Wheat, Sugar and Paddy



1 ton of wheat =
1.5 tons of wheat straw

1 ton of rice/paddy =
1.2 tons of rice straw +
0.24 tons of rice husk

1 ton of sugarcane =
0.28 tons of sugar tops +
0.3 tons of bagasse

Crop	By Product	Uses
Wheat	Straw	As Animal Feed, for Soil enrichment in biogas plants, paper & pulp production for making boards
Paddy	Straw and Husks	Straw as animal feed, husks in gasifiers for electricity
Sugarcane	Tops, Trash and Bagasse	Tops for feeding to animals, trash for burning in gasifier, bagasse for use in sugar mills for generation of electricity

* Source: Secondary Research

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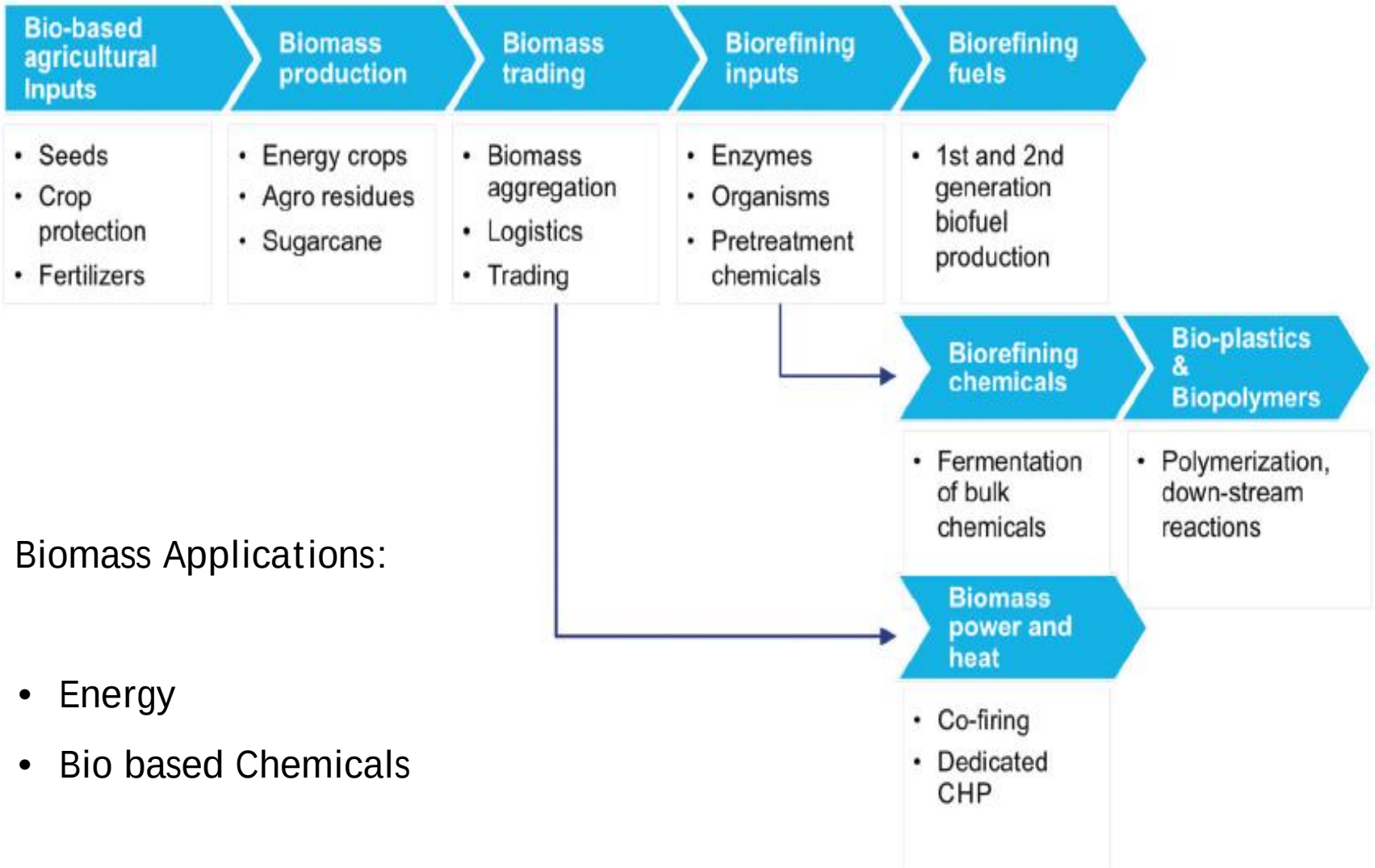
Biomass Value Chain



Biomass Applications:

- Energy
- Bio based Chemicals

* Source: Secondary Research

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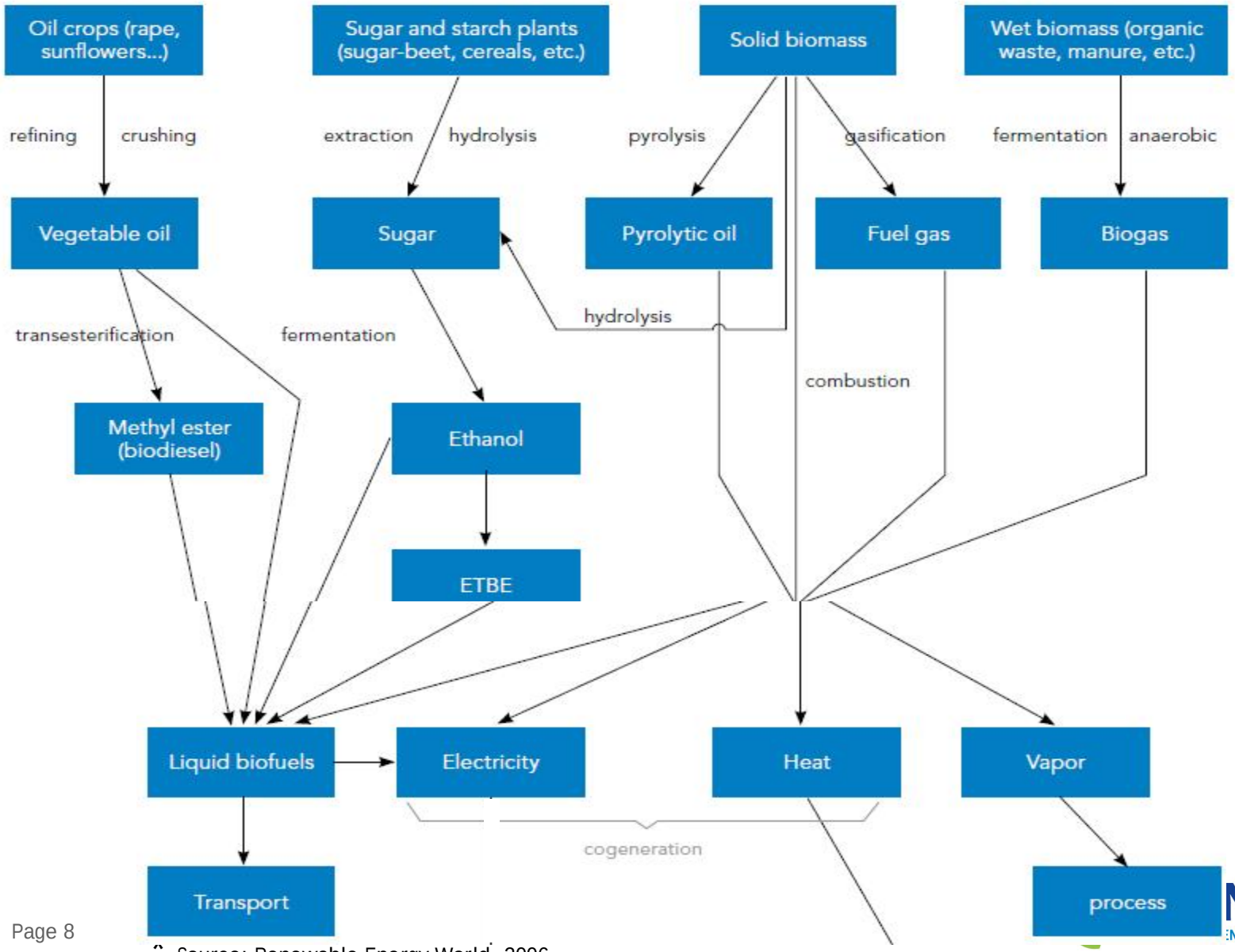
Biomass Application – Energy

Biomass Energy Conversion Overview



Source: Renewable Energy World, 2006.

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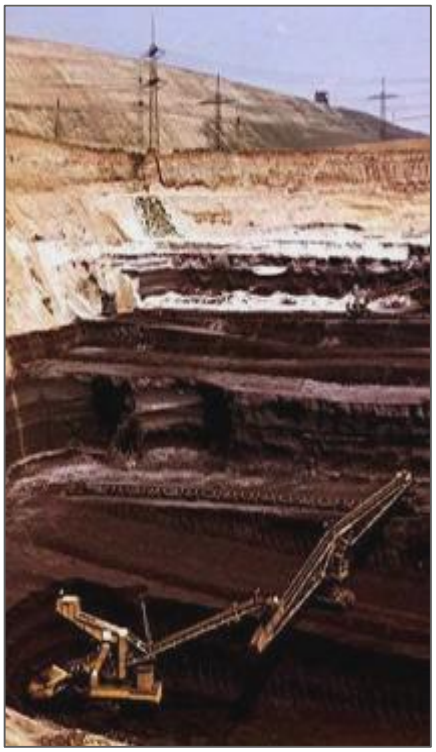
Focus Areas Biofuels and Biogas

Where did it start and where are we heading?



Coal Oil Biomass

Non-renewable → Renewable

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Need for new and sustainable energy resources

First generation

Ligno-cellulosic

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DSM frontrunner in Ligno-cellulosic biofuel tech

- DSM's yeast and enzyme technologies is unique combination
- New robust enzymes-mix able to break down biomass more efficiently
- Advanced yeast strain capable of converting C5/C6 sugars into bio-ethanol
- DSM engaged with Ligno-cellulosic bio-ethanol front-runners and on-track for commercial demonstration facilities to start up in 2014

- UBS estimates 2G: 40bn gallon market by 2020
- Enzymes / Yeasts ~ 20% of costs
- NREL recently increased their enzyme cost outlook to $0.34 / gallon

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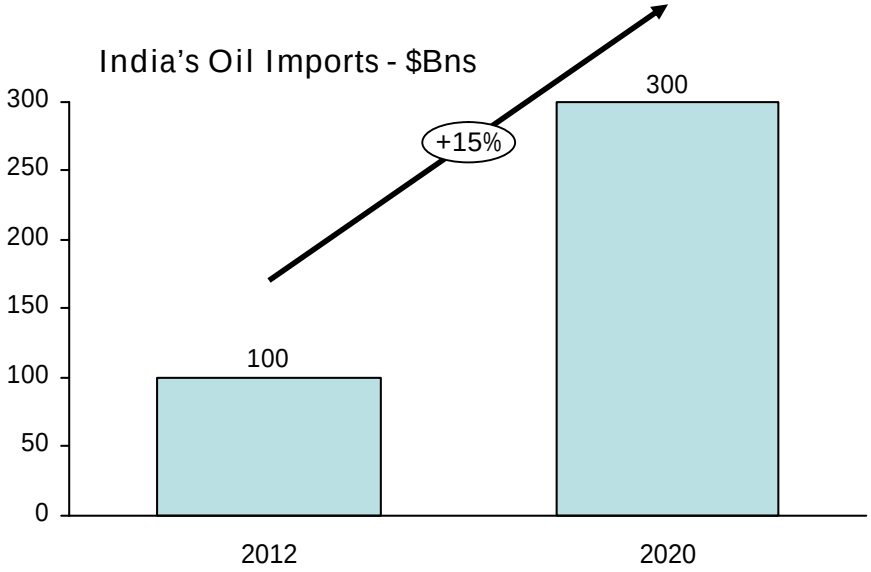
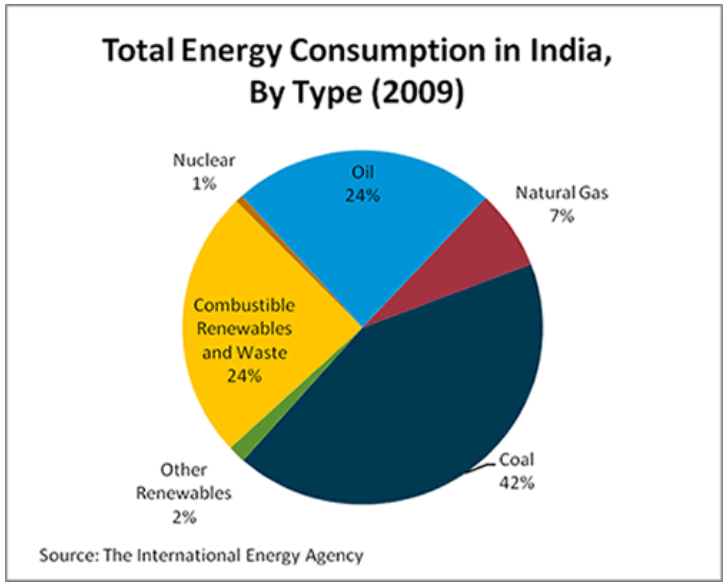
India Oil Status - Opportunity for Biofuels

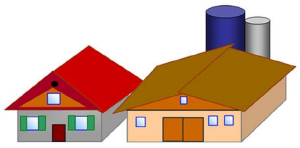




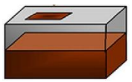
Bio Fuel Opportunities India

- India is a agrarian country with excellent climatic conditions.
- World leader in F&V, Grains & Sugarcane
- Large acreage under forest lands.
- With a dedicated policy framework, India can leapfrog to lignocellulosic fuels without having to graduate from 1st Generation.
- The country generates 600Mn tons of Agri and Forest waste – which is quite sufficient to produce 1Bn barrels of oil thereby replacing the entire oil consumption with Bio fuels.
- Key requirements for take-off this sector:
  - Independent Regulator for Bio Fuels under the emerging "Bio Energy Mission"
  - Demonstration of lignocellulosic Bio Fuels technology in partnership with Government and Private Sector
  - Lobbying for a better price for Bio Fuels (Ethanol) – indexed to crude oil

Biogas as an Energy Source from Biomass

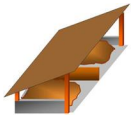


Animal farming



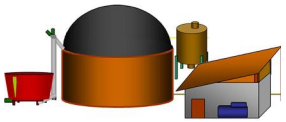
Manure

(cattle, pig, poultry)

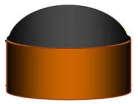


Substrate

(energy crops, organic waste stream)



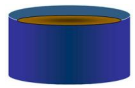
1st fermenter



2nd fermenter

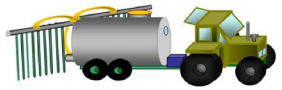
(optional)

disinfection



export

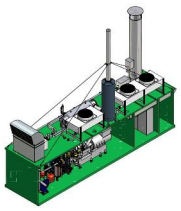
fertilizer



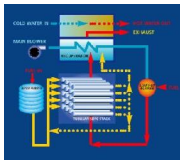
fertilization

gas treatment

(H_2S + H_2O removal)



CHP

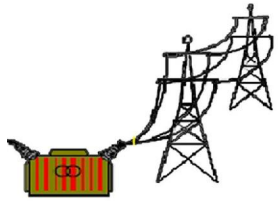


gas purification

(60% to 96% CH_4)

heat to be used

gas grid



electricity grid

Substrate stream

(bio)gas stream

Electricity

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DSM Biogas India - Partnership with the PEDA(Govt. of India) on a revenue share model

Biogas plant

- 2004 - capacity 235 mt of droppings (for 1 MW electricity)
- GHG reduction of ~ 1 mt CO_2-C eq./hr
- Winner of the best Green Power Plant in Asia Award in 2007
- In operation since 6th January 2012

Drivers for DSM

- Showcase DSM's abilities in the area
- Develop solutions for feedstock that are not currently being used to generate biogas
- Develop a relationship with the government and leverage it for future growth in the area of Bio-energy

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Bio Based Chemicals for Industrial Applications

Major applications of these bio chemicals we have sized the market for below mentioned underlying markets

Bio Chemical	Pharma	Automotive	Food Processing	Personal Care	Furniture	Textiles	Construction	Paints & Coating	Pigments	Electronics	Paper
Succinic Acid	■	■	■	■	■	■	■		■	■	
Adipic Acid		■			■	■	■				
HMDA		■				■					
Lactic Acid	■		■	■							
D-Lactic Acid			■	■							
Itaconic Acid		■			■			■		■	■
Levulinic Acid	■	■	■	■	■	■	■		■	■	
Sebacic Acid			■	■		■	■				

■ Major application industries

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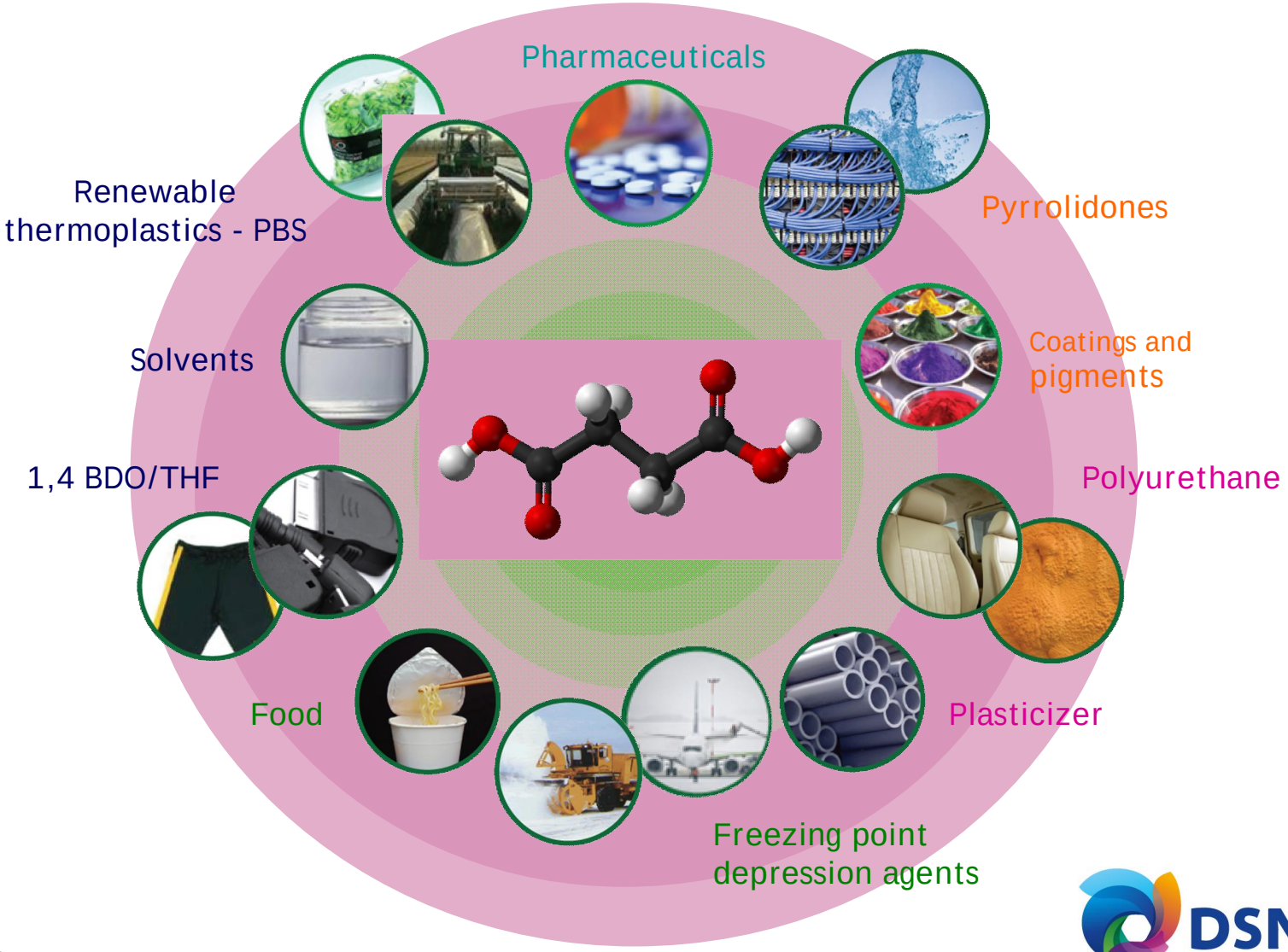
Example: Huge additional market potential bio-succinic



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Ongoing R&D and Commercial Activity in India: Biofuels and Biochemicals

Commercial And R&D Activities – BioBased Products and Chemicals India (1/3)

Players	Details
Praj Industries	• Praj has set up a demo plant for manufacturing of ethanol from bagasse • It has partnered with US bio-processing platform developer Qteros to accelerate commercialization efforts for industrial-scale cellulosic ethanol production. •Qteros is a leading developer Consolidated Bioprocessing (CBP) platform for the lowest cost production of cellulosic ethanol
Godavari Sugar Mills- NCL	• It has developed Bio refinery developed in Sameerwadi, Karnataka and will use sugarcane bagasse to produce a range of value-added products (paper, cardboard, textiles from cotton and fibre, water soluble adhesives, cement, dyes, etc) by breaking it down into cellulose, hemicellulose and lignin, with the possibility of producing ethanol in future. • The project, which being undertaken with technology licensed from NCL, hopes to be able to process about 5000 tonnes of raw material within four years
IOCL-NREL	• IOCL has partnered up with NREL for a pilot project to produce ethanol from agricultural and wood waste at its R & D centre in Faridabad, Haryana • IOCL will invest $4 million in the pilot effort and NREL will provide technical assistance with the plant

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Commercial And R&D Activities – BioBased Products and Chemicals India (2/3)

Players	Details
TIFAC - NIIST	• TIFAC under its Bioprocess & Bioproducts Programme supported National Institute of Inter disciplinary science and technology (NIIST) -Trivandrum to establish a dedicated Centre for Biofuels to carry out advanced research in ligno-cellulosic ethanol production along with the development of other bio-chemicals for improved process economics to address some of the critical technology issues in the sector • NIIST has been in the forefront of biomass derived ethanol research and has been working on cellulase enzyme production, strain improvement of cellulase producers, production of glucose tolerant beta-glycosidase and fermentation process development
DBT - ICT	• The Department of Biotechnology, Ministry of Science and Technology, Government of India has funded and established a centre of excellence as DBT-ICT Centre for Energy Biosciences • DBT – ICT claim to have come out with a technology for lignocellulosic ethanol which is expected to make production of ethanol more competitive than by any other known technology. The necessary intellectual property protection has been ensured and MoU has been signed with India Glycols Ltd, India to set up a 10 ton biomass/day plant at their Kashipur site in Uttarakhand

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Commercial And R&D Activities – BioBased Products and Chemicals India (3/3)

Players	Details
Tata Chemicals	• The bioethanol plant in Nanded, Maharashtra, with a capacity of 30KL/day, uses sweet sorghum as feedstock and sweet sorghum bagasse as fuel for generating power • For biodiesel, the company is currently focused on identifying, developing and cultivating superior varieties of jatropha as feedstock. Tata Chemicals has also recently acquired an equity stake in JOil (Singapore), a jatropha seedling company founded by Temasek Life Sciences Laboratory, that will set up tissue culture labs in India and other locations
PRAJ-Matrix - The Innovation Center	• PRAJ-Matrix - The Innovation Center (a division of Praj Industries Limited), was inaugurated on April 21, 2008. Department of Scientific and Industrial Research, Government of India has certified Praj Matrix as a recognized In-House R&D laboratory unit •Praj Matrix will enable the growth of Praj in: •BioChemicals or BioMaterials based on: Pentose Sugars, Hexose Sugars, Lignin, Oil, Glycerol, Algae
India Glycol Ltd	• First and only company in the world to have commercialized the production of ethylene oxide, its derivatives, and glycols from renewable agricultural resources • It is making bio-derived ethylene glycol for incorporation into PET
Jubilant Life Sciences	•Jubilant is a leading manufacturer of Acetyls in India. It use renewable biomass (molasses; which is a by product from sugar mills), as feedstock for manufacturing Acetyls

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Thank You


Sustainable Society
Fossil resources
It's time for renewable resources (biomass) to take over the burden
High Moon

ANNEXURES

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INDIAN POTENTIAL – AGRICULTURE RESIDUES

- 350 million MT of sugarcane, generates > 140 million MT/year of agricultural residues at field & sugar mill (cane trash, bagasse, filter cake).

  90 million MT of rice, generates > 110 million MT/year of agriculture residues at field & rice mill (rice straw, rice husk)

- Cane trash (all over India) Rice straw (in Punjab, Haryana and Western U.P.) are burnt in the fields … total quantity is of 70 to 80 million MT/year.
  This is a major source for Environmental Pollution and hence converting this to Biomass Briquettes would mitigate Environment Pollution apart from being a source for Renewable Energy.

- In addition, ground nut husk, maize stalks & corn cobs, cotton stalks, mustard waste, pulses stalks, palm fronds, etc., are surplus agri residues in field (crop residues).

- *The availability of agri residues for energy is > 120 million MT/year of crop residues + 130 million MT/year of Bagasse & Husk*

ILLUSTRATION - FUEL SHIFT
BRIQUETTES FROM RICE STRAW/ CANE TRASH
& PELLETS FROM BAMBOO/ FOREST WASTE

Rice straw

India has 43.81 million hectares in rice cultivation with annual production of > 90 million MT paddy …. near equivalent amount of rice straw.

Rice straw is animal feed in many parts of India.

In Punjab, Haryana & parts of Western UP the rice straw is burnt in fields --> 40 million MT/year

Cane trash

India has 5.06 million hectares in sugarcane cultivation with annual production of around 350 million MT.... around 10% of this quantity is cane trash.

All over India,Cane trash is burnt in the fields → 35 million MT/year

Potential for 50 million MT/ year Briquettes, for firing in Industrial Boilers, competing with landed cost of coal : Indian (Rs 3,600/MT) ; Imported ($ 100/MT)

Briquettes - Feed Stock for Industrial Boilers

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BAMBOO

- India has 8.96 million hectares (out of 70 million hectares forest area) under Bamboo cultivation with growing stock of 80.43 million MT.

- **Fast growing & non flowering species of bamboo, gives potential for**
  - **# very significant enhancement in bamboo growing stock**
  - **# bamboo to be adopted for energy plantations**
- **<u>50 million MT/year of Bamboo for energy</u> could be achieved through**
  - **# expanding area under bamboo to 10 million hectares**
  - **# shifting to high yield/non flowering bamboo species.**
- **Bamboo pellets can be an effective cooking fuel in rural households**

Pellets could be retailed in 15 kg bags @ Rs 1,000, which would be less than actual cost (including subsidy component) of displaced kerosene

Pellets – cooking fuel for rural households

Chullah
(> 10% efficiency)

Kerosene Stove

Pellets + Smokeless Stove
(> 40% efficiency)

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